Climate service iCOLT

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AGENZIA REGIONALE PREVENZIONE E AMBIENTE DELL'EMILIA-ROMAGNA

Servizio IdroMeteoClima

Area agrometeorologia, territorio e clima

arpa agenzia regionale prevenzione e ambiente dell'emilia-romagna

Gelate e siccità, il 2003 chiude i conti in rosso

SABATO 19 NOVEMBRE 2011 IL GIORNO - il Resto del Carlino - LA NAZIONE QN

Siccità in Romagna, appello ai cittadini «No al bagno nella vasca, fate la doccia»

Piano anti sprechi. Ridracoli: riserve per 20 giorni, via libera ai pozzi

Da luglio a oggi non c'è stata una sola pioggia che abbia portato acqua da bere. Per la Romagna lo spettro di una crisi idrica senza precedenti. Siamo a un passo dall'emergenza

Pier Luigi Martelli
BOLOGNA

L'INGEGNER Demetrio Egidi, gran capo della protezione civile regionale, ha un dato sotto gli occhi che lampeggia come la spia della riserva.
«Ecco qua, 27 dicembre 1994: 4,8 milioni di metri cubi dietro la diga di Ridracoli».
Quello è il minimo storico, si era alle soglie della potabilità. Lo spettro di quel Natale a raschiare il fondo aleggia oggi sulla Romagna. Ridracoli è a poco più di sei milioni di metri cubi e ogni giorno ne consegna alla sete sottostante circa 70mila. Ci vuol poco a fare i conti.

IL DESERTO

> Non pioverà fino a Natale, si profila un evento climatico eccezionale

Demetrio Egidi, capo regionale della Protezione civile

ALLARME significa serrare i rubinetti, accendere le autobotti, significa tornare indietro di mezzo secolo per comuni come Forlimpopoli o Cesenatico che dipendono in massima parte da Ridracoli.
«Al momento - spiega il responsabile della Protezione civile regionale - attiveremo tutte le connessioni possibili delle reti, chiederemo alle industrie idroesigenti di ridurre i consumi del 6-7% pur senza intaccare la produzione, metteremo in moto tutti i potabilizzatori in dotazione alla protezione civile, alle direzioni regionali della sanità e all'Arpa».

CHI NON SOFFRE

I nubifragi che hanno devastato la Liguria hanno 'salvato' l'Emilia

Cosa va spiegato al cittadino?

COSA FARE

I consigli

**Una doccia consuma 25 litri d'acqua, riempire una vasca ne richiede almeno 130.
Non vanno lavate le strade, le automobili, non si devono irrigare i giardini e gli orti casalinghi**

La connessione

Tutte le fonti sotterranee saranno messe in rete per alimentare i comuni della Romagna. Dalle falde del Marecchia e del Conca arriverà un terzo del fabbisogno totale, che è di 3mila litri al secondo

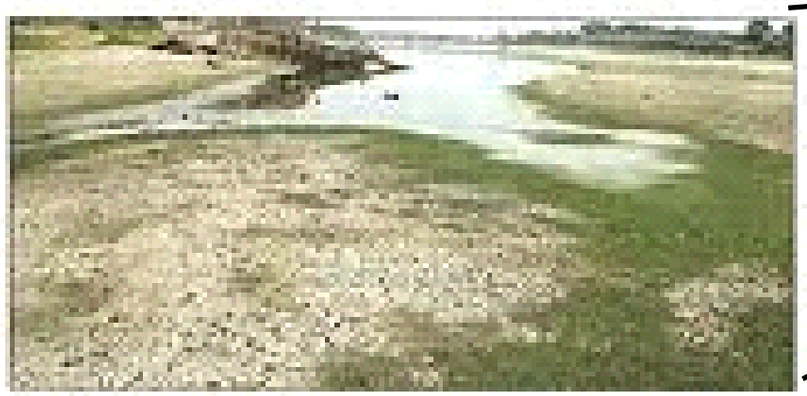
The drought of 2007

Invaso della diga di Ridracoli, siccità 2007

Oggi il Consiglio dei ministri affronta il caso. Tra settembre e febbraio le precipitazioni sono diminuite del 30%

Siccità, è già emergenza

Governo diviso sullo stato di crisi. Bertolaso: estate da incubo



IL CASO

La Grande secca nel nostro futuro

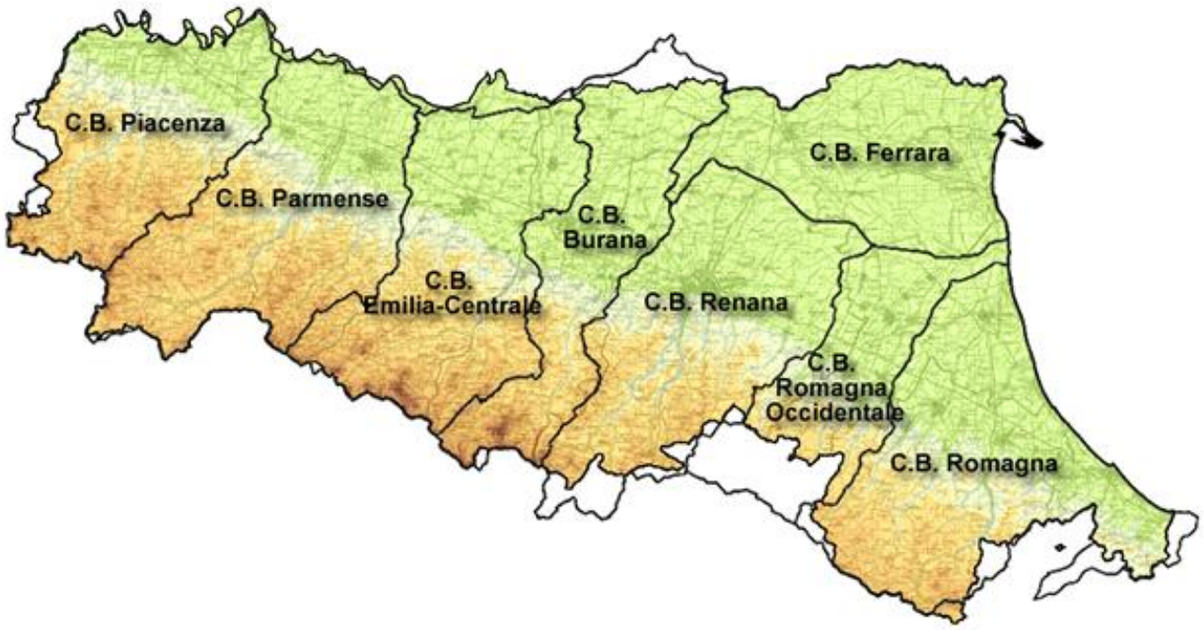
LUCA MERCALLI

picture of Po river during the spring of 2007

iCOLT

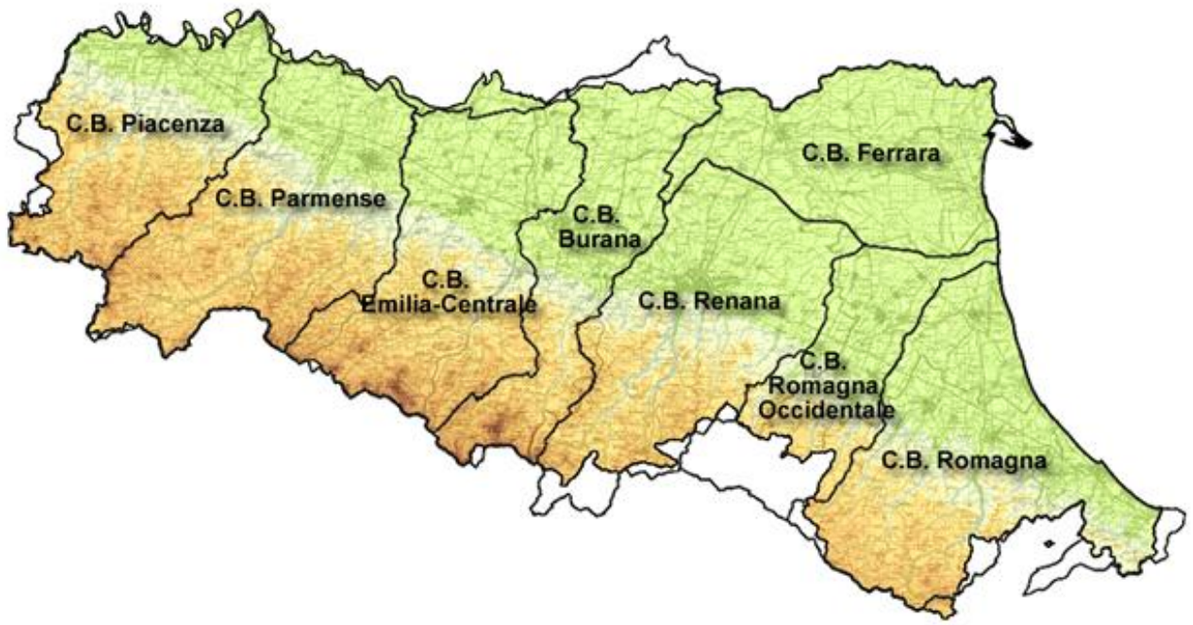
• Aim of iCOLT is to provide a probabilistic early assessment of irrigation demand of crops for the Emilia-Romagna regional plain area and also for each of the eight reclamation consortia.

• The system has been operational at ARPA-SIMC since 2010, making available the results via the agency official web site.



The users of iColt project:

- It is an example of climate service for agriculture, with specific application in the field of water management for regional authorities and irrigation consortia



iCOLT evolution

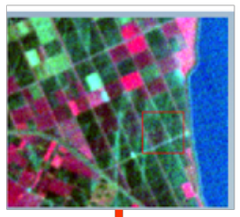
Year	Remote sensing coverage	Seasonal predictions
2007-2008	Plain between Bologna and Reggio-Emilia	NO
2008-2009	Emilia-Romagnaplain	NO
2009-2010	Emilia-Romagna plain	YES
2010-2011	Emilia-Romagna plain	YES
2011-2012	Emilia-Romagna plain	YES
2012-2013	Emilia-Romagna plain	YES

iCOLT ingredients

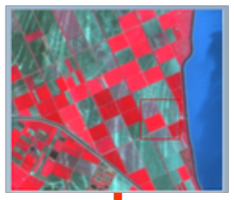
- Current crop map (divided in macro classes) obtained by remote sensing and field survey
- Seasonal forecasts properly downscaled
- Obs weather data and synthetic series for the summer
- Mathematical model for the simulation of water balance and irrigation assessment
- Geographical system

The iCOLT system workflow

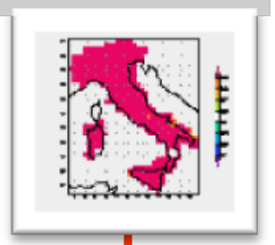
Acquisition of the first image from UK-DMC2 satellite



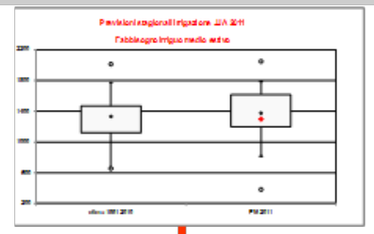
Acquisition of the third from UK-DMC2 satellite



Seasonal forecast JJA emission

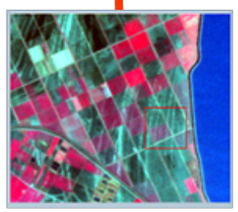


Check of the irrigation forecast at the end of the summer

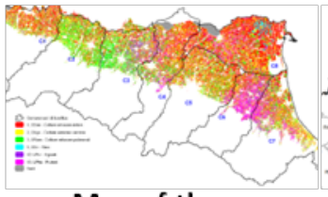


Ground survey — Ground survey — Ground survey — Ground survey

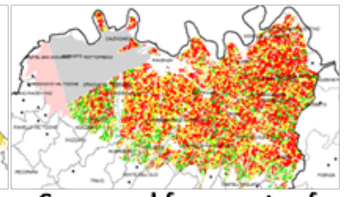
October — November — December — January — February — March — April — May — June — July — August — September — October



