



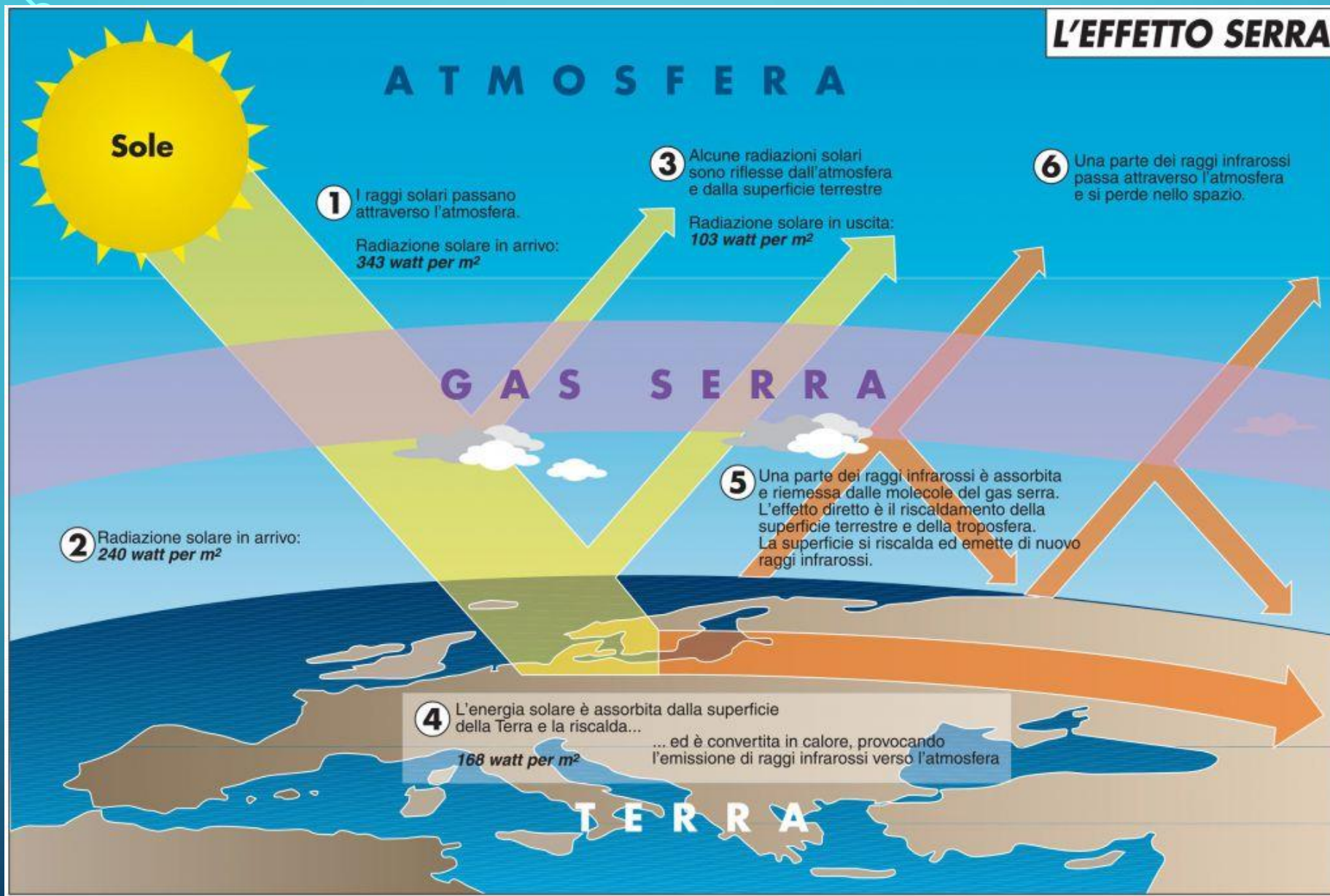
WATER AND ENVIRONMENTAL SUSTAINABILITY
IN A CLIMATE-CHANGING CONTEXT

Speaker: Renato Morbidelli
Perugia University

renato.morbidelli@unipg.it

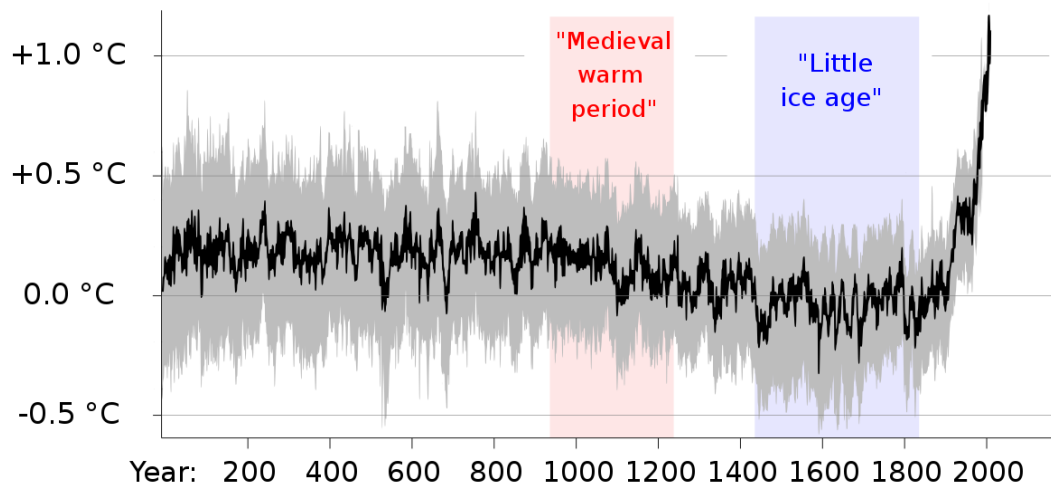
Todi, Italy, 24 August 2023

L'EFFETTO SERRA

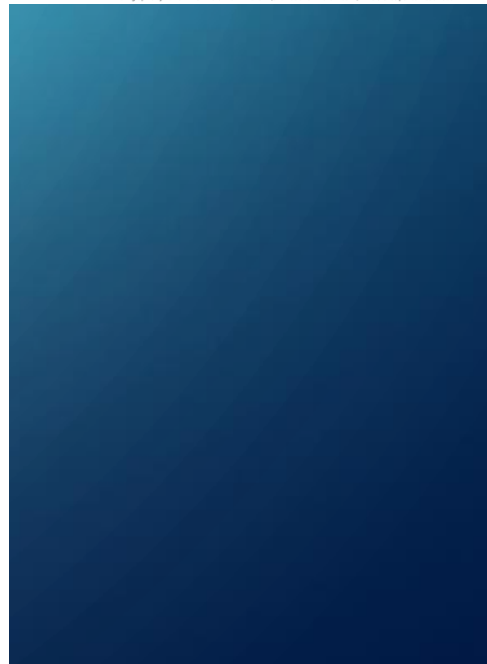
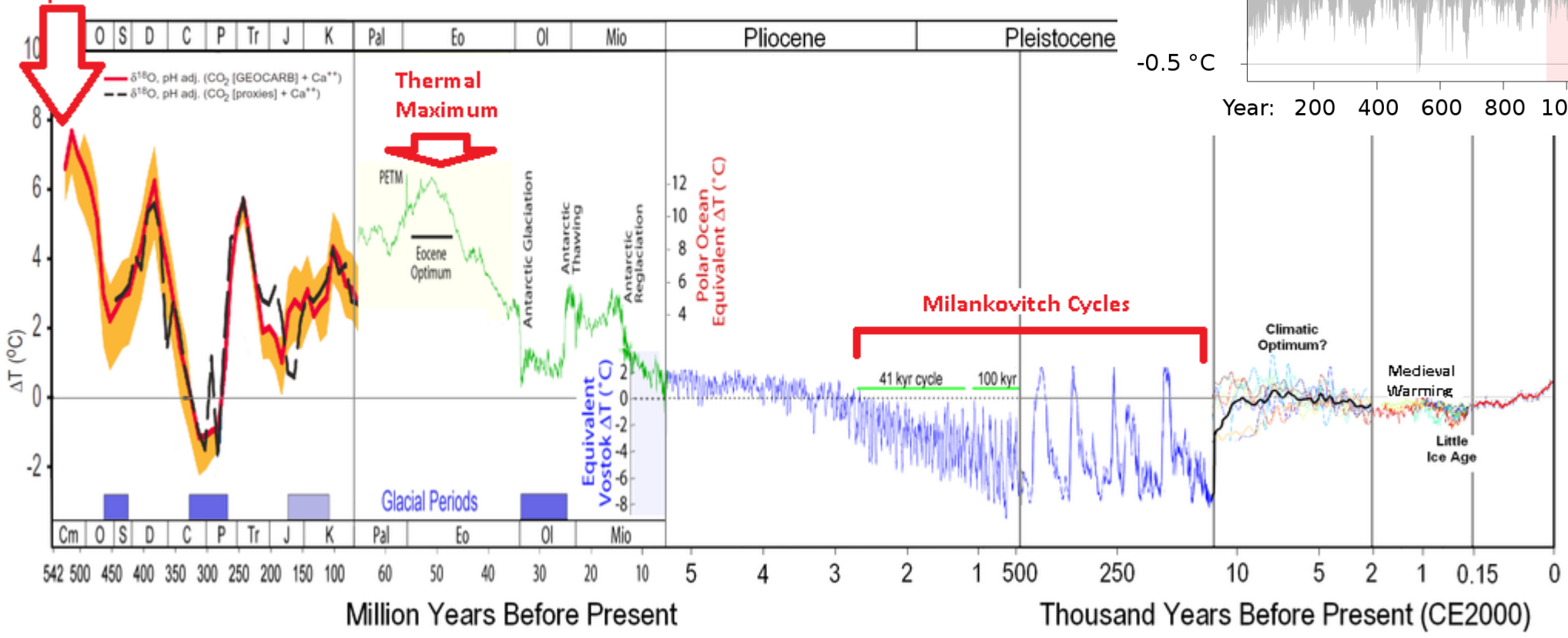




