Extreme floods value distributions under recent global warming in Northern Italy, and new risk management policies. The project FLORIMAP

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ABSTRACT

Flood risk in Italy is a wide-spread and never-ending issue. Traditional flood defense focused on making the river system "resistant" to flood events, possibly by flood-control structures including floodwalls, levees, dams and channels. These actions reduce the frequency of inundations, but they do not affect flooding effects, and associated impacts once the flood plain is inundated. In facts, structural flood defenses are designed and operated to accommodate floods not exceeding a given magnitude, as fixed by the original design. Thus, these engineering works are highly inefficient to cope with capacity-exceeding floods, the magnitude of which was fixed many years ago using poor data sets, and it is expected to increase with climate changes.

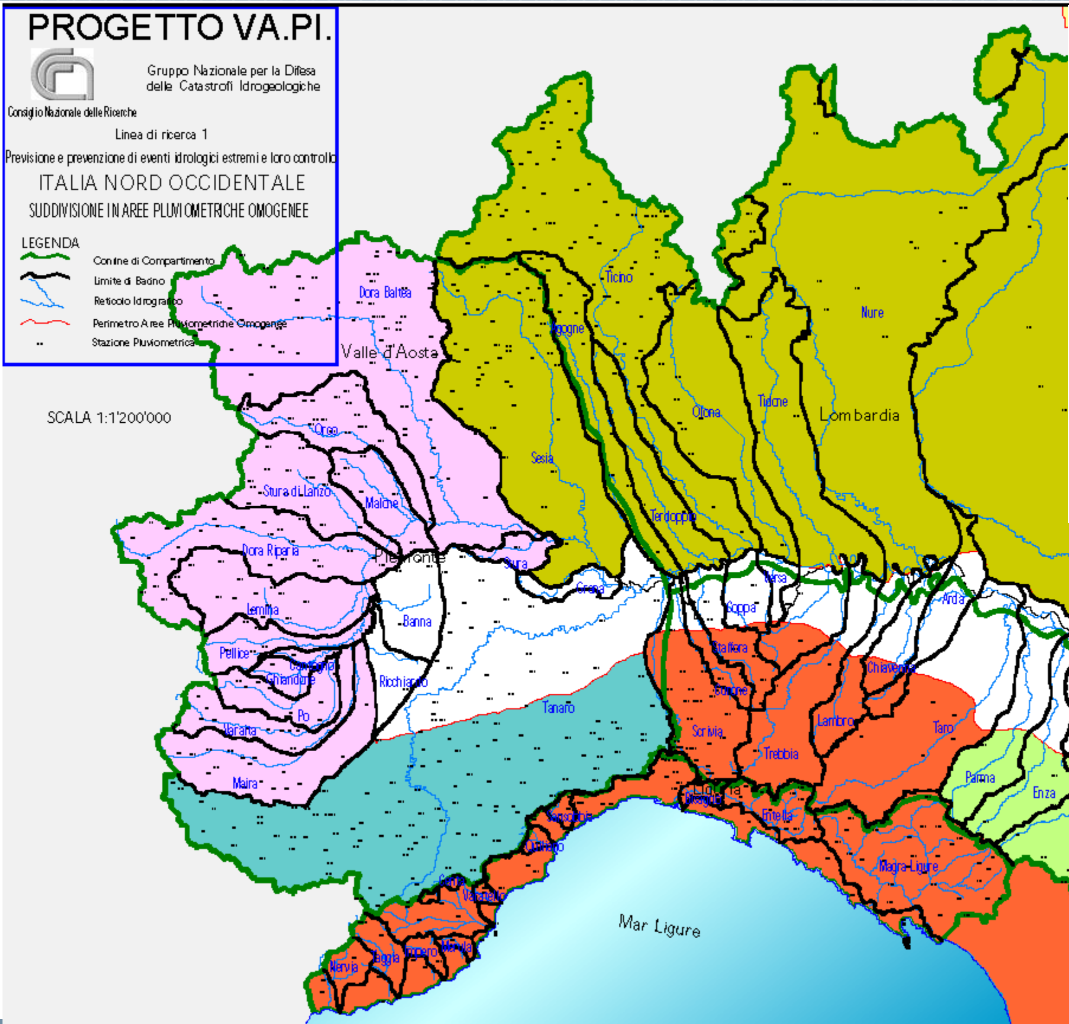
FLORIMAP (Smart FLOod RIsk MAnagement Policies), a project funded by Fondazione CARIPLO aims to revalue extreme floods distribution in the different homogeneous areas of northern Italy, updating the regional approaches originally designed by VAPI (Flood Evaluation) project, based upon a previous dataset covering approx. 1920-1970. For this purpose, in the FLORIMAP project we use flood data gathered during the last three decades.

FLORIMAP will first cover open issues associated with the quantification of flood hazard and inundation risk, then it will assess human exposure and vulnerability, and combine these issues with strategies of communication and risk management, because risk communication is an important activity that can influence the flood risk management. Communication is the bridge between the technical and professional community, decision makers, elected officials, funding sources, and the public at large. The literature on risk communication and perception has highlighted that the understanding of the psychological perception of environmental risk is a crucial factor in order to foster the community resilience and to promote adaptive attitudes and behaviors.

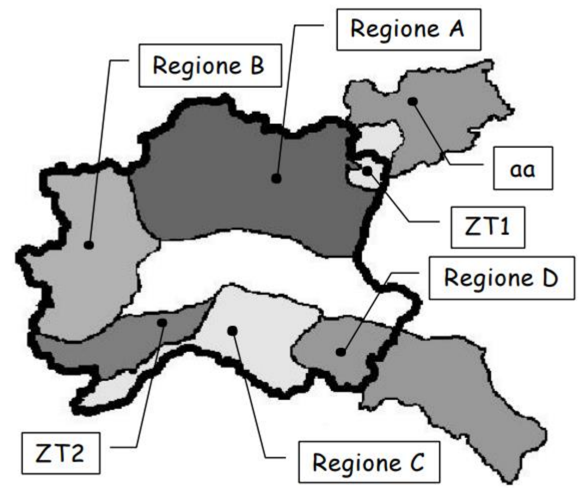
Here, we present a preliminary assessment of updated extreme values distribution for the case study of Northern Italy hydrologically homogeneous regions. The results will be then compared against those obtained with previous dataset dating until 1970, to study the evolution of flood hazard and inundation risk under recent climate change. We then provide application of flood hazard, and risk for a case study area, and demonstrate modified hazard under recent climate change.

