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Indices on Extreme Climate Events
An application on Italian Regional Municipalities by Istat

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Istat

Background on Climate Statistics

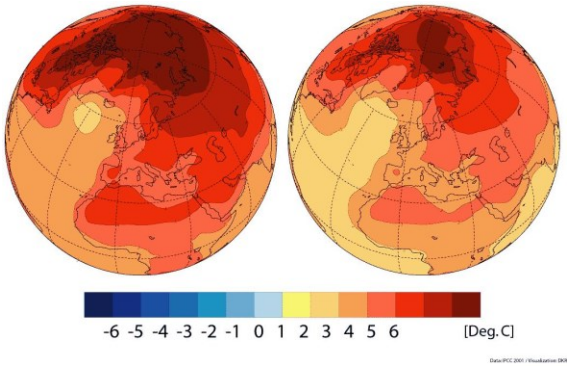
- increasing interest on **Climate Change (CC)** has led a growing demand of **Official Statistics** at international, national and local level

- multidisciplinary integrated approaches are required for improving analysis on global phenomena connected to CC:

  Climate Change & Related Statistics

  Extreme Events and Disasters

  Sustainable Development



- all statistical domains are involved-interconnected:

  social ⟷ **environmental** ⟷ **economic**

- NSOs are called to enhance their role to provide high quality statistical information reliable, consistent, timely, comparable, accessible

Role of NSOs to improve CC and Related Statistics

- **official statistics already available** but produced in many cases with different purposes
  - make existing statistics useful for CC analysis and produce '*new statistics*'

- **data provided by different producers**
  - needs of coordination, standardization, cooperation at national and international level among agencies, public institutions, research centers

Key concepts:
- meet users information needs
- reliable statistics
- methodologically sound
- several data providers; several sources
- cooperation, coordination
- standardization of terminology, definitions, methodologies
- integrated multidimensional interdisciplinary approach
- international comparable indicators

International Initiative and Framework

Main Tools

FDES

UNSD

Figure 2.3: The components of the FDES

SEEA

Agreements and Policy

United Nations Framework Convention on Climate Change

COP21

COP22

COP21 · CMP11 PARIS 2015 UN CLIMATE CHANGE CONFERENCE

MARRAKECH COP22 | CMP12 UN CLIMATE CHANGE CONFERENCE 2016

Demand

SDG

SDG: 17 goals 169 targets, 232 indicators

MEED

CCRS

CCRS: 5 Areas-Sectors, 39 Indicators

SENDAI

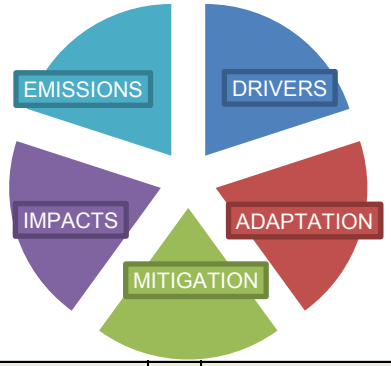
UN World Conference on Disaster Risk Reduction
2015 Sendai Japan

OEIWG on Indicators & Terminology relating to DRR

UNISDR Terminology&DRR

OEIWG: 7 Targets, 38 Indicators

UN-ECE Task Force on CCRS



- **CCRS Climate Change Related Statistics**

objectives:

- provide guidelines, definitions, standardization
- enhance and clarify role of NSOs
- define internationally comparable sets of key statistics

Area	Sub-area	No.	Indicator	Tier	SDG indicator Sendai Framework indicator
Impacts	Physical Conditions	16	Annual average surface temperature ←	I	
		17	Percentage of land area suffering from unusual wet or dry conditions (Standard Precipitation Index) ←	I	
	Water resources	18	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources ←	I	6.4.2 (tier 1)
	Land, Land Cover, Ecosystems and	19	Cumulative number of alien species	III	
		20	Carbon stock in soil	III	
		21	Proportion of land that is degraded over total land area	III	
	Extreme Events and Disasters	22	Number of deaths and missing persons attributed to hydro-meteorological disasters, per 100,000 population ←	III	1.5.1 (tier 2), 11.5.1 (tier 2) and 13.1.2 (tier 2) Sendai Framework indicator A-1
		23	Occurrence of extreme weather events ←	II	
		24	Direct economic loss attributed to hydro-meteorological disasters in relation to GDP ←	III	11.5.2 (tier 2) Sendai Framework indicator C-1
		25	Number of people whose destroyed dwellings were attributed to hydro-meteorological disasters ←	III	Sendai Framework indicator B-4
	Human settlements and human health	26	Distribution of cases of vector-borne diseases	I	
		27	Heat-related mortality ←	II	
	Agriculture, forestry and fishery	28	Direct agricultural loss attributed to hydro-meteorological disasters ←	III	

Istat survey on Meteo-climatic and hydrological data (PSN IST 02190)

database on meteo-climatic and hydrological data collected by institutions and agencies managing national networks of georeferenced gauging stations (1971-2014)

Aim of the work

- provide tools to analyze meteo-climatic conditions in Regional municipality

Variables

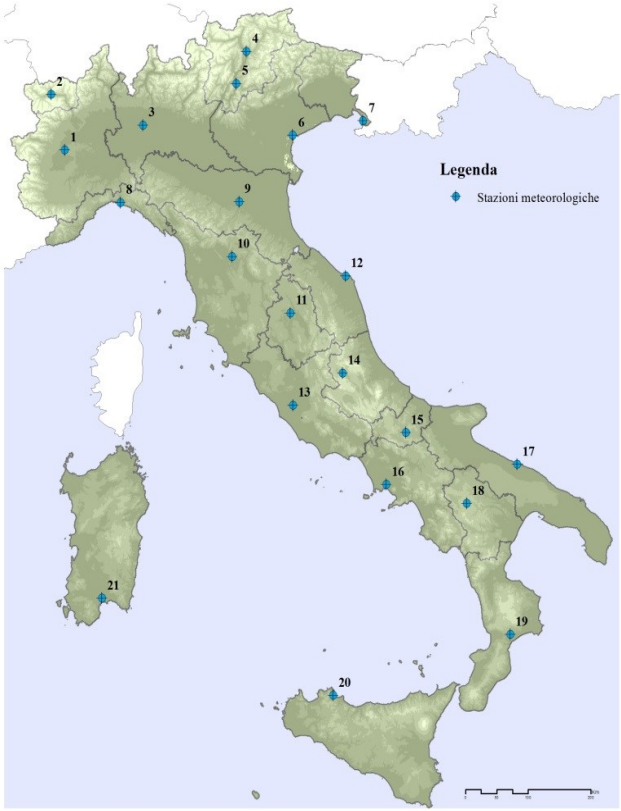
- daily data on *precipitation* and *temperature*

Sources

- measuring stations located within the municipal territory

Period

- years from 1971 to 2014
- Climatic Normal (CLINO) 1971-2000
- 2001-2014 period observed with respect to CLINO value
- coverage degree analysis



Results

- ***ETCCDI Indices on Extreme Climate Events on 21 Regional Italian Municipality (IECE-RIM)***

  allow to assess the climatic variability and the persistence of hot and cold conditions (refferring to each station) both in absolute terms and on the CLINO value

Indices on Extreme Climate Events by ETCCDI

- **International methodological framework**

World Climate Research Program (WCRP)

International Council for Science (ICSU)
World Meteorological Organization (WMO)
Intergovernmental Oceanographic Commission UNESCO

Expert Team on Climate Change Detection and Indices (ETCCDI)

- provides international coordination/collaboration on CC detection, Indices relevant to CC detection, specific methodologies
- encourages modelled data and observations comparison at different spatial scale
- http://etccdi.pacificclimate.org/list_27_indices.shtml

- **Istat provides ETCCDI for 21 Italian Regional Municipality**
  - 7 Indices based on precipitations
  - 9 Indices based on temperatures
  - period analyzed 2001-2014 compared to the Climatic Normal 1971-2000