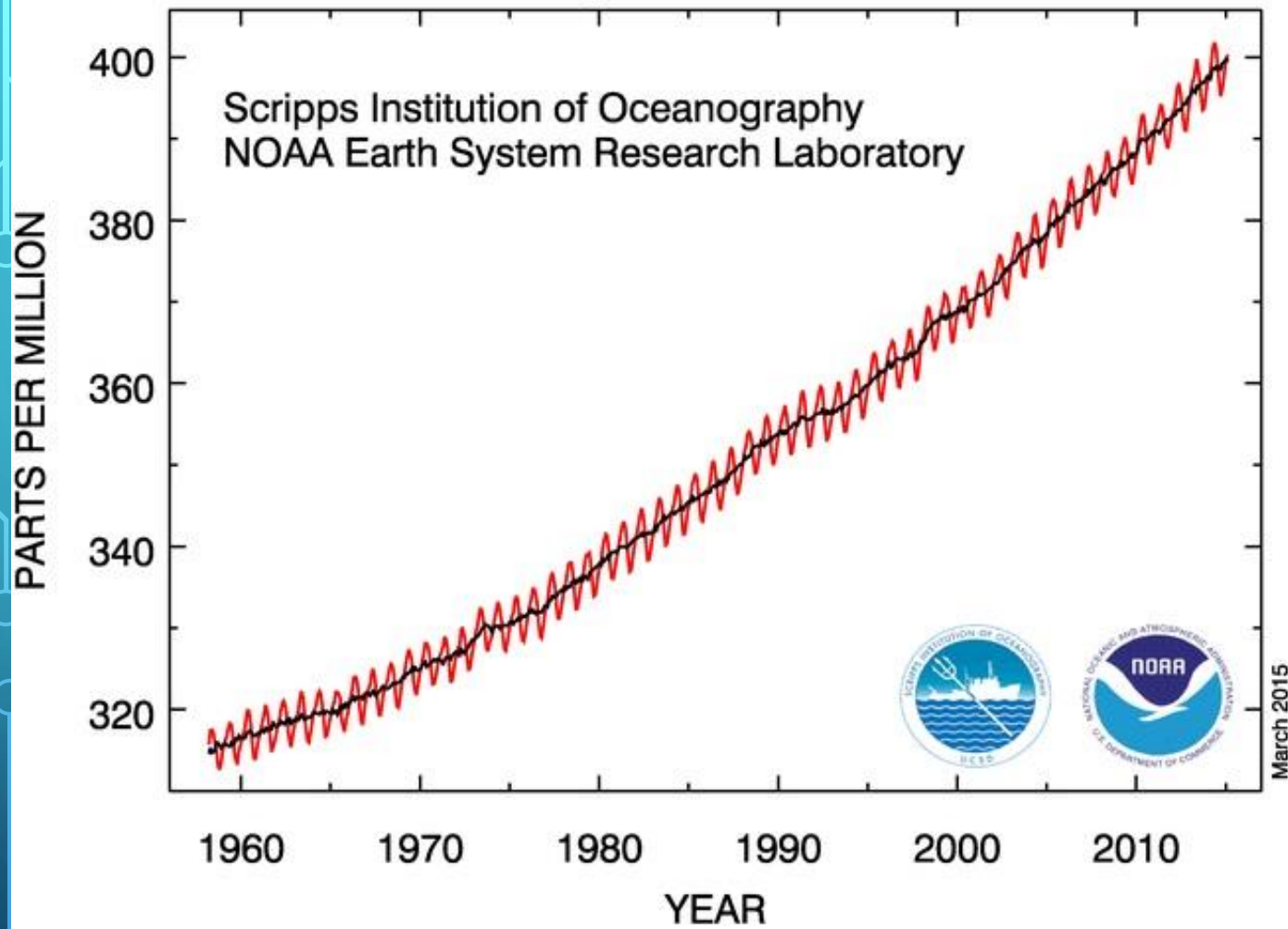
Global Average Temperature Change



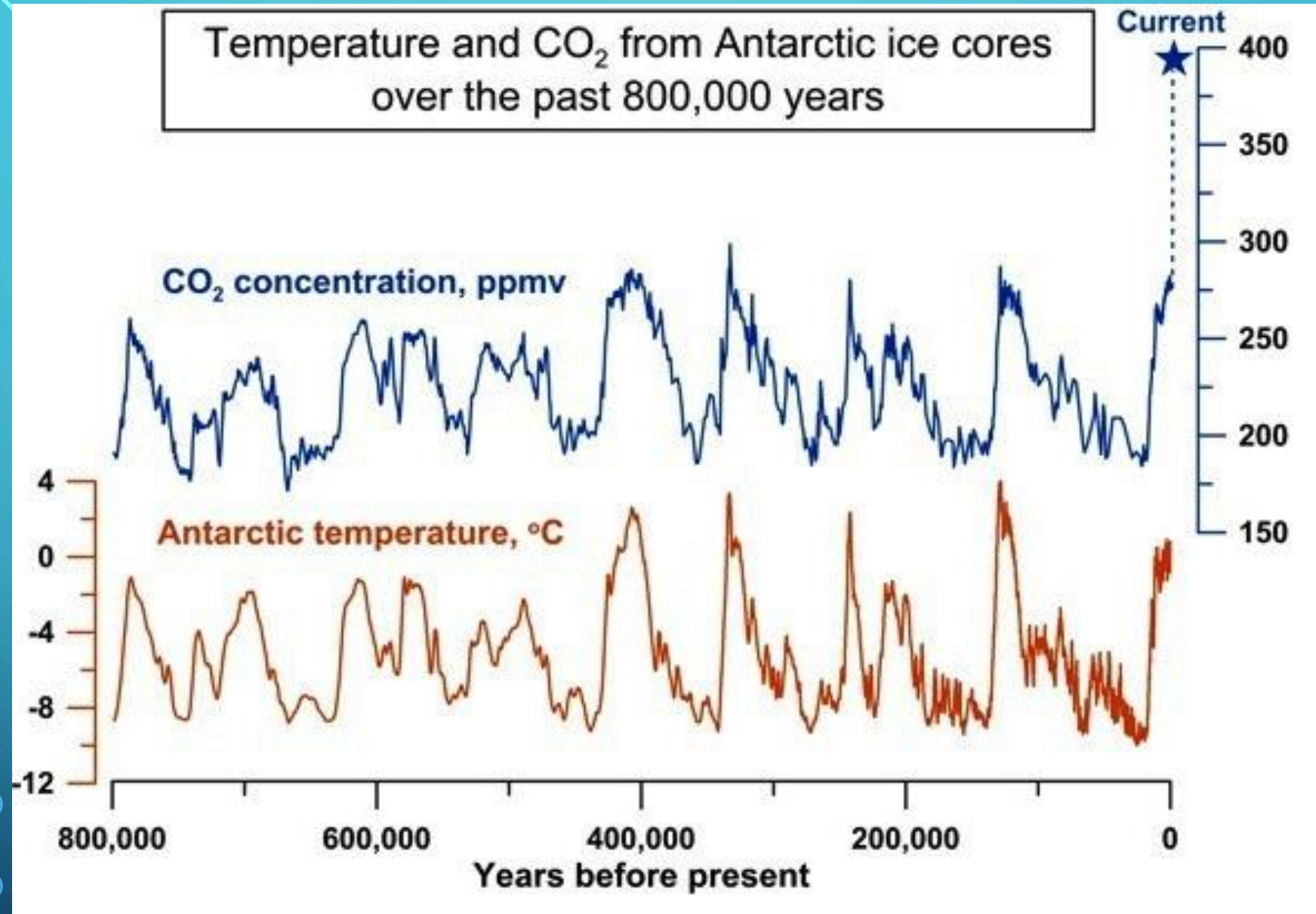
Temperature of Planet Earth

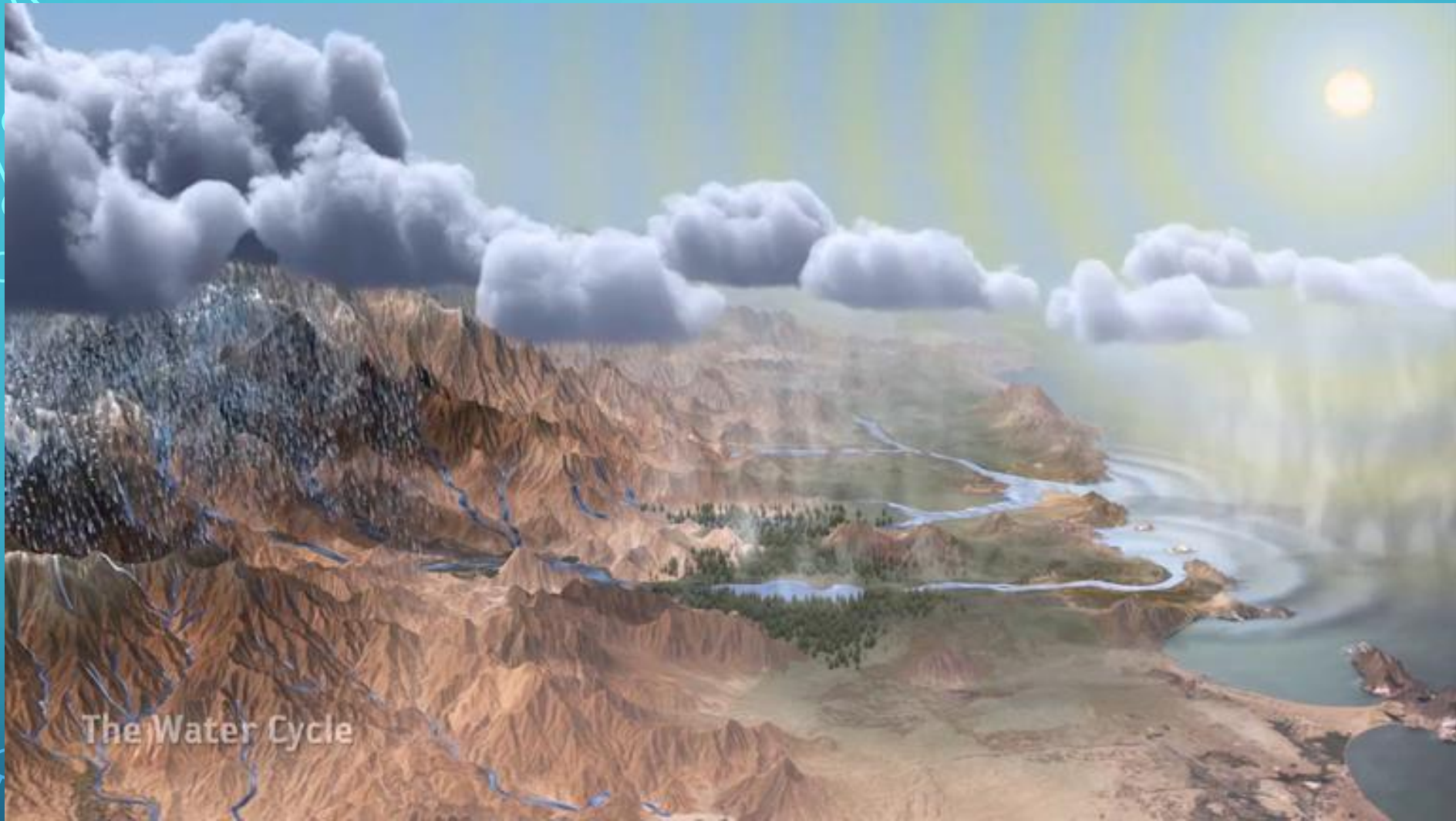


Atmospheric CO₂ at Mauna Loa Observatory

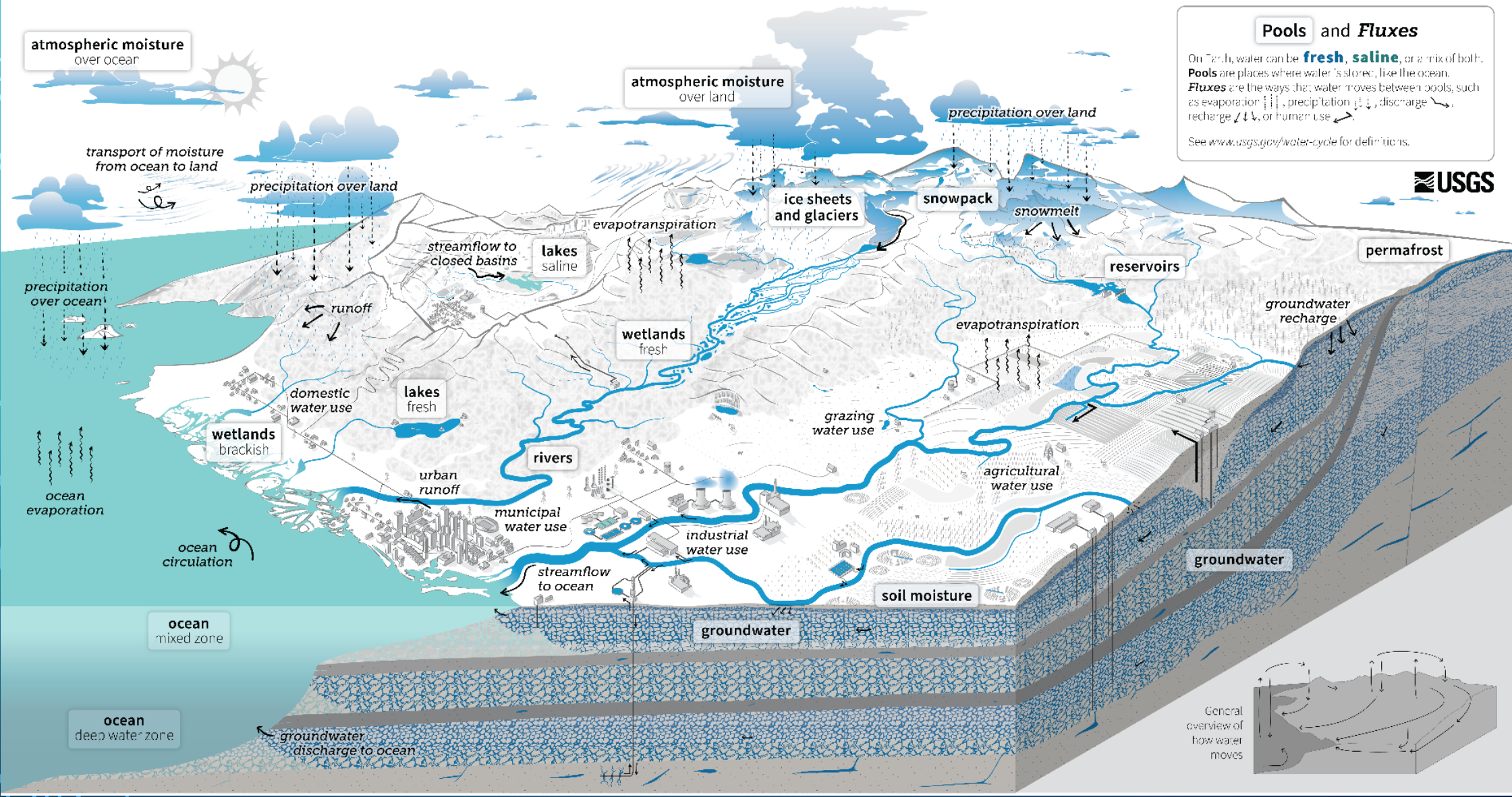


Temperature and CO₂ from Antarctic ice cores over the past 800,000 years





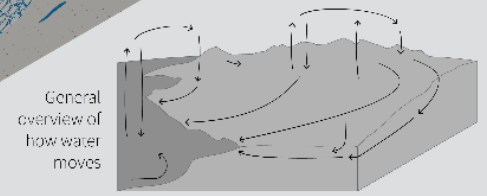
The Water Cycle



Pools and Fluxes

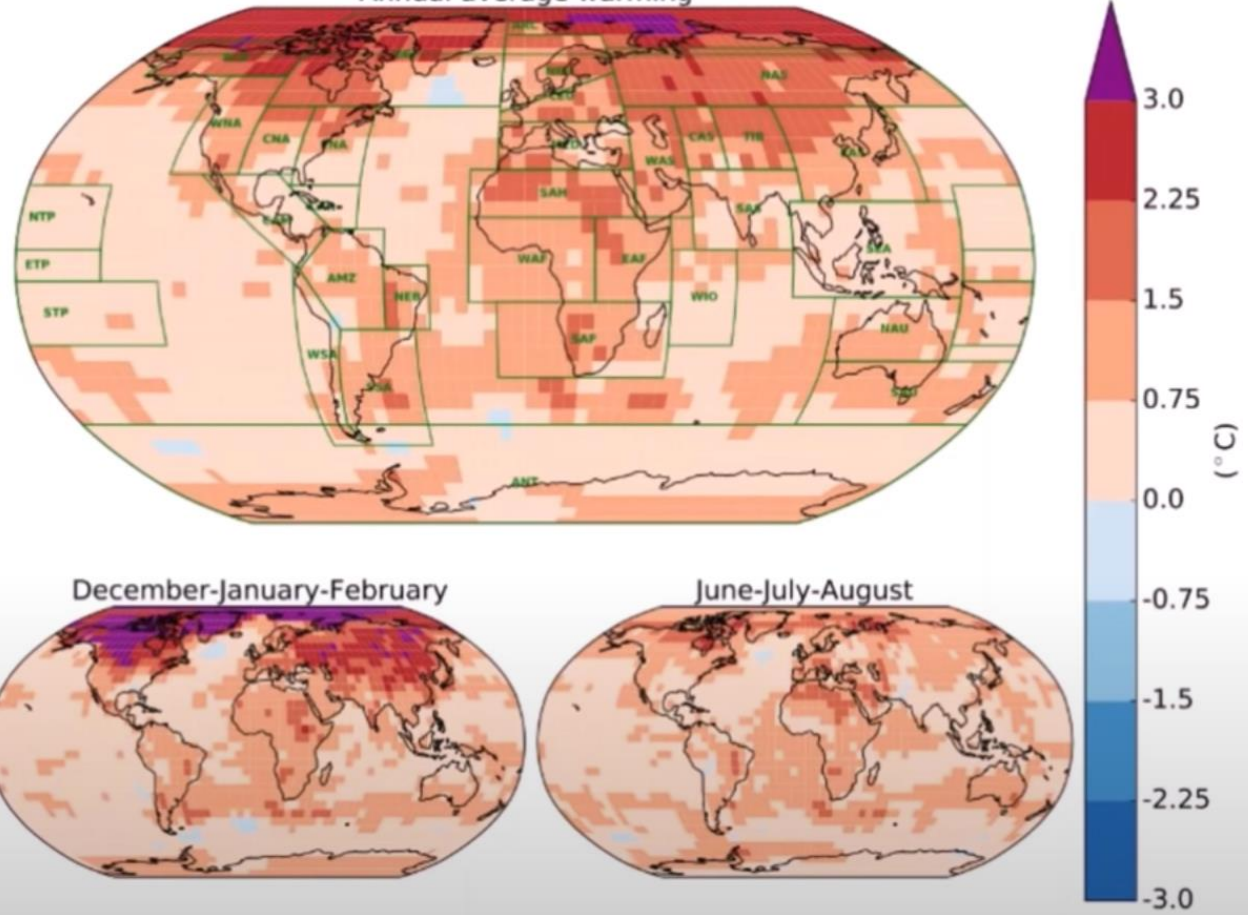
On Earth, water can be **fresh**, **saline**, or a mix of both. **Pools** are places where water is stored, like the ocean. **Fluxes** are the ways that water moves between pools, such as evaporation [↑], precipitation [↓], discharge [↘], recharge [↙], or human use [↔].

See www.usgs.gov/water-cycle for definitions.



Regional warming in the decade 2006-2015 relative to preindustrial

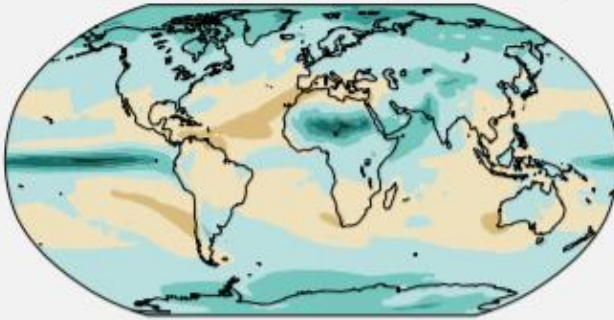
Annual average warming



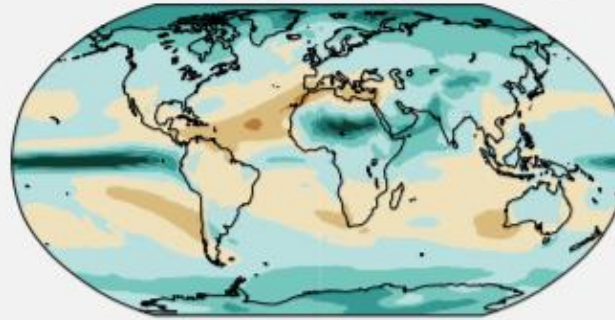
(c) Annual mean precipitation change (%) relative to 1850–1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

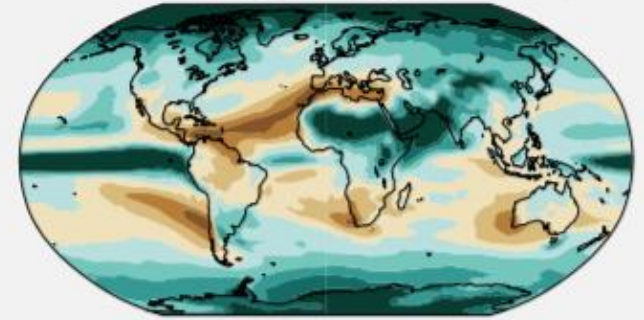
Simulated change at 1.5°C global warming



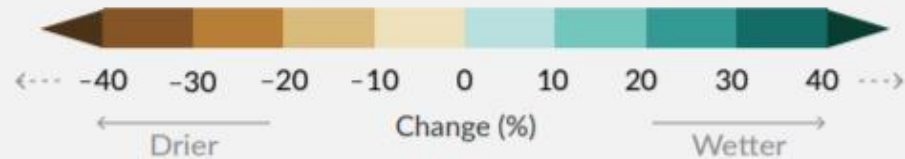
Simulated change at 2°C global warming

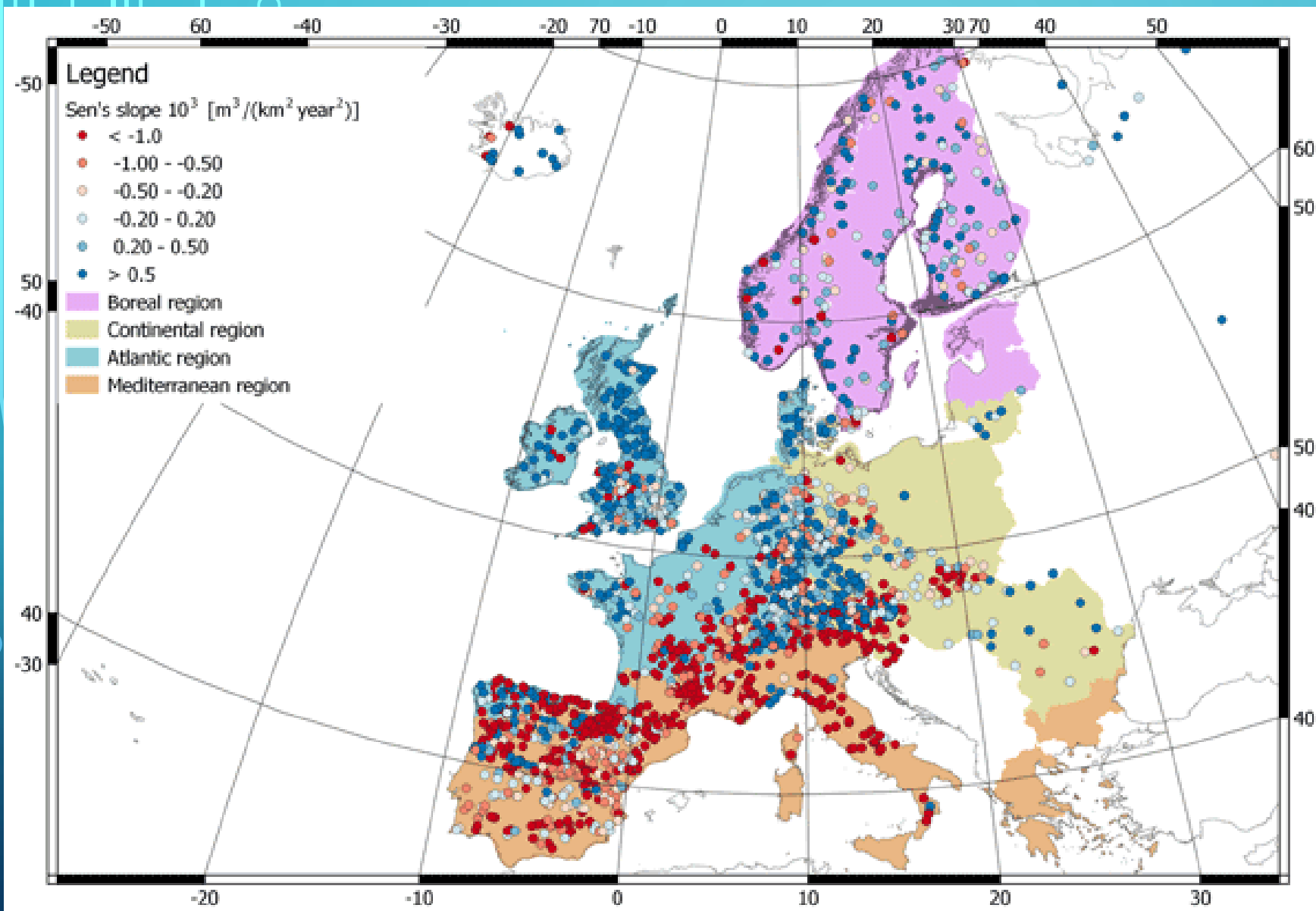


Simulated change at 4°C global warming



Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions.





Masseroni et al. (2021)

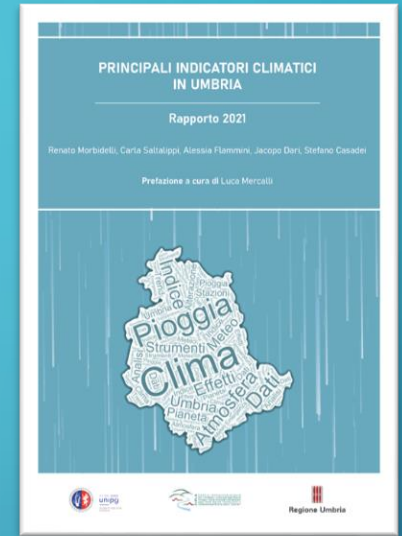
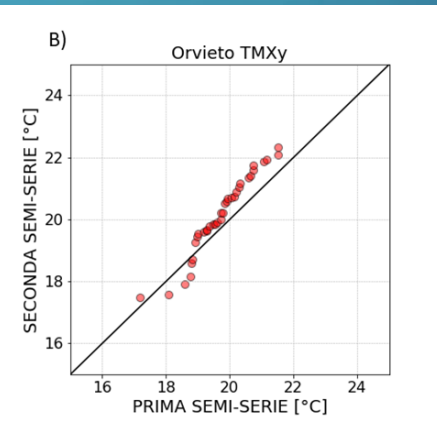
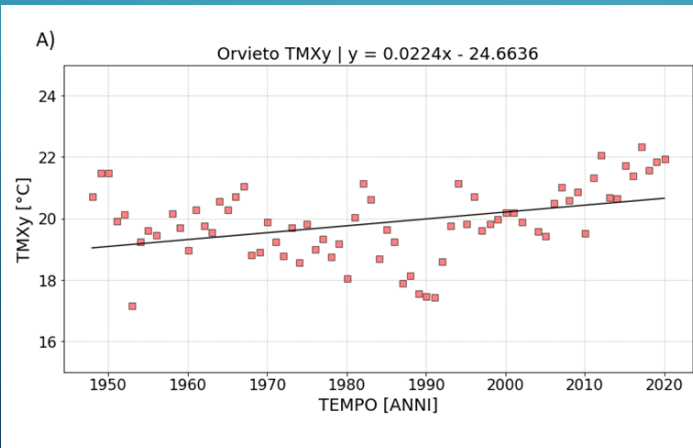
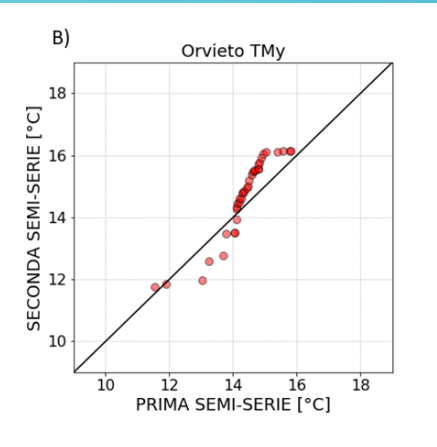
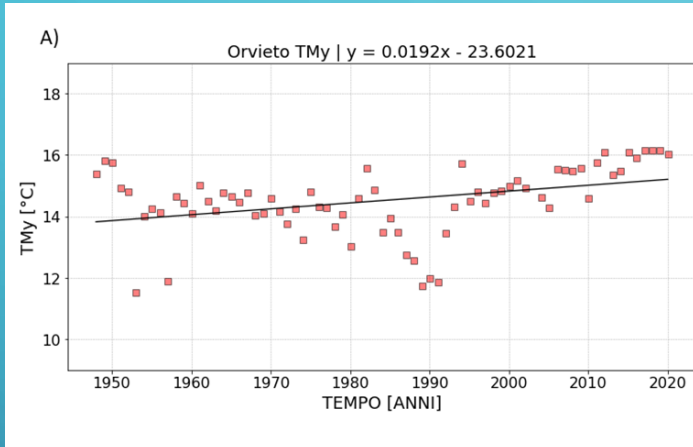
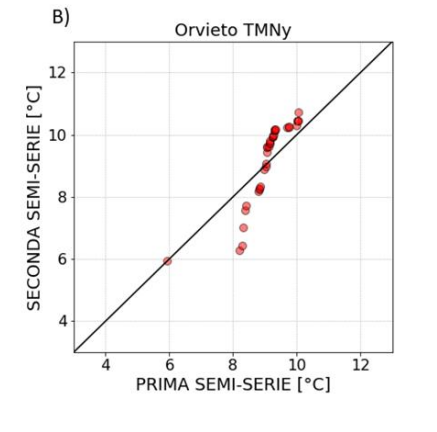
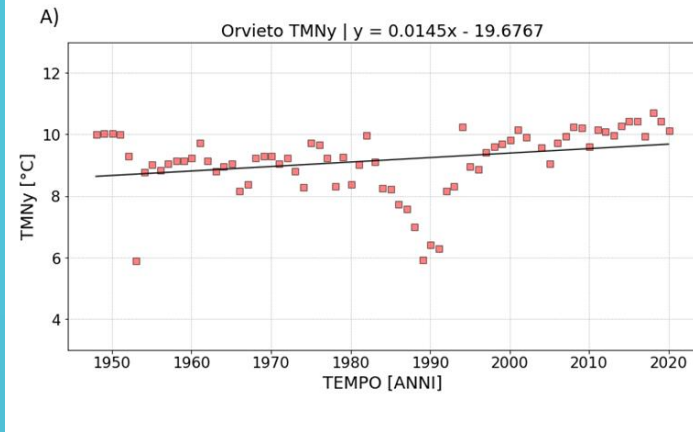
<https://hess.copernicus.org/articles/25/5589/2021/>

A decorative graphic on the left side of the slide consists of white and light blue lines forming a circuit-like pattern. The lines are vertical and horizontal, with small circles at various points, resembling a stylized tree or a network diagram. The background is a gradient of blue, transitioning from a lighter shade at the top to a darker shade at the bottom.