We then discuss implications for risk communication in the target areas, and provide suggestions for prosecution of the FLORIMAP project.

HOMOGENEOUS AREAS OF NORTH-WESTERN ITALY



Homogeneous areas of North-Western Italy in relation to floods regime



DATA - REGION A

HOMOGENEOUS REGION A						
#	Station	Basin	A [km^2]	N "Pre '70"	N "Post'70"	N "Completo"
1	Capo di Ponte	Oglio	777	11	/	11
2	Ponte Cene	Serio	445	25	22	47
3	Ponte Briolo	Brembo	765	31	29	60
4	Tirano	Adda	906	15	/	15
5	Fuentes	Adda	2498	44	41	85
6	Colombaio	Bevera	40.2	18	/	18
7	Ponte Gurone	Olona	97	9	/	9
8	Passobreve	Cervo	22	13	9	22
9	Ponte Folle	Mastallone	149	33	10	43
10	Santino	San Bernardino	125	14	8	22
11	Ponte Aranco	Sesia	695	17	/	17
12	Campertogno	Sesia	170	26	8	34
13	Cadarese	Toce	183	15	/	15
14	Candoglia	Toce	1532	38	30	68

DATA – REGION B

HOMOGENEOUS REGION B						
#	Station	Basin	A [km2]	N “Pre ‘70”	N “Post’70”	N “Completo”
1	Saint Oyen	Artanavaz	69.1	14	/	14
2	Champorcher	Ayasse	42.7	22	/	22
3	Fenestrelle	Chisone	154.2	19	/	19
4	San Martino	Chisone	580.5	21	17	38
5	Aosta	Dora Baltea	1845.7	16	/	16
6	Ponte Mombardone	Dora Baltea	372.1	14	/	14
7	Ulzio	Dora Riparia	260	30	13	43
8	Sant'Antonino Susa	Dora Riparia	1040	31	6	37
9	Monterosso	Grana	109.8	35	20	55
10	Gressoney St. Jean	Lys	90.7	18	/	18
11	Pont Canavese	Orco	613.9	42	7	49
12	Eau Rousse	Savara	82.4	16	2	18
13	Lanzo	Stura di Lanzo	578.3	40	24	64
14	Rore	Varaita	278.3	28	30	58

DATA – REGION C

HOMOGENEOUS REGION C						
#	Station	Basin	A [km2]	N "Pre '70"	N "Post'70"	N "Completo"
1	Saint Dalmas Tende	Roja	173	19	/	19
2	Airole – Piena	Roja	477	33	14	47
3	Merelli - Cent. Arg.	Argentina	192	46	20	66
4	Rugge di Pontedassio	Impero	69	29	7	36
5	Villanova d'Alb.	Lerrone	47	14	/	14
6	Cisano	Neva	124	37	20	57
7	Salto del Lupo	Varatello	17	9	/	9
8	Segheria Piccardo	Letimbro	35	17	/	17
9	Ponte Poggi - Ellera	Sansobbia	32	44	9	53
10	San Martino	Lavagna	163	39	/	39
11	Vignolo	Sturla	102	21	/	21
12	Caminata	Graveglia	41	24	17	41
13	Panesi	Entella	364	36	13	49
14	Nasceto - Santa Margherita	Vara	206	31	22	53
15	Piana Battolla	Vara	548	10	/	10
16	Cabanne	Aveto	43	29	12	41
17	Valsigiara	Trebbia	226	39	10	49
18	San Salvatore	Trebbia	631	20	/	20
19	Santa Maria	Taro	30	24	/	24
20	Piane di Carniglia	Taro	91	30	/	30
21	Pradella	Taro	298	14	9	23
22	Ostia	Taro	408	10	10	20
23	San Quirico	Taro	1476	23	/	23
24	Licciana	Taverone	77	12	/	12
25	Baracche - Pertuso	Borbera	202	22	/	22
26	Isola del Cantone	Scrivia	214	12	/	12
27	Serravalle	Scrivia	605	28	12	40

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Index-Flood Method

$$q_T = q_{indice}\, x_T \quad \begin{cases} q_{indice} = \mu_Q \\ x_T = x(T) \\ x = Q/q_{indice} \end{cases}$$

$Q =$ *Maximal Annual Floods*

Growth curve

$$x_T = \varepsilon + \frac{\alpha}{k}\left[1 - \left(-ln(1 - 1/T)\right)^k\right]$$

GEV distribution

$k, \alpha, \varepsilon =$ *regional parameters*

$$y_T = -\ln(-\ln(((T-1))/T))$$

$$Var[\hat{x}_T] = \left(\frac{\alpha^2}{n}\right)\exp(y_T \exp(-1.823k - 0.165))$$