Acquisition of the second image from DEIMOS-1 satellite

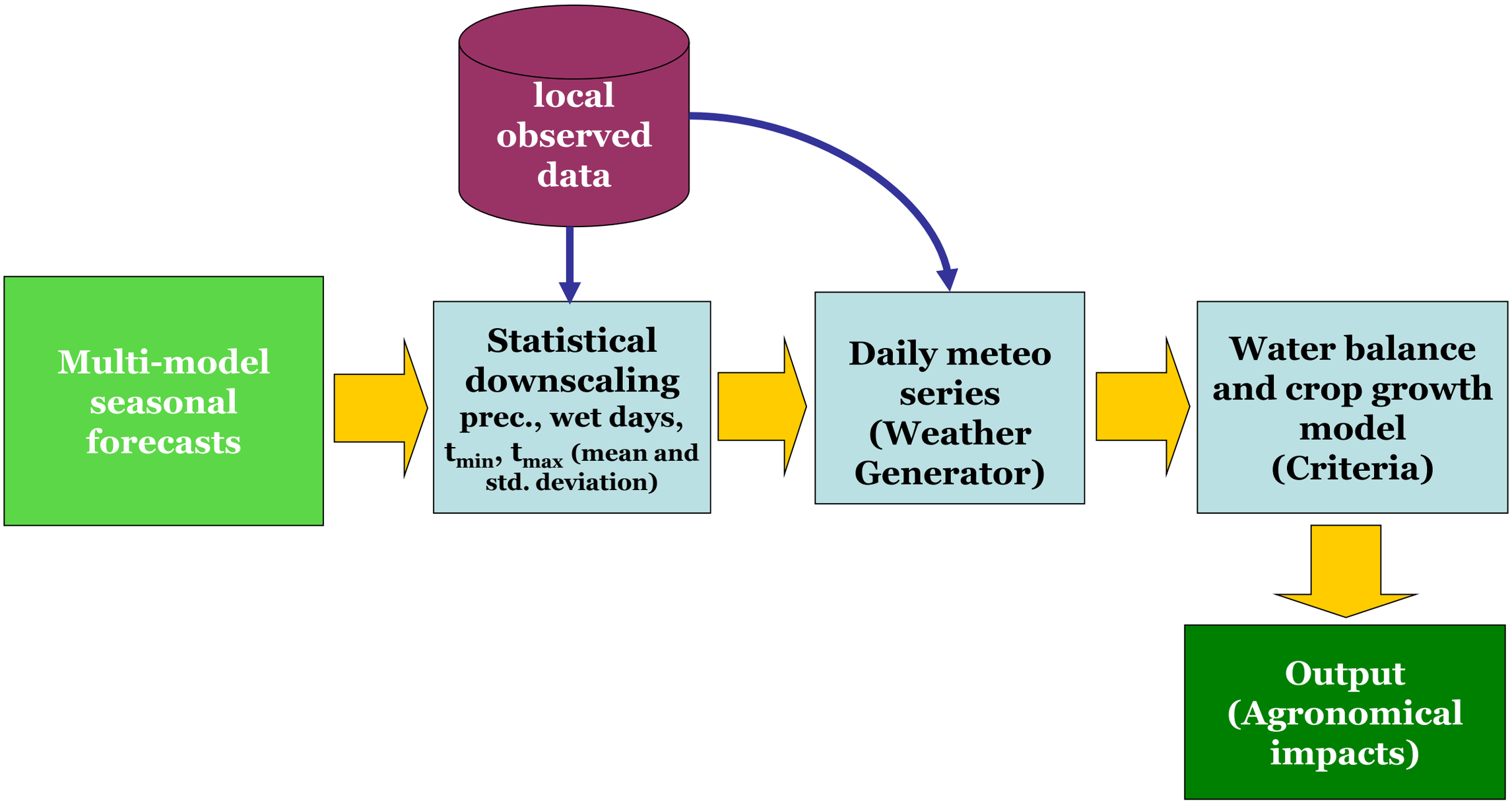


Map of the crop classes



Seasonal forecast of irrigation water need

Agronomical impact simulations - modelling scheme
Seasonal predictions



Acquisition windows

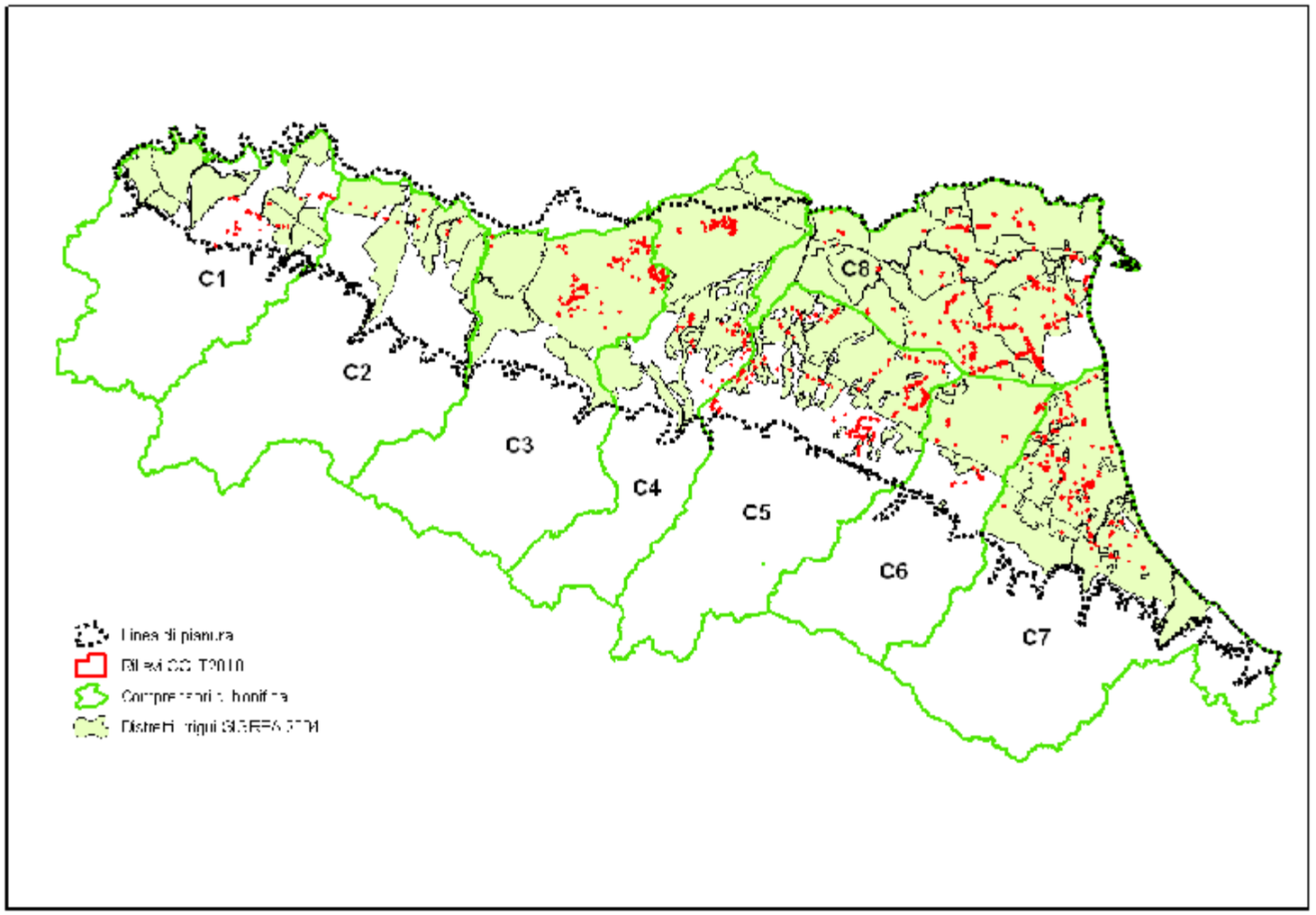
1. November
2. February
3. April
4. June (optional)

		Months									
Bare soil	TYPE	10-11-12	01	02	03	04	05	06	07	08	09
Minimun cover	*Herbaceous*										
Medium cover	Wheat										
Max cover	Barley										
Senescence starting	Alfa-alfa										
Senescence	Maize										
	Sorghum										
	Tomato										
	Suger beet										
	Potato										
	Melon										
	Water melon										
	Pumpkin										
	Rice										
	Soya										
	Meadow										
	Fruit trees										
	Vineyard										
	Pear										
	Apple										
	Peach										
	Plum										

Field survey

During the acquisition windows a team of two technicians go around the study area to collect field information such as: crop, BBCH, ect....

In COLT2010 there were 826 plot surveyed (red dot in map)



What you need in field survey

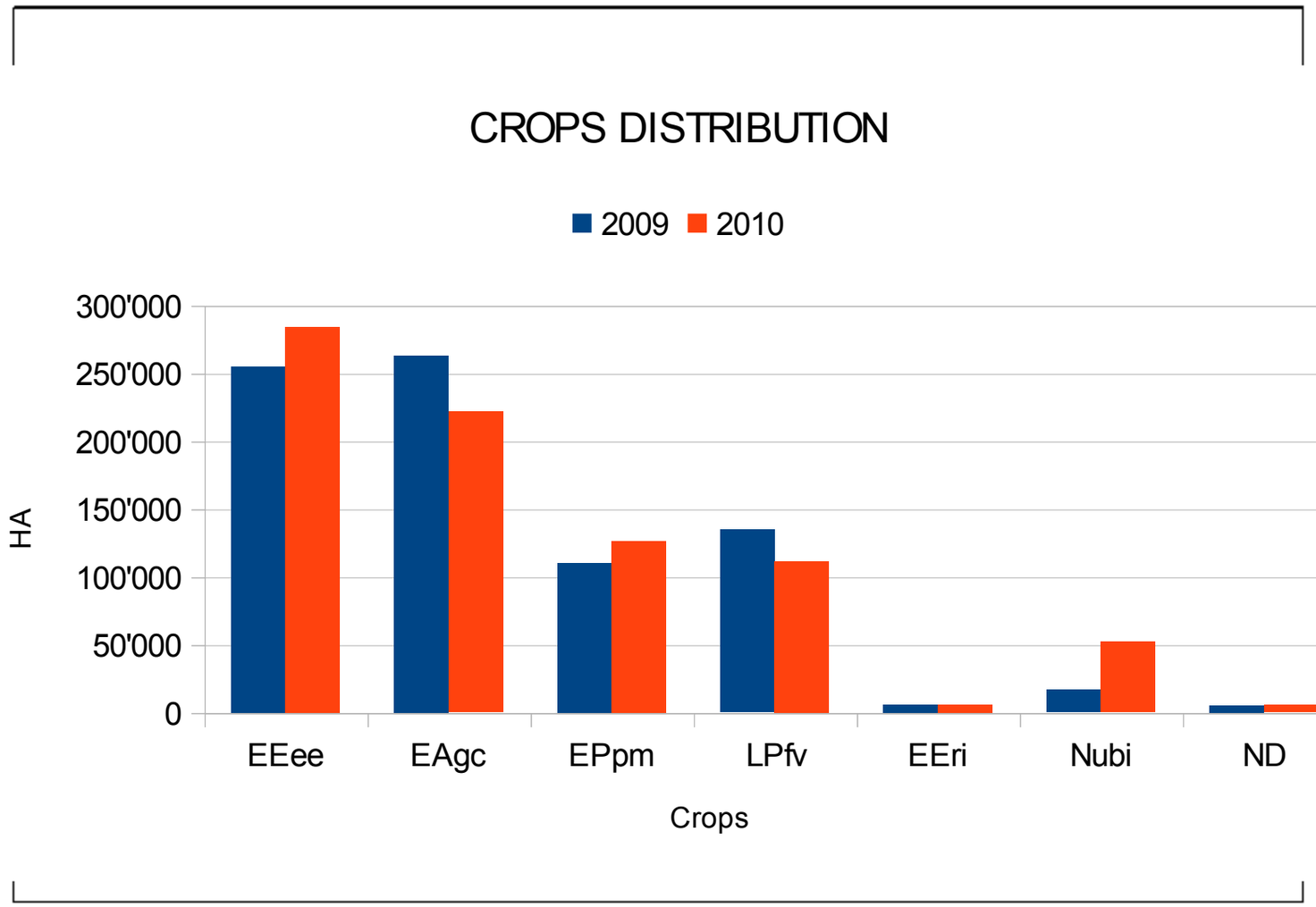
GPS trimble or similar able to manage georeferenced images and data base

BBCH manuals and agro-pheno bullettins

Satellite and sensors

- Clouds and fog cover are the major constrains in the November and February windows
- It's mandatory to choose a satellite platform with frequent revisiting time, able to increase chances of good acquisition.
- To prevent different crop's development stages, we prefer a sensor with wide swath width, able to acquire the whole study area in only one pass.