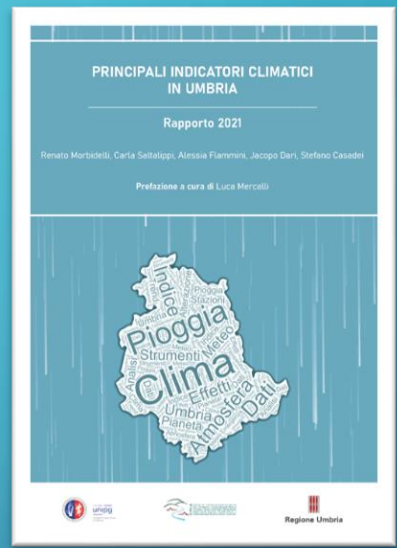
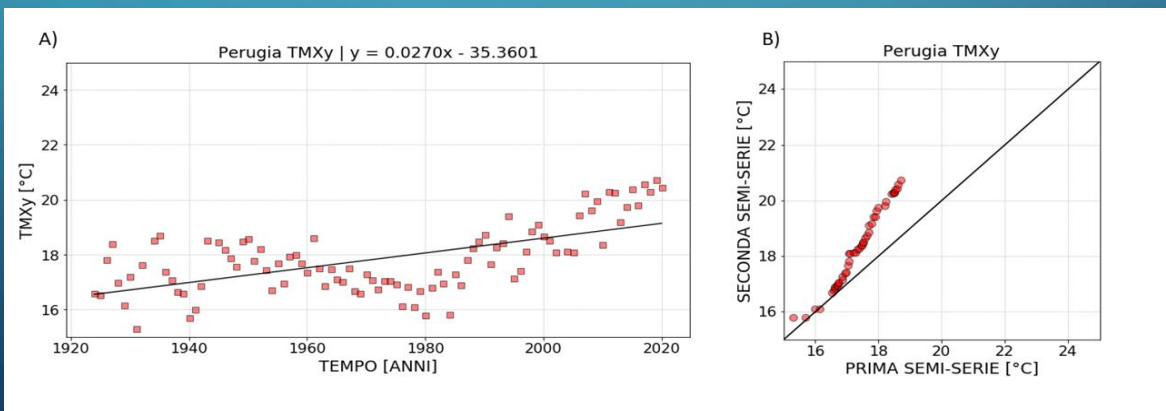
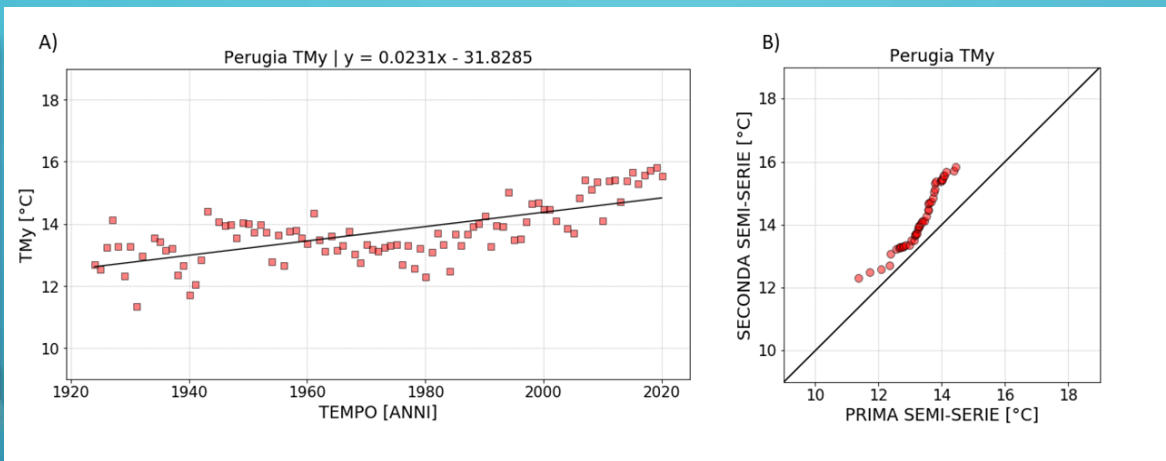
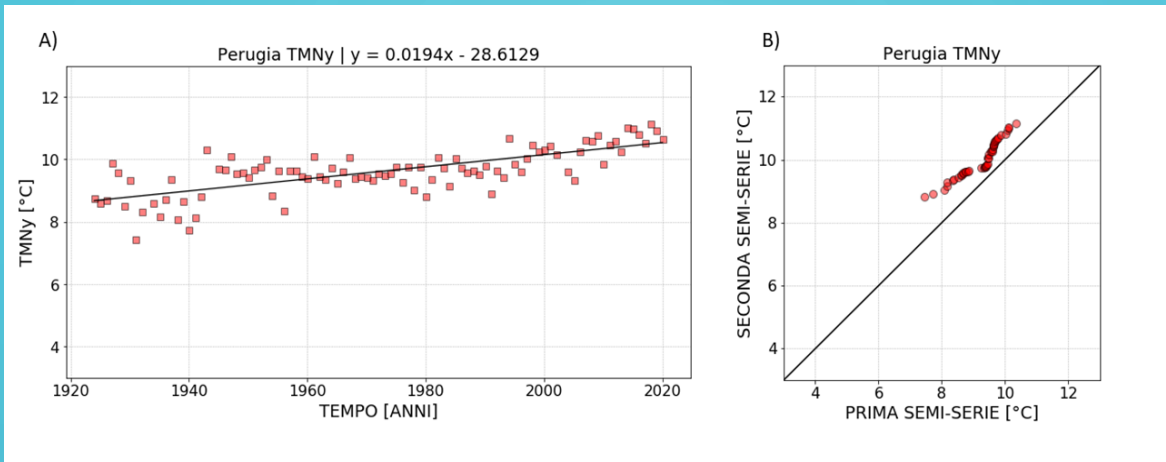
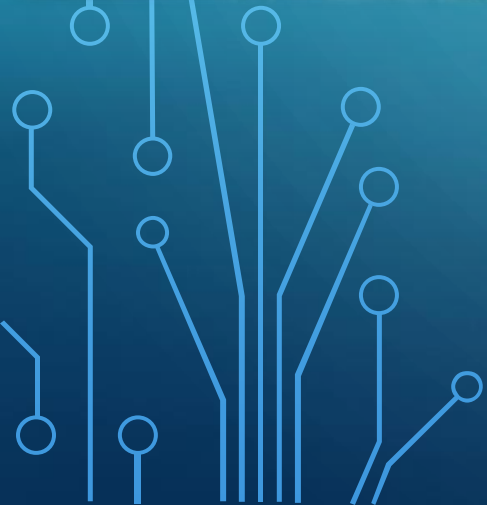
What are the effects of climate change in the Umbria region?



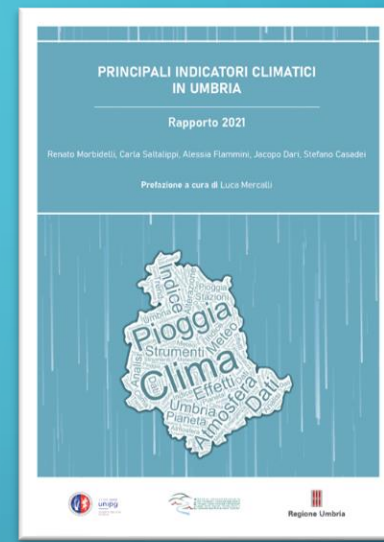
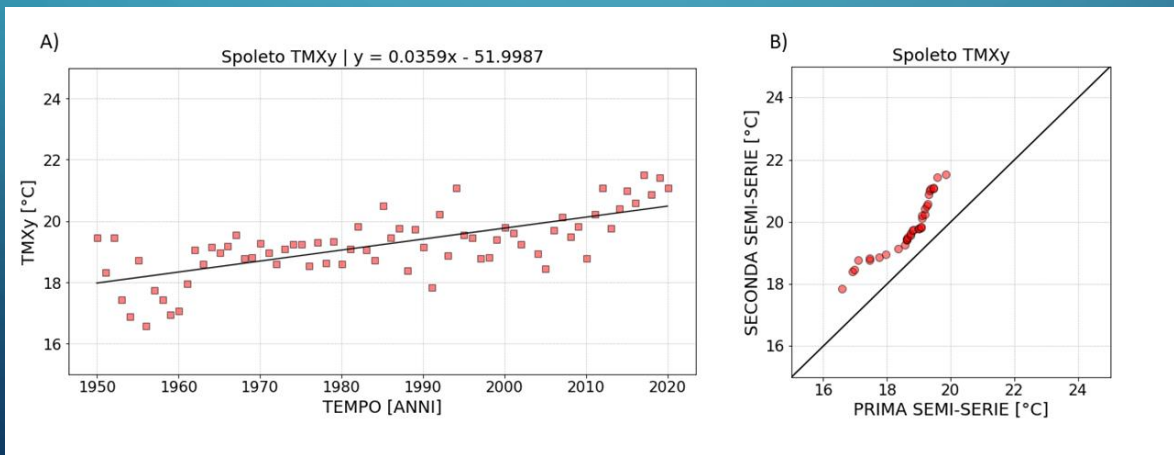
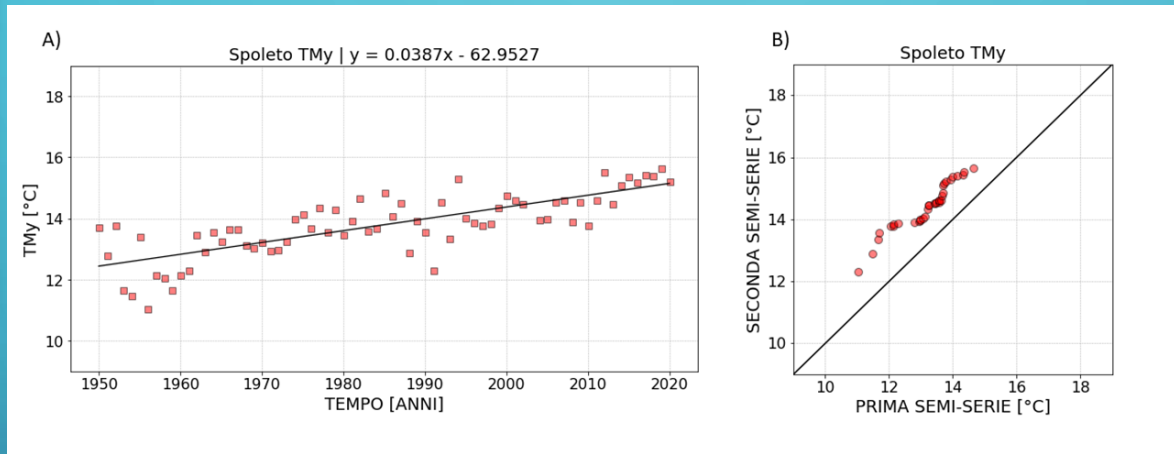
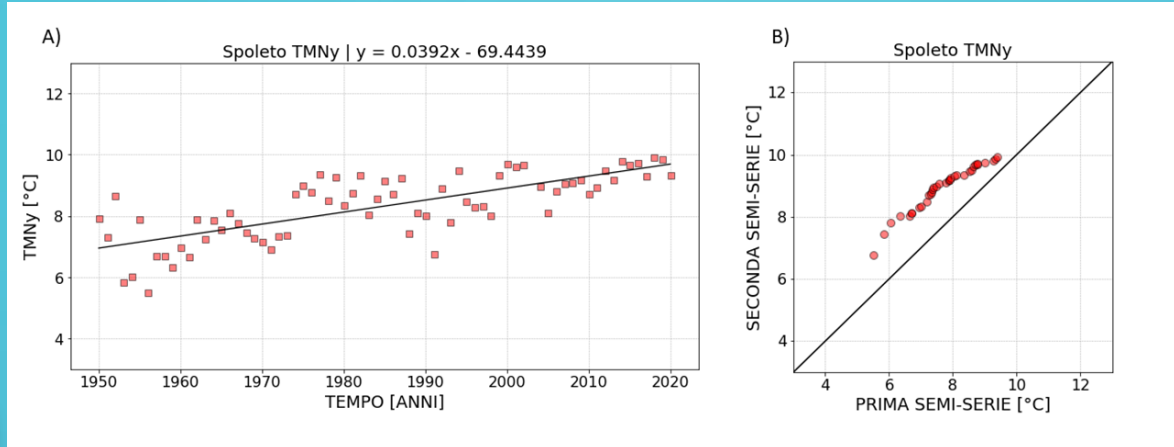
AIR TEMPERATURE



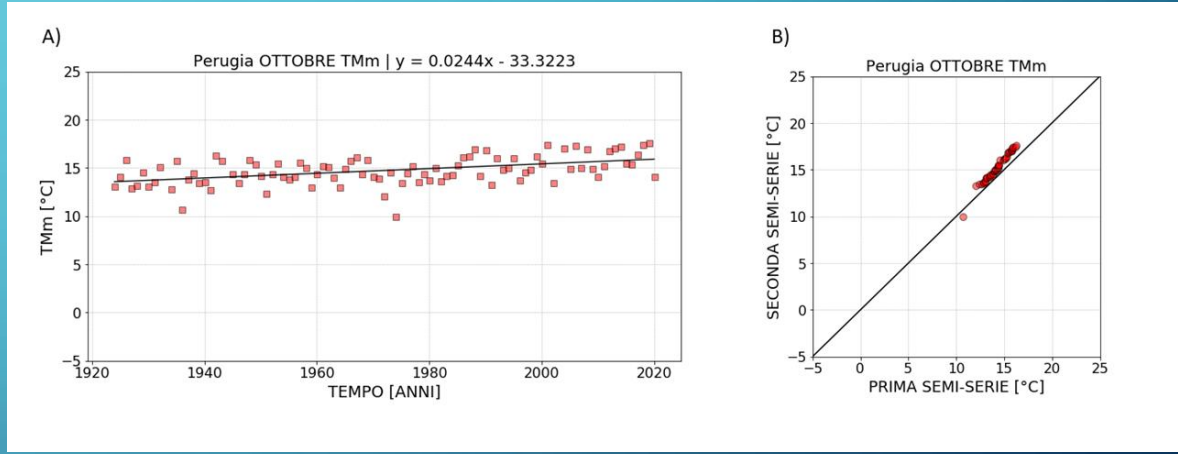
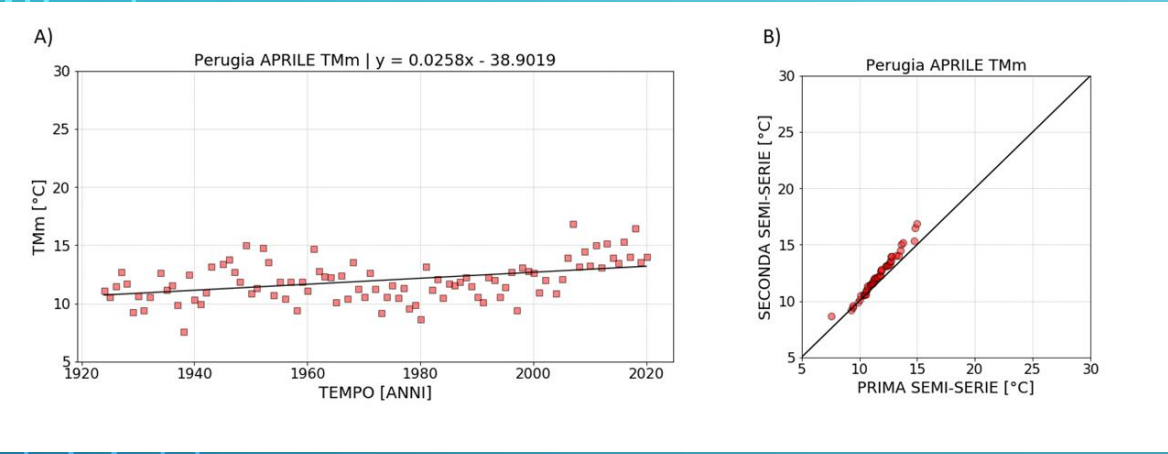
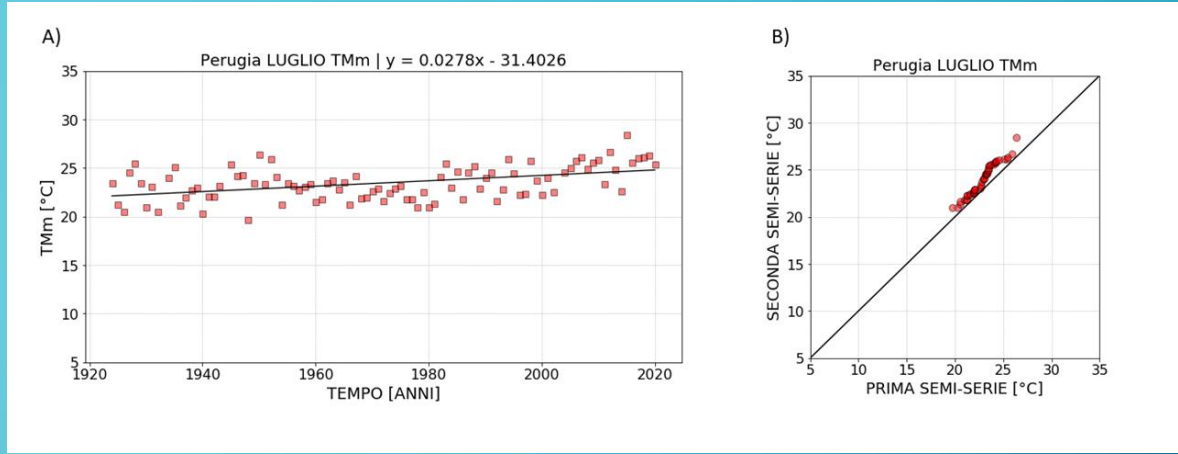
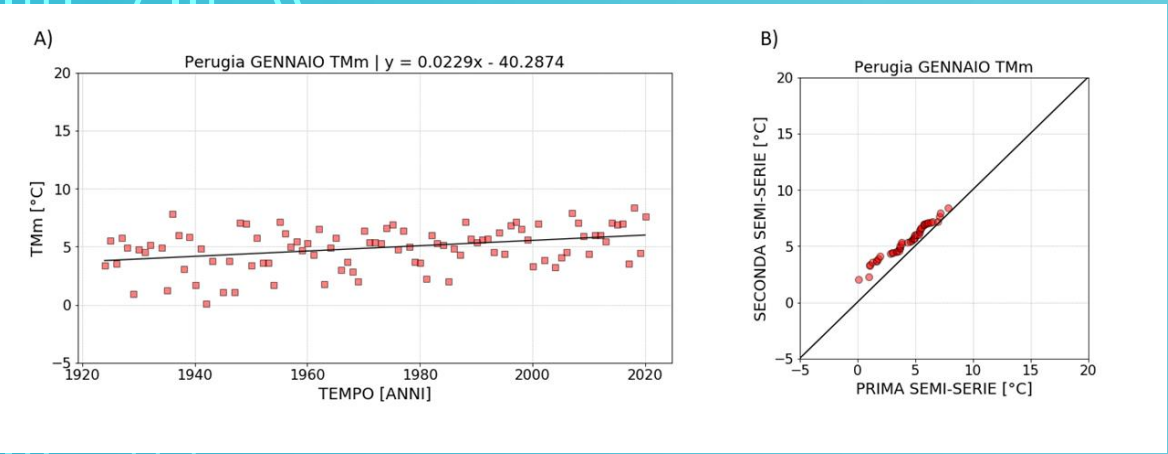
Annual average air temperature in Orvieto



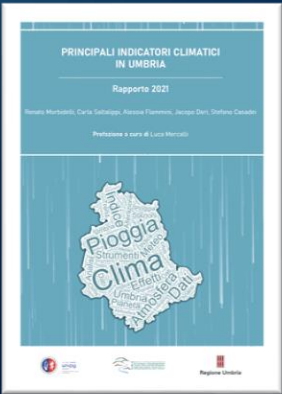
Annual average air temperature in Perugia