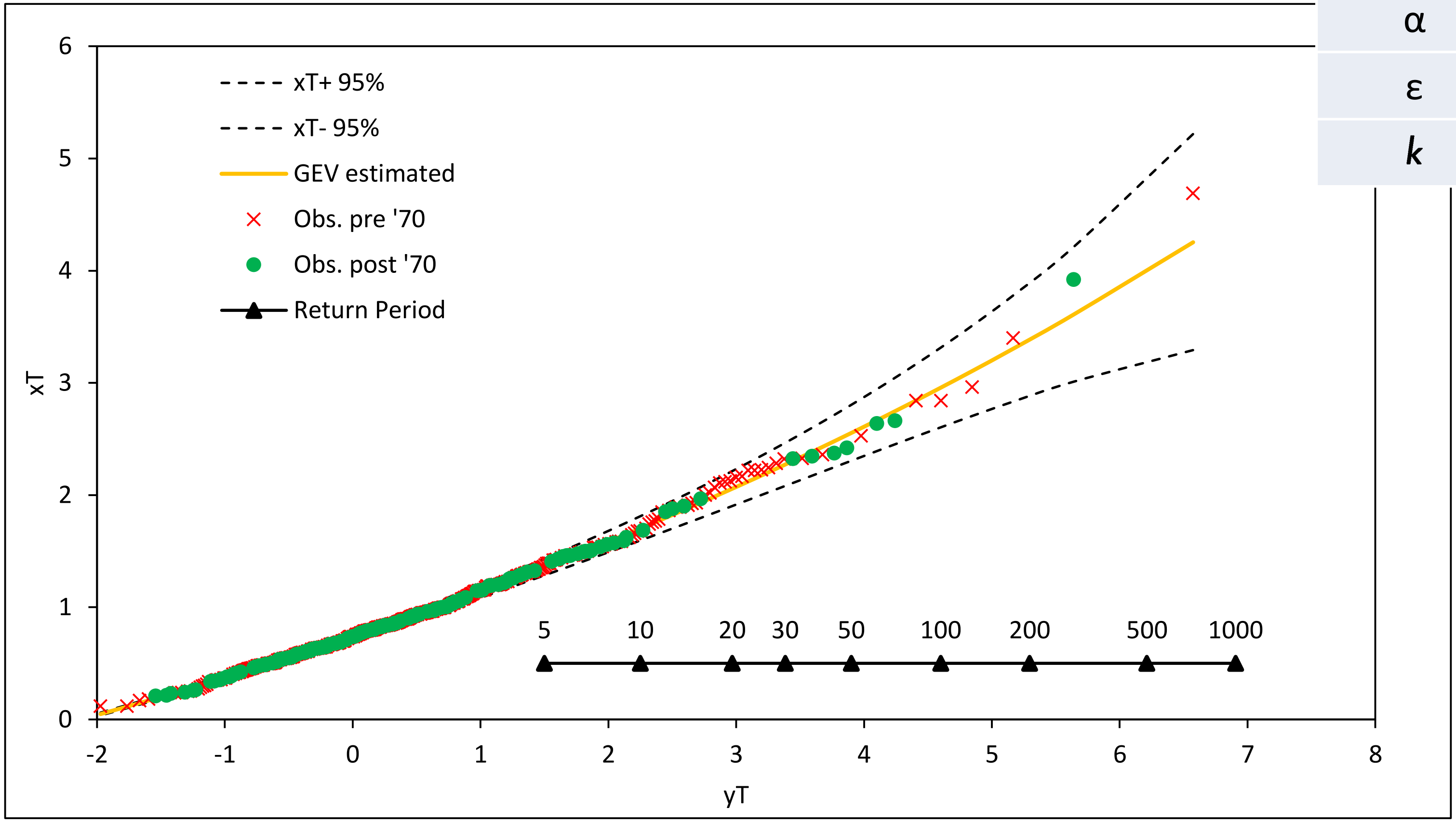
$n =$ *sample size*

$$\hat{q}_T \pm z_{1-\alpha/2}[Var(\hat{q}_T)]^{1/2}$$

$\alpha\%$ *Confidence limits*

Region A - Completo

GEV distribution fitting



GEV Parameters	
α	0.384
ε	0.738
k	-0.096

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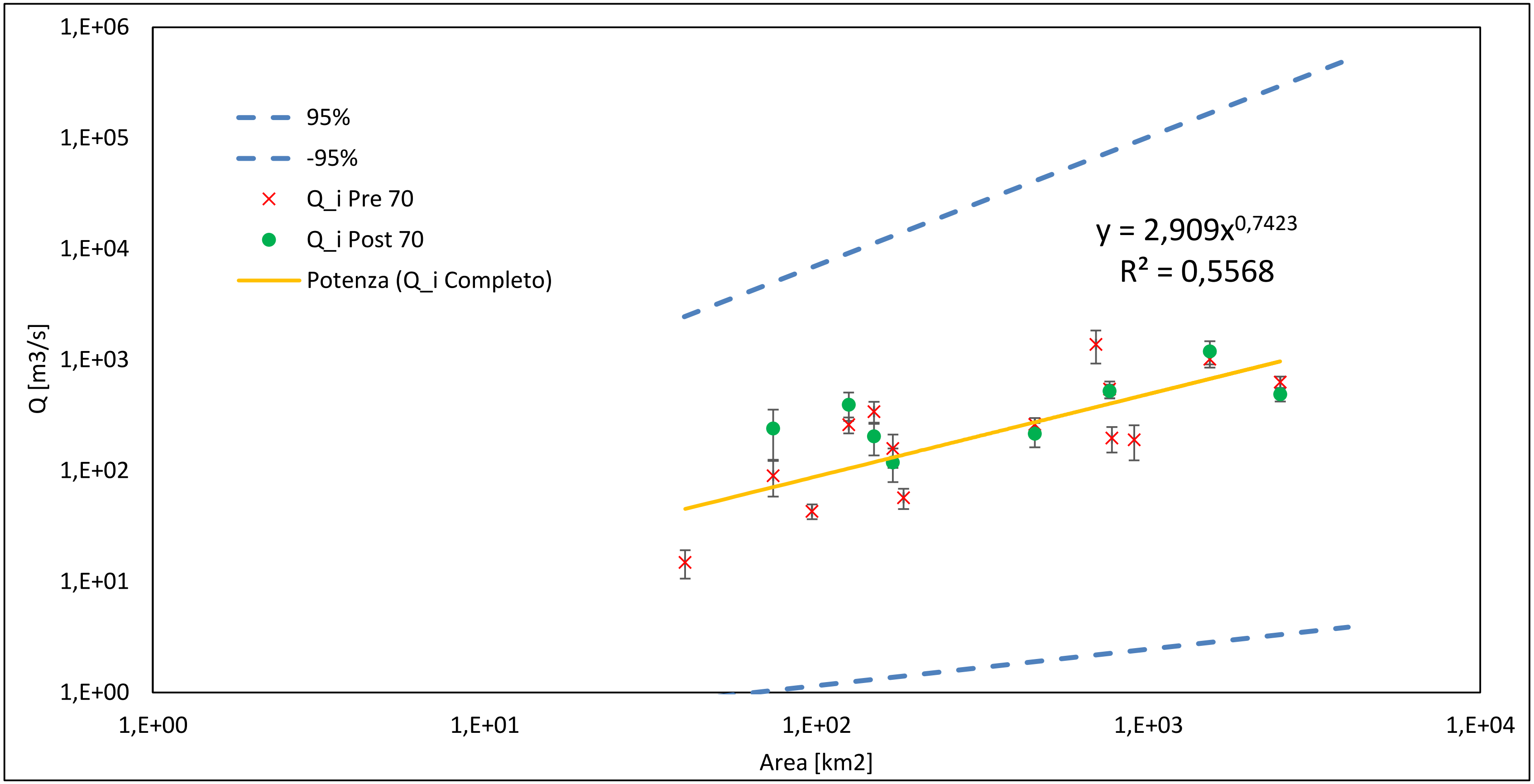
GEV distribution fitting