Indices on Extreme Climate Events on Italian Regional Municipality

ETCCDI Temperature indices

- **Summer days** SU25: annual count of days when daily max temp TX > 25°C
- **Tropical nights** TR20: annual count of days when daily min temp TN > 20°C
- **Warm days** TX90p: % of days when TX > 90th percentile
- **Warm nights** TN90p: % of days when TN > 90th percentile
- **Warm speel duration** index WSDI: annual count of days with at least 6 consecutive days when TX > 90th percentile
- **Frost days** FD0: annual count of days when daily min temp TN < 0°C
- **Cool days** TX10p: % of days when TX < 10th percentile
- **Cool nights** TN10p: % of days when TN < 10th percentile
- **Cold speel duration** index CSDI: annual count of days with at least 6 consecutive days when TN < 10th percentile

ETCCDI Precipitation indices

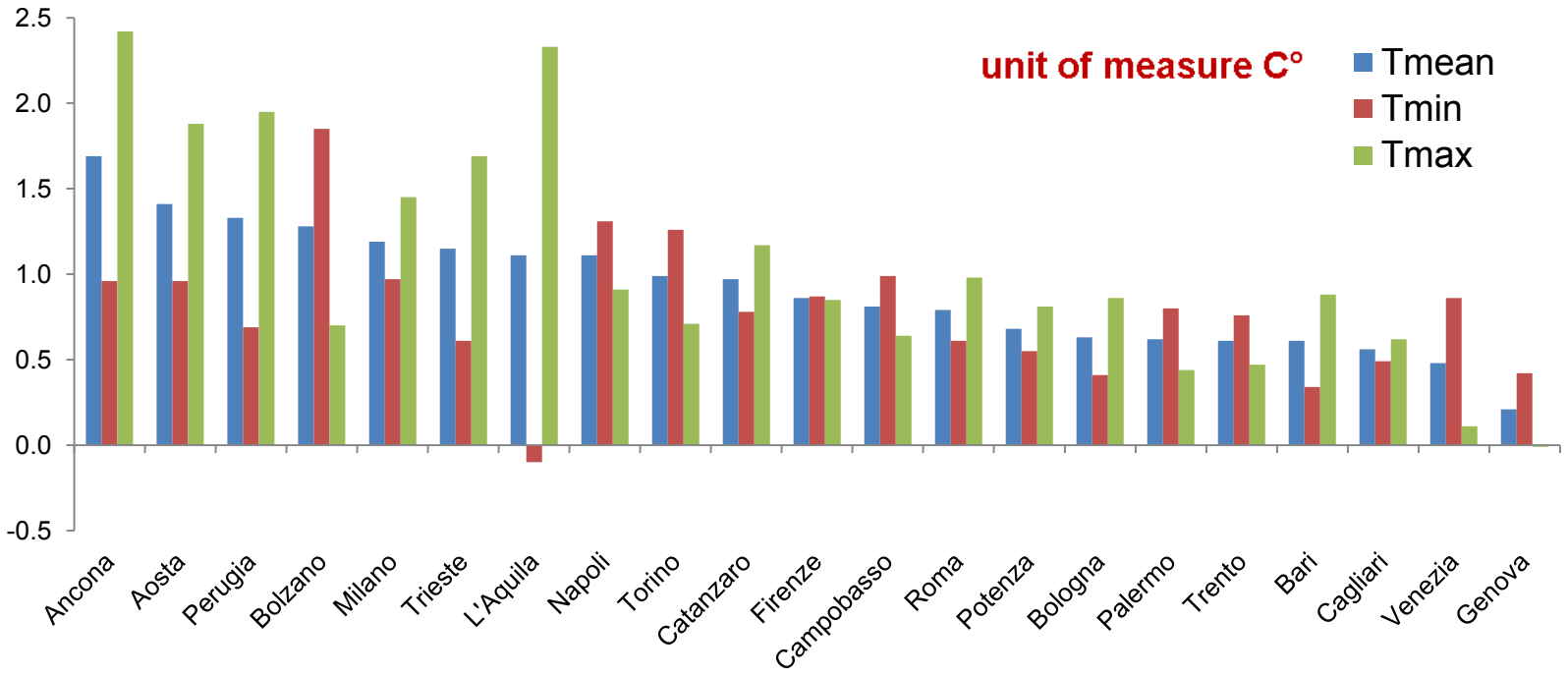
- **Rainy days** R1: annual count of days when PRCP≥ 1mm
- **Very intense precipitation days** R20: annual count of days when PRCP≥ 20mm.
- **Extremely intense precipitation days** R50: annual count of days when PRCP≥ 50mm
- **Consecutive days with rain** CWD: max length of wet spell, max number consecutive days with RR ≥ 1mm
- **Consecutive days without rain** CDD: max length of dry spell, max number consecutive days with RR < 1mm
- **Precipitation on very rainy days** R95p: annual total PRCP when RR > 95p
- **Precipitation on extremely rainy days** R99p: annual total PRCP when RR > 99p
- **Annual total precipitation in wet days** PRCPTOT

Meteo-climatic guaging stations and variables

COD	STATIONS	Sea level quota (m)	Mean temperature 1971-2000	Mean temperature 2001-2014	Difference from the climatic value	Mean total precipitation 1971-2000	Mean total precipitation 2001-2014	Difference from the climatic value
1	Torino (Bric Della Croce)	710	11,3	12,3	1,0	775,7	809,9	34,2
2	Aosta (Saint Christophe)	545	10,6	12,0	1,4	565,8	513,5	-52,3
3	Milano (Linate)	107	13,1	14,3	1,2	838,9	608,0	-230,9
4	Bolzano/Bozen	254	11,9	13,2	1,3	692,1	718,0	26,0
5	Trento (Laste)	312	12,3	12,9	0,6	901,5	989,1	87,6
6	Venezia (Istituto Cavanis)	20	14,2	14,7	0,5	808,4	847,1	38,7
7	Trieste	2	14,6	15,8	1,2	1002,5	902,0	-100,5
8	Genova (Università)	21	16,0	16,3	0,2	1337,5	1069,8	-267,7
9	Bologna (Borgo Panigale)	37	13,5	14,1	0,6	599,5	590,5	-8,9
10	Firenze (Peretola)	37	14,9	15,8	0,9	859,5	788,4	-71,2
11	Perugia (Santa Giuliana)	417	13,5	14,8	1,3	832,1	878,5	46,4
12	Ancona (Torrette)	6	15,5	17,2	1,7	675,4	704,7	29,3
13	Roma (Osservatorio Collegio Romano)	49	16,3	17,1	0,8	662,3	702,8	40,5
14	L'Aquila	595	11,6	12,7	1,1	676,7	638,9	-37,8
15	Campobasso	793	12,2	13,0	0,8	551,8	652,8	101,1
16	Napoli (Capodichino)	72	15,8	16,9	1,1	924,1	871,4	-52,7
17	Bari (Palese)	44	15,9	16,5	0,6	512,8	484,7	-28,0
18	Potenza	811	12,7	13,4	0,7	677,2	743,8	66,5
19	Catanzaro	334	16,0	17,0	1,0	953,6	1073,6	120,0
20	Palermo (Osservatorio Astronomico)	37	18,5	19,1	0,6	469,7	614,0	144,3
21	Cagliari (Elmas)	5	16,7	17,3	0,6	418,0	355,6	-62,4

Temperature

Difference of 2001-2014 annual average temperature on the CLINO 1971-2000 value, by municipality



2001-2014 annual average temperature = **15,1°C** (**+ 0,9°C** on the CLINO value)

2014 annual average temperature **15,7°C** is the highest value since 1971

2001-2014 annual average temperature increases in all Regional municipalities on CLINO