Annual average air temperature in Spoletto

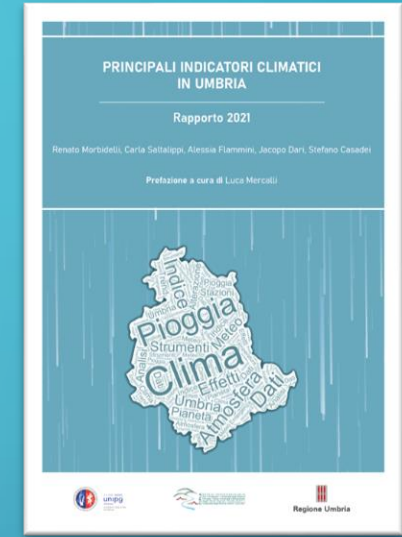
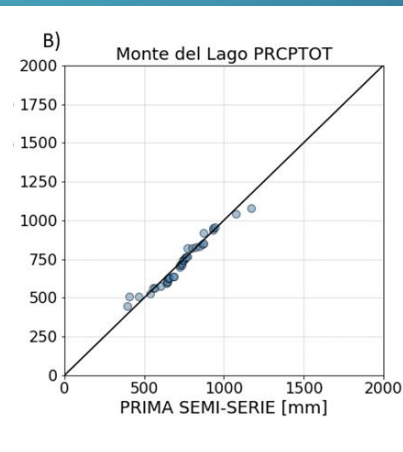
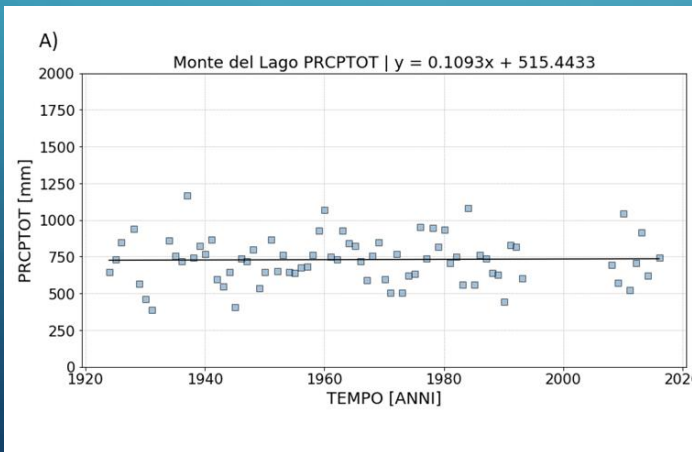
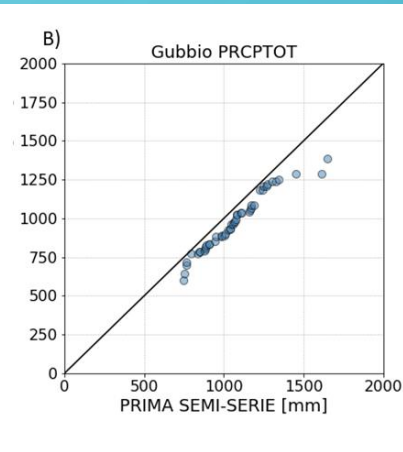
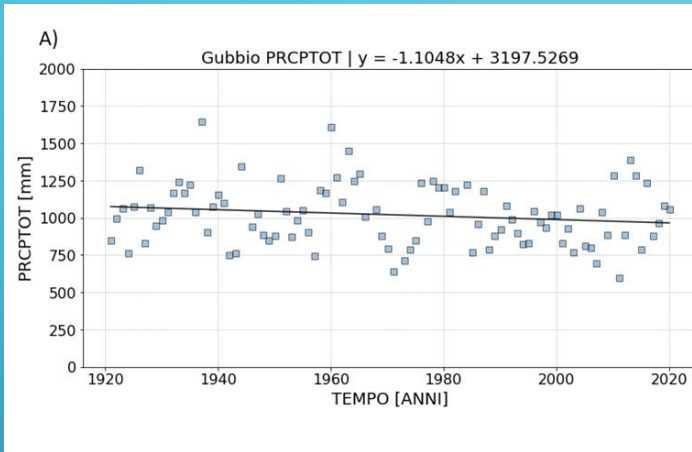
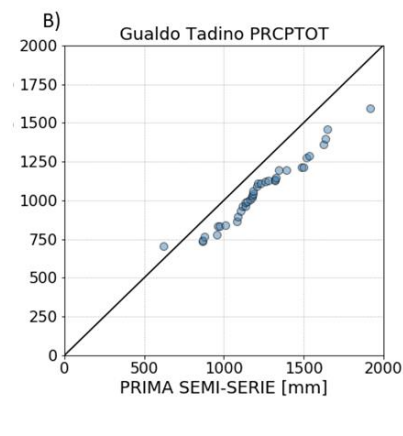
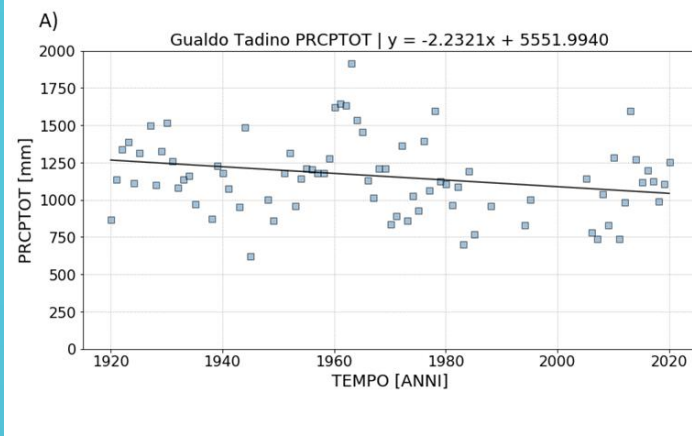


Average monthly air temperature in Perugia

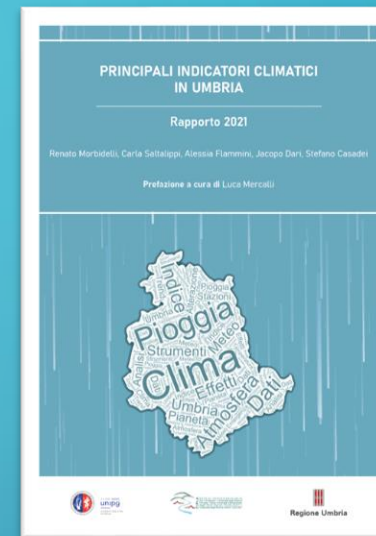
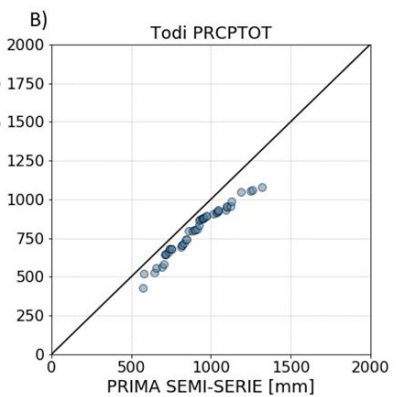
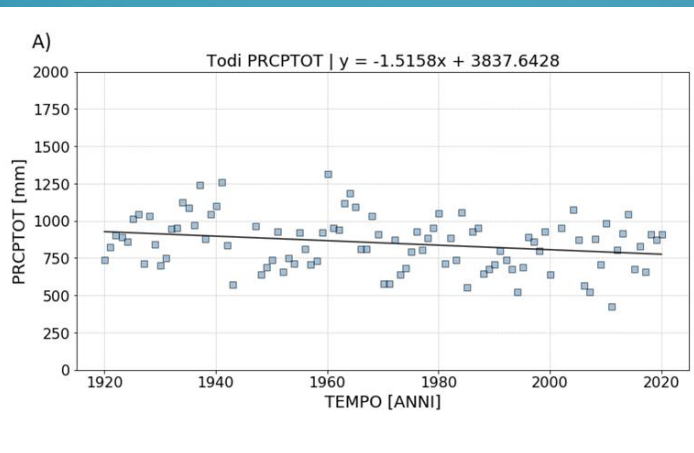
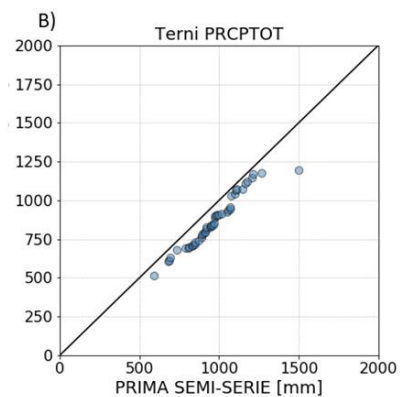
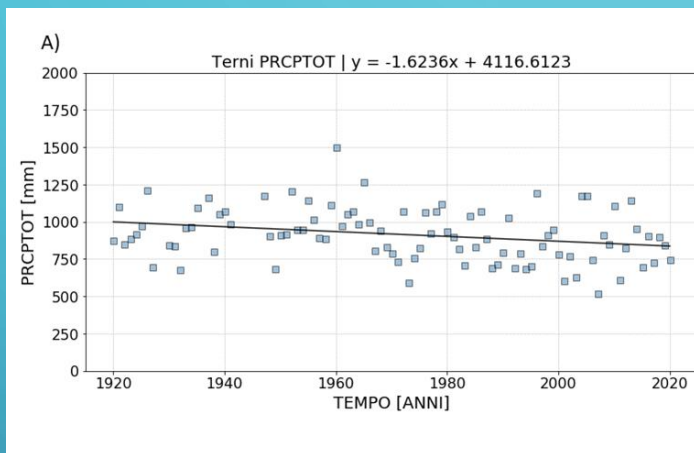
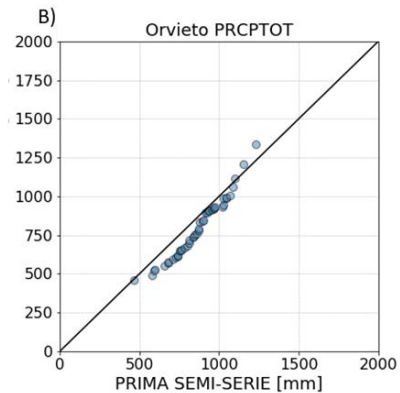
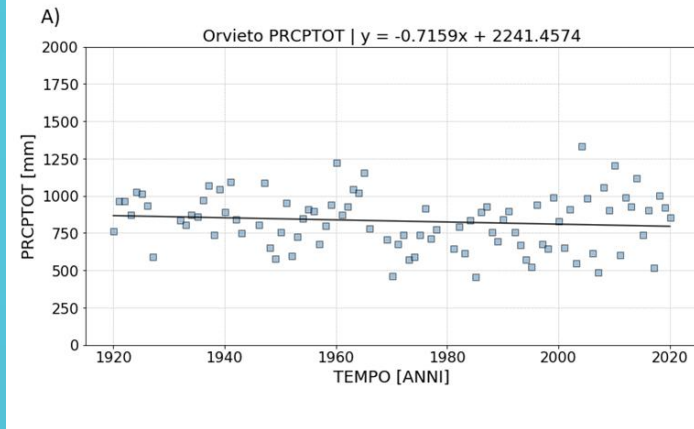




TOTAL ANNUAL RAINFALL



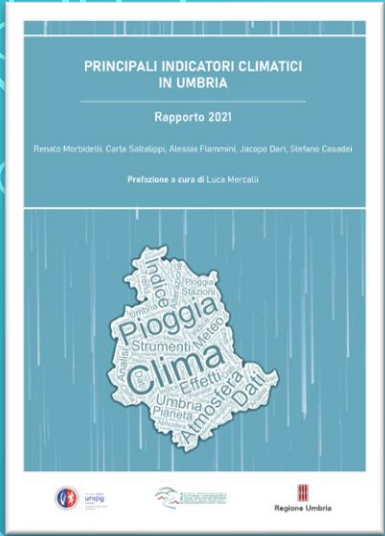
Total annual rainfall
in Gualdo Tadino,
Gubbio and Monte
del Lago



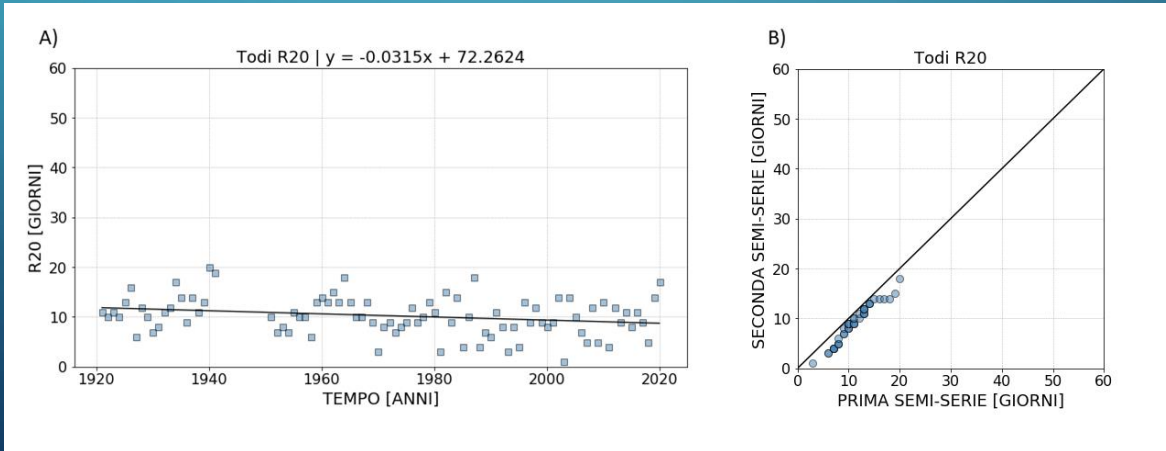
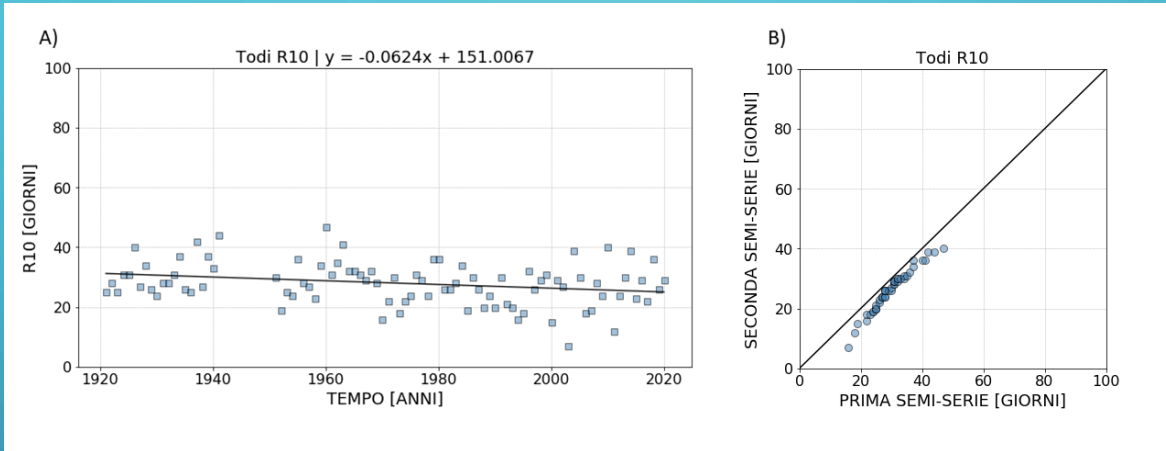
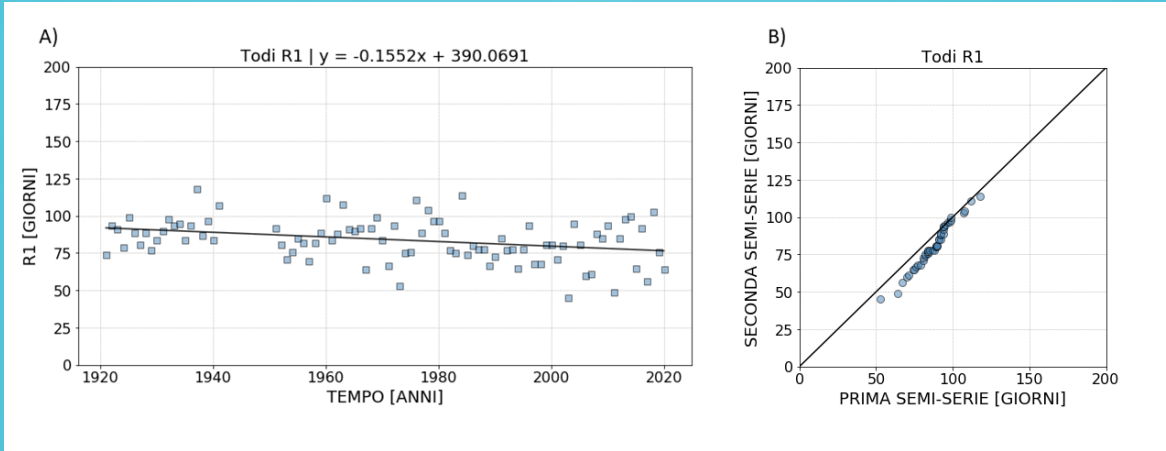
Total annual rainfall
in Orvieto, Terni and
Todi



RAININESS



Annual rainy days in Todi

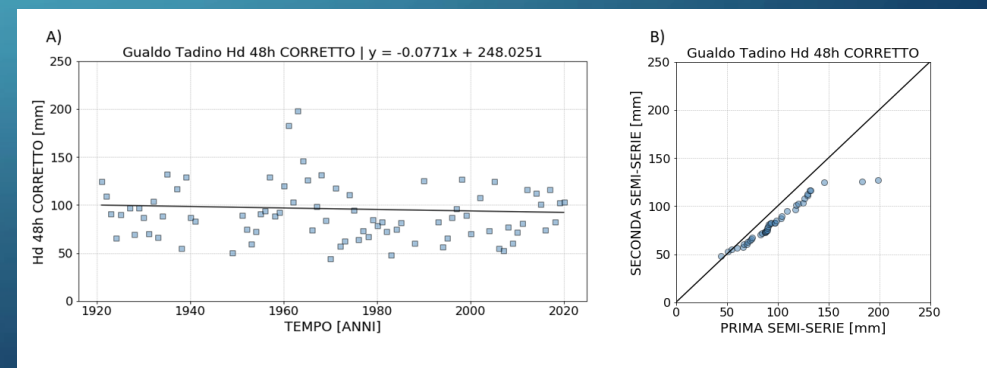
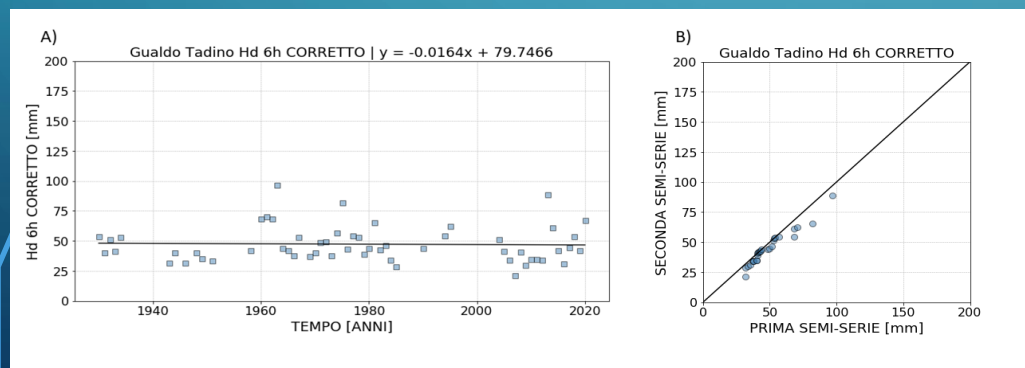
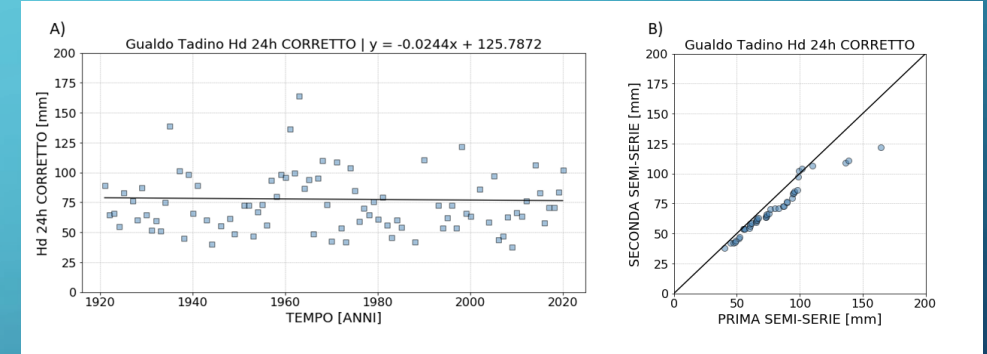
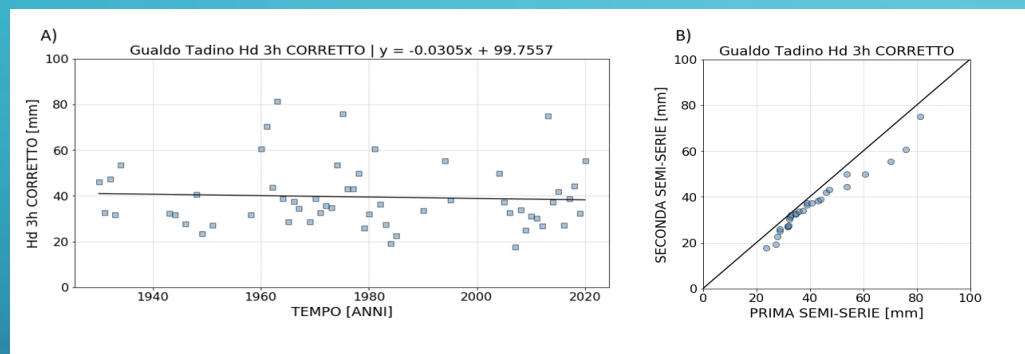
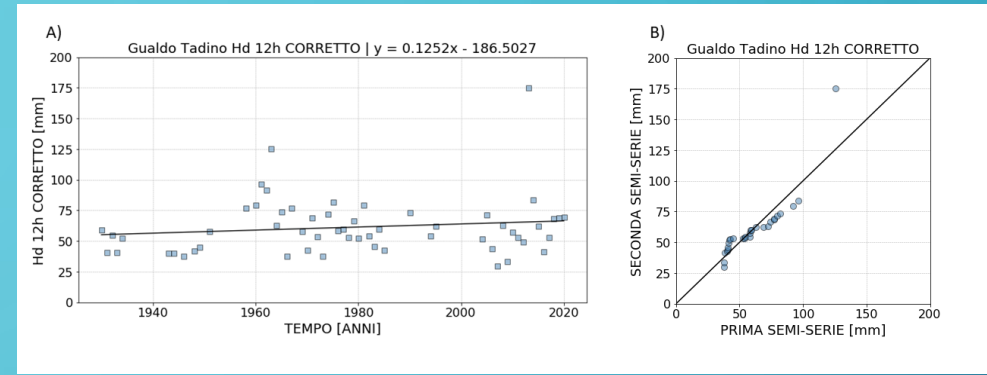
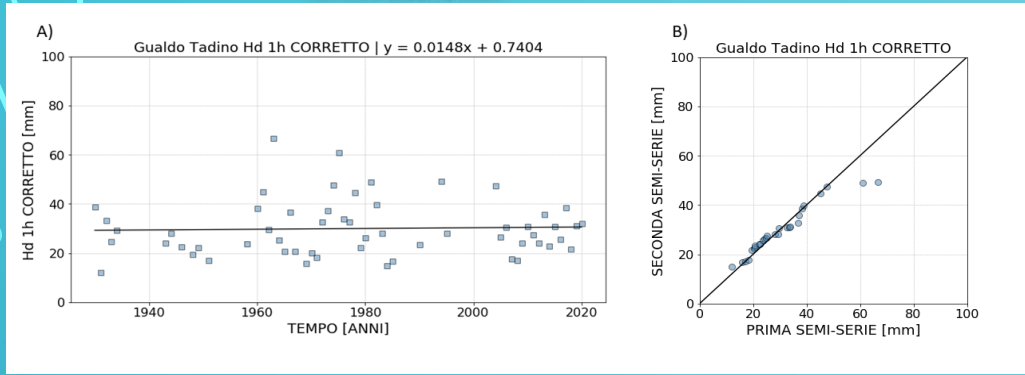




