



Modelli per la gestione delle risorse idriche: il contributo della statistica ufficiale

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I dati delle acque in Veneto

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Le sfide nella gestione delle risorse idriche

> Cambiamenti climatici

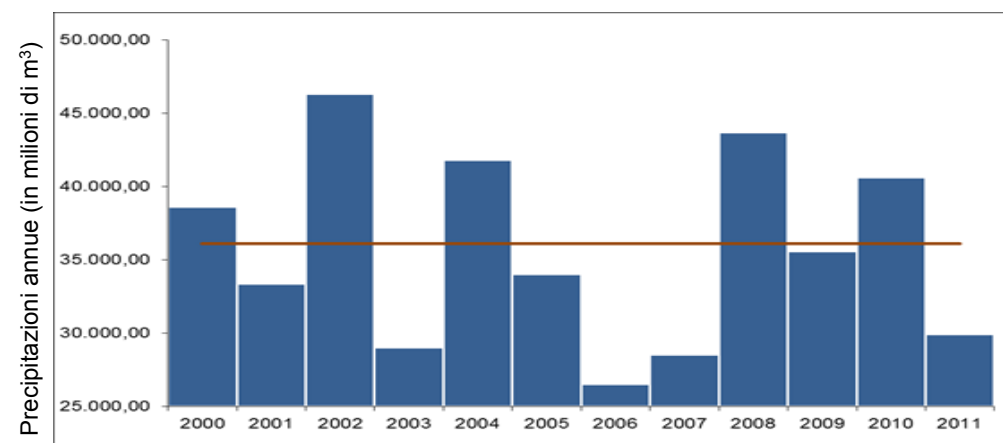
> Alluvioni

> il fenomeno più costoso
(vite umane, perdite economiche, etc.)



> Siccità

> e.g. Bacino del Po: Stato di Emergenza dichiarato tre volte (2003, 2006, 2007) -21 mesi in totale



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Perchè modellizzare?

1. Misurare gli impatti di eventi estremi/cambiamenti climatici
2. Analizzare il potenziale di diverse politiche per combattere questi eventi

Per modellizzare serve avere dati e statistiche.

La **statistica ufficiale** offre diversi **vantaggi**:

- **Pubblica**
- **Continua (tempo e spazio)**
- **Omogenea, validata**

Questa presentazione offre diversi risultati ottenuti con modelli che utilizzano statistiche ufficiali

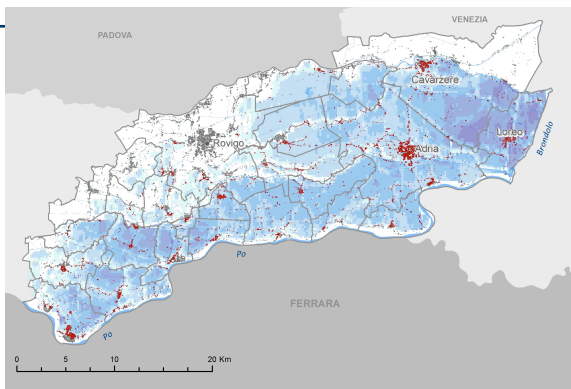
A. Modellizzazione degli impatti

Impatti diretti e indiretti delle alluvioni

- > Le statistiche ufficiali misurano gli impatti diretti
- > Le stime degli impatti indiretti non sono abituali
- > NHG della FEEM ha sviluppato un modello per stimare entrambe

A.1.

Impatti diretti e indiretti delle alluvioni

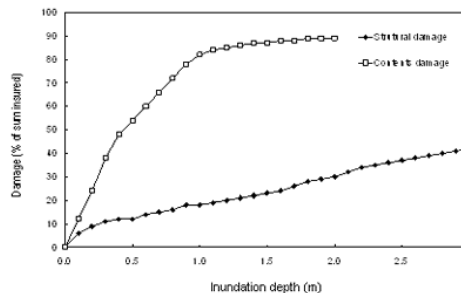


Mappa evento alluvionale (area, profondità?)
ARPA, Regioni, A. di Bacino (AdBPo)

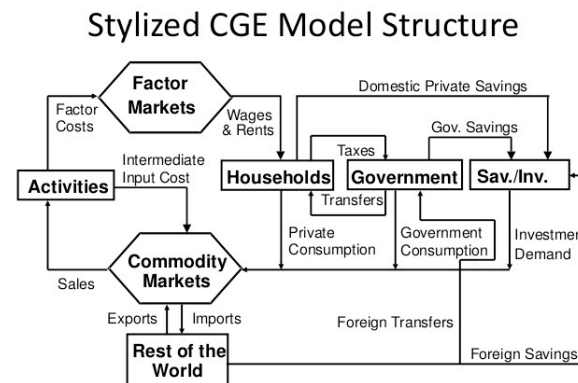


Modello regionalizzato:

- Flussi bilaterali di commercio (ISTAT, trasporto su strada, aereo, marittimo, ferroviario)
- Valore aggiunto, lavoro (ISTAT, Conti Economici Regionali)



Depth-damage curves
(Impatti diretti)



CGE model
(Impatti indiretti)

21

A.1.

Impatti diretti e indiretti delle alluvioni

Esempio: Alluvione 2000 (Piemonte, Valle d'Aosta)