Genova smallest Tmean increase + 0,2°C
Palermo highest Tmean increase +1,7°C

Indices on Extreme Climate Events on temperature (number of days) 1/2

STATIONS		Summer days	Tropical nights	Warm days	Warm nights	Warm speel duration index	Frost days	Cool days	Cool nights	Cold speel duration index
Torino	1971-2000	35	7	34	33	9	41	34	33	11
	2001-2014	45	15	42	71	15	34	26	21	12
Aosta	1971-2000	73	..	34	34	9	106	34	34	11
	2001-2014	104	1	85	60	29	97	19	19	8
Milano	1971-2000	95	13	32	32	11	49	33	33	10
	2001-2014	113	29	76	70	24	49	17	19	7
Bolzano/Bozen	1971-2000	96	1	27	25	10	95	28	26	8
	2001-2014	110	9	39	79	11	76	27	11	7
Trento	1971-2000	85	7	27	27	9	64	29	27	9
	2001-2014	91	10	52	53	17	52	25	15	11
Venezia	1971-2000	77	43	34	33	9	19	34	34	10
	2001-2014	79	59	46	69	19	13	35	18	9
Trieste	1971-2000	79	43	34	34	9	8	35	34	9
	2001-2014	99	54	100	62	41	9	21	31	11
Genova	1971-2000	74	61	35	34	6	2	35	35	12
	2001-2014	68	70	39	59	13	2	37	33	10
Bologna	1971-2000	99	18	31	31	11	42	31	31	14
	2001-2014	106	25	59	45	22	45	24	24	10
Firenze	1971-2000	116	11	32	32	10	33	33	33	9
	2001-2014	125	19	55	50	20	28	26	19	12
Perugia	1971-2000	78	14	34	34	10	18	35	34	9
	2001-2014	109	23	98	69	43	20	19	27	10
Ancona	1971-2000	94	43	33	32	12	4	33	33	12
	2001-2014	131	65	101	63	41	5	15	28	15

*Fonte: Istat, Rilevazione d*ati meteo-climatici ed idrologici

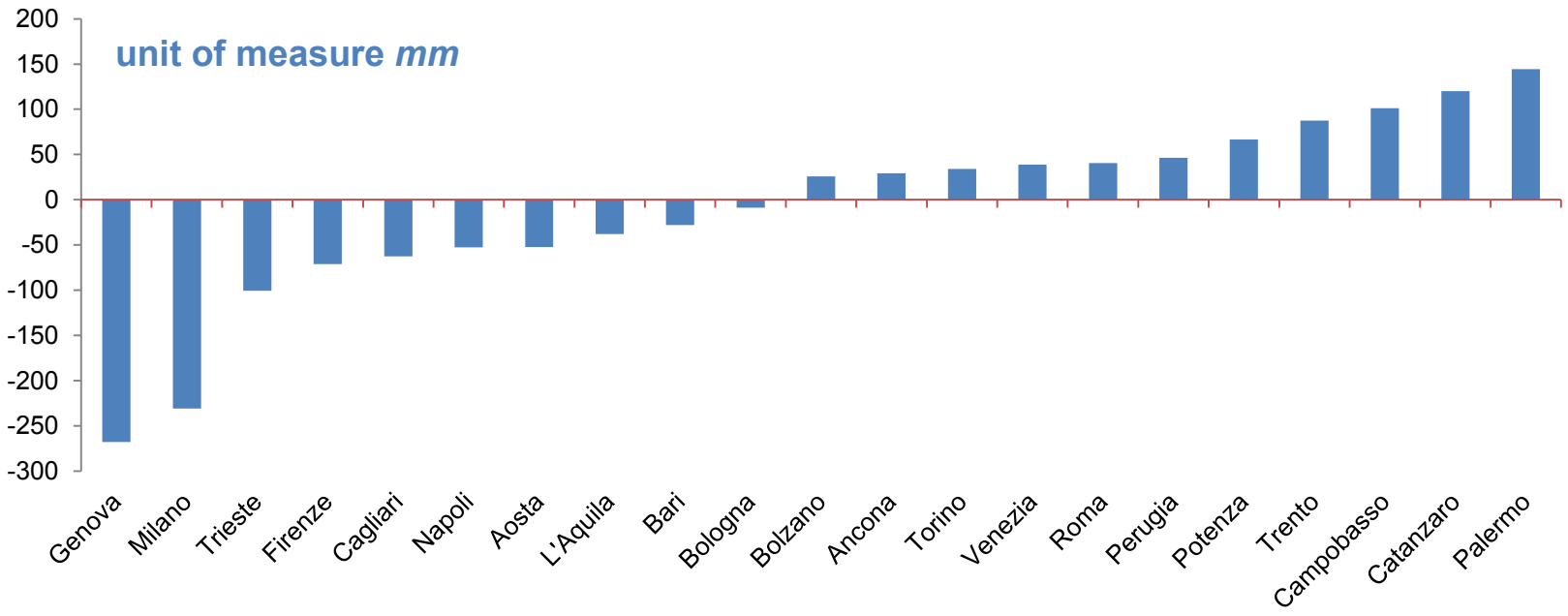
Indices on Extreme Climate Events on temperature (number of days) 2/2

STATIONS		Summer days	Tropical nights	Warm days	Warm nights	Warm speel duration index	Frost days	Cool days	Cool nights	Cold speel duration index
Roma	1971-2000	115	47	34	34	12	3	34	34	15
	2001-2014	126	63	79	58	28	4	24	26	9
L'Aquila	1971-2000	86	1	33	32	10	63	32	32	11
	2001-2014	111	1	72	40	23	73	10	53	10
Campobasso	1971-2000	57	12	33	32	10	31	34	33	10
	2001-2014	67	25	51	60	21	23	25	21	10
Napoli	1971-2000	104	19	30	29	10	6	31	31	11
	2001-2014	119	47	53	73	15	6	21	16	8
Bari	1971-2000	100	25	32	32	9	2	31	31	11
	2001-2014	109	33	44	34	9	4	29	35	9
Potenza	1971-2000	78	5	34	34	9	28	35	34	10
	2001-2014	86	8	57	57	19	28	27	27	7
Catanzaro	1971-2000	86	50	32	31	13	2	31	31	12
	2001-2014	107	70	56	55	12	1	17	26	6
Palermo	1971-2000	131	73	35	35	8	..	35	34	11
	2001-2014	140	94	47	50	17	-	29	16	7
Cagliari	1971-2000	120	28	32	33	7	3	33	33	8
	2001-2014	127	42	61	49	21	2	18	19	-

*Fonte: Istat, Rilevazione d*ati meteo-climatici ed idrologici

Precipitation

Difference of 2001-2014 annual average precipitation on the CLINO 1971-2000 value, by municipality



2001-2014 annual average precipitation = **740,8 mm (-1,1%)**

2010 is the most rainy year . Precipitation has a high spatial-temporal variability

Genova highest decrease (-267,7 mm)
Palermo highest increase (+144,3 mm)

Indices on Extreme Climate Events on precipitation (number of days, mm) 1/2

STATIONS		Rainy days	Very intense precipitation days	Extremely intense precipitation days	Consecutive days with rain	Consecutive days without rain	Precipitation on very rainy days	Precipitation on extremely rainy days
Torino	1971-2000	74	11	1	6	27	178,0	100,5
	2001-2014	75	13	2	6	25	223,7	91,7
Aosta	1971-2000	72	6	1	5	24	152,5	96,9
	2001-2014	73	5	1	5	25	102,0	89,7
Milano	1971-2000	77	12	2	6	23	201,9	120,3
	2001-2014	65	9	1	5	25	105,7	101,8
Bolzano/Bozen	1971-2000	78	8	..	6	26	163,8	78,0
	2001-2014	78	9	1	6	27	161,1	90,5
Trento	1971-2000	113	9	1	9	26	199,7	98,2
	2001-2014	115	12	..	9	23	258,4	87,9
Venezia	1971-2000	79	11	1	6	24	188,1	101,6
	2001-2014	79	11	2	5	23	237,6	131,1
Trieste	1971-2000	92	15	1	7	23	231,8	143,8
	2001-2014	91	12	1	6	25	170,9	111,9
Genova	1971-2000	80	20	6	6	26	398,9	251,2
	2001-2014	78	17	3	6	27	198,5	182,7
Bologna	1971-2000	68	7	1	5	23	153,4	90,2
	2001-2014	69	7	..	5	27	112,5	92,0
Firenze	1971-2000	85	11	1	6	24	204,6	147,7
	2001-2014	84	9	..	6	24	151,9	54,7
Perugia	1971-2000	85	11	1	6	24	186,5	101,3
	2001-2014	89	11	2	6	24	217,1	136,9
Ancona	1971-2000	79	8	1	5	24	167,0	96,3
	2001-2014	82	9	1	7	24	157,5	87,6