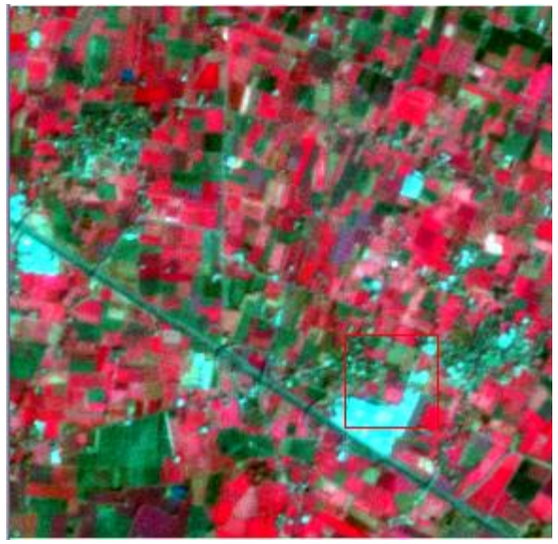
Remote sensing analysis



WORKFLOW

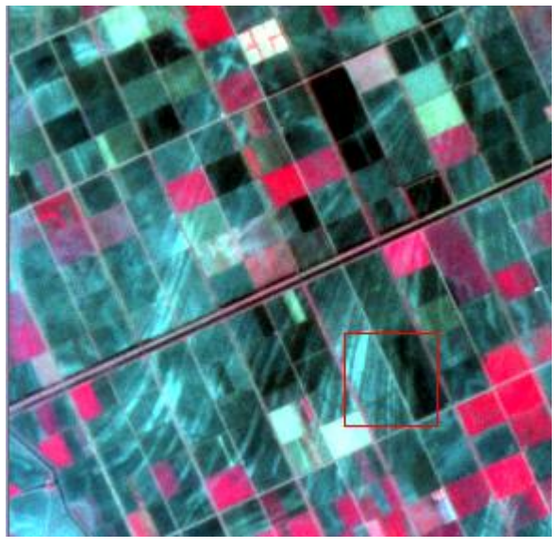
Precision

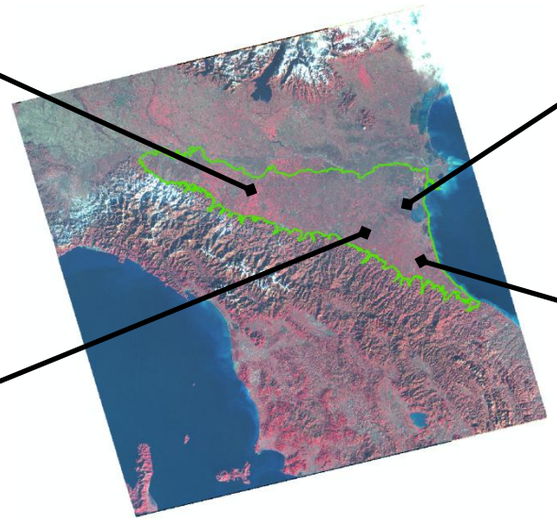
Precision depends on plot size and crop rotation



…Good
(wide plot average)
Alfalfa for Parmigiano Reggiano production

…Good
(plot average 25ha)
Herbaceous crops





Fair
(variable plot average)
Herbaceous crops

So so
(small plot average)
Orchards, horticulture and others

Remote sensing analysis needs

2 expert techinicians in remote sensing and field survey which work together.

<u>Each working day refers to two workers:</u>

1. 15/20 days for field surveys;
2. 15/20 days image analysis;
3. 20 days for reports;

From classification to modelling

- The shapefile vector is then dissolved in ArcGIS environment at the minimun area of 1 ha;
- The shapefile is split according to Reclamation Consortia boundaries;
- The shapefiles are loaded in CRITERIA.

Remote sensing map iCOLT
Consortium C7 – Romagna

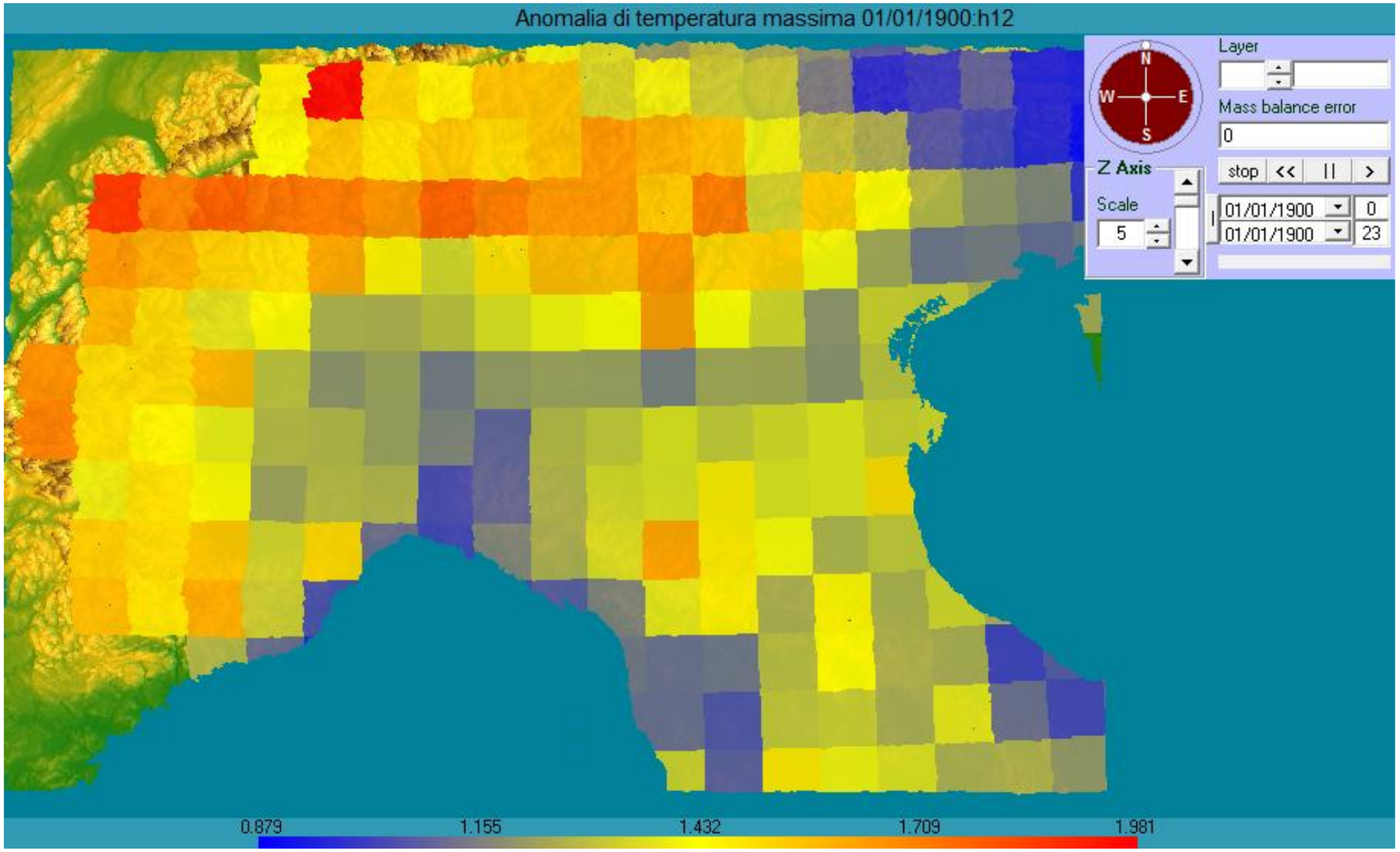
Coltura	
Erbacee autunno-vernine	
Erbacee primaverili-estive	
Erbacee perenni (medica)	
fruttiferi	
vite	

summer herbaceous, winter herbaceous, multiannual fodder crops, fruit orchards and vines, rice paddies

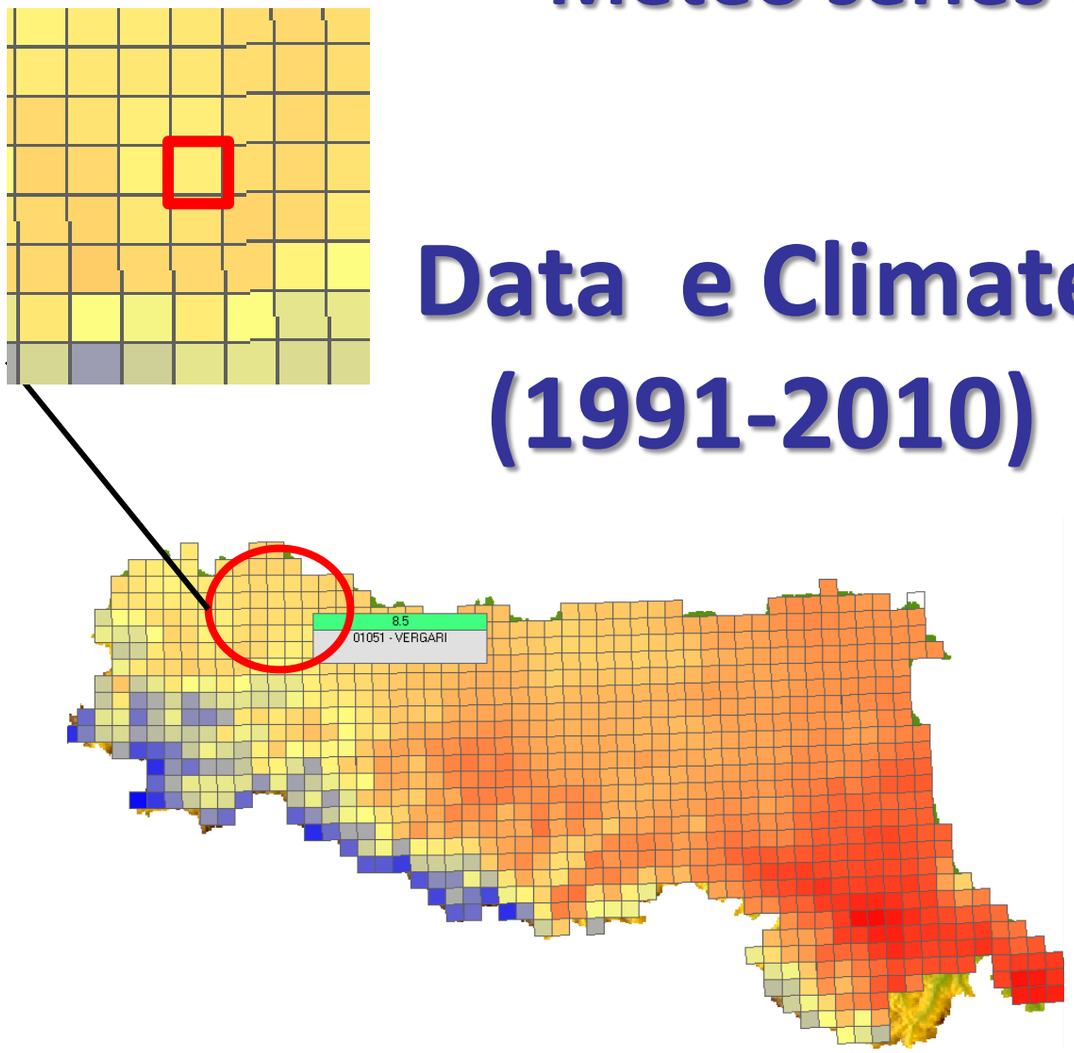
Seasonal predictions

- Global probabilistic seasonal forecasts “multi-model ensemble” are produced at ECMWF by means of 2 models ECMWF (SFEC) and Météo France (LFPW) and they are available from 1981 up to now.
- Global forecasts are calibrated and downscaled to local climate at SIMC, from large scale fields Z500 (geopotential at 500 hPa) e T850 (temperature at 850 hPa).
- High resolution final prediction for each model consists in an ensembles of seasonal anomalies for several variables needed as input of the weather generator scheme