INTENSE RAINFALL EVENTS

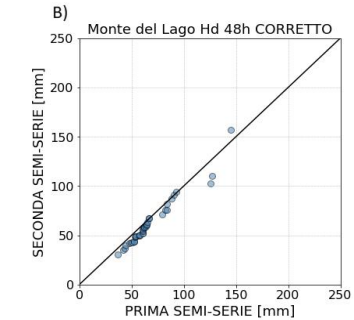
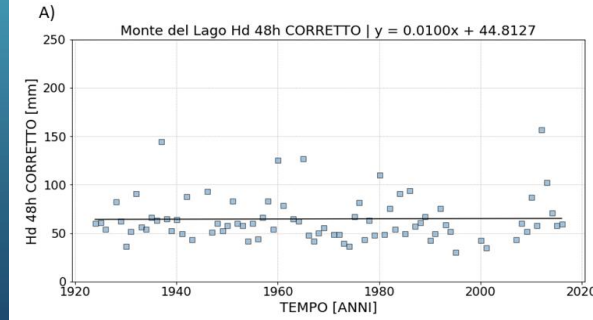
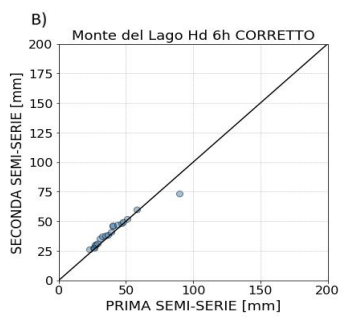
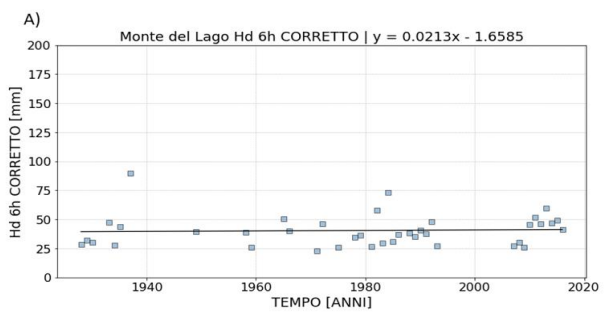
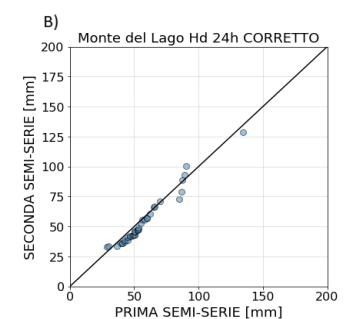
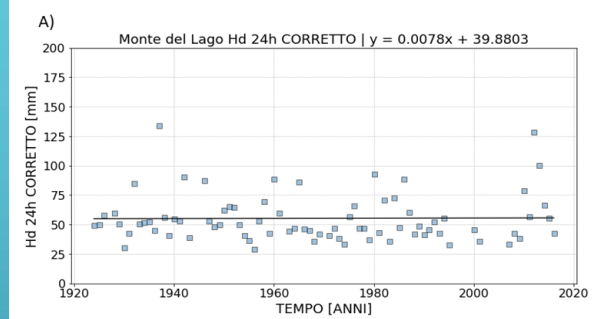
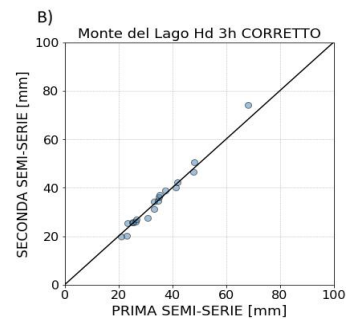
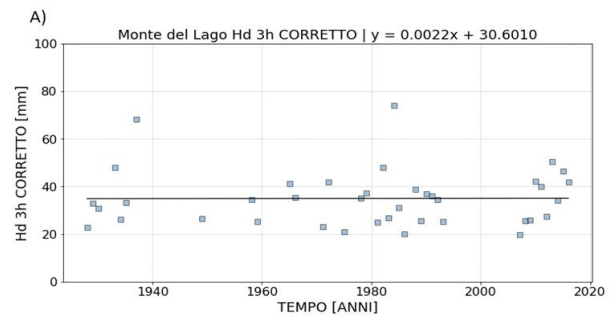
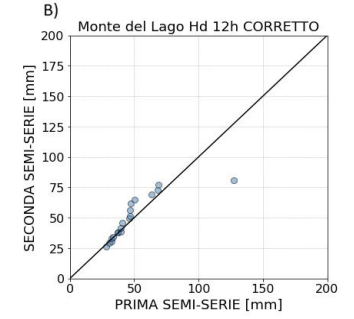
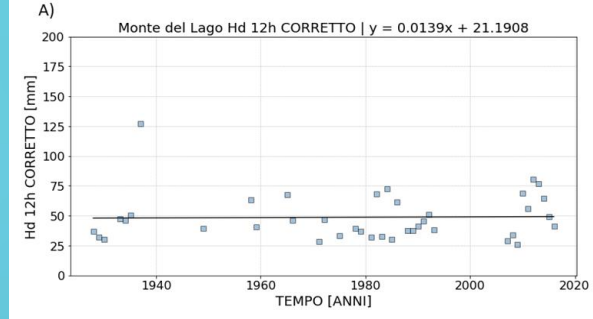
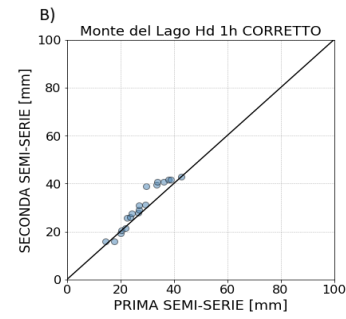
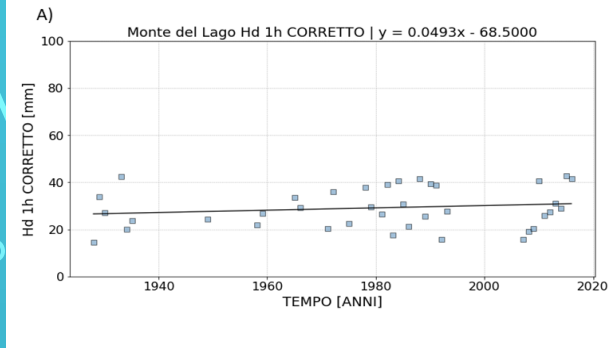


Intense rainfalls in Gualdo Tadino



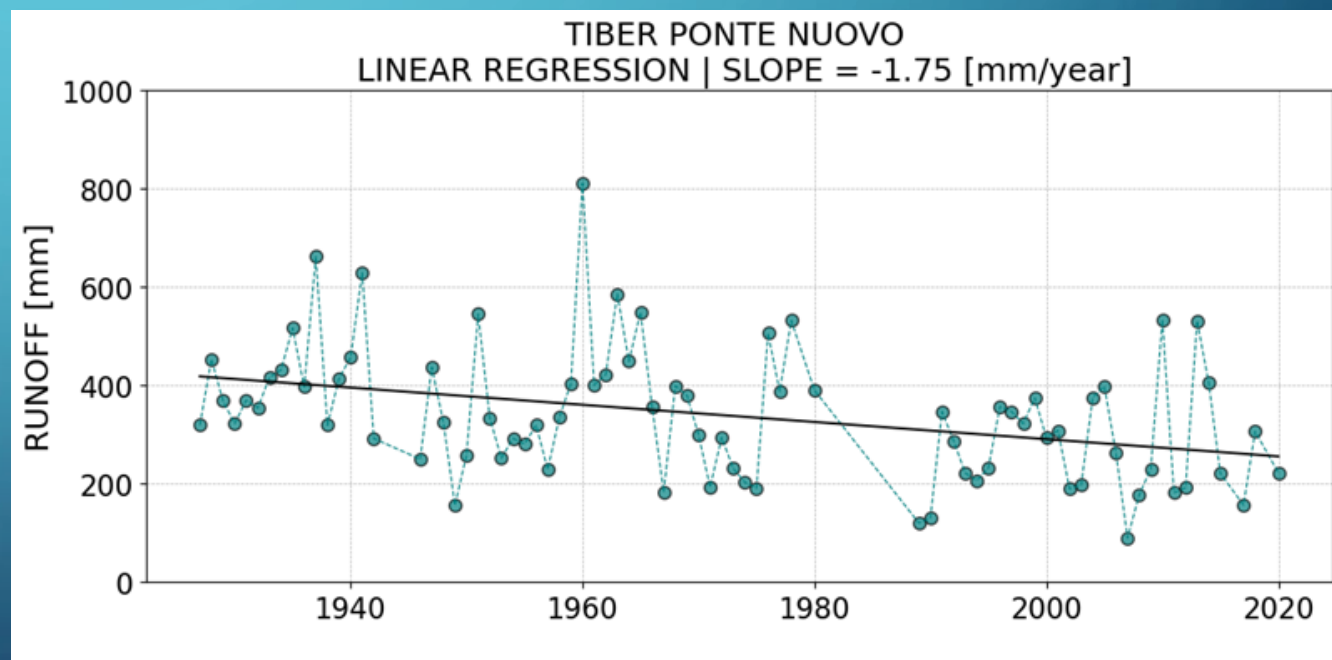
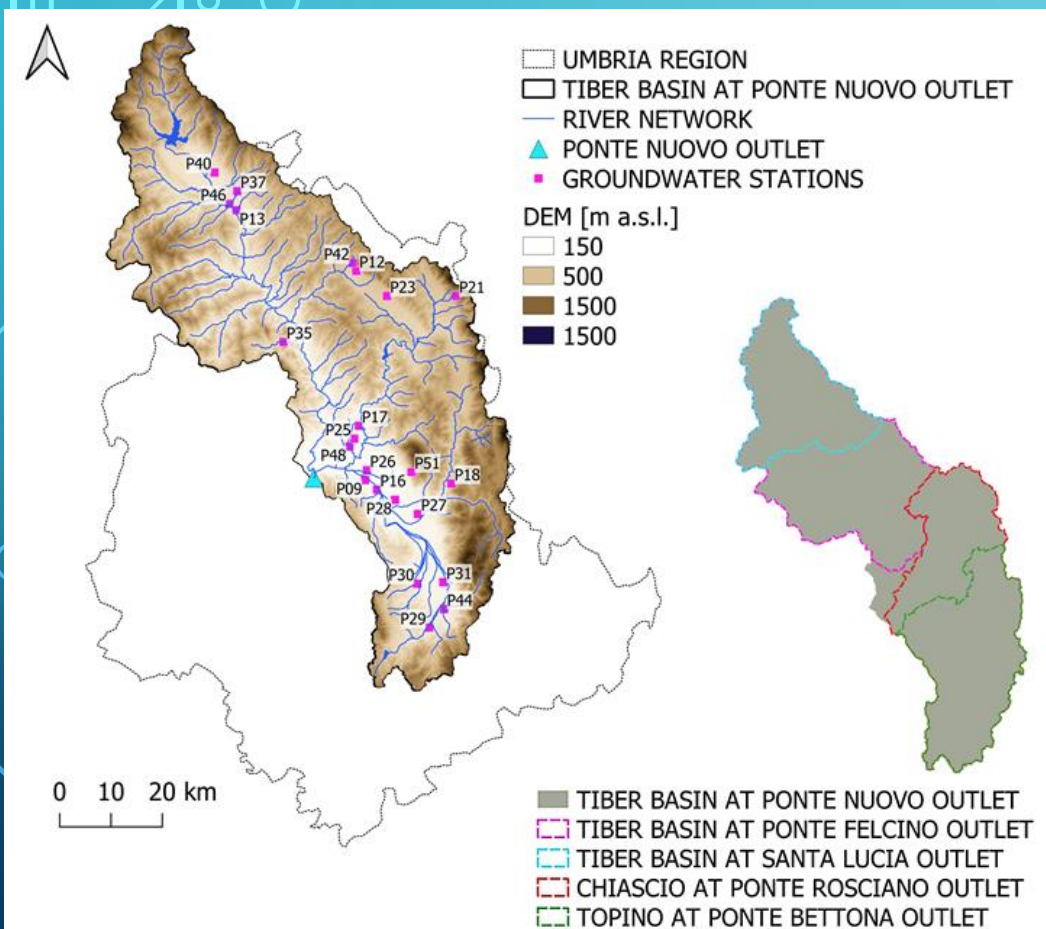


Intense rainfall events in Monte del Lago





Runoff volume in the Tiber River at Ponte Nuovo





POINT OF INTEREST

Analysing the issues in which water
resource and environmental sustainability
interact



A **sustainable** use of **water resources** suggests:

- ✓ Reducing water consumption (especially wastage)
- ✓ Using water to produce renewable energy
- ✓ Returning to respect natural rivers
- ✓



... reduction of water consumption (wastage)

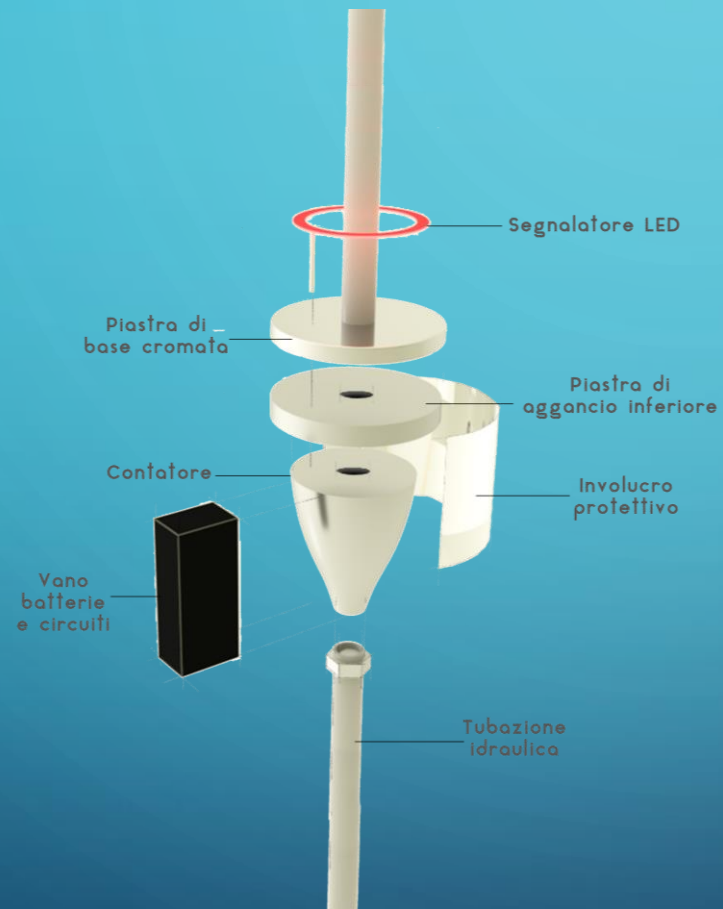
a.y. 2019/2020 - **Idea Contest** (objective: reducing domestic water consumption)

a.y. 2020/2021 - **Idea Contest** (objective: reducing water consumption in University buildings)

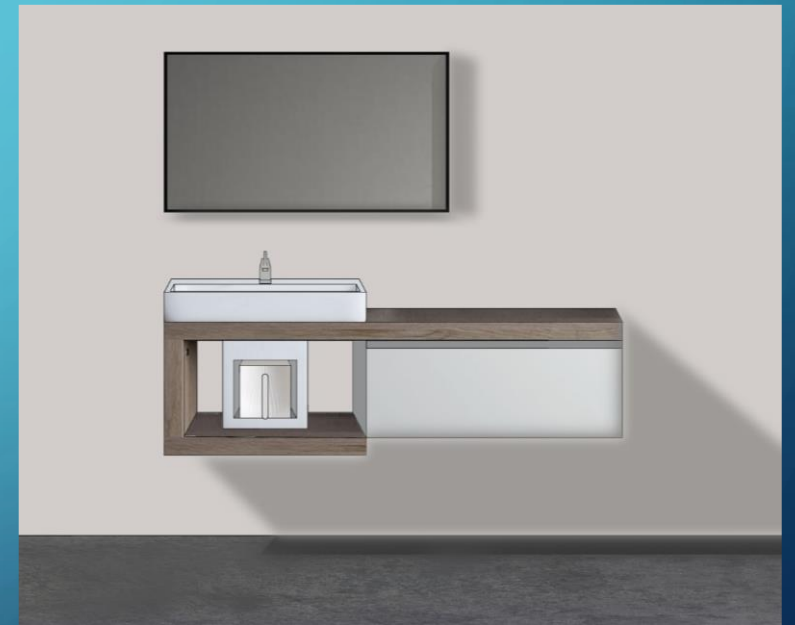
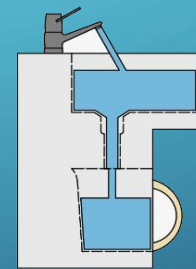
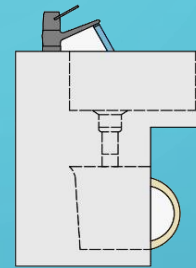
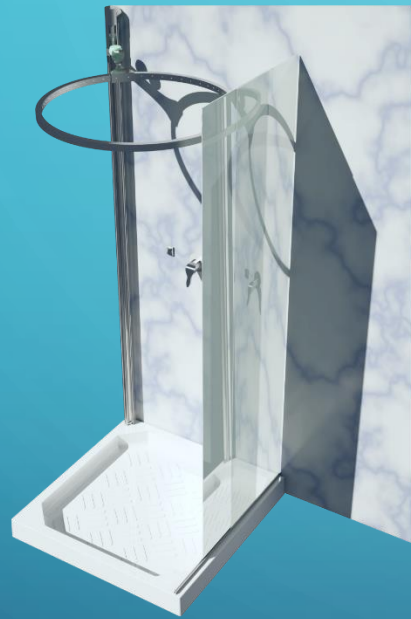
a.y. 2021/2022 - **Idea contest** (objective: bathroom project of the future)

a.y. 2022/2023 - **Experiment** (objective: quantification of the effect of awareness on household water consumption)