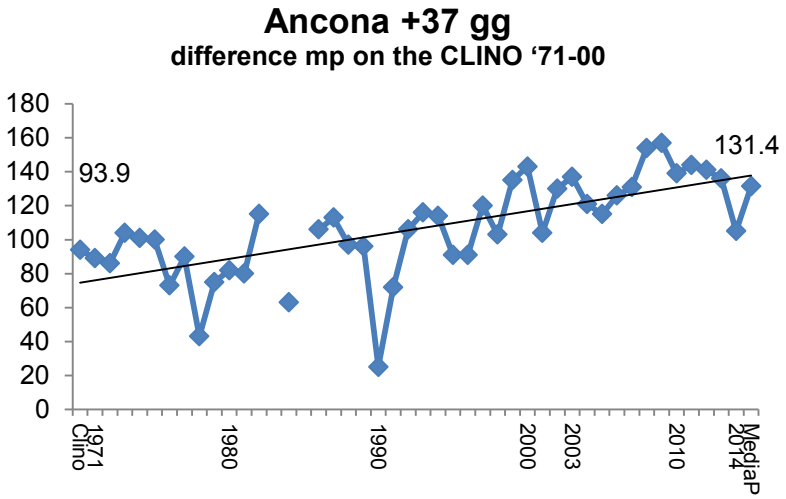
*Fonte: Istat, Rilevazione d*ati meteo-climatici ed idrologici

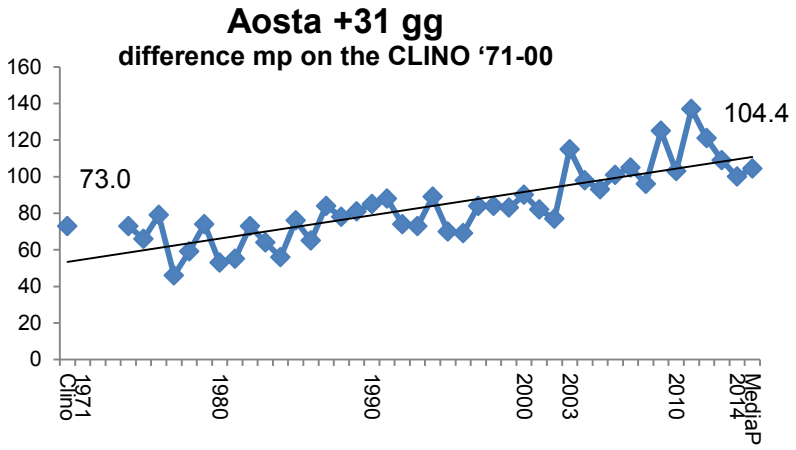
Indices on Extreme Climate Events on precipitation (number of days, mm) 2/2

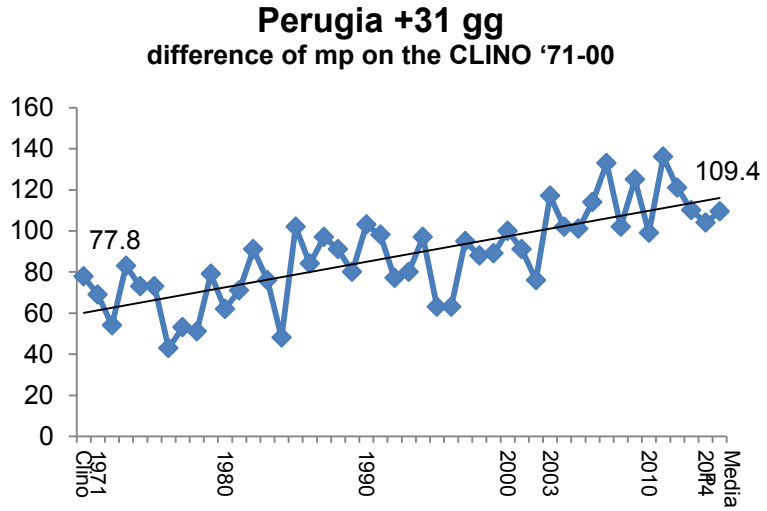
STATIONS		Rainy days	Very intense precipitation days	Extremely intense precipitation days	Consecutive days with rain	Consecutive days without rain	Precipitation on very rainy days	Precipitation on extremely rainy days
Roma	1971-2000	73	8	1	6	28	162,8	100,7
	2001-2014	77	7	1	6	27	157,2	109,5
L'Aquila	1971-2000	88	6	..	6	23	141,9	63,4
	2001-2014	88	5	..	5	22	114,9	82,9
Campobasso	1971-2000	81	5	..	5	24	125,8	78,5
	2001-2014	86	7	..	6	23	175,7	92,9
Napoli	1971-2000	79	14	2	6	26	242,7	155,6
	2001-2014	78	14	2	7	27	215,1	84,3
Bari	1971-2000	61	6	1	5	25	150,8	152,4
	2001-2014	63	5	1	5	27	147,6	134,5
Potenza	1971-2000	89	6	..	6	25	142,9	68,6
	2001-2014	96	7	..	7	23	151,1	86,5
Catanzaro	1971-2000	86	13	2	7	28	259,8	234,5
	2001-2014	93	16	2	7	27	302,2	128,9
Palermo	1971-2000	66	4	1	5	30	121,0	77,2
	2001-2014	74	6	..	7	31	167,2	101,6
Cagliari	1971-2000	61	3	1	5	30	123,2	126,4
	2001-2014	57	3	..	5	30	100,8	53,0

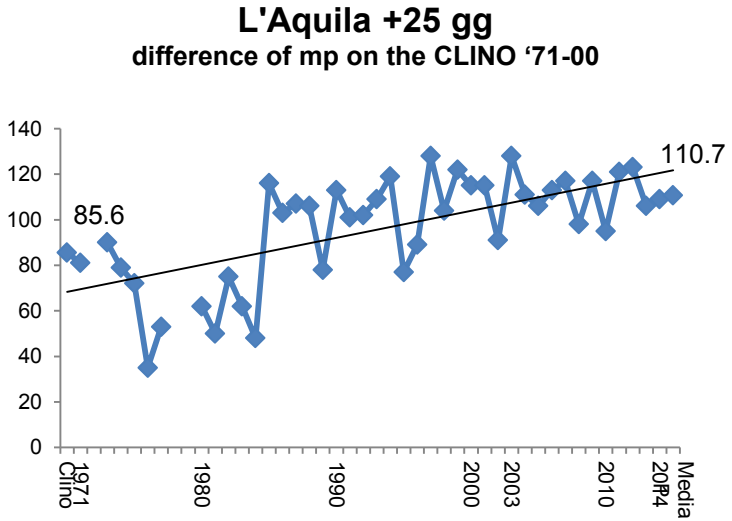
*Fonte: Istat, Rilevazione d*ati meteo-climatici ed idrologici

some insights on temperature: Summer days (1/2)