Format of the seasonal prediction anomalies for the WG

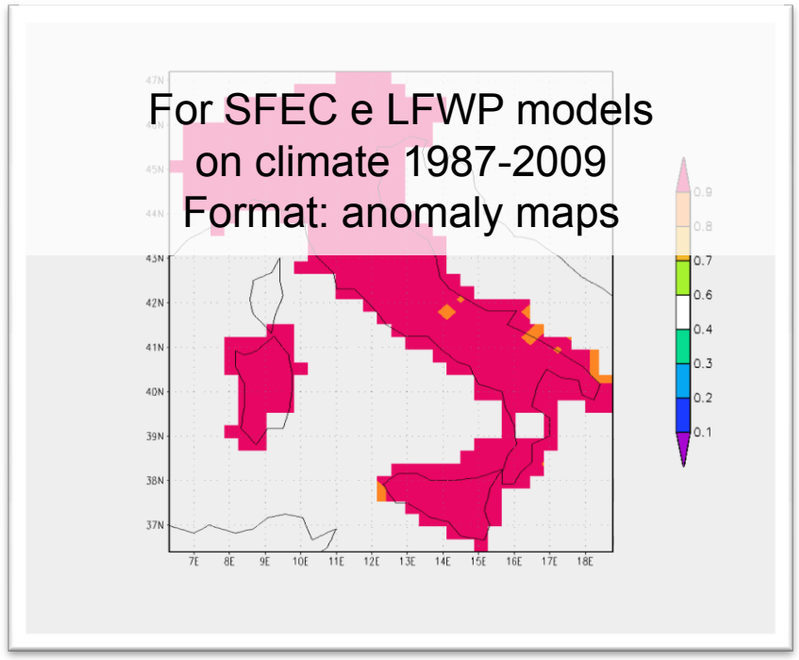


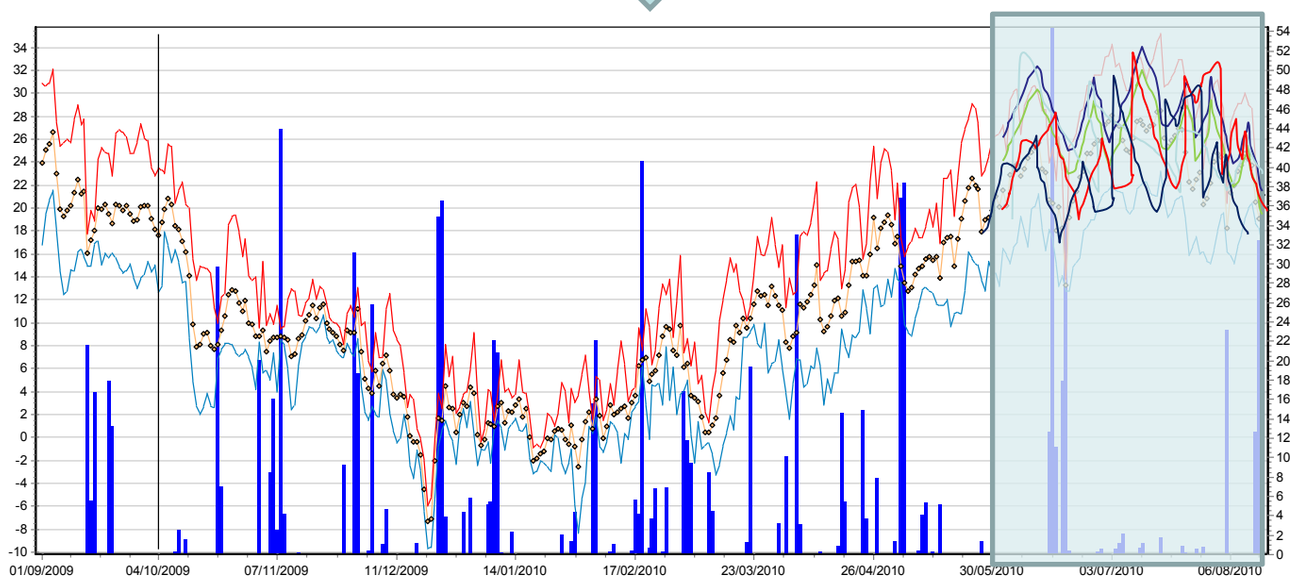
Meteo series and seasonal forecasts



Data e Climate (1991-2010)

Seasonal forecasts JJA





AGENZIA REGIONALE PREVENZIONE E A

Servizio IdroM

arpa
agenzia regionale prevenzione e ambiente dell'emilia-romagna

Weather Generator input variables

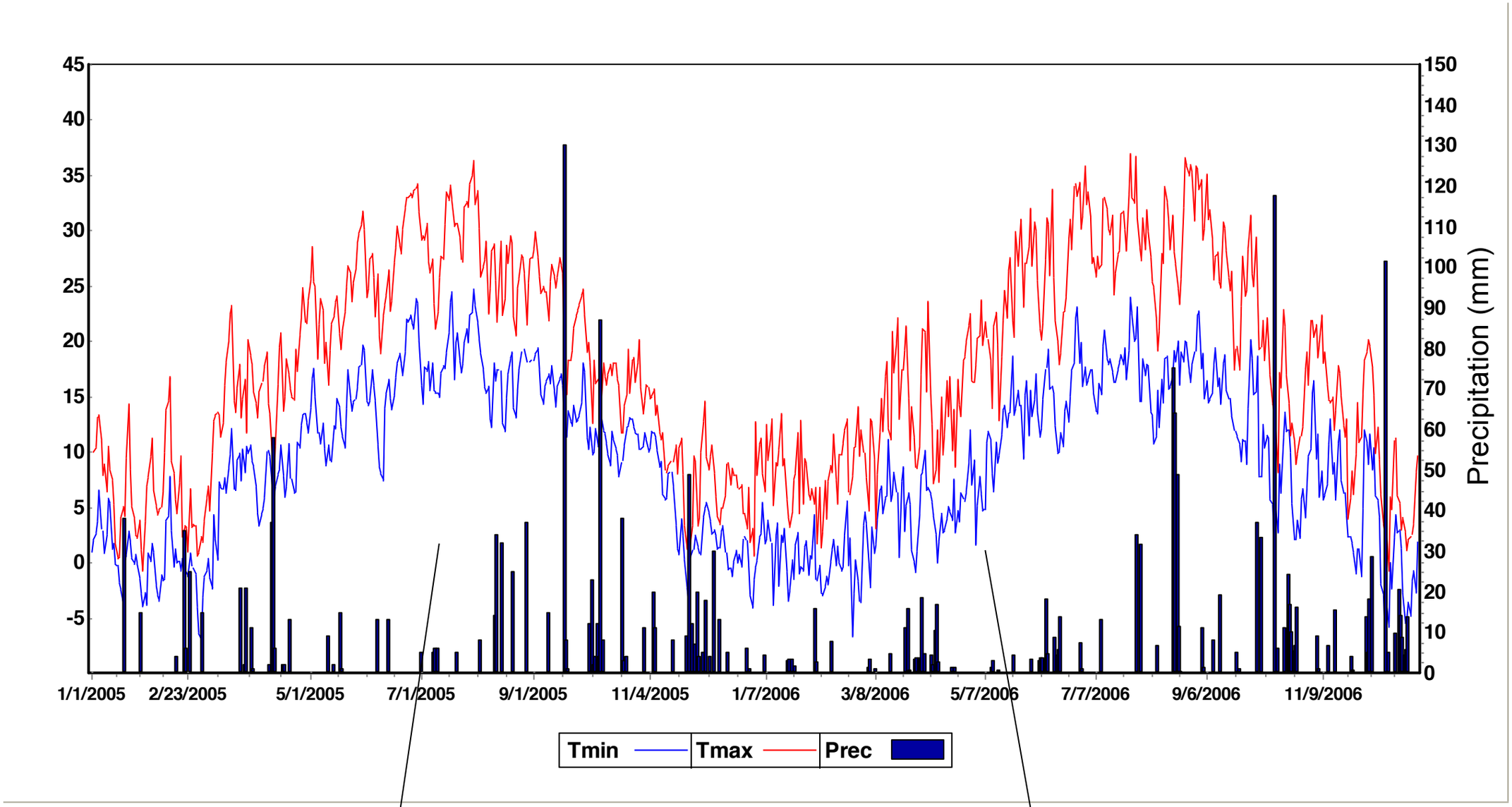
Variable code	Input data of WG	Unit
Tmax	mean of maximum temperature	°C
Tmin	mean of minimum temperature	°C
Txsd	standard deviation of maximum temperature	°C
Tnsd	standard deviation of minimum temperature	°C
Prcp	mean of total precipitation	mm
Fwet	fraction of wet days	-
Tdw	difference between maximum temperatures on dry and wet days	°C

Seasonal forecast

Richardson, C. W., and Wright, D. A. (1984). *WGEN: A model for generating daily weather variables*. U.S. Department of Agriculture, Agricultural Research Service, ARS-8, 83 pp.

Stöckle, C.O., Campbell, G.S., and Nelson, R. (1999). *ClimGen manual*. Biological Systems Engineering Department, Washington State University, Pullman, WA. 28 pp.

Weather generator

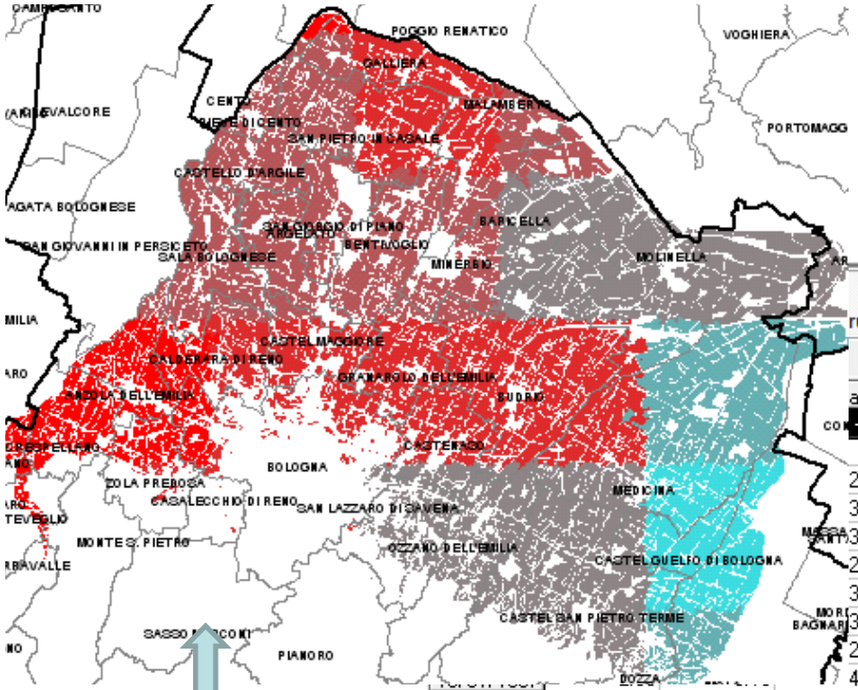


Real year (2005)

Generated year on climate 1991-2008

CRITERIA INPUT

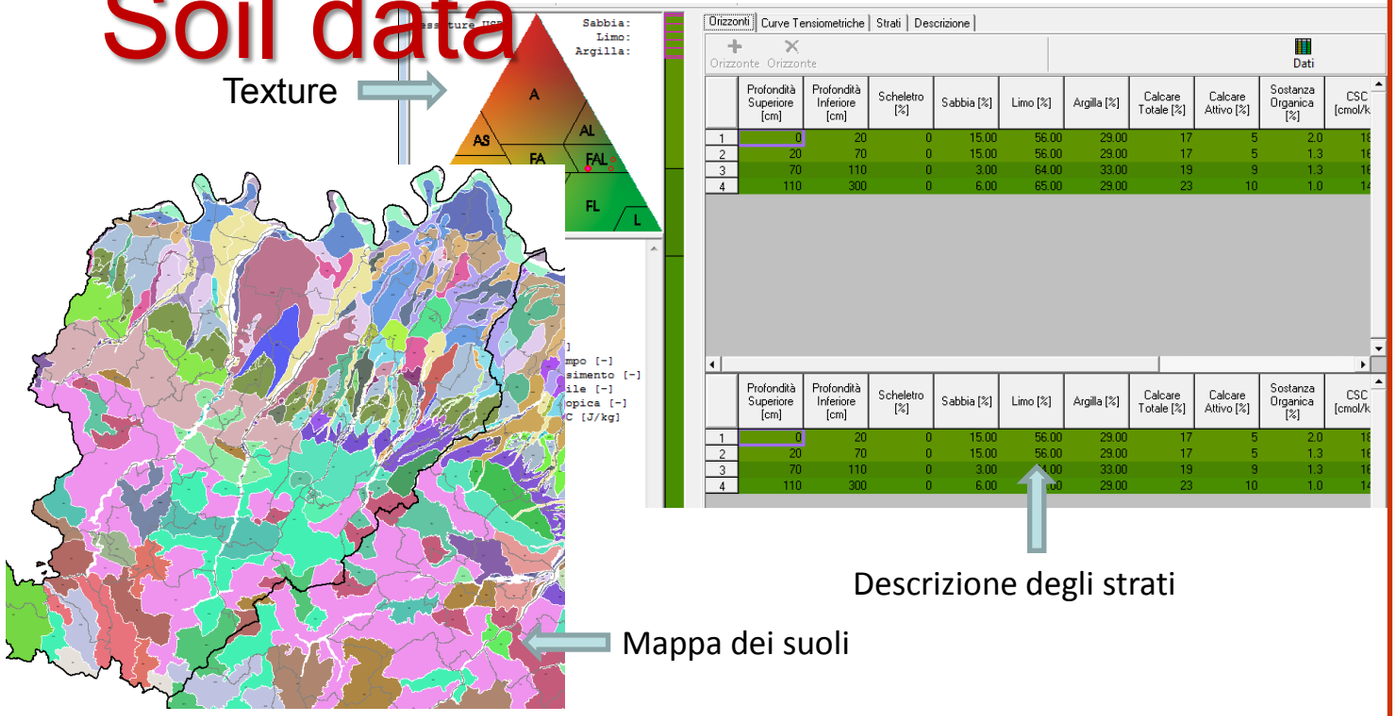
Weather data



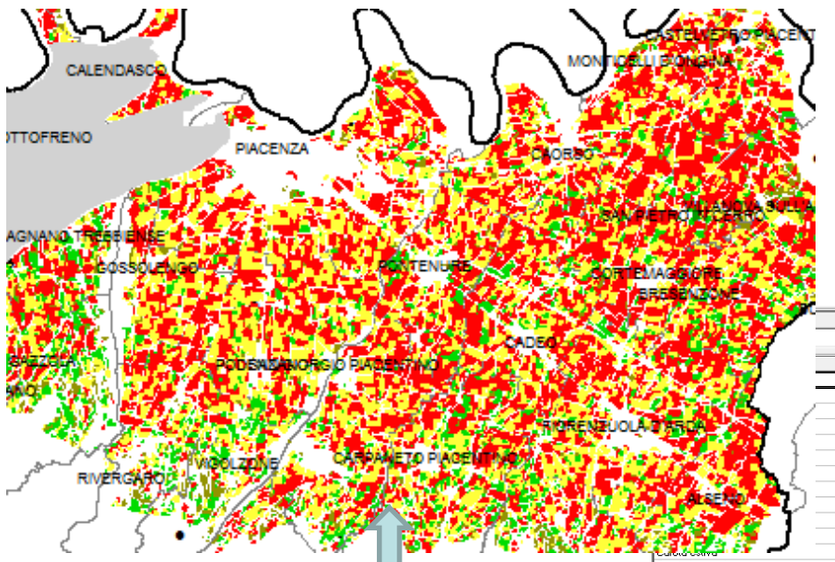
	Temperature min	Temperature max	Precipitazio
11/01/1997	2.40	7.60	4.70	.00
12/01/1997	2.30	7.30	4.10	.00
13/01/1997	1.10	8.00	3.70	.00
14/01/1997	.50	8.90	3.60	.00
15/01/1997	.50	11.90	5.20	.00
16/01/1997	1.70	13.00	5.80	.00
17/01/1997	-.10	10.40	3.90	.00
18/01/1997	-1.60	2.90	.60	.00
19/01/1997	-.30	2.70	1.30	.00