... reduction of water consumption (wastage)

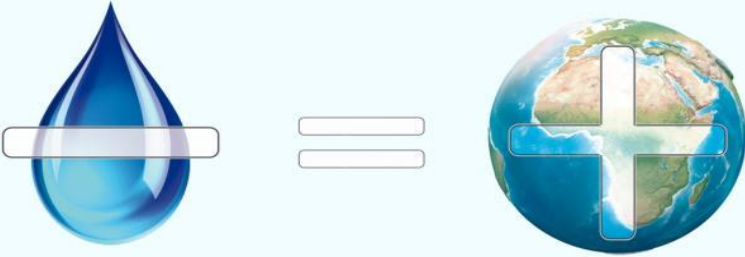


... reduction of water consumption (wastage)

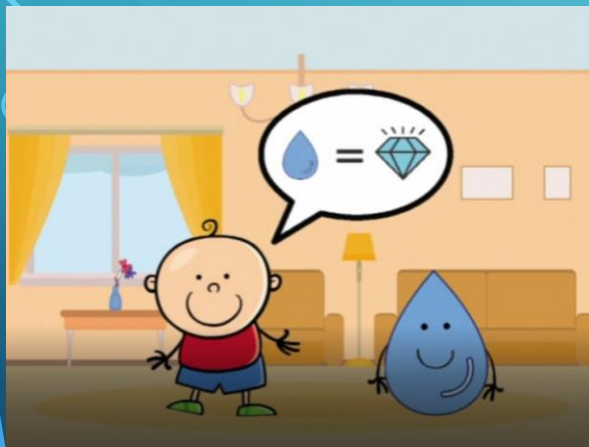


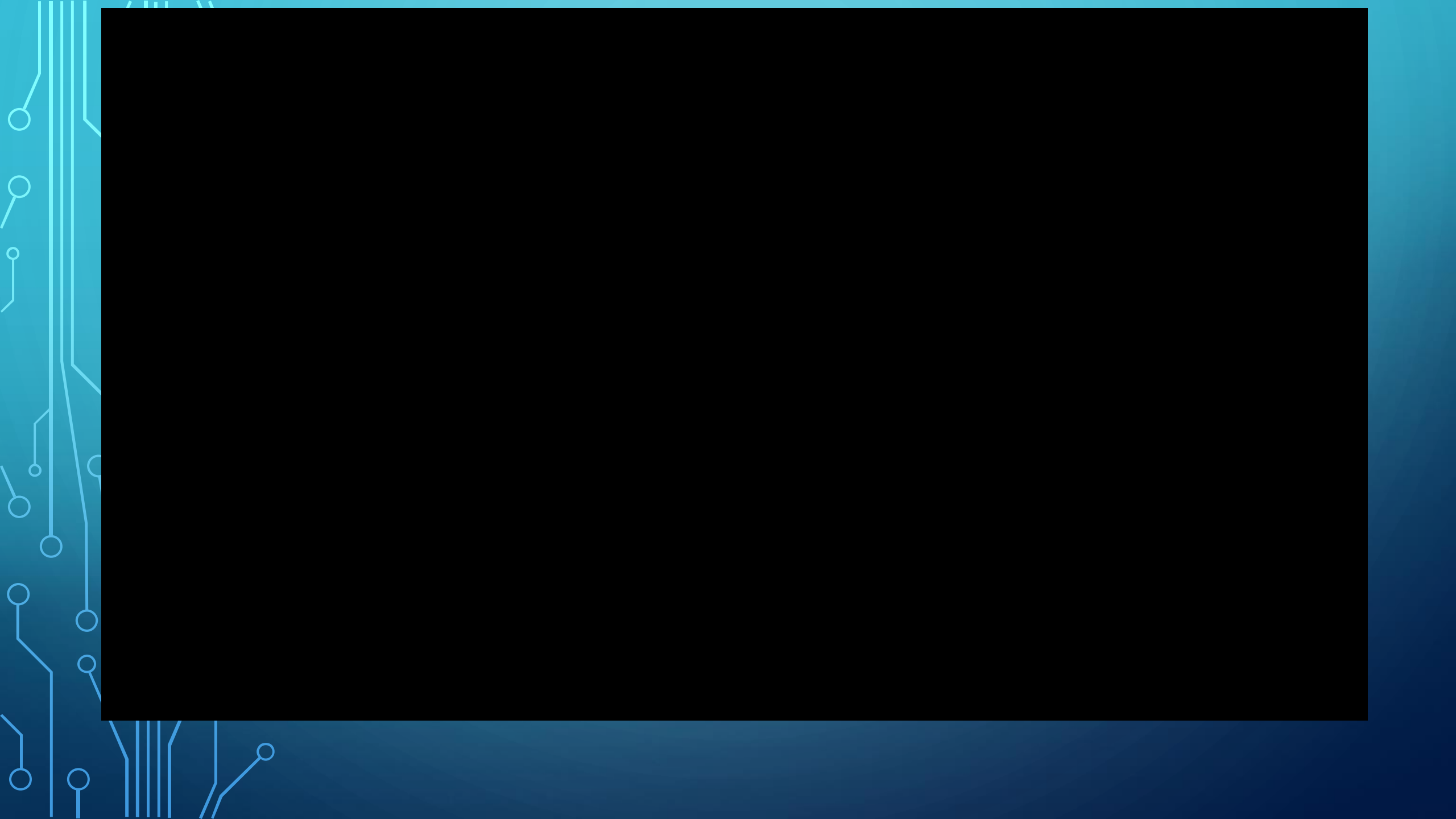
... reduction of water consumption (wastage)

meno consumi più vivi

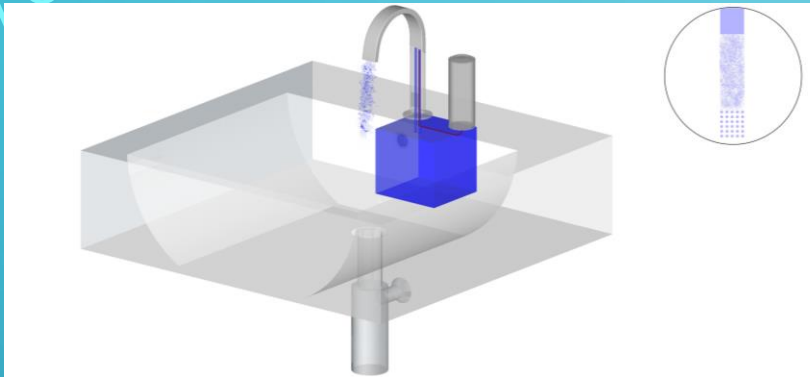


LESS IS MORE



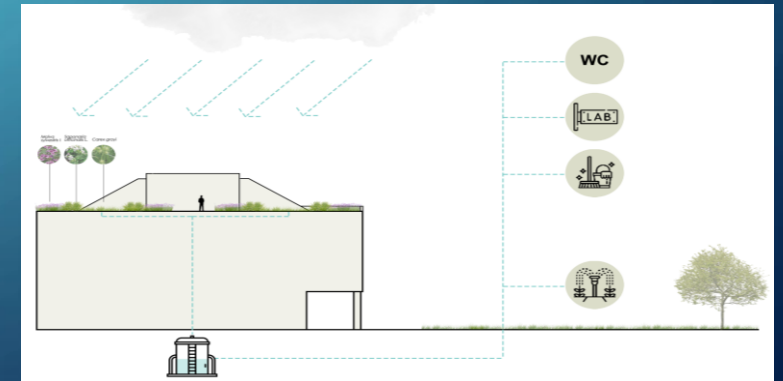
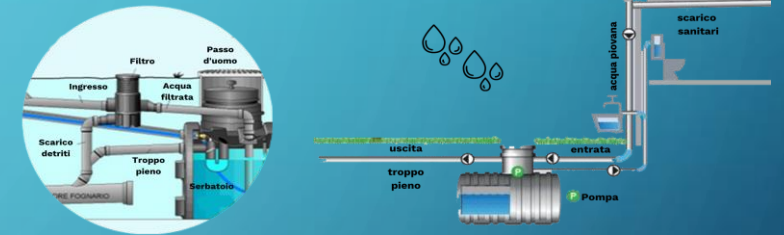


... reduction of water consumption (wastage)

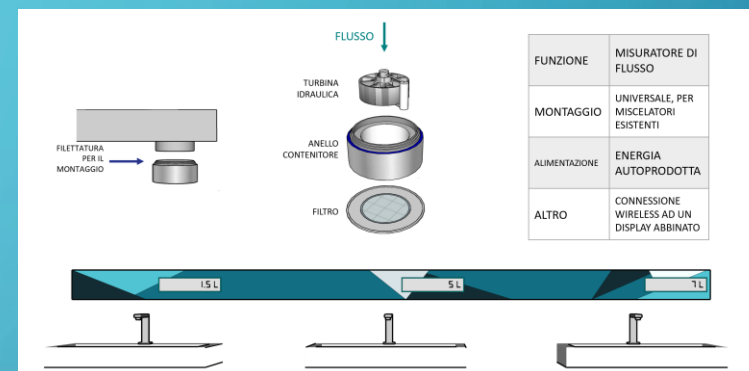
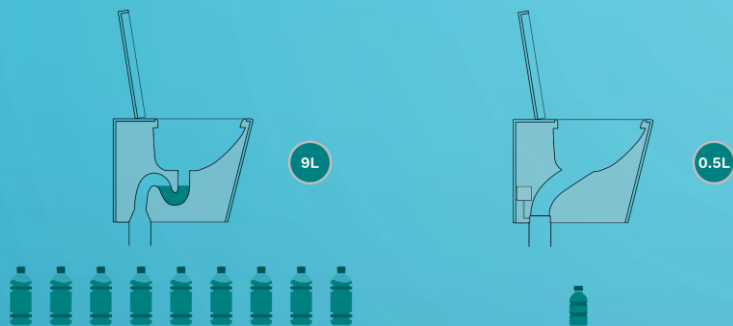


Proposte per il risparmio idrico

Schemi di tipologie di impianto per raccolta acqua piovana



... reduction of water consumption (wastage)



DROPS: Water-closet

Pensato per ridurre gli sprechi in ateneo

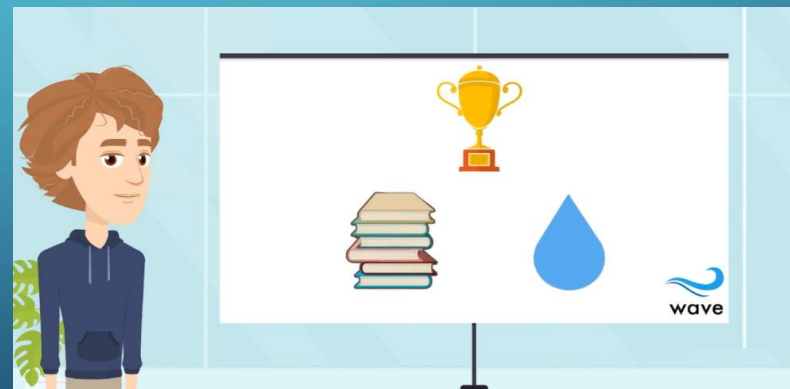
Obiettivi

- Riducare
- Sensibilizzare

Il podcast che
RESPONSABILIZZA

Volete saperne di più?
Buon ascolto!

... reduction of water consumption (wastage)



... reduction of water consumption (wastage)





... reduction of water consumption (wastage)



... reduction of water consumption (wastage)



ABBASSA
IL PULSANTE
QUANDO HAI
FINITO!



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UNIVERSITÀ PER IL
PUGLIA

NON C'È
ACQUA
DA
PERDERE



SCEGLI
IL TASTO
PICCOLO
PER
PICCOLE
NECESSITÀ



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ACQUA
DA
PERDERE



INTERROMPI
IL FLUSSO
D'ACQUA
MENTRE USI
IL SAPONE!



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PUGLIA

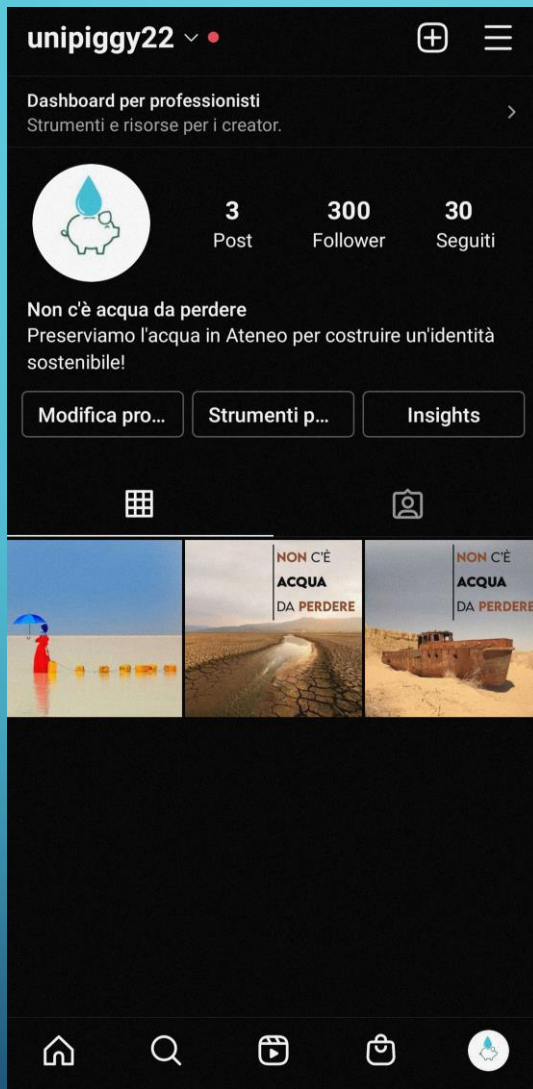
NON C'È
ACQUA
DA
PERDERE



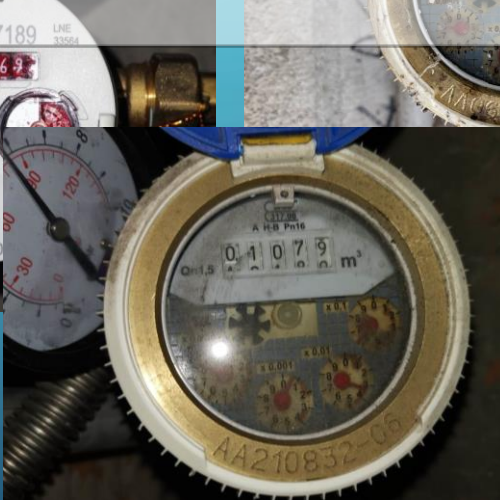
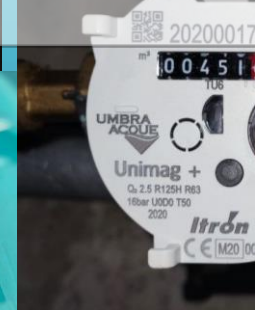
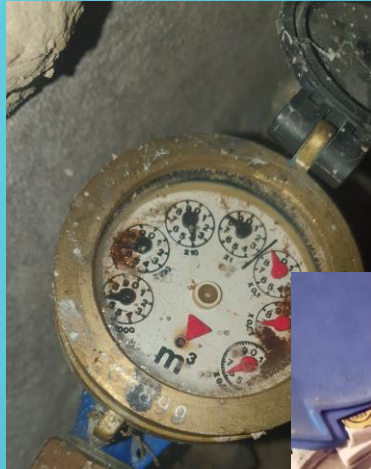
... reduction of water consumption (wastage)



... reduction of water consumption (wastage)



NON C'È ACQUA DA PERDERE





... reduction of water consumption (wastage)

- ✓ Municipalities involved: **Perugia, Foligno, Città di Castello, Orvieto, Assisi, Todi, Umbertide, Bastia Umbra, Magione, Città della Pieve, Collazzone, Castiglione in Teverina (VT), Sinalunga (SI), Rosignano Marittimo (LI), Roma**
- ✓ Number of housing unit involved: **40**
- ✓ Number of people involved: **394**

... reduction of water consumption (wastage)

- ✓ Total number of dispensers: **656**
- ✓ Total number of showers: **232**
- ✓ Total number of WC cisterns: **254 (34% with double push-button)**
- ✓ Total number of washing machines and dishwashers: **113**
- ✓ Housing unit with indoor plants: **78%**
- ✓ Housing unit with flowering terraces: **73%**
- ✓ Housing unit with garden: **38%**

... reduction of water consumption (wastage)

Phase 1



March 03 2023 (8:20)
6781,868 m³



March 24 2023 (8:33)
6785,338 m³

Phase 2



March 24 2023 (8:33)
6785,338 m³



April 14 2023 (8:44)
6788,366 m³

3470 liters
30253 minutes →

0,1147 l/min
(82,58 l/day person)

3028 liters
30251 minutes

0,1001 l/min
(72,07 l/day person)

difference: $(82,58 - 72,07) / 82,58 = 0,1277$

Saving 12,77%

... reduction of water consumption (wastage)

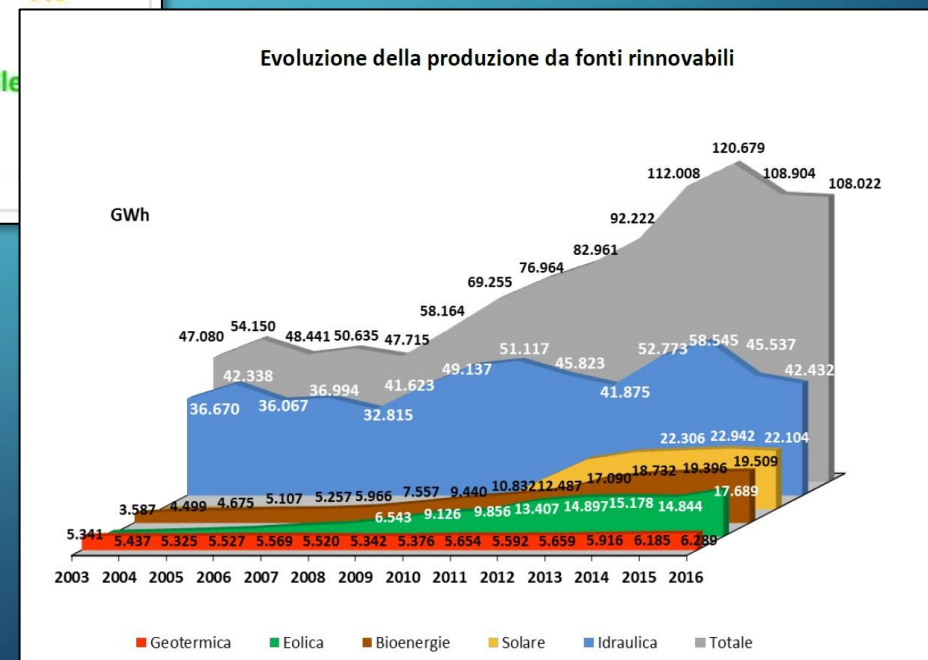
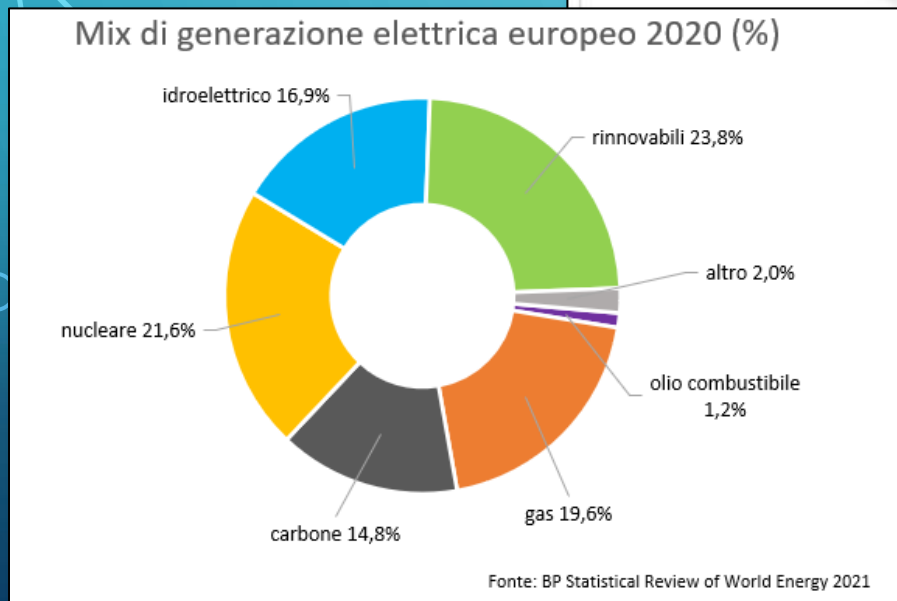
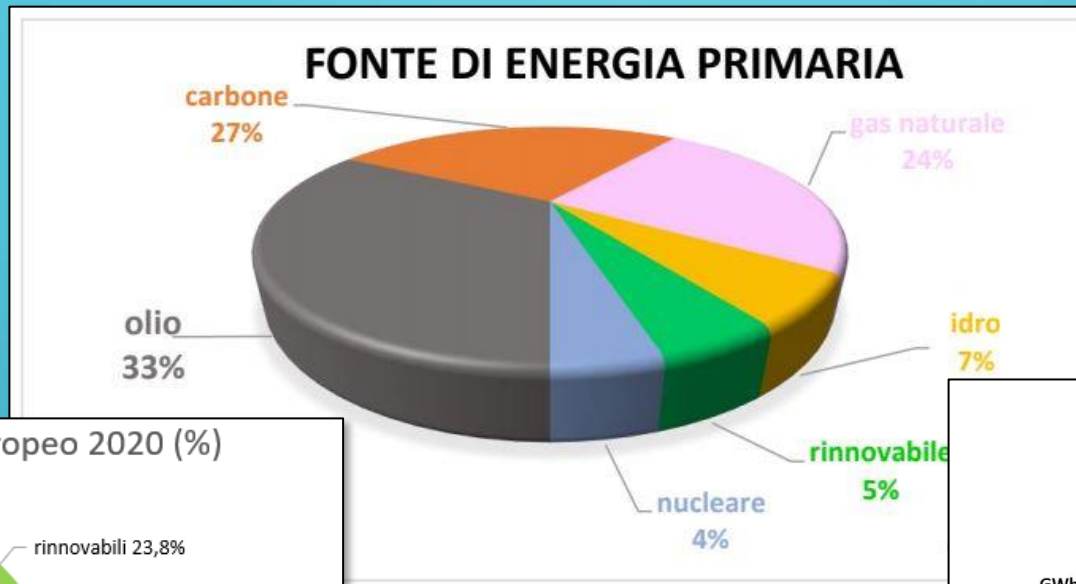
✓ Percent differences «(Phase1-Phase2)/Phase1»