	VAPI	PRE '70	POST '70	COMPLETO
α	0,365	0,371	0,400	0,384
ε	0,745	0,750	0,762	0,738
k	-0,110	-0,093	-0,017	-0,096
N	316	309	157	466

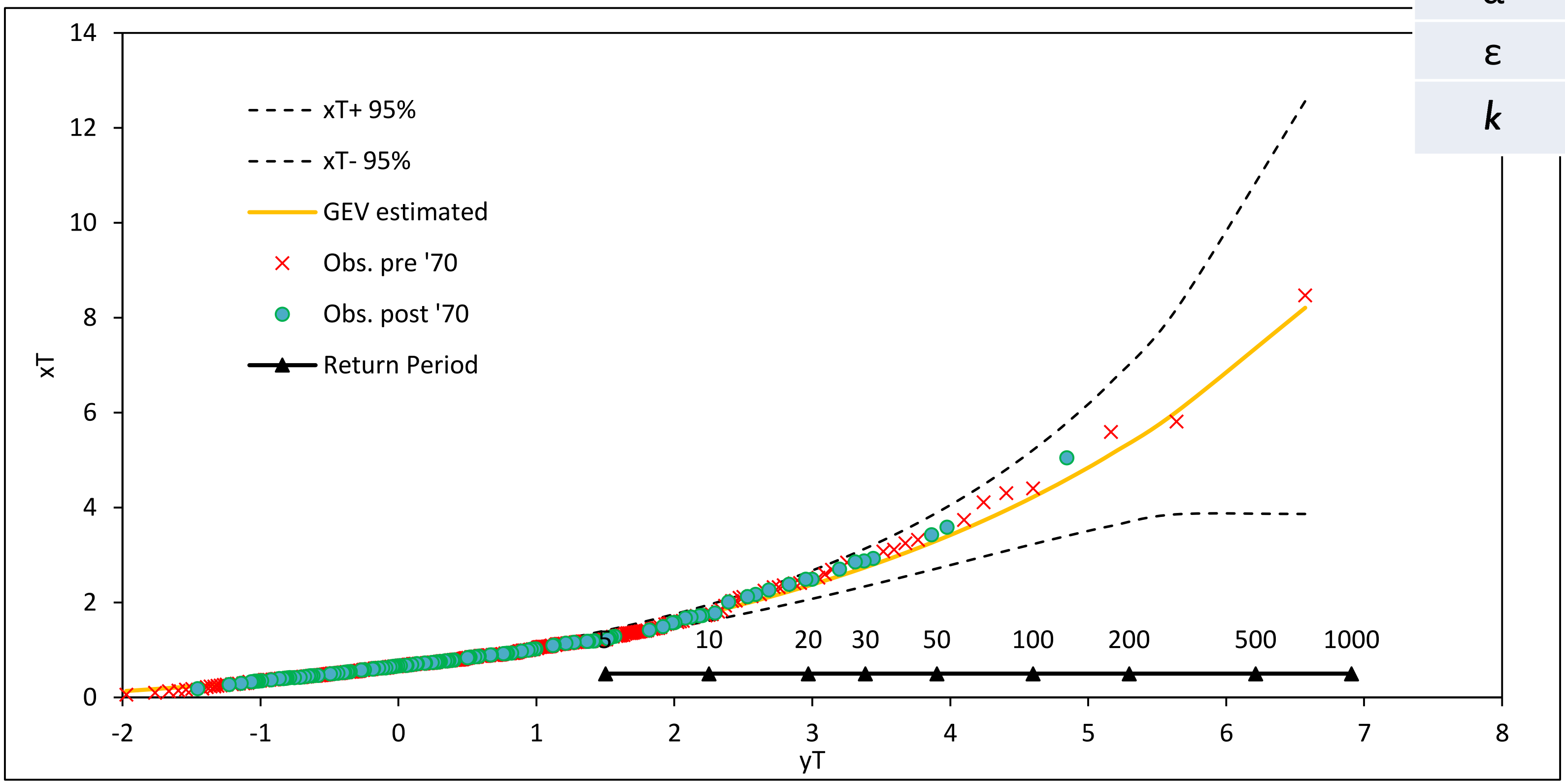
Region A – Completo

Scale Invariance



Regione B– Completo

GEV distribution fitting



GEV Parameters	
α	0.348
ε	0.646
k	-0.312

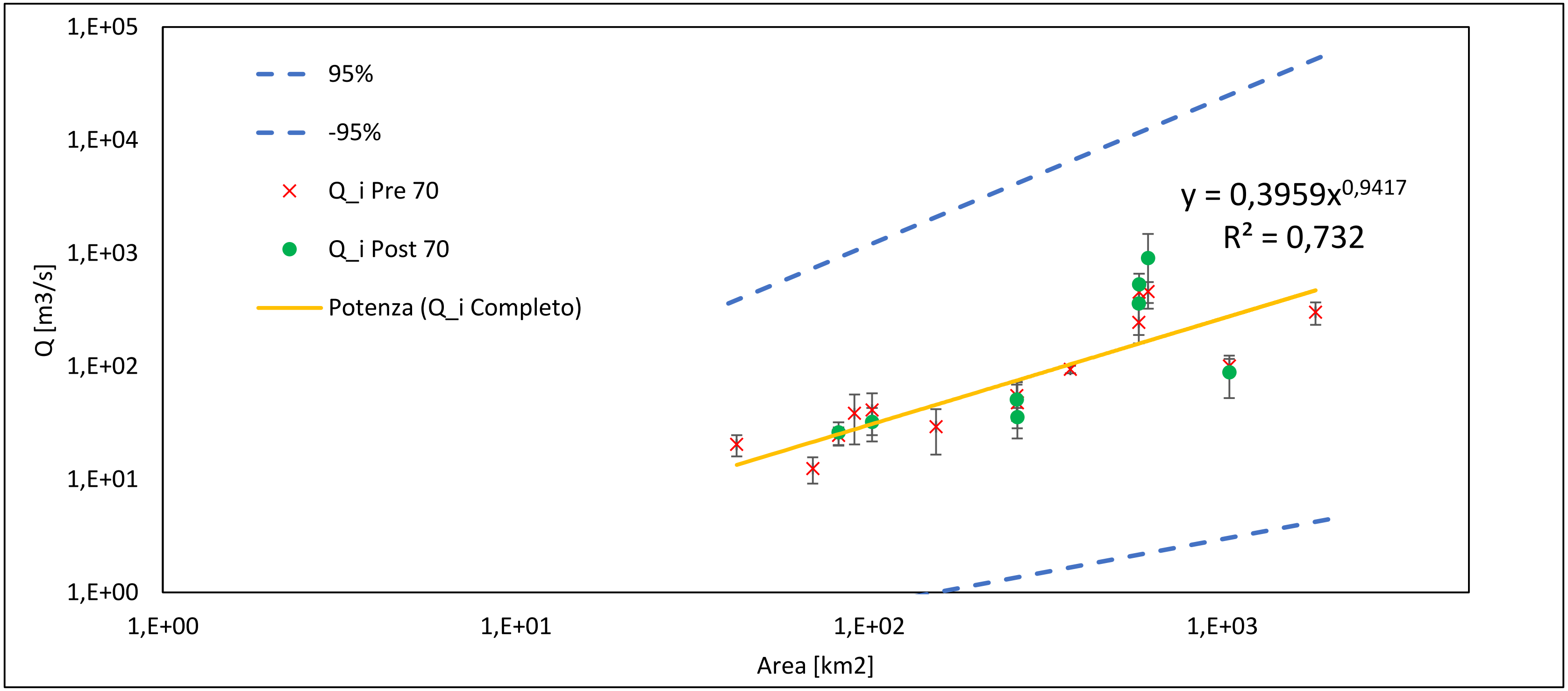
Region B – Results Comparison

GEV distribution fitting

	VAPI	PRE '70	POST '70	COMPLETO
α	0,352	0,352	0,391	0,348
ε	0,635	0,651	0,677	0,646
k	-0,320	-0,299	-0,203	-0,312
N	347	346	119	465