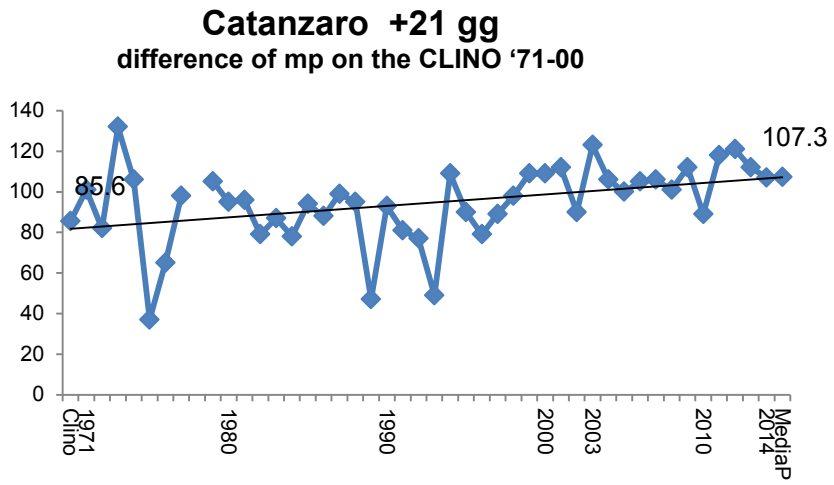


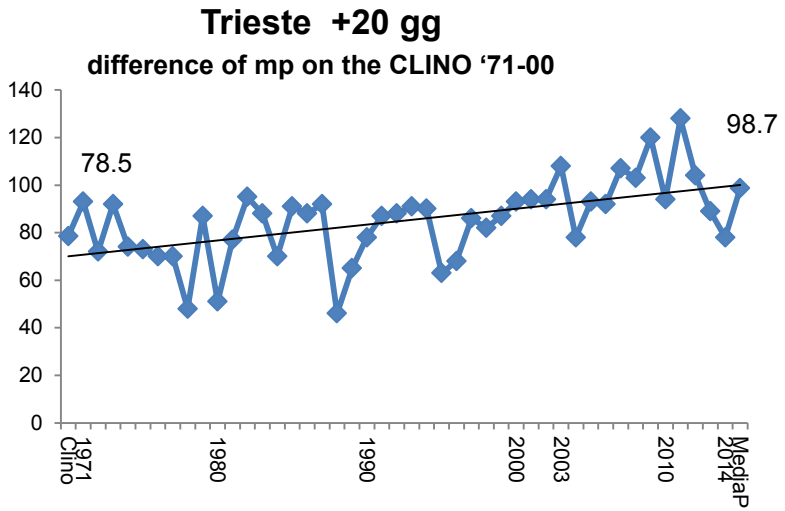


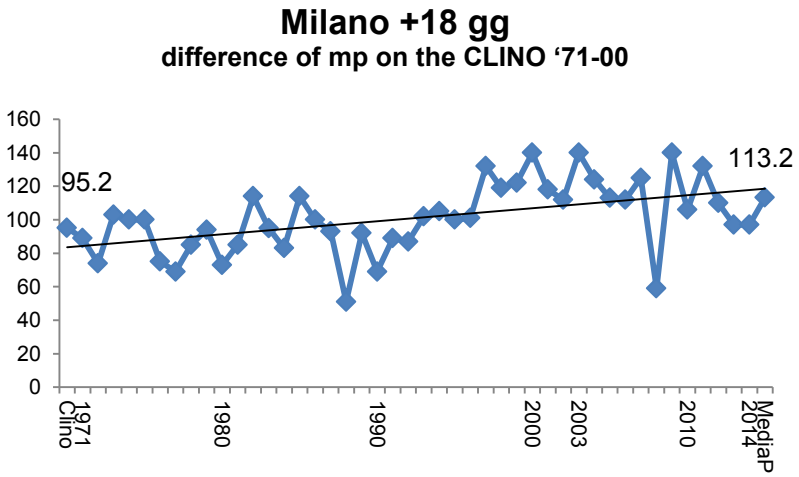


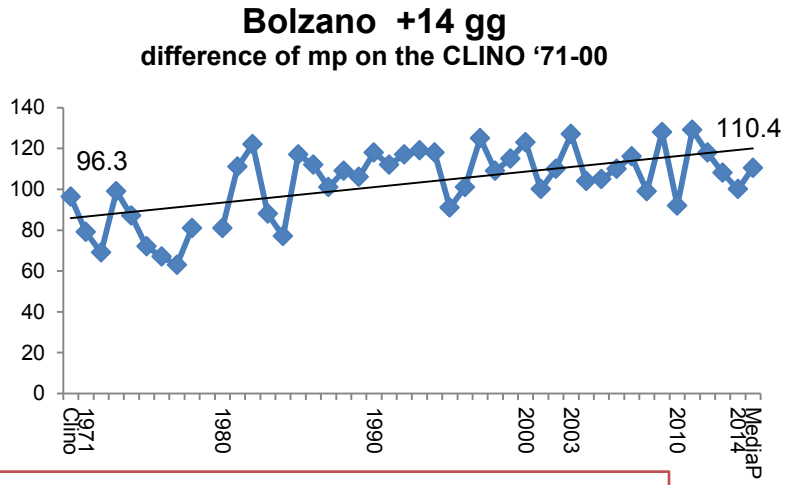
Legenda x: CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014
y: average number of days

some insights on temperature: Summer days (2/2)





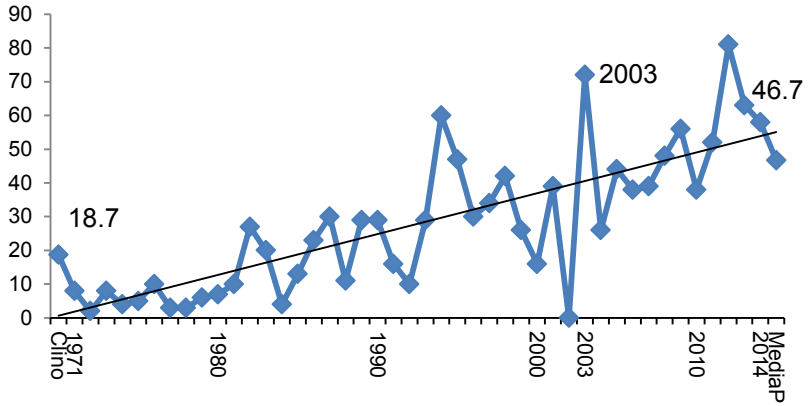




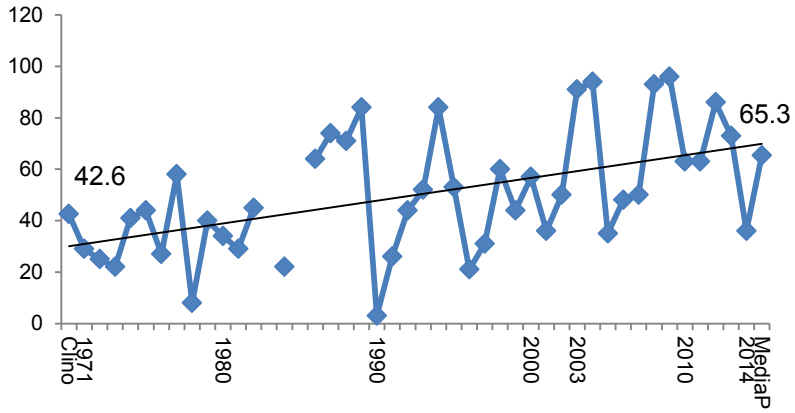
Legenda x: CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014
y: average number of days

some insights on temperature: Tropical nights (1/2)

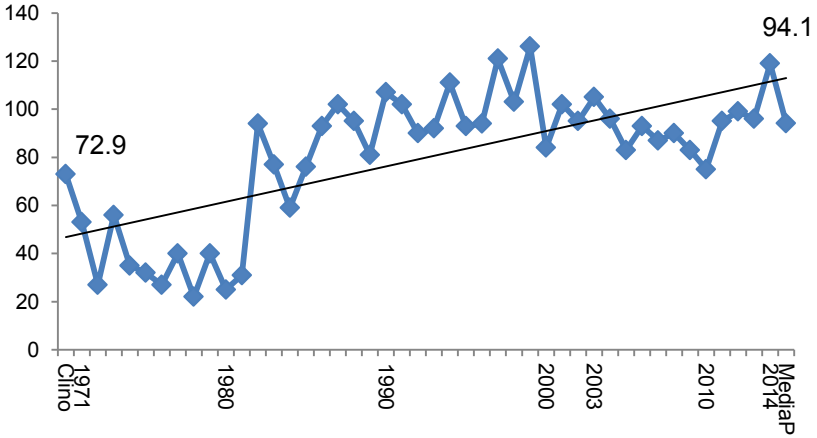
Napoli +28 gg
difference of mp on the CLINO '71-00