Min Saving -11,4%

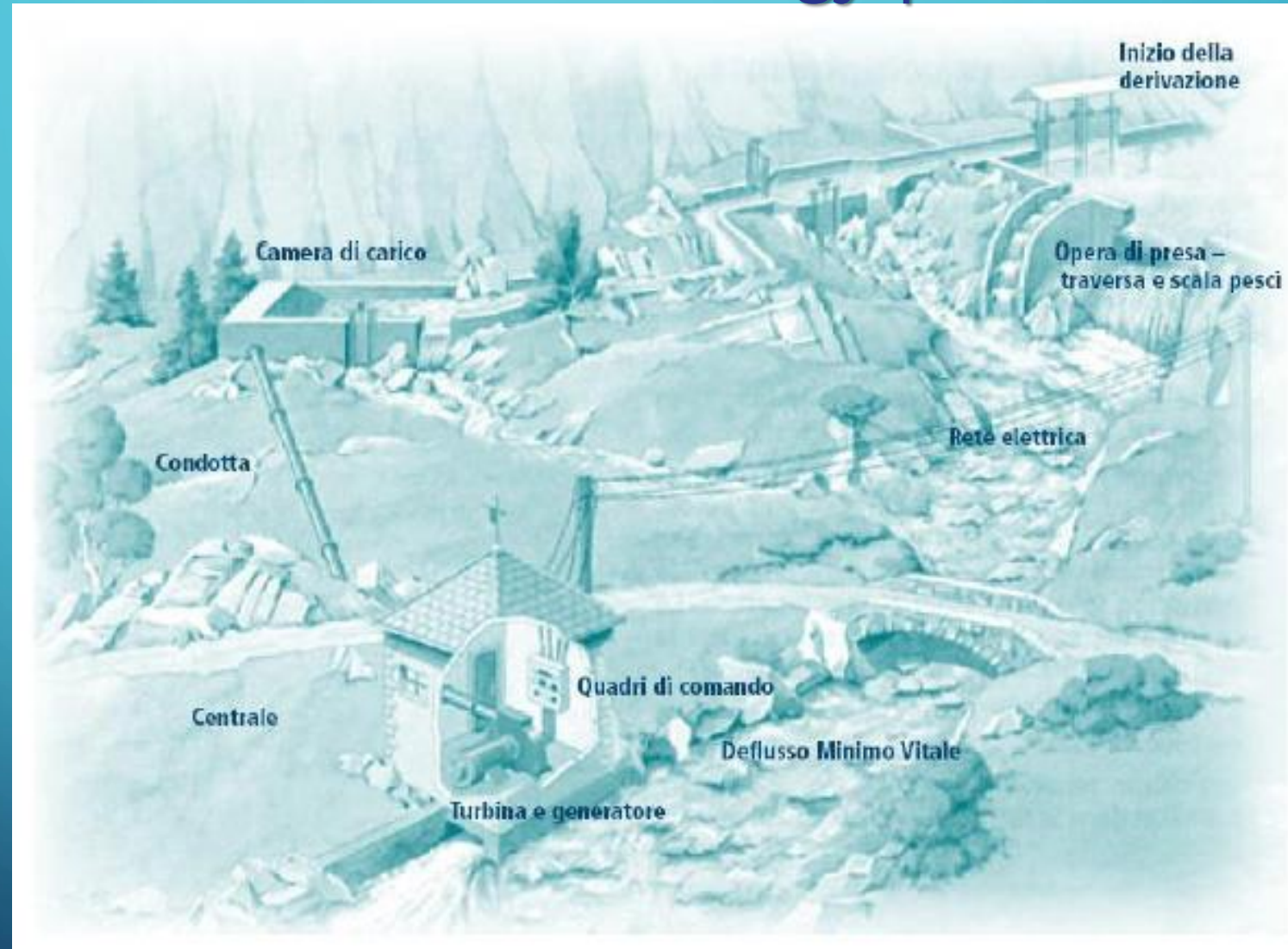
Max Saving +50,5%

**Average Saving
+16,9%**

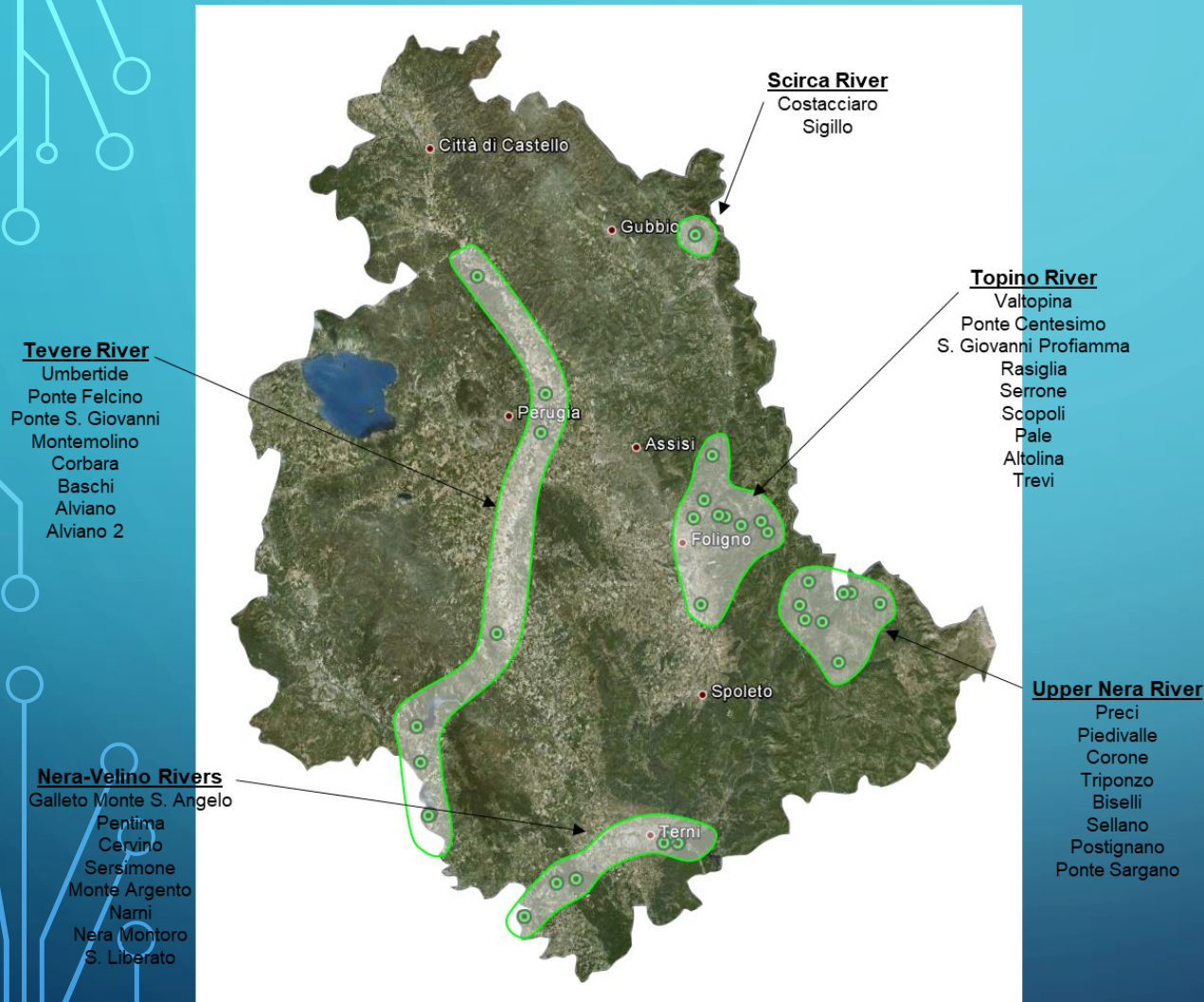
... use of water for energy production



... use of water for energy production

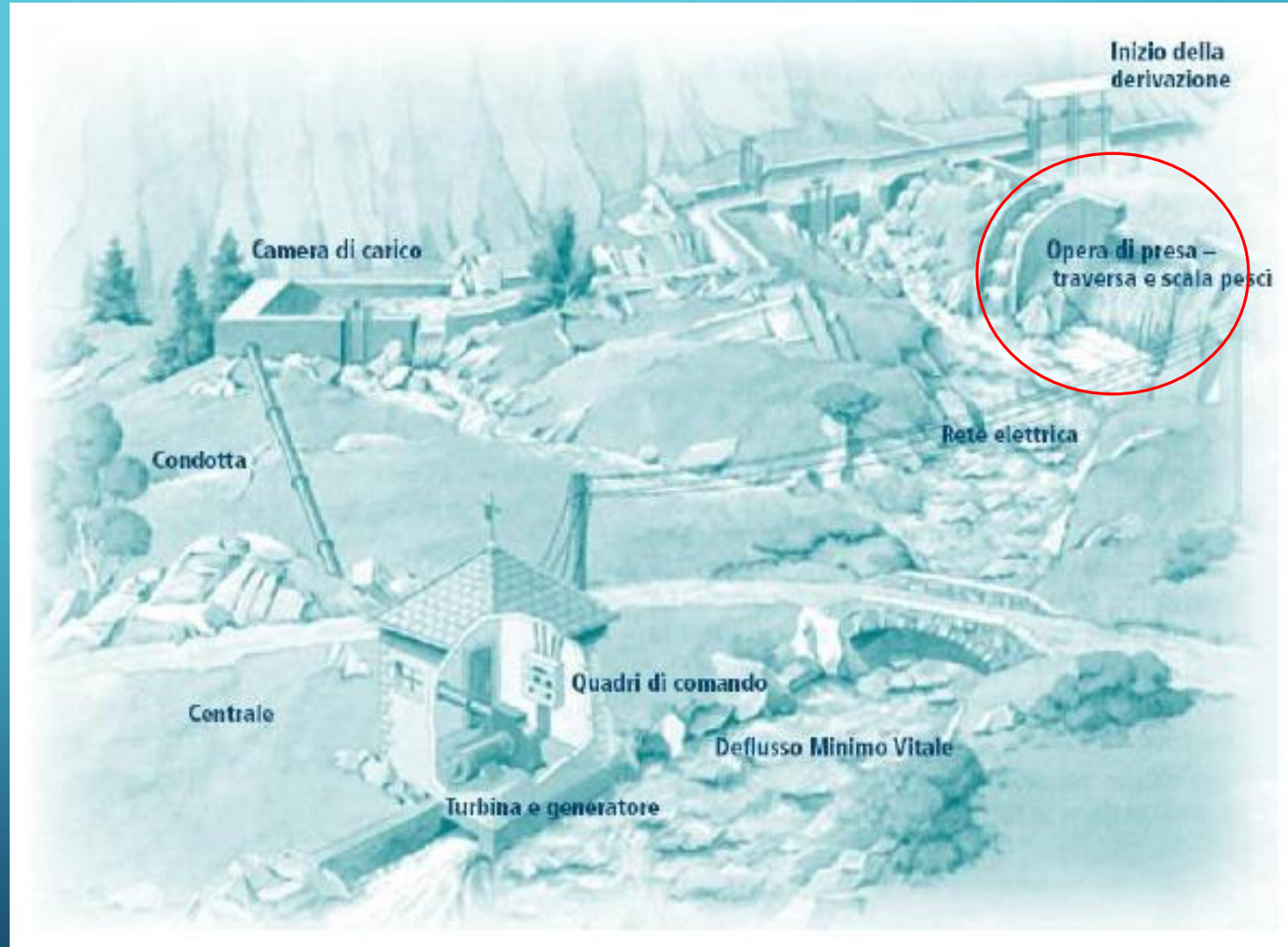


... use of water for energy production



N.	Denominazione impianto	Tipo impianto	N. prese	N. turbine	Tipo turbina	Asse	Salto (m)	Portata Max (m ³ /s)		Potenza (kw)		PMA (MWh)
								Conc.	Turb.	Conc.	Inst.	
1	Umbertide	Af	1	2	K	V	5,20	15,00	15,00	392	671	2820
2	Ponte Felcino	Af	1	5	EL	V	5,50	40,00	42,20	800	1985	5000
3	Ponte S. Giovanni	Af	1	2	K	V	5,90	30,00	20,00	1100	2000	5700
4	Montemolino	Af	1	2	K	O	5,74	40,00	40,00	1250	1000	4000
5	Corbara	Af	1	1	F	V	34,93	2,46	2,46	864	732	4350
6	Baschi	B	1	2	F	V	53,00	150,00	201,00	36180	94000	156875
7	Alviano	B	1	2	K	V	7,30	160,00	167,00	5167	12394	26984
8	Alviano 2	Af	1	2	K	O	4,10	160,00	200,00	2011	5016	8800
9	Preci	Af	1	2	F	V	150,89	8,00	8,10	8136	10884	37635
10	Piedivalle	Af	1	2	F	O	47,61	1,00	1,45	450	450	1300
11	Corone	Af	1	1	BM	O	6,00	1,10	1,00	24	48	10
12	Triponzo	Af	2	1	K	V	40,00	16,00	20,67	5176	7388	26420
13	Biselli	Af	1	1	K	V	5,50	8,00	5,00	270	250	1500
14	Sellano	Af	2	2	F	O	73,00 (64,95)	1,30	1,20	653	700	1500
15	Postignano	Af	1	1	E	O	5,20	0,30	0,15	10	10	50
16	Ponte Sargano	Af	2	2	F	V	91,42 (56,78)	2,40	4,00	1926	3104	6099
17	Galletto Monte S. Angelo	B e Af	5 1	7	6 F 1 K	V	202,50 37,72	226,90 18,09	184,60 19,10	89518 3445	336640 6600	627570 5250
18	Pentima	Af	1	1	F	O	151,78	5,00	4,00	1442	6060	40000
19	Cervino	Af	1	2	F	O	19,40	4,50	4,00	535	656	3091
20	TK AST 2	Af	1	1	K	I	3,98	4,40	5,30	172	180	1050
21	Pentima 3	Af	1	1	F	O	55,70	1,40	1,60	765	650	3400
22	Terria 2	Af	1	1	P	O	55,81	0,15	0,15	83	83	473
23	Sersimone	Af	1	1	F	O	25,45	4,50	5,00	702	1150	4182
24	Monte Argento	B e Af	1	3	F	V	50,60	150,00	150,00	37950	68580	165689
25	Narni	B	2	2	K	V	27,95	180,00	182,00	21511	46776	103128
26	Nera Montoro	Af	1 1	4	3 F 1 K	V	24,20 15,20	150,00 25,00	150,00 25,00	18743 2161	33540 2944	91761 13533
27	S. Liberato	B	1	2	K	V	11,45	180,00	200,00	11787	21000	51500
28	Valtopina	Af	1	1	F	O	4,95	2,20	2,20	58	106	382
29	Ponte Centesimo	Af	1	2	F	O	31,00	3,50	1,30	672	800	4000
30	S. Giovanni Profiamma	Af	1	1	K	V	14,60	1,00	0,75	105	120	500
31	Rasiglia	Af	1	1	F	O	20,20	1,50	1,50	119	240	870
32	Serrone	Af	1	2	F	O	12,55	1,50	2,80	147	148	541
33	Scopoli	Af	1	2	F	O	46,08	1,50	2,00	542	900	1500
34	Pale	Af	1	1	F	O	26,83	1,50	1,50	342	270	1500
35	Altolina	Af	1	2	F	O	156,63	1,50	2,00	1889	2430	5604
36	Trevi	Af	1	1	E	O	4,20	2,00	1,50	45	62	20
37	Costacciaro	Af	1	1	F	O	12,75	0,10	0,30	12	22	26
38	Sigillo	Af	1	1	F	O	7,00	0,16	0,16	7	20	22

... use of water for energy production



... use of water for energy production

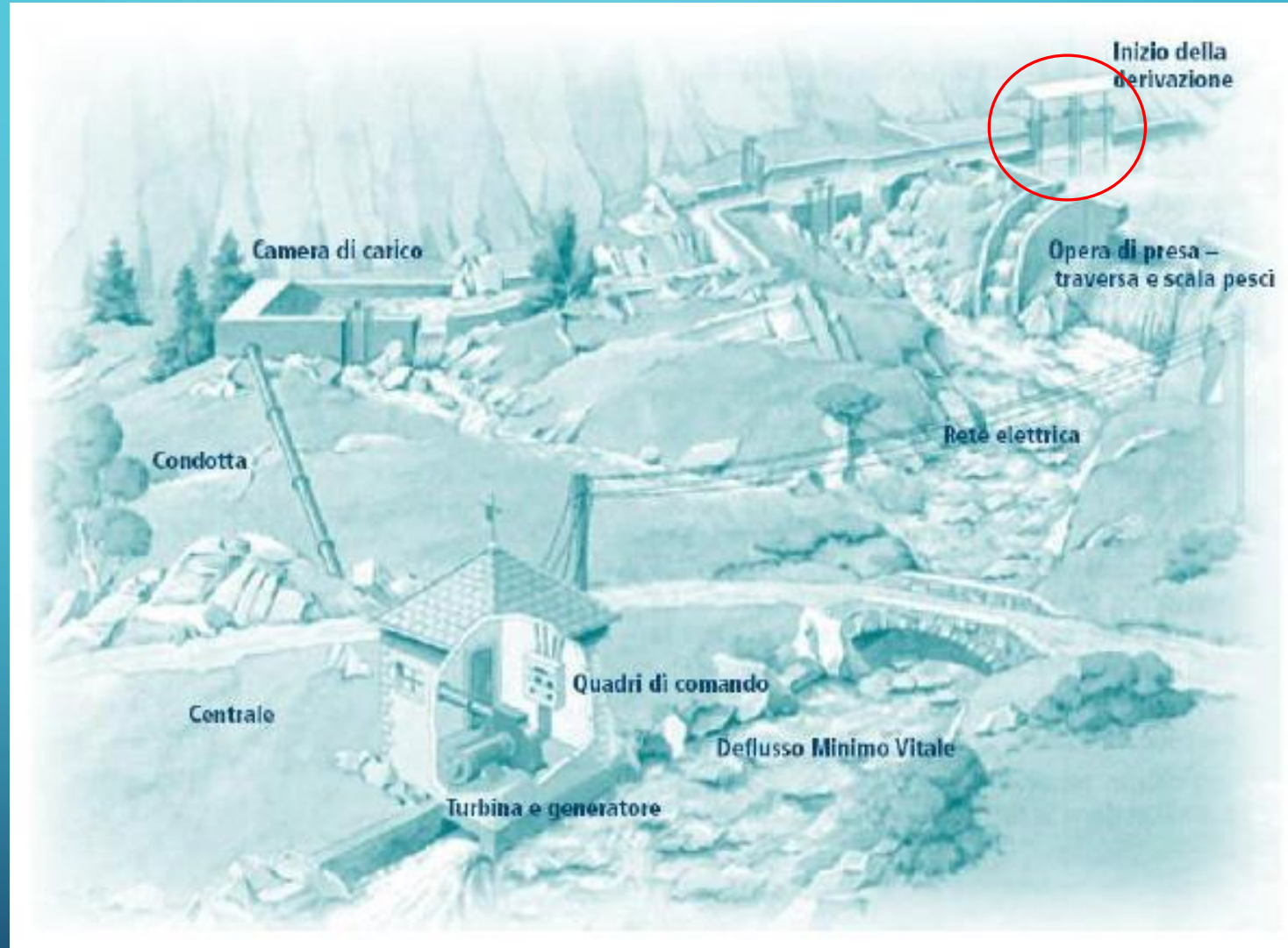


Barriers

San Giovanni a Piro
Ponte San Giovanni
Ponte San Giovanni

chi

... use of water for energy production



... use of water for energy production

Intake works

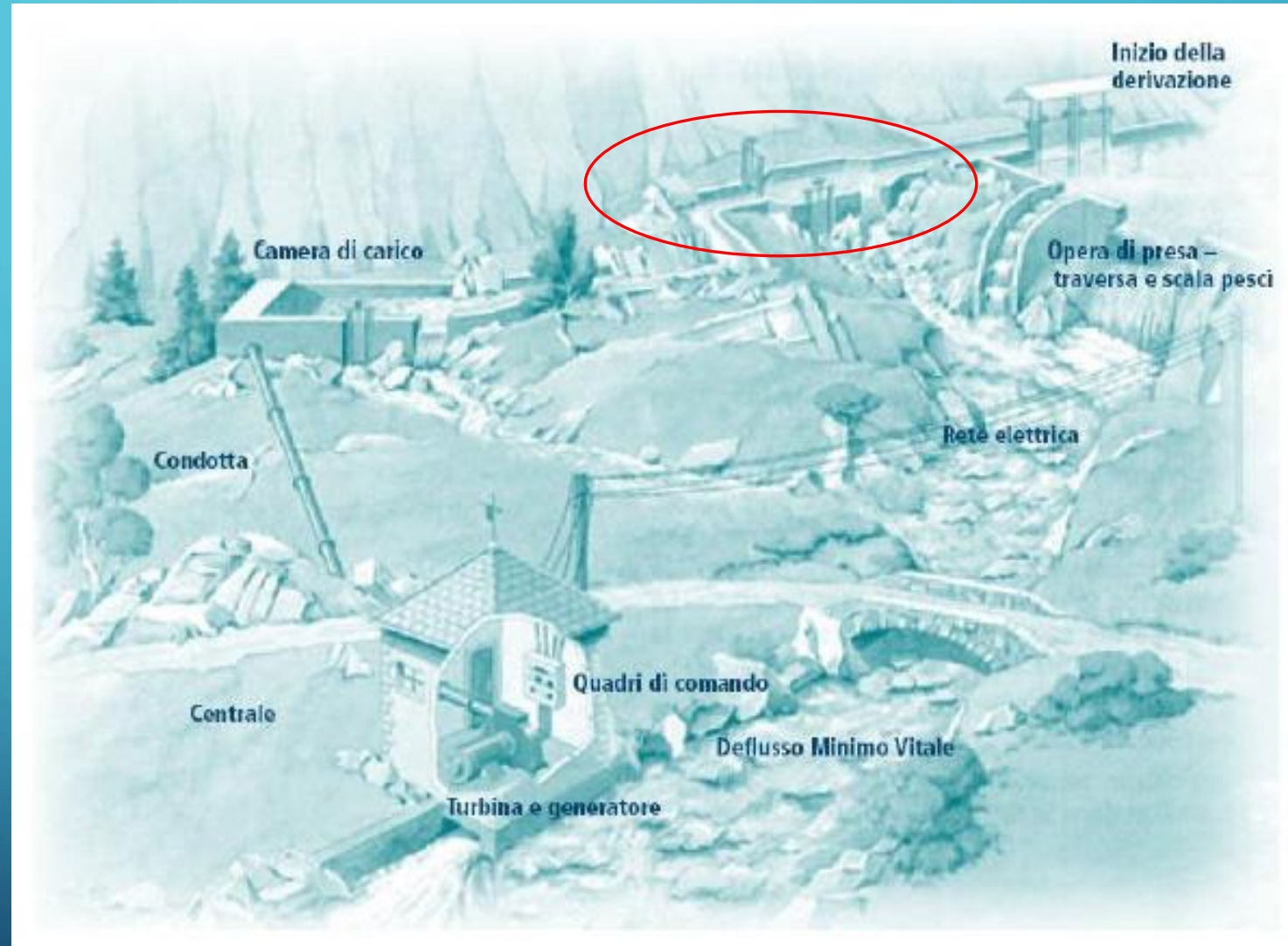


Galleto

Sellano (Fosso delle Rote)

(Bertone)

... use of water for energy production



... use of water for energy production



Callabate



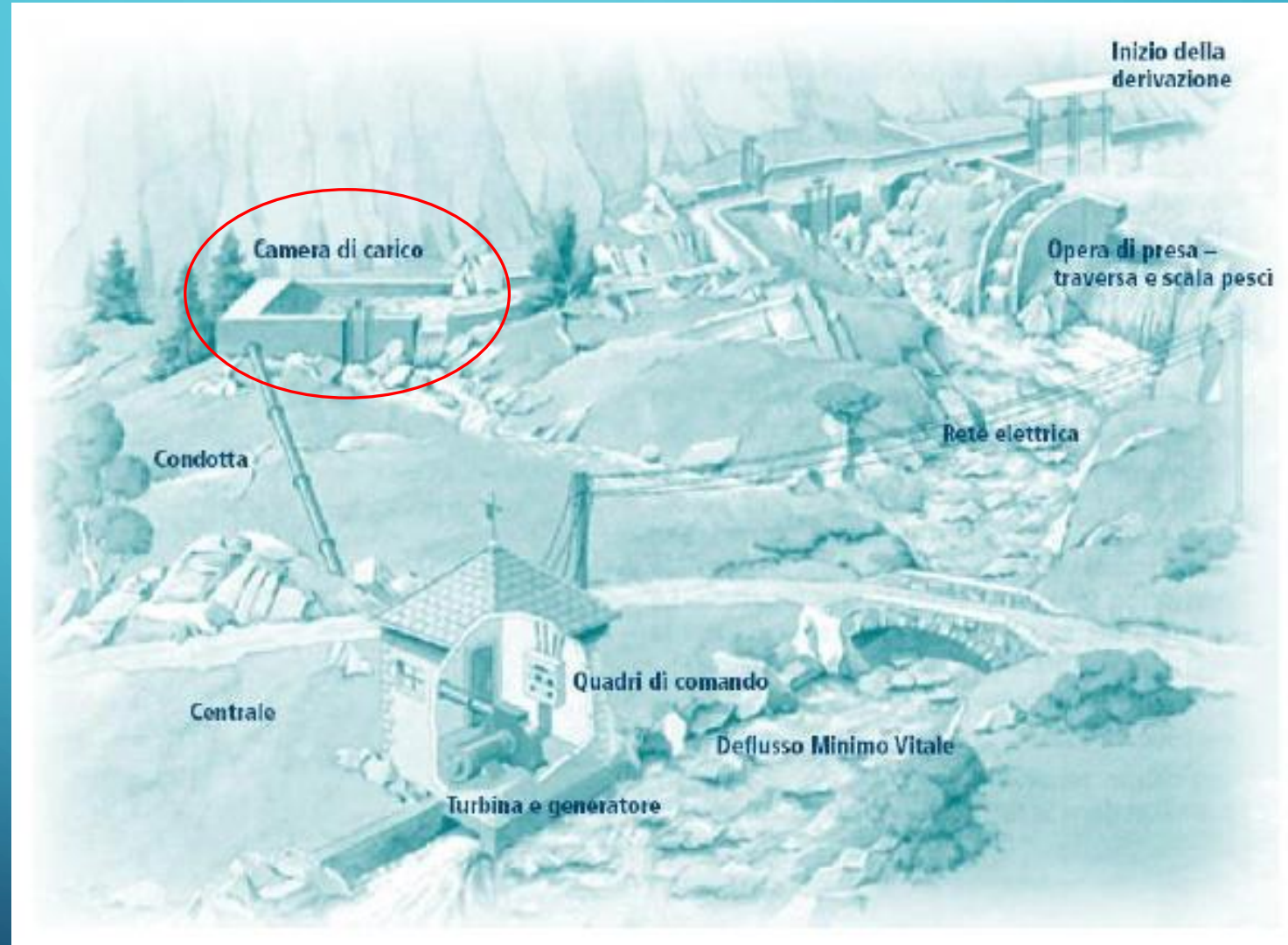
Montemolino



San Bello

Bypass
channels

... use of water for energy production



... use of water for energy production

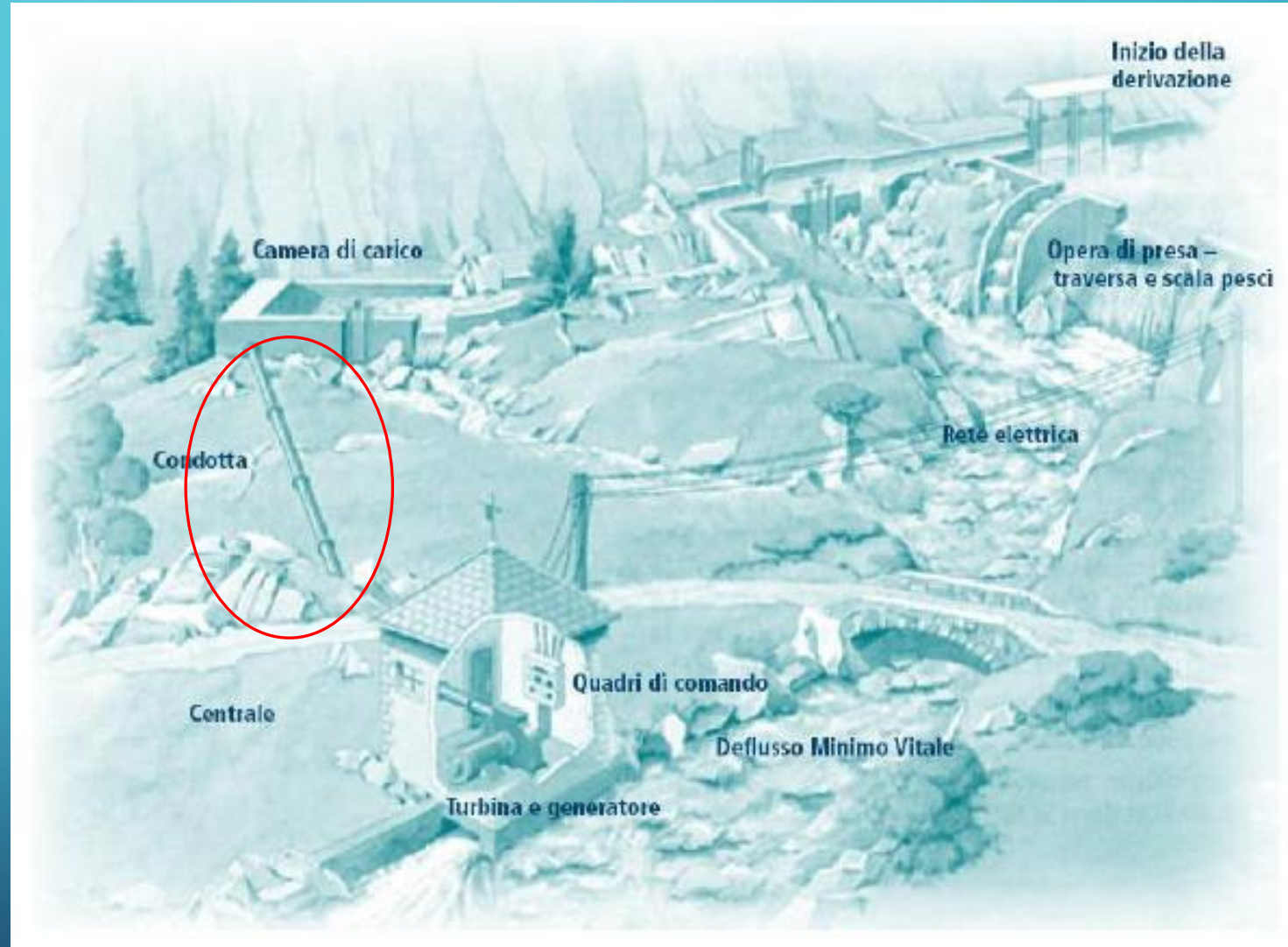


Loading tanks

Costacciaro

(SUEC SpA)
(SUEC SpA)

... use of water for energy production



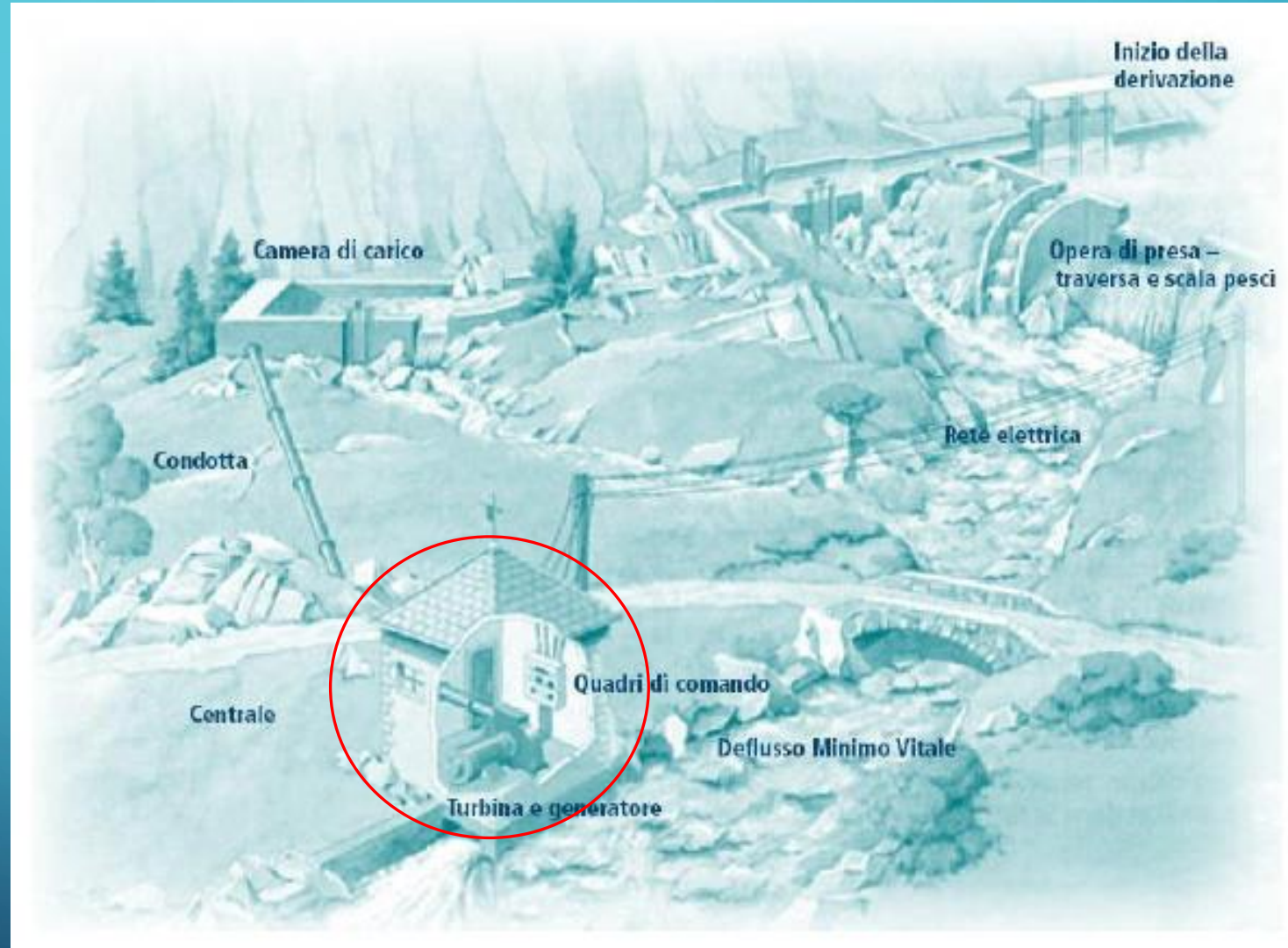
... use of water for energy production

Forced conduits



Gaetano Vignati, Angelo Ponzonzo
Pontesingola

... use of water for energy production

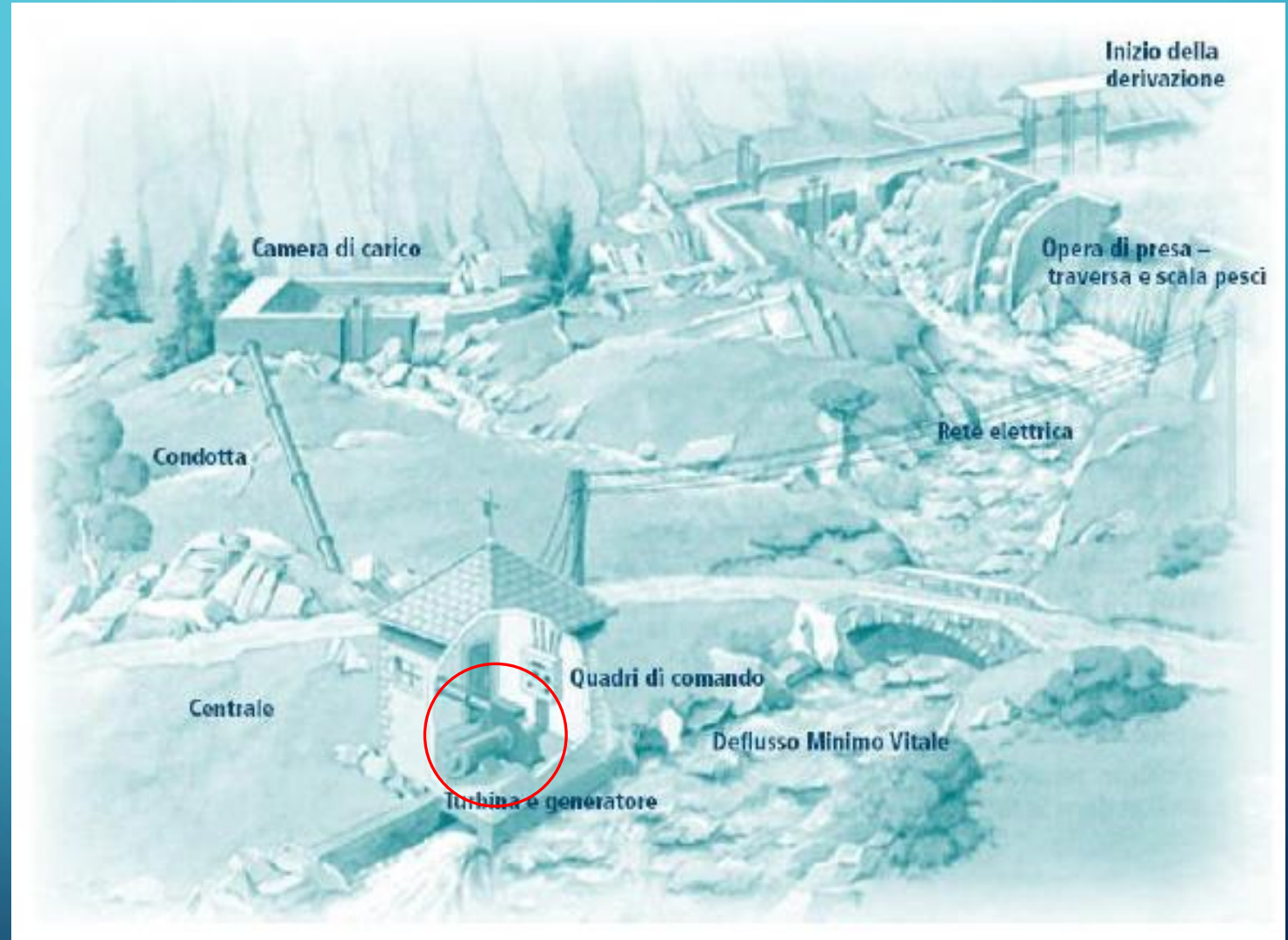


... use of water for energy production



Power station
buildings

... use of water for energy production



... use of water for energy production



Electro-
mechanical units

S. Giovanni Profiamma (disused)
Galleria (1961)

... respect for natural rivers





WATER AND ENVIRONMENTAL SUSTAINABILITY
IN A CLIMATE-CHANGING CONTEXT

Thanks

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