Region B – Completo

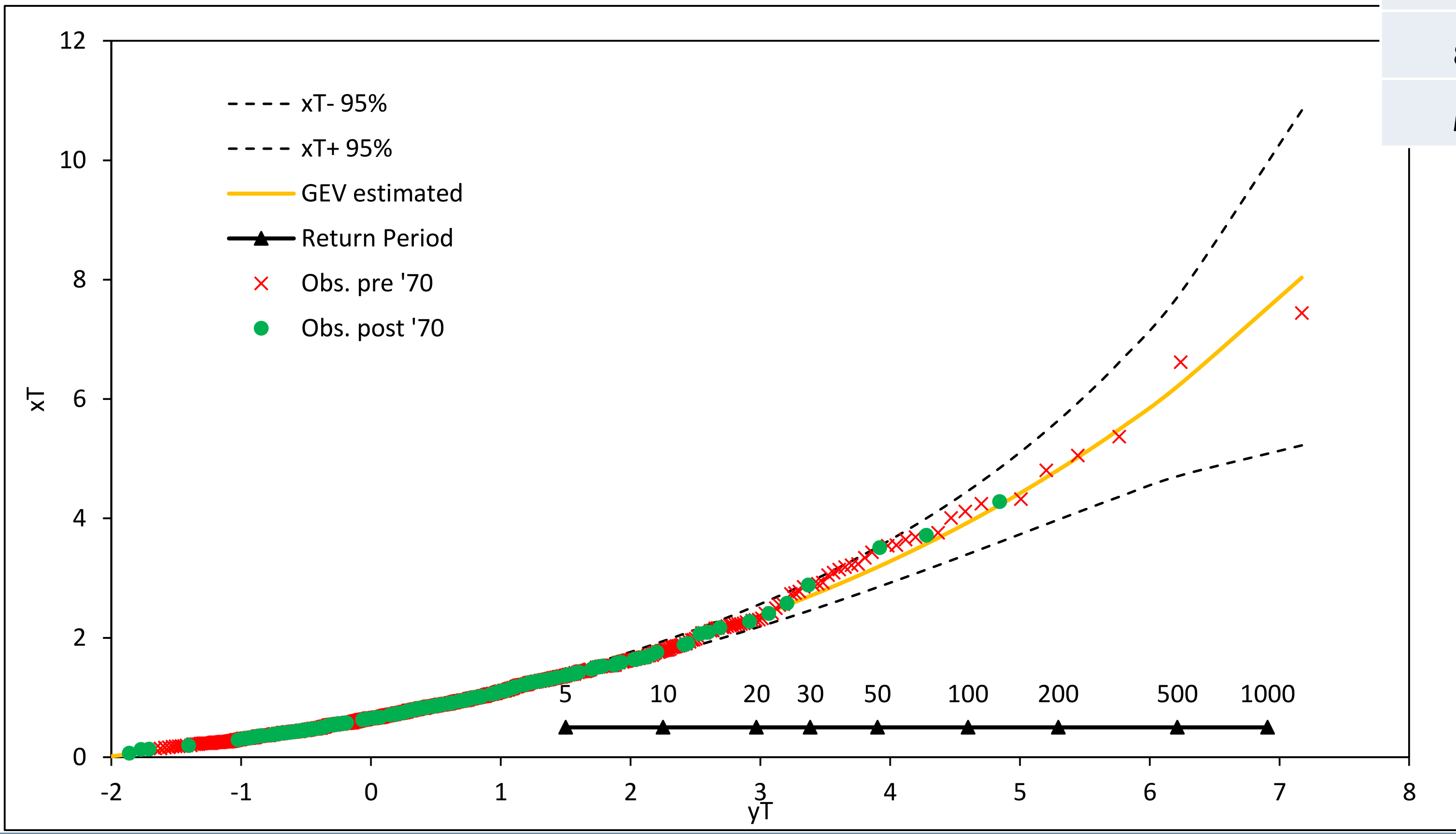
Scale Invariance



Region C – Completo

GEV distribution fitting

GEV Parameters	
α	0.377
ε	0.653
k	-0.233



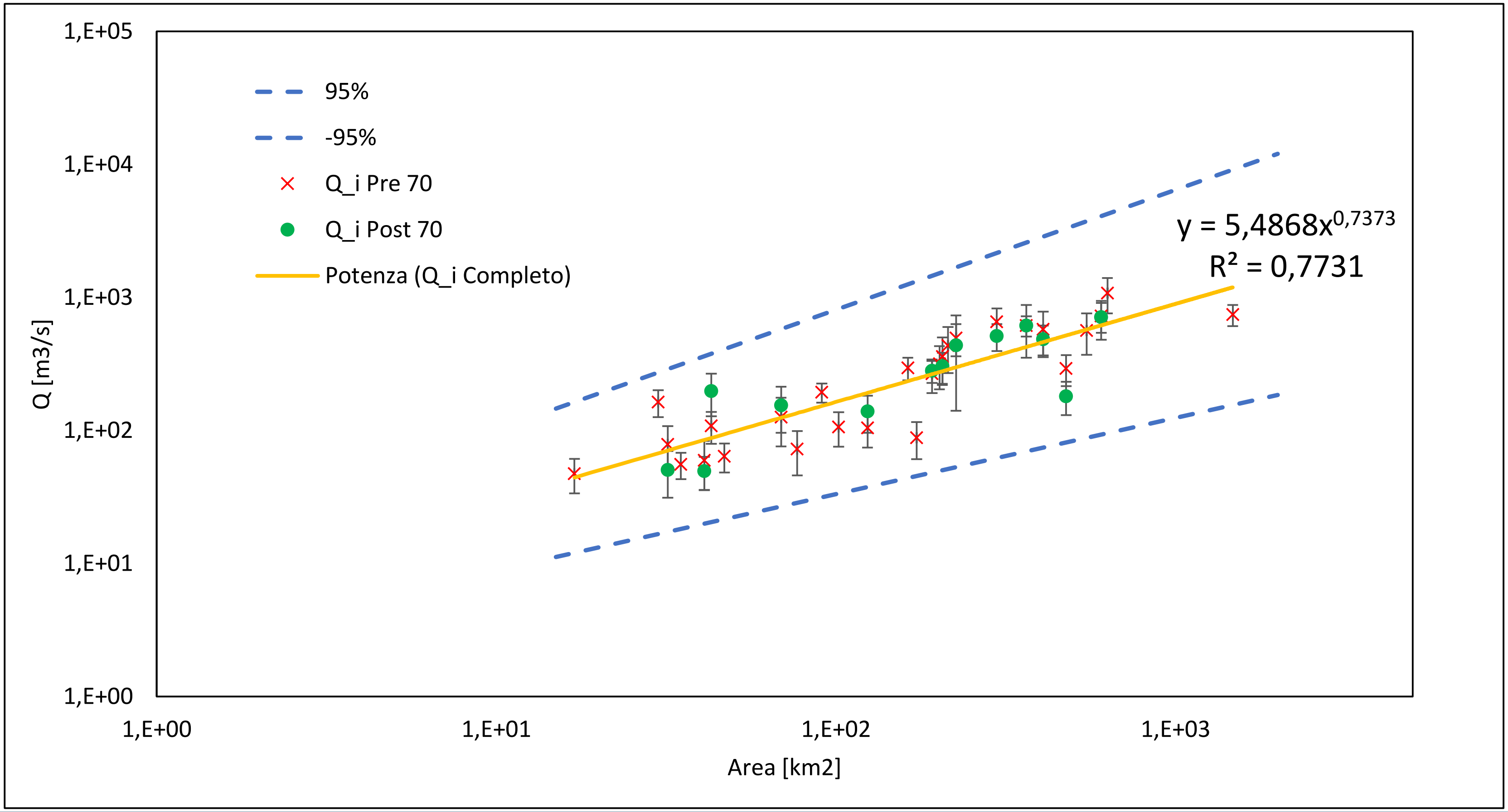