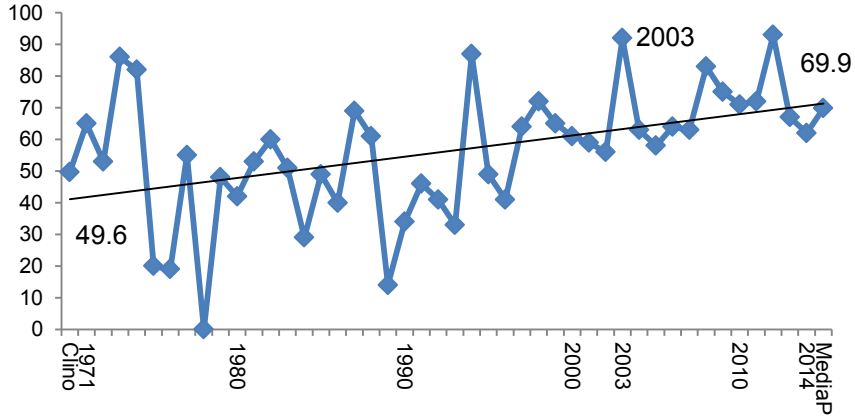
Ancona +22,7 gg
difference of mp on the CLINO '71-00



Palermo +21,1 gg
difference of mp on the CLINO '71-00



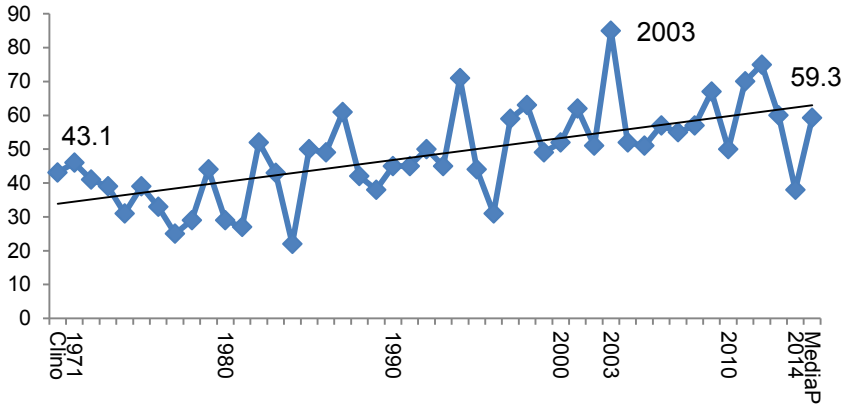
Catanzaro +20,2 gg
difference of mp on the CLINO '71-00



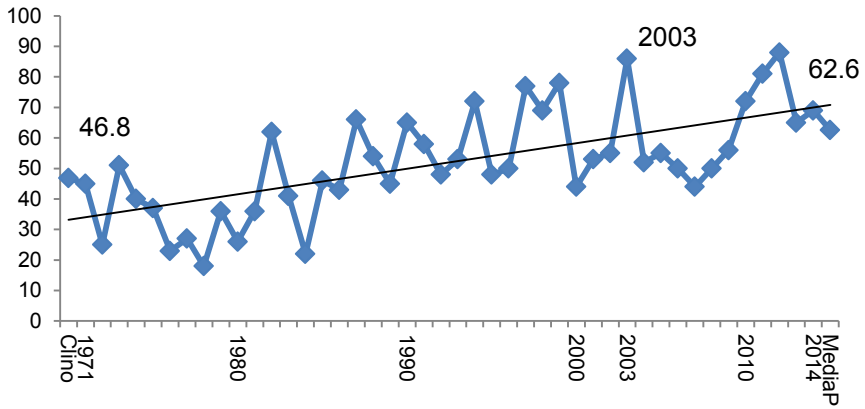
Legenda x: CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014
y: average number of days

some insights on temperature: Tropical nights (2/2)

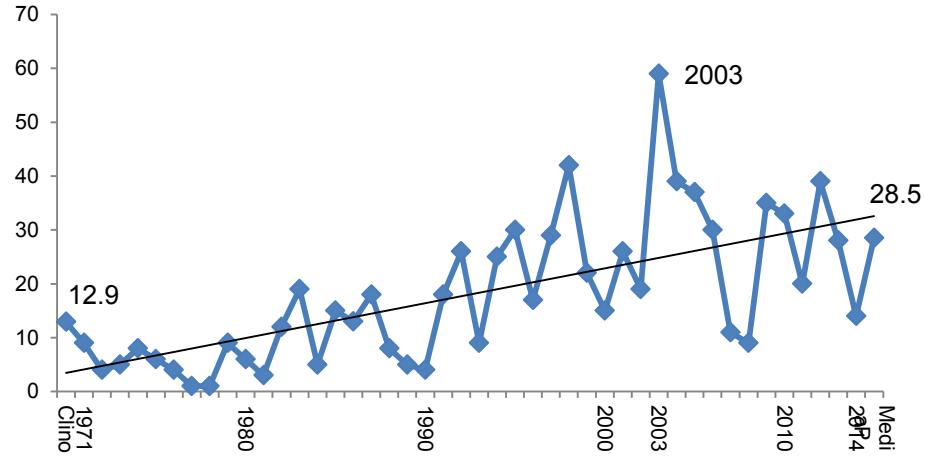
Venezia +16,2 gg
difference of mp on the CLINO '71-00



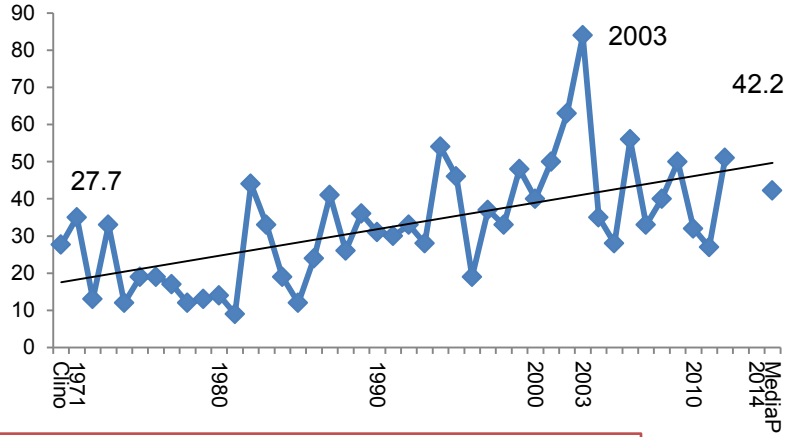
Roma +15,7 gg
difference of mp on the CLINO '71-00



Milano +15,6 gg
difference of mp on the CLINO '71-00



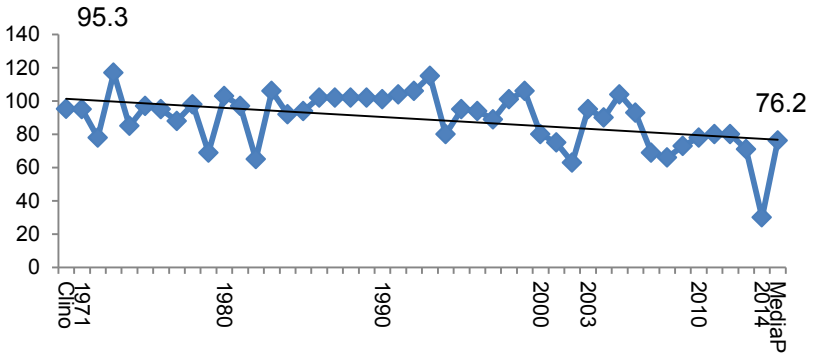
Cagliari +14,6 gg
difference of mp on the CLINO '71-00