Temperature min
Temperature max
Precipitation

Soil data



Crop data



Crop Parameters

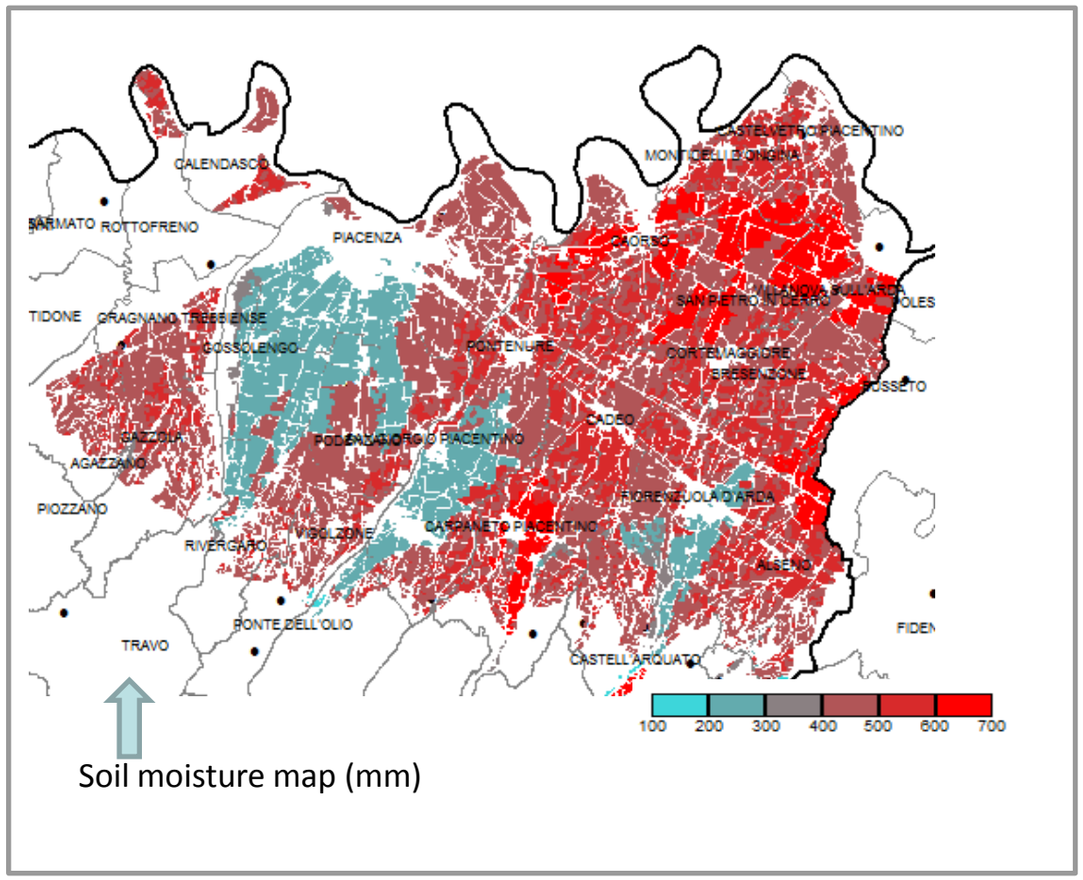
Predefinito: 0 Intervallo: 0 - 0 Descrizione:

	ciclo	soglia	Emergenza	Trapianto	Crescita	Decrescita	Lai min	Lai max
	175	8	30	0	900	1000	0	5
	190	5	50	0	950	1220	0	5
	175	10	75	0	650	980	0	5
	260	0	120	0	1400	1200	0	5
	220	0	120	0	800	1000	0	5
	115	10	0	150	575	575	0	4
	175	10	60	0	660	900	0	5
	180	10	60	0	660	700	0	5
	150	7	50	0	820	500	0	3,5
	200	8	80	0	700	900	0	3,5
	140	0	150	0	850	1000	0	3
	190	5	50	0	950	1225	0	3
Carota invernale	190	5	50	0	950	1225	0	3
Medica 1^ anno	285	5	100	0	1030	700	0	4
Medica	365	5	0	0	700	1	1	4
Erbaio Intercalare (aut-prim)	240	0	120	0	1155	100	0	4
Prato di Graminacee	365	2	0	0	1400	200	1	4
Asparago	365	5	0	0	800	800	1	4
Incolto	365	2	0	0	600	2000	1	3
Incolto rado	365	2	0	0	600	2000	0,5	1,5
Vite a Spalliera	365	8	0	0	1200	1300	0	3
Pesco su Inerbito	365	7	20	0	1000	1500	0	4
Pesco	365	7	20	0	1000	1500	0	4
pescoGF677 su inerbito	365	7	20	0	1000	1500	0	4
Pero su Inerbito	365	7	0	0	1800	1000	0	3,5
Actinidia su Inerbito	365	5	0	0	1600	2000	0	3,5
Actinidia	365	5	0	0	1600	2000	0	3,5

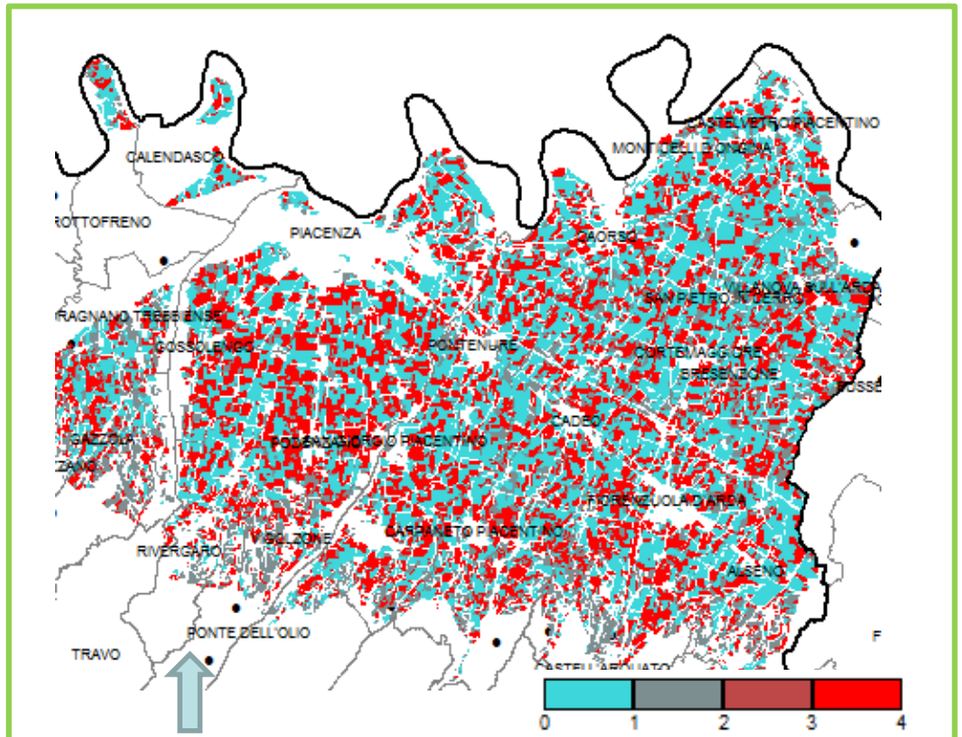
iCOLT

Area agrometeorologia, territorio e clima

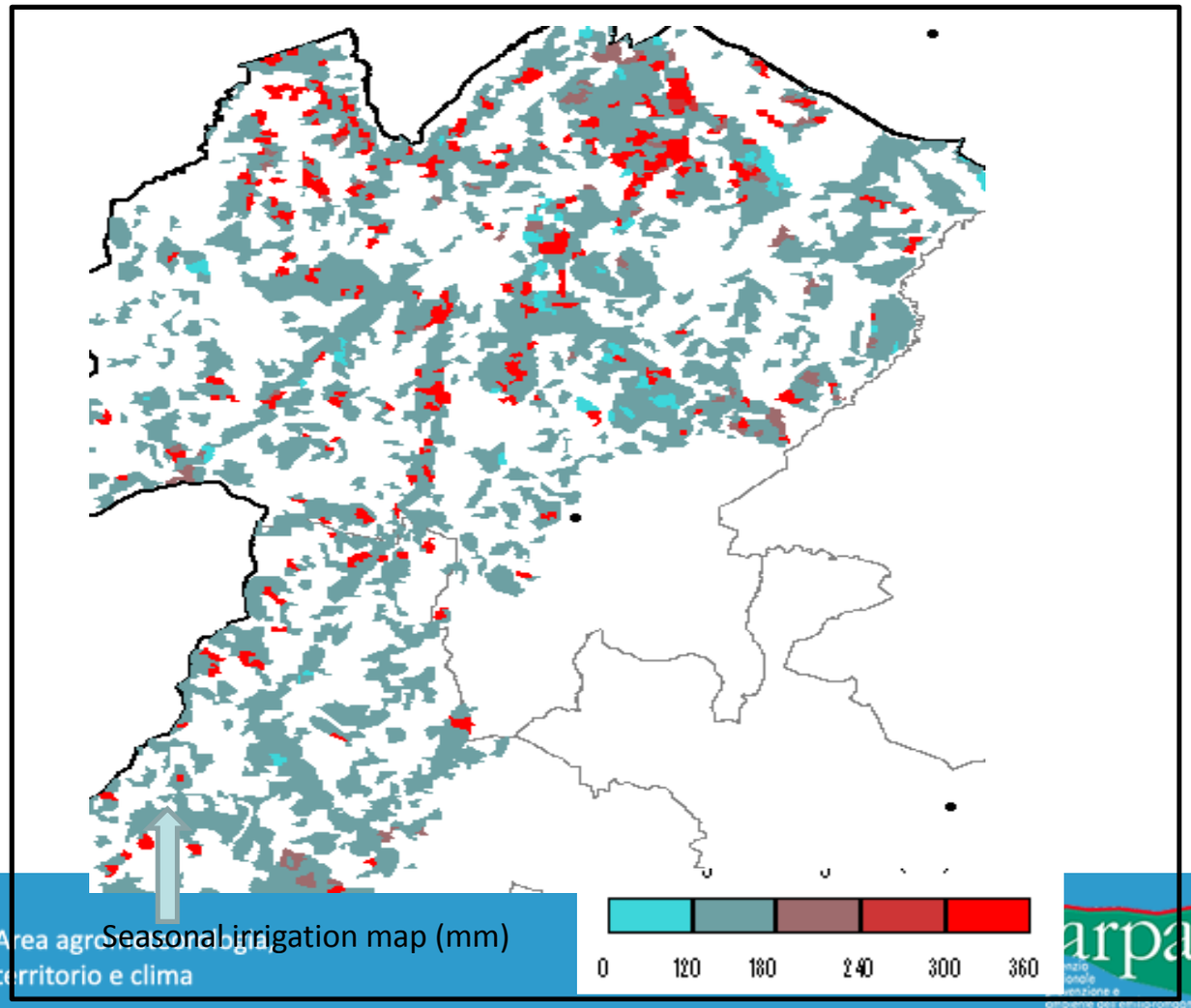
CRITERIA OUTPUT



Soil moisture map (mm)

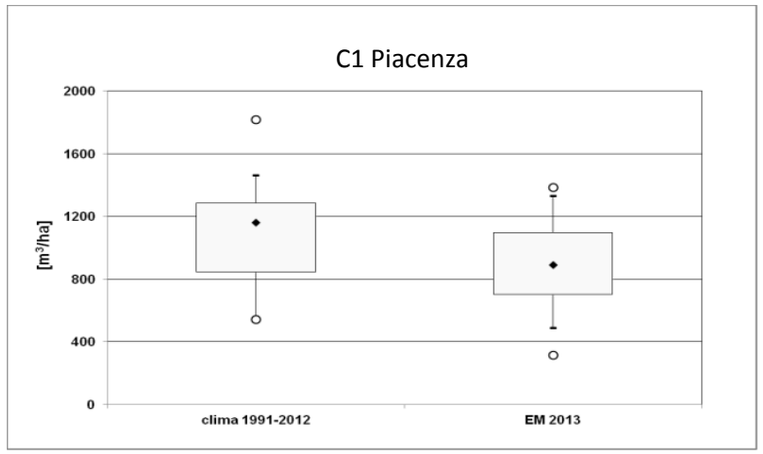


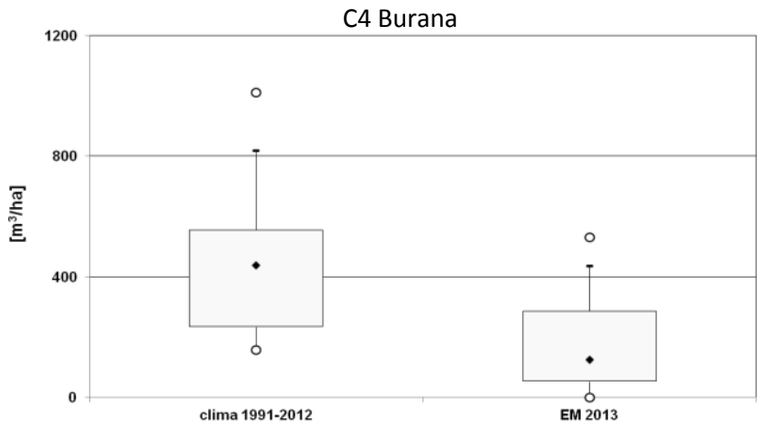
LAI map

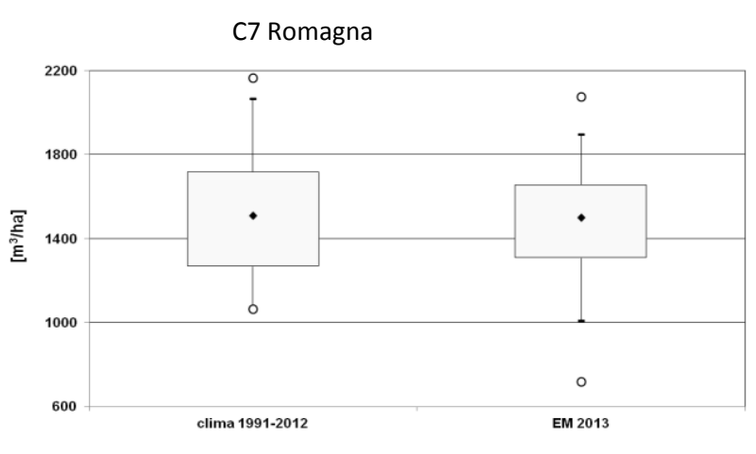


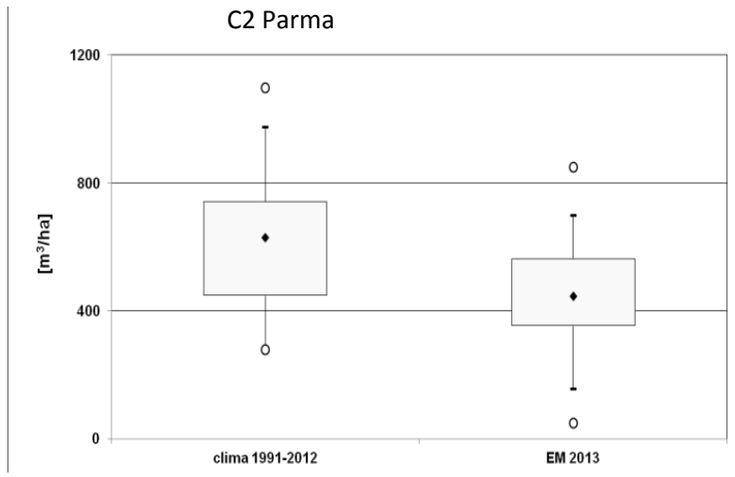
Seasonal irrigation map (mm)

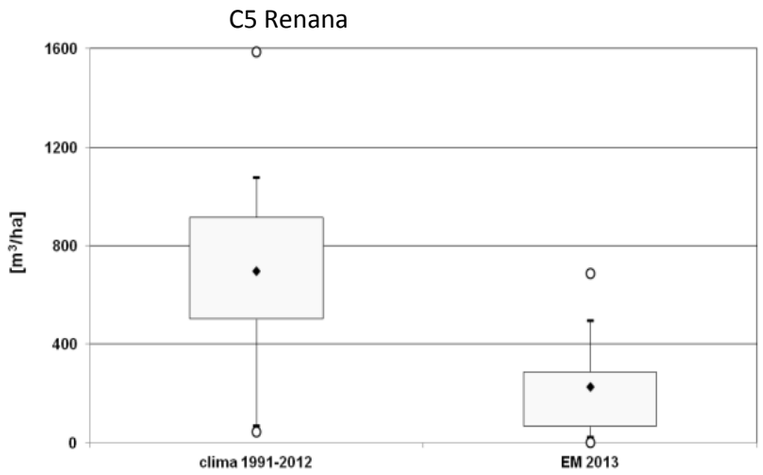
Irrigation water needs forecasts for summer (m3/ha)

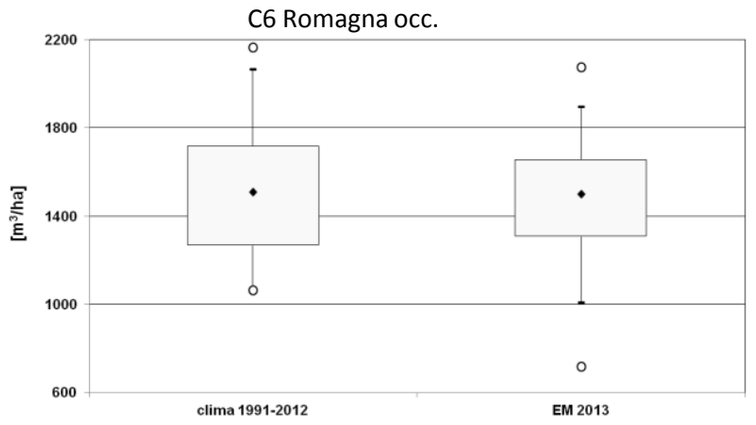


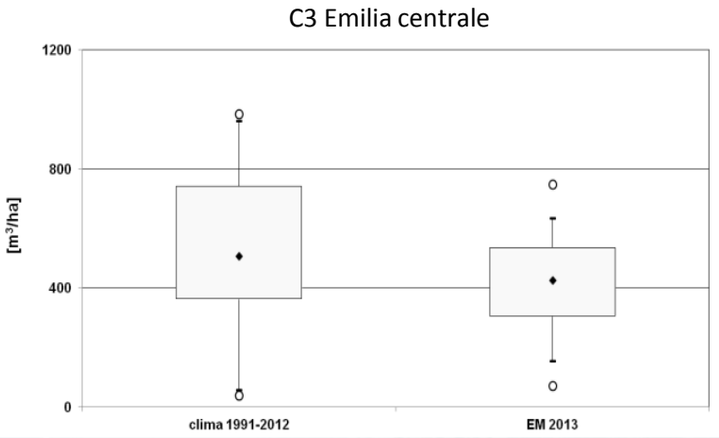


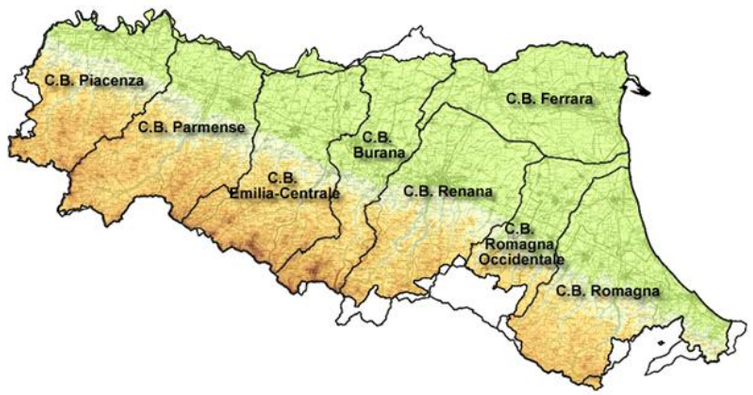


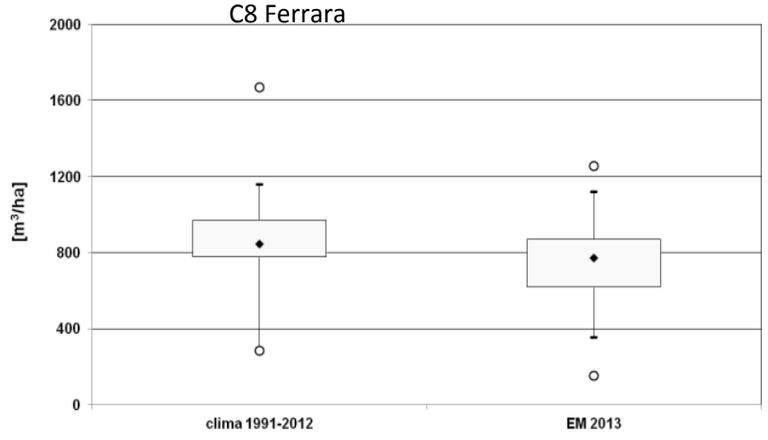








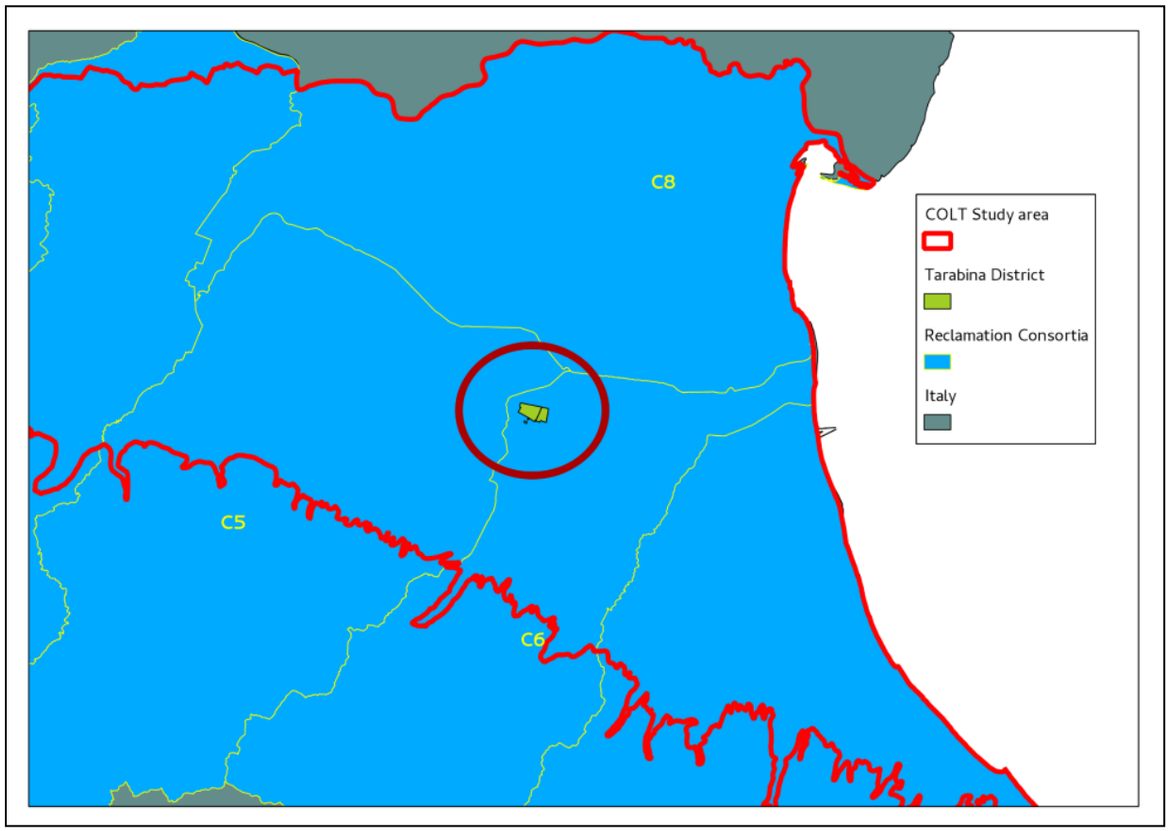




Problems (2012)

- More information are needed on real irrigation in order to check the systems
- Solutions…

Test area Tarabina (Ra) for 2011



Consorzio Bonifica Romagna Occ.
Tarabina
Irrigated area 2011: 571 ha
Observed irrigation value 2011:
0,44 Mm^3 (average77 mm/ha)

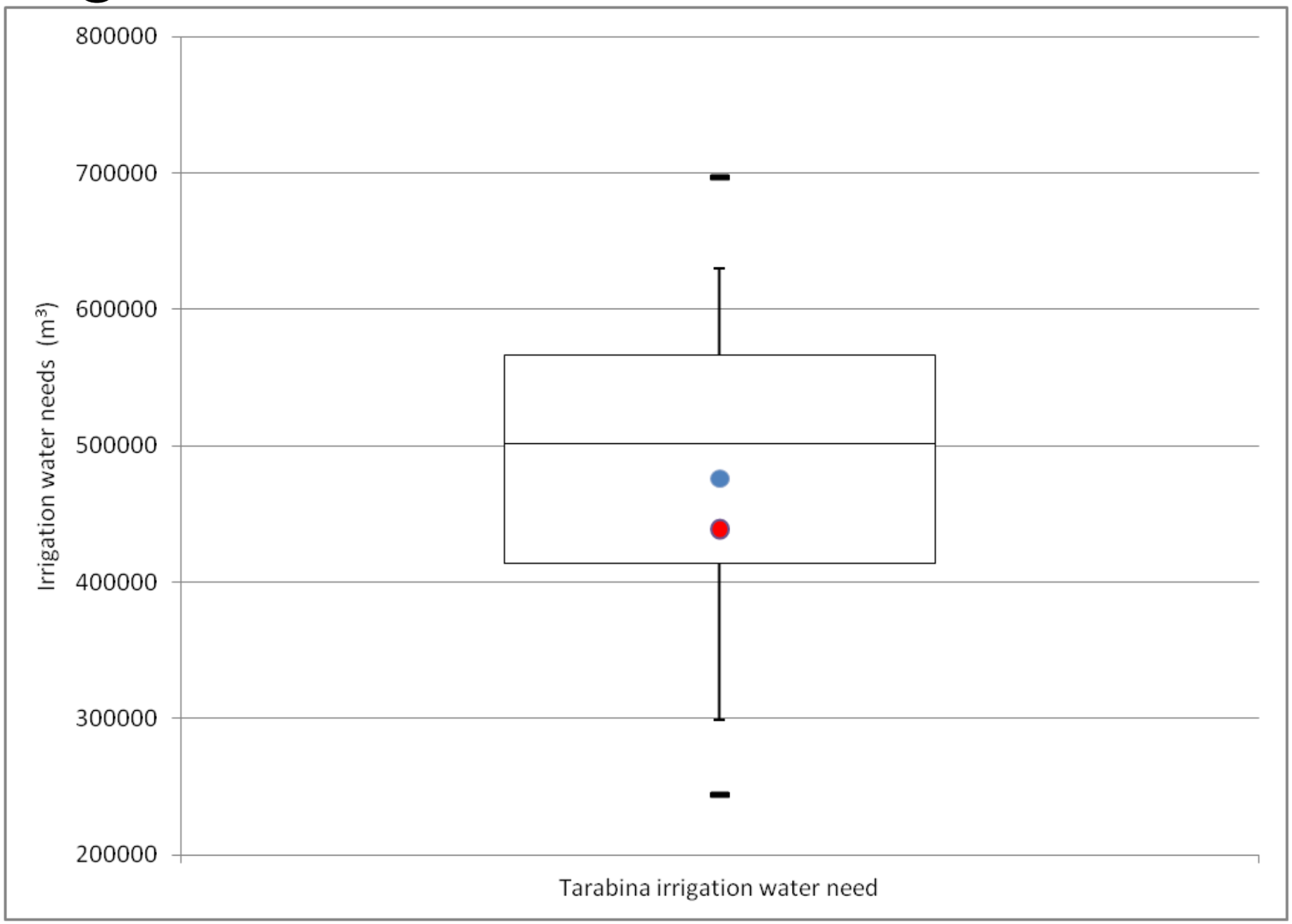
Observed and estimated crop areas Tarabina 2011

AGREA CLASSIFICATION	COLT CLASSIFICATION	AGREA AREA (ha)
Apricot	LPfm	0.2
Seed beat	EAgc	4.0
Winter cereal	EAgc	173.2
Onion	EEee	25.6
Forage	EPpm	50.7
Fruit	LPfm	0.9
Sunflower	EEee	4.6
Persimmon	LPfm	0.3
Maize	EEee	159.1
Apple	LPfm	1.2
Melon	EEee	0.3
Vegetable	EEee	3.7
Potatos	EEee	9.3
Pear	LPfm	15.2
Peach	LPfm	13.4
Meadow	EPpm	0.2
Hedge	EAgc	2.7
Trees (hedge)	EAgc	13.1
Soya	EEee	4.4
Sorghum	EEee	23.6
Plum	LPfm	0.2
Vineyard	LPfm	65.5
Extra agricultural area		44.9
Total crop area		**571.2**
Total area		616.1

	AGREA (ha)	COLT (ha)	Diff (%)
EEee	230.5	253.6	10%
LPfm	96.7	109.3	13%
EAgc	193.0	197.8	3%
EPpm	51.0	58.9	16%
Totale	**571.2**	**619.7**	8%

EEee	Erbacee estive
EAgc	Erbacee Autunno vernine
EPpm	Erbacee poliennali
LPfm	Frutticole e vite

Irrigation demand 2011 for Tarabina



Box plot: seasonal forecasts iCOLT (summer 2011)

iCOLT simulation forcing the model with observed data

Observed irrigation

Irrigation water needs for Emilia-Romagna for June-July-August 2011 (millions of m3)

Reclamation Consortium	Seasonal forecasts JJA 2011	Observed meteo data 2011	Difference %	Observed meteo data 2010
C1Consorzio di Bonifica di Piacenza	80.18	73.43	-8.4%	54.6
C2 Consorzio della Bonifica Parmense	58.88	58.94	0.1%	37.6
C3 Consorzio di Bonifica dell'Emilia Centrale	47.71	68.36	43.3%	50.7
C4 Consorzio della Bonifica Burana	83.10	113.04	36.0%	65.5
C5 Consorzio della Bonifica Renana	91.46	106.41	16.3%	55.5
C6 Consorzio di Bonifica della Romagna Occidentale	81.12	82.36	1.5%	47.0
C7 Consorzio di Bonifica della Romagna	97.07	105.47	8.7%	62.7
C8 Consorzio di Bonifica Pianura di Ferrara	252.69	237.13	-6.2%	75.5
TOTAL	**792.21**	**845.14**	**6.7%**	**449.1**

Irrigation water needs for Emilia-Romagna for June-July-August 2012 (millions of m3)

Reclamation Consortium	Seasonal forecasts JJA 2012	Observed meteo data 2012	Difference %
C1Consorzio di Bonifica di Piacenza	89.73	96.52	
C2 Consorzio della Bonifica Parmense	74.77	106.81	
C3 Consorzio di Bonifica dell'Emilia Centrale	94.31	130.34	
C4 Consorzio della Bonifica Burana	133.67	179.58	
C5 Consorzio della Bonifica Renana	130.65	176.47	
C6 Consorzio di Bonifica della Romagna Occidentale	104.52	121.29	
C7 Consorzio di Bonifica della Romagna	121.79	151.23	
C8 Consorzio di Bonifica Pianura di Ferrara	327.87	378.07	
TOTAL	**1077.31**	**1340.32**	**24%**

Irrigation water needs for Emilia-Romagna for June-July-August 2013 (millions of m3)

Reclamation Consortium	**Seasonal forecasts JJA 2013**	**Observed meteo data 2013**
C1Consorzio di Bonifica di Piacenza	63.1	92.0
C2 Consorzio della Bonifica Parmense	35.5	44.7
C3 Consorzio di Bonifica dell'Emilia Centrale	36.8	48.7
C4 Consorzio della Bonifica Burana	11.4	42.3
C5 Consorzio della Bonifica Renana	21.1	56.1
C6 Consorzio di Bonifica della Romagna Occidentale	97.0	108.1
C7 Consorzio di Bonifica della Romagna	71.6	80.3
C8 Consorzio di Bonifica Pianura di Ferrara	129.6	156.6
TOTAL	466.0	628.8

Forecasts 2012

AGENZIA REGIONALE PREVENZIONE E AMBIENTE DELL'EMILIA-ROMAGNA

Servizio IdroMeteoClima

Le irrigazioni dell'estate 2012 previste sopra la media

Dopo le basse esigenze irrigue del 2010, (intorno ai 500 milioni di metri cubi) e quelle normali del 2011 (circa 850 Mm3), i quantitativi irrigui globali per il 2012 sono previsti in aumento (circa 1000 Mm3), con valori superiori alla media.

(19/06/2012) Scopo dell´attività Colt è simulare nell´ambiente modellistico integrato Criteria il bilancio idrico dei suoli agricoli di pianura della regione utilizzando la mappa da satellite delle colture dell´anno in corso, i dati meteorologici registrati fino a inizio giugno e le previsioni stagionali per l´estate.

Le elaborazioni sono state suddivise in diversi sottoprogetti aventi come delimitazione territoriale le aree irrigue dominate dai diversi Consorzi di bonifica nell´estensione definita dalla recente ristrutturazione.

Quest´anno, dopo le basse esigenze irrigue del 2010, (intorno ai 500 milioni di metri cubi) e quelle normali del 2011 (con circa 850 milioni di metri cubi), i quantitativi irrigui regionali sono previsti in aumento (circa 1000 Mm3) con valori quindi superiori alla media.

Nella tabella seguente il confronto tra i fabbisogni irrigui delle colture per l´anno 2011 simulata sulla base dei dati meteo osservati nel 2011 e i fabbisogni irrigui delle colture per l´anno 2012 ottenuti con le previsioni stagionali per il trimestre Giugno Luglio Agosto (GLA).

Fabbisogno irriguo regionale in milioni di m3

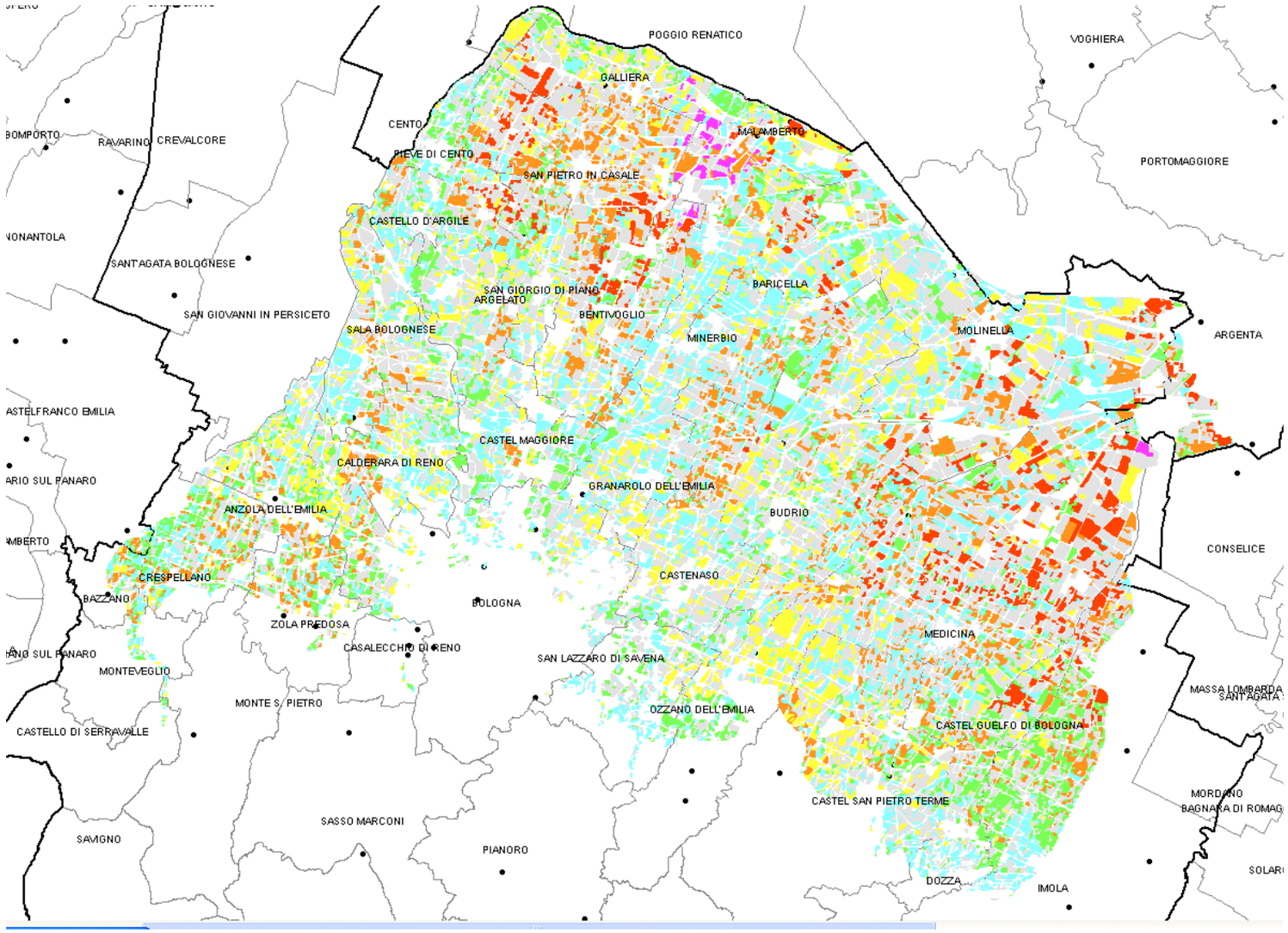
Consorzio di bonifica	2011 (dati meteo osservati)	2012 (previsioni stagionali)
C1 (Piacenza)	73.43	89.63
C2 (Parma)	58.94	74.77
C3 (Emilia cen.)	68.36	94.31
C4 (Burana)	113.04	113.67
C5 (Renana)	106.41	130.65
C6 (Romagna occ.)	82.36	104.52
C7 (Romagna)	105.47	121.79
C8 (Ferrara)	237.13	317.33
TOTALE	845.14	1066.66

Maggiori informazioni sull´attività **Colt**.

The outputs: maps or charts

We can have real time information but also estimates the total, seasonal or annual, irrigation needs

here an example of the total annual irrigation in mm



The outputs: maps or charts

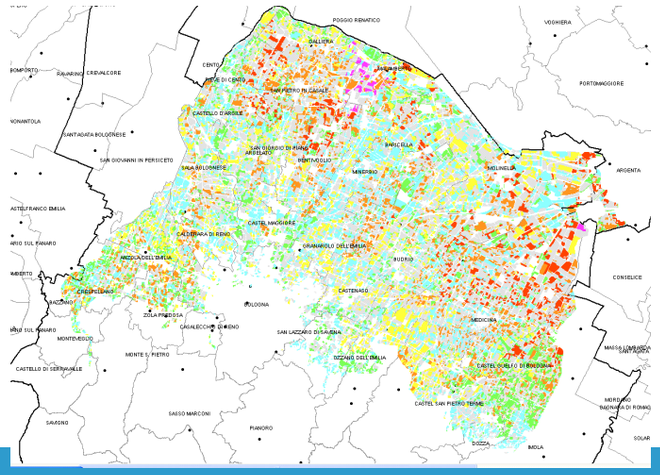
CONSORZIO DELLA BONIFICA RENANA

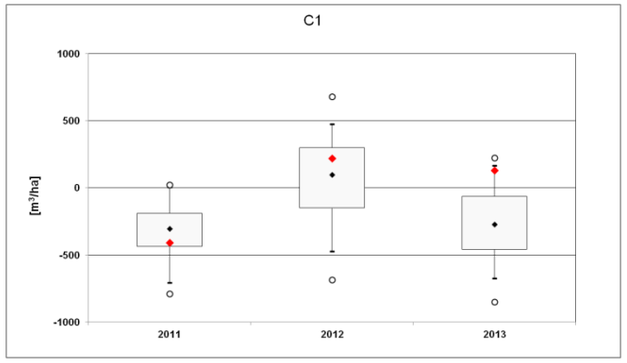
Classi colturali	Ha	Irrigazione media (mm)	Irrigazione minima (mm)	Irrigazione massima (mm)	Volume globale in Mm3
Erbacee Autunno Vernine	41950	0	0	0	0.0
Erbacee Primaverili Estive 1°	23237	227	100	350	54.0
Erbacee Primaverili Estive 2°	4206	199	120	280	8.4
Erbacee Poliennali	14757	97	50	100	14.3
Fruttiferi e vite	15240	116	30	210	17.9
Riso	0				
				totale	94.8

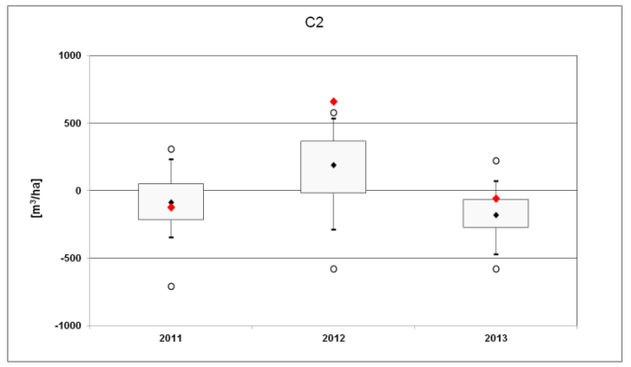
CONSORZIO DELLA BONIFICA RENANA Distretto irriguo	Area del distretto (Ha)	Esigenza irrigua media (mm)	Esigenza irrigua globale (Mm3)
Aree non raggiunte	30117	107	28.4
	16		0.0
CER GRAVITA'	593	120	0.4
DEPURATORE CASTEL SAN PIETRO TERME	289	108	0.2
DEPURATORE OZZANO	4064	103	4.1
DISTRETTO IN PRESSIONE PO	508	115	0.4
DISTRETTO IN PRESSIONE RENO	41445	91	39.4
PO	6	117	0.0
QUADERNA	252	123	0.3
RENO	16028	113	16.0
SAMOGGIA LAVINO	1774	107	1.9
SAMOGGIA RENO	3125	104	2.6
SILLARO	1175	117	1.1
	99393	Totale	94.8

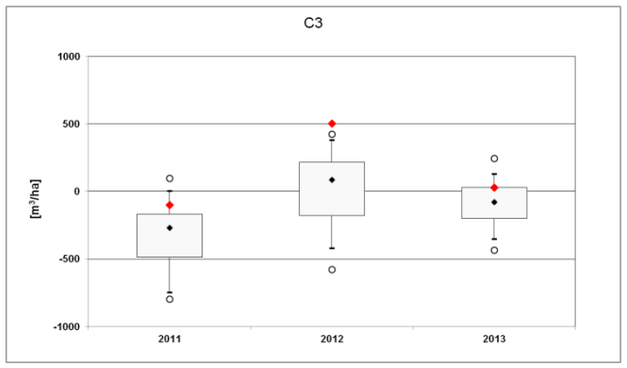
The model can give outputs in tables, subdivided for different crops classes or irrigation districts

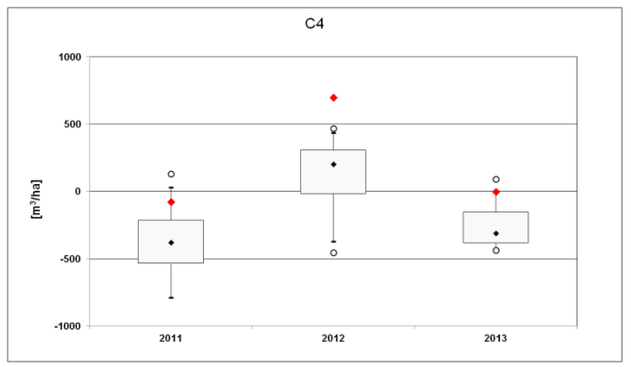
For example: the total irrigation needs is approximately 98 million cubic meters

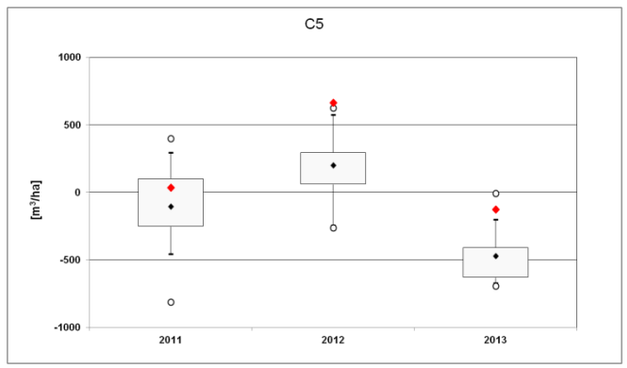


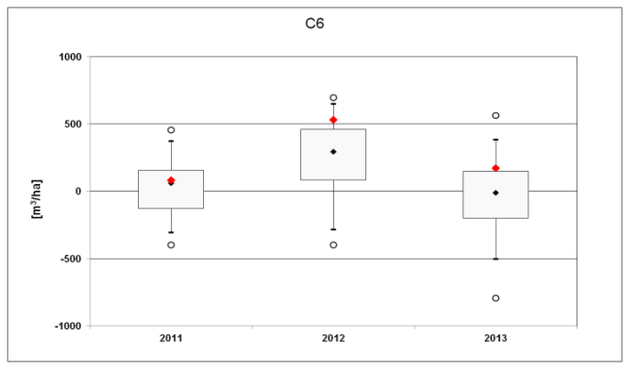


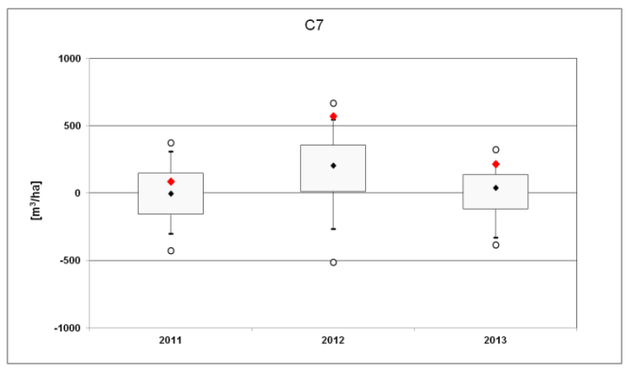


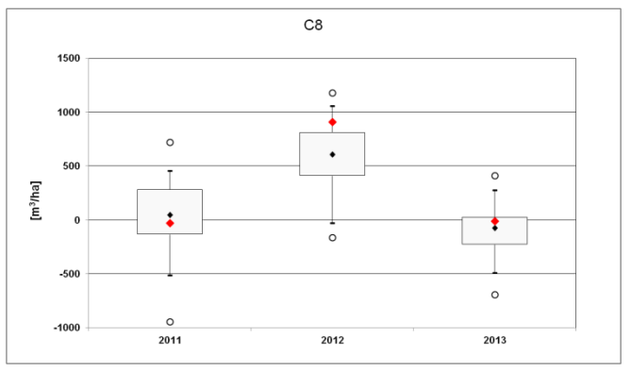












The eight panels refer to each Emilia-Romagna reclamation consortium and show the box plot for the probabilistic seasonal predictions of irrigation need anomaly (in m^3/ha) obtained using the iCOLT system for the years 2011, 2012 and 2013. Climatological values and validation values (red dots) are estimated using the CRITERIA water balance model forced with observed meteorological data. Boxes cover from the 25th to the 75th percentile, whiskers extend to the 5th and 95th percentile while extreme values are indicated by black dots. Red, solid dots indicate the observed values.

Future development

- Integration with other models (eg. Direct soil moisture surveys and remote sensing estimation of real evapotranspiration)
- Importance of these mothodologies under climate change conditions
- Application of the iCOLT chain to other Italian irrigated areas and Euro-mediterranean regions

Needs

- To better control the water distribution
- To know in more detail the irrigation demand, that represents the 50-70% of the total water demand
- To develop effective adaptation tecniques

Thank you!

ARPA-SIMC Calibration Scheme

Large-scale Predictions
(monthly Z500-T850)
Euro-SIP @ 2.5°x2.5° over Euro Atlantic

Local Obs.
(daily T_{max},T_{min}, Prec)
UCEA analysis @ 35Km over Italy

PC An.

Predictors

MLR
in cross-val.

PC An.

Predictands

EOF obs + PC pred

Probabilistic Forecast Maps

Skill of T_{max} JJA predictions over Italy

Results refere to ENSEMBLES-STREAMII multi-model seasonal forecasts (1971-2005)

Preprocessing	DMO		Calibrated	
	Cor	BSS	Cor	BSS
Full fields	0.38*	0.14	0.49**	0.21
Detrended	-0.01	0.004	0.27	0.11
Full fields - 2003	**0.45**	**-0.08**	**0.60****	**0.17**
(Full fields – 2003) detrended	**0.09**	-0.03	**0.49**	0.09

Pavan and Doblas-Reyes (2013)

Conclusions

- Calibrated seasonal multi-model seasonal predictions have better skills than DMO multi-model predictions
- Over Italy and in the summer season the DMO T_{max} predictions skill is mostly due to the correct representation of linear trends.
- Calibration can still produce skilful predictions even if trends are removed.
- The presence of extreme events in the data-set has a strong influence on the evaluation of the skill of the system and on the calibration process.