Region C – Results Comparison

GEV distribution fitting

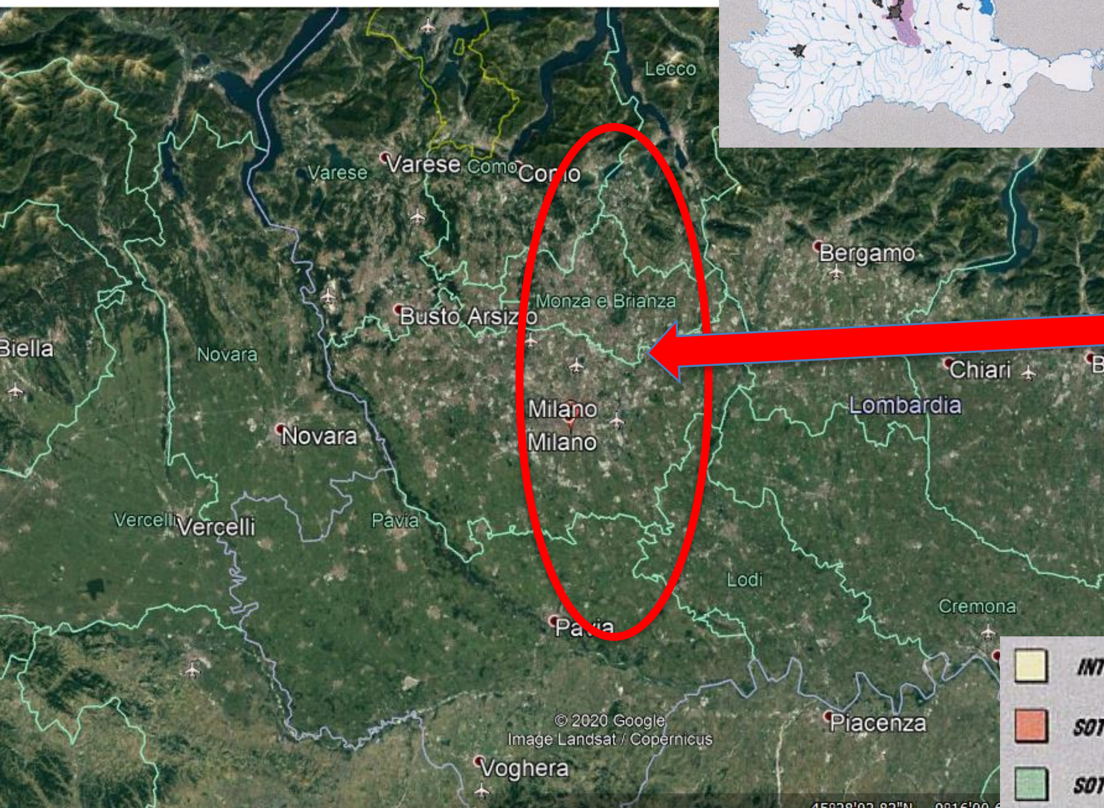
	VAPI	PRE '70	POST '70	COMPLETO
α	0,377	0,392	0,411	0,398
ε	0,643	0,644	0,725	0,653
k	-0,276	-0,254	-0,087	-0,233
N	347	346	119	465