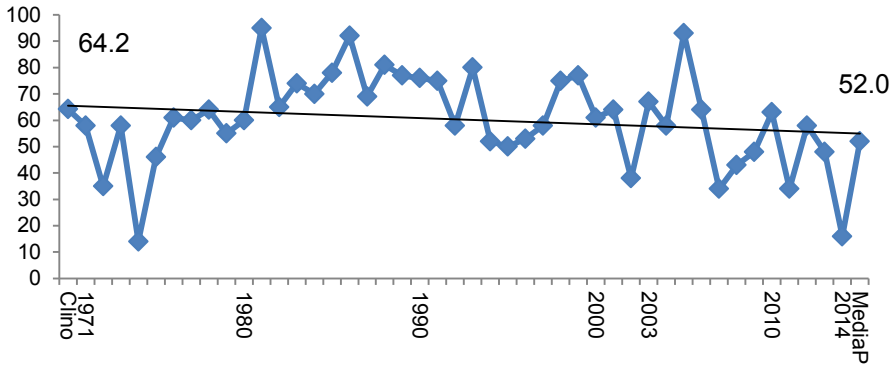
Legenda x: CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014
y: average number of days

some insights on temperature: Frost days

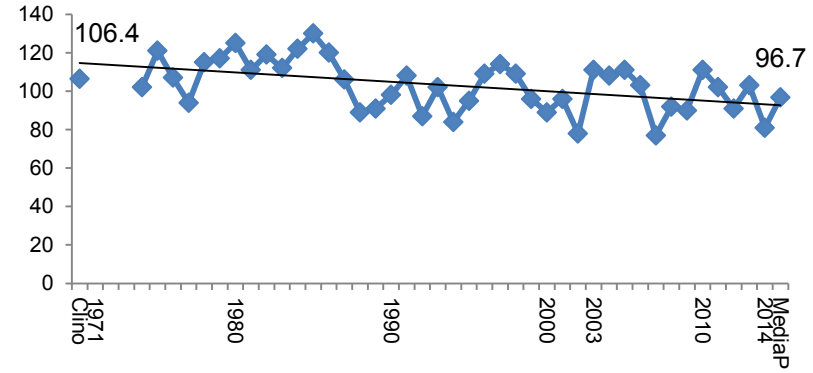
Bolzano - 19,1 gg
difference of mp on the CLINO '71-00



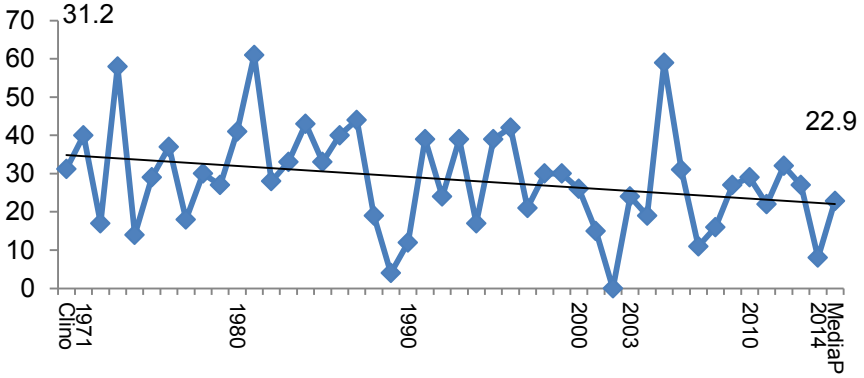
Trento - 12,2 gg
difference of mp on the CLINO '71-00



Aosta - 9,7 gg
difference of mp on the CLINO '71-00



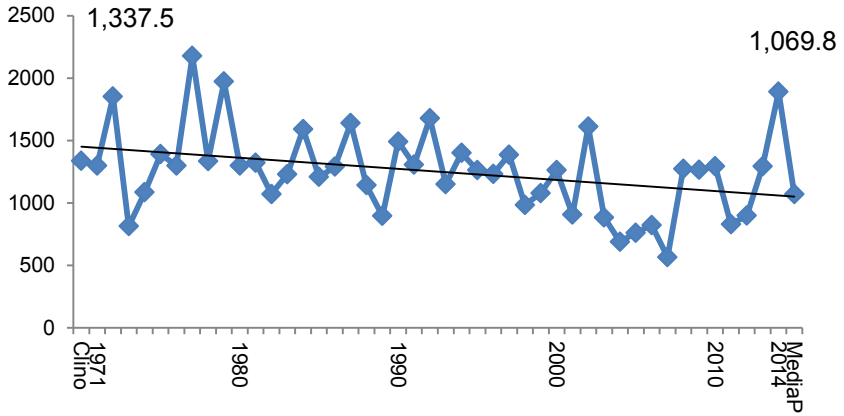
Campobasso - 8,3 gg
difference of mp on the CLINO '71-00



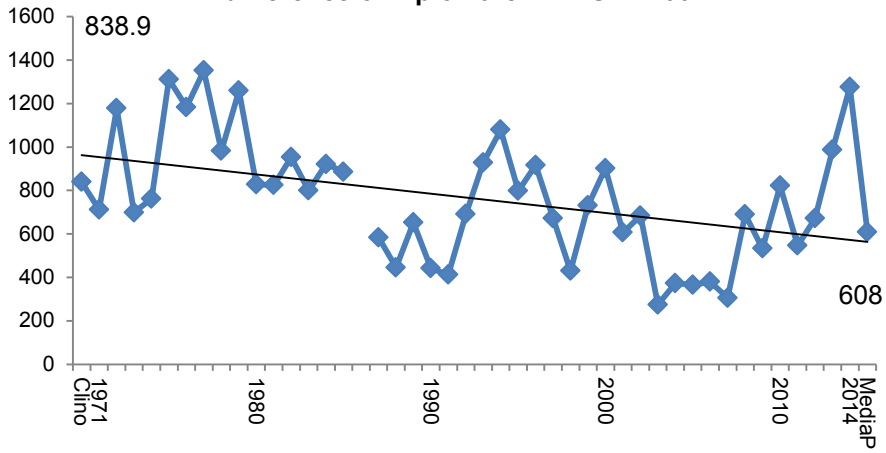
Legenda x: CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014
y: average number of days

some insights on total annual precipitation

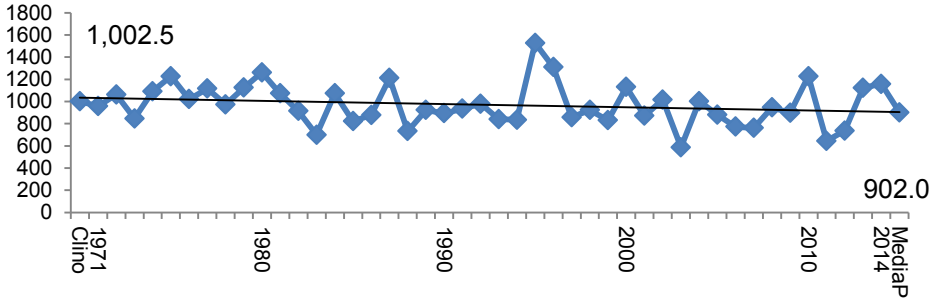
Genova (-268 mm)
difference of mp on the CLINO '71-00



Milano (-231 mm)
difference of mp on the CLINO '71-00



Trieste (-100 mm)
difference of mp on the CLINO '71-00



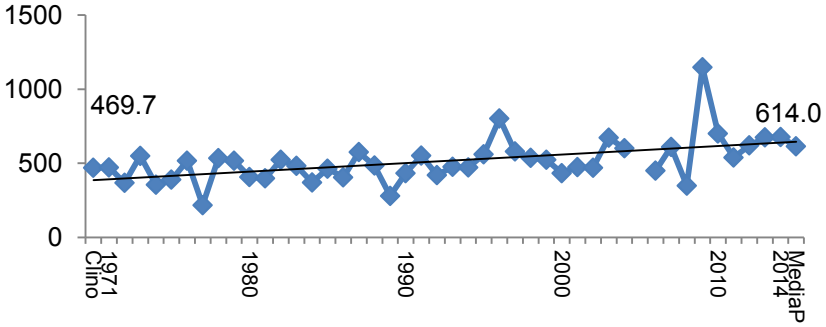
Legenda

x: **CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014**

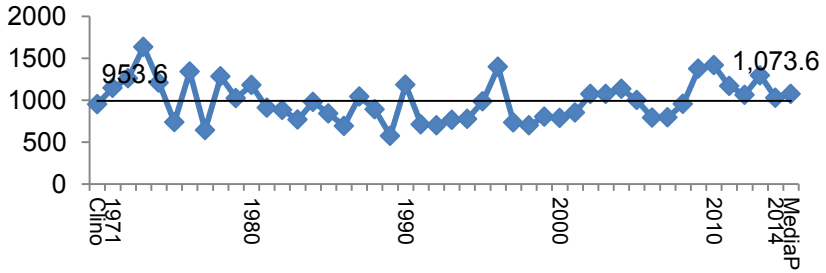
y: **mm**

some insights on total annual precipitation

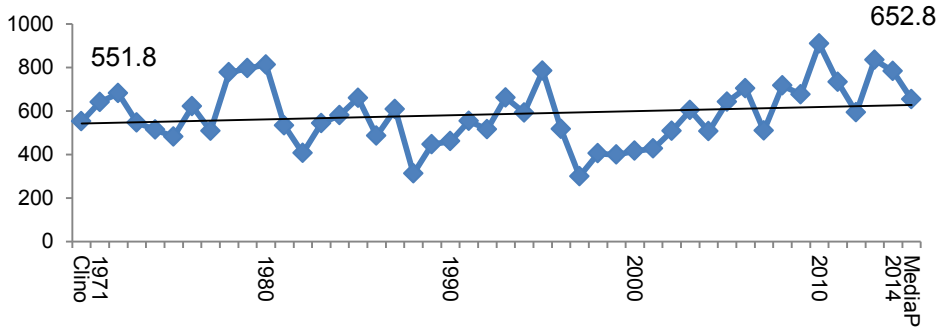
Palermo (+144,3 mm)
difference of mp on the CLINO '71-00



Catanzaro (+120 mm)
difference of mp on the CLINO '71-00



Campobasso (+101 mm)
difference of mp on the CLINO '71-00

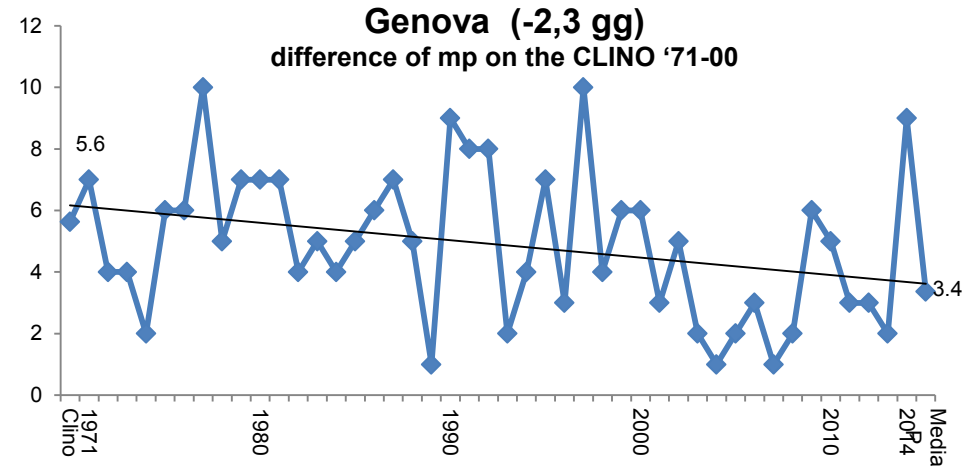


Legenda

x: **CLINO 1971-2000; each year from 1971 to 2014; Media P (mean period) 2001-2014**

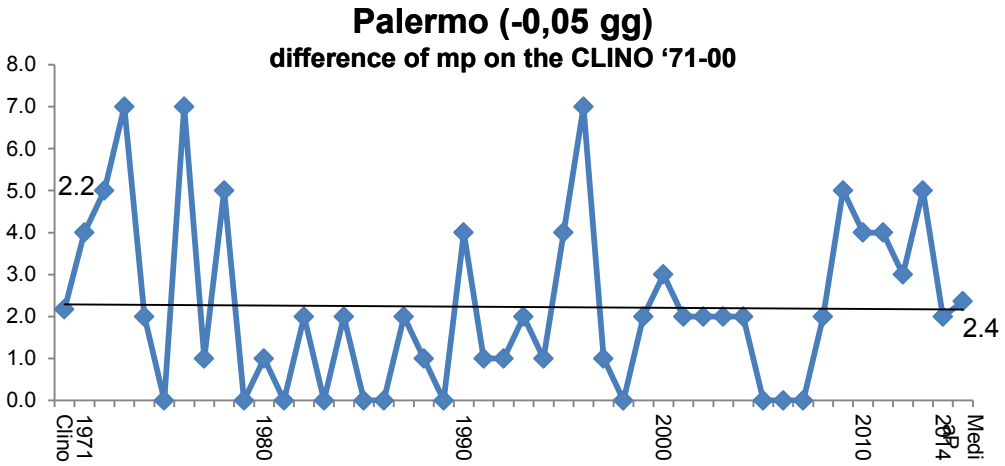
y: **mm**

some insights on IECE-RIM temperature: very intensive precipitation >50 mm



Genova
2001-2014 annual average precipitation

-268 mm on the CLINO



Palermo
2001-2014 annual average precipitation

+ 144,3 mm on the CLINO

Legenda

x: **CLINO 1971-2000; year from 1971 to 2014; Media P (mean period) 2001-2014**

y: **number of days**

Conclusions and further work

- **CC affects many dimensions** and its effects occur over different temporal and spatial scales
- **official statistics coherent with international guidelines** solid basis for CC related phenomena analysis
- **recommended indicators combining different thematic issues implies a widening of data availability** on climate, environment, population, health, economy, cities, agriculture, land, biodiversity
- **how to evolve meteo-climatic statistics to be closer to new information needs?**
- **methodological improvements in surveys** for making existing statistics useful for CC analysis and producing '*new statistics*'
- **statistics with a higher temporal-spatial detail** and timeliness are needed
- **In Italy many Institutions, agencies, research institutes provide meteo-climatic data/information**
- **meteo-climatic microdata come from different sources**

  Open issues:
  - integration of data
  - databases homogeneity
  - completeness and quality of time series provided by different bodies by station
  - methodologies used for reconstracting missing data
  - maintenance and preservation of measuring stations and their historical data archives

Conclusions and further work

- ✓ **CC is in place in our country**
- ✓ concentration and intencity of climatic events need in many case to be investigated on daily scale
- ✓ **among people the perception of CC extreme events and disasters in the cities is growing** (risks for human health and death, economic activities, infrastructures and public services)
- ✓ **vulnerability of urban systems vs resilient cities**
- ✓ **adaptation policies and actions** to make cities safer areas in response to CC risks
- ✓ **Indices on Extreme Climate Events methodology applied for Italian Regional Municipality**
  - a tool for representing climatic phenomena in italian cities to be integrated with other tools
  - experimental analysis that welcomes suggestions and synergies
- ✓ **new Istat survey 2017**
  - respondents: **72** Institutions, Agencies, Research centers, Regions
  - guaging stations: **700** metereological gauging stations
  - objectives: - collect meteoclimatic data about temperature and precipitation for all Italian Provincial Capitals
    - calculate **ETCCDI for 110 Provincial Capitals**

enhance CCRS official statistics production and sharing
scientific community, Institutions, policy makers, civil society to better understand and analyse CC phenomena

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Istat Italian National Institute of Statistics