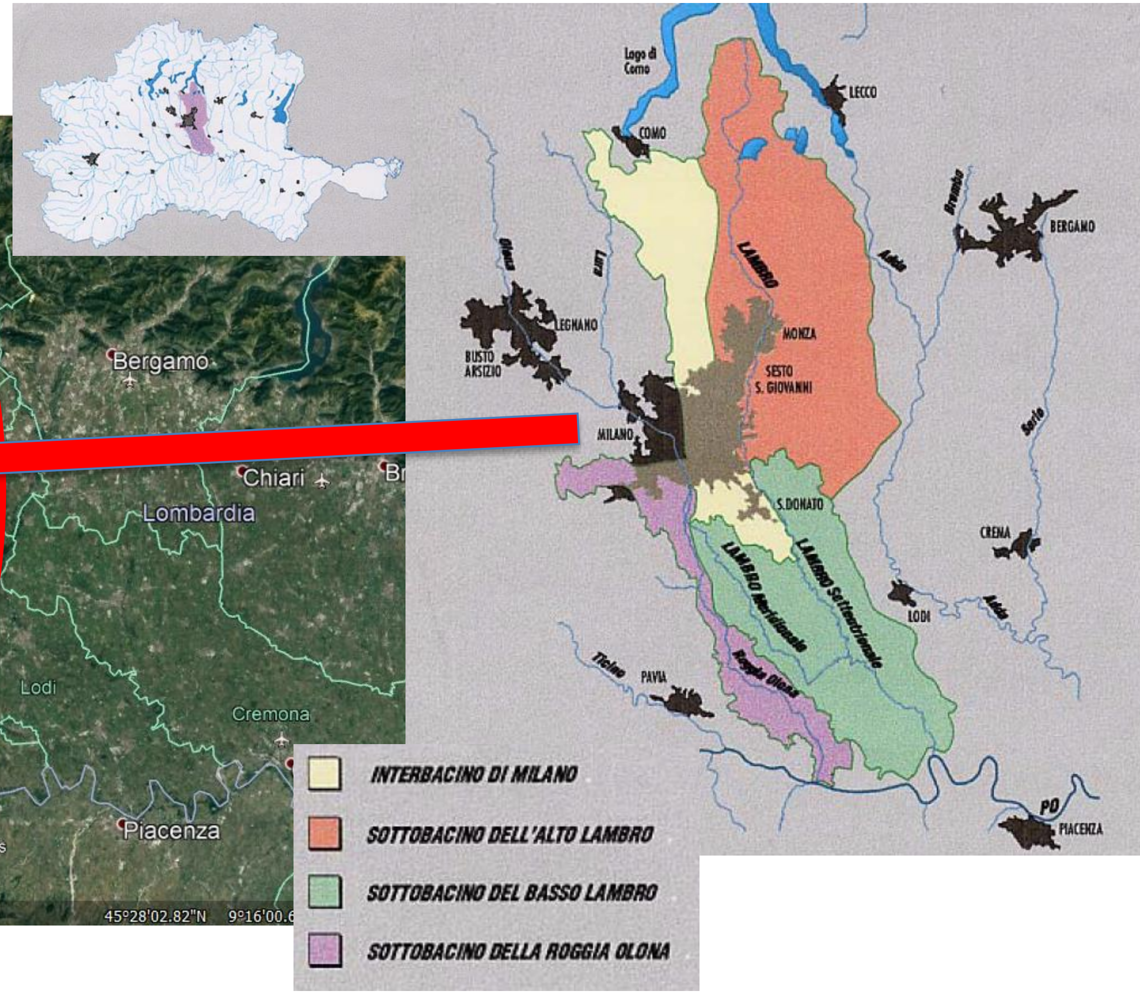
Regione C – Completo

Scale Invariance



Lambro Basin





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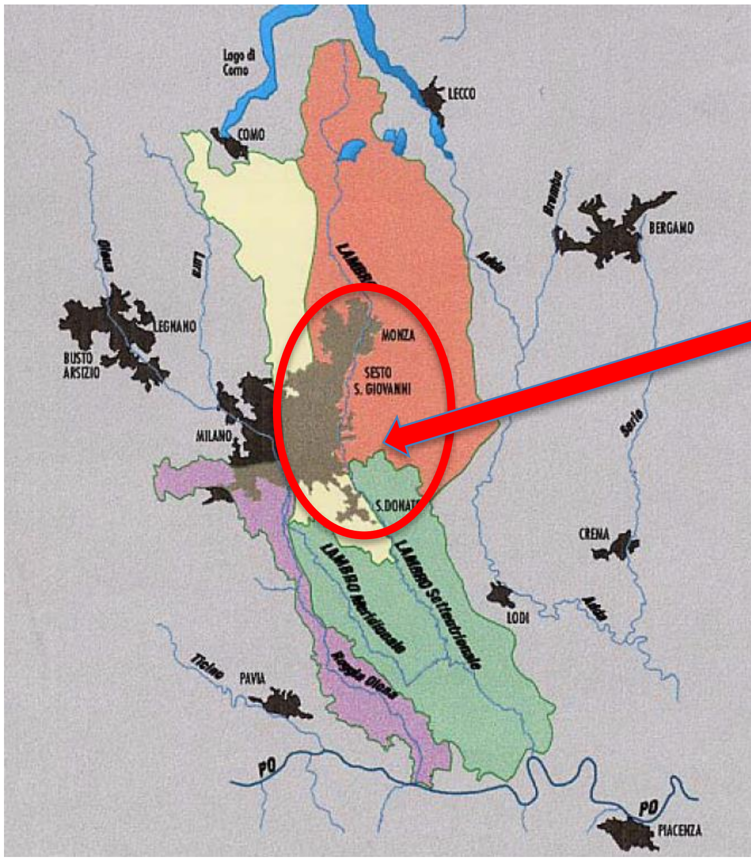
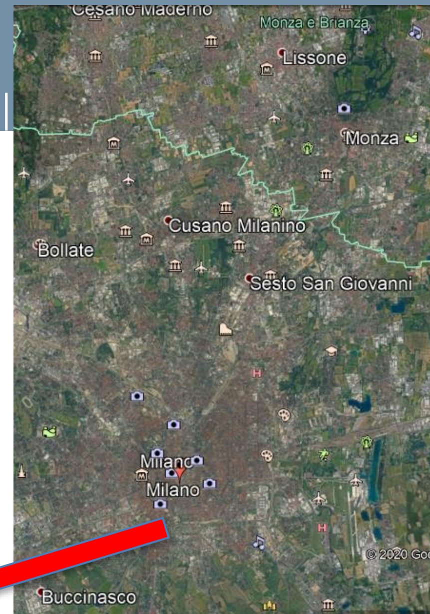
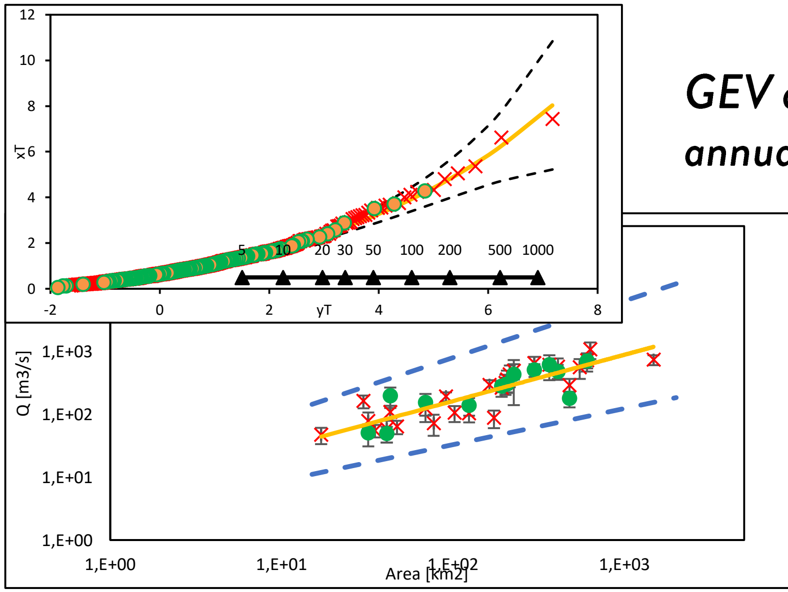
Urban Area Lambro





CASE STUDY – FUTURE

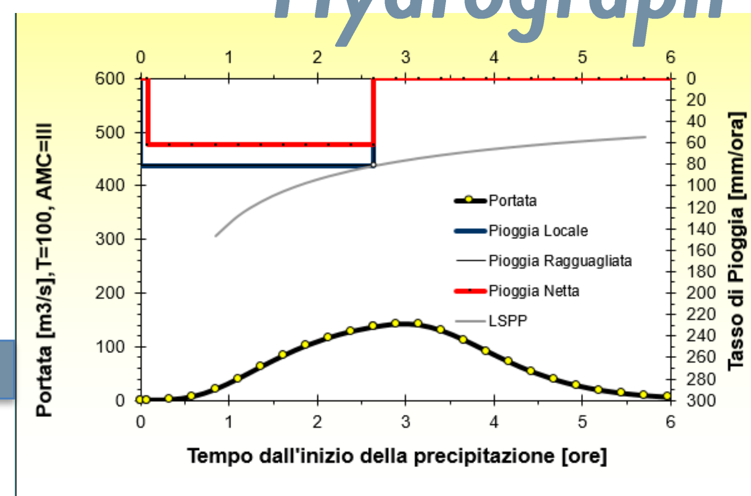


GEV distribution maximal annual flow

Q_T

Scale invariance

Hydrograph



Inundation Scenarios

CONCLUSION

- *No significative variation of GEV distribution*
- *Slight decrease of k parameter in all three homogeneous regions → slightly less rapid increase of the growth curve* x_T
- *No particular trends in the Pre'70 and Post'70 dataset → no particular trend in extreme event series such as flood maxima.*
- *Sample size increase → more robust parameters estimation*
- *New GEV distribution will be used to estimate the new T-year Flood quantile* Q_T *for the urban area of the Lambro basin in order to study the evolution of flood hazard and inundation risk under recent climate change*

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Thank You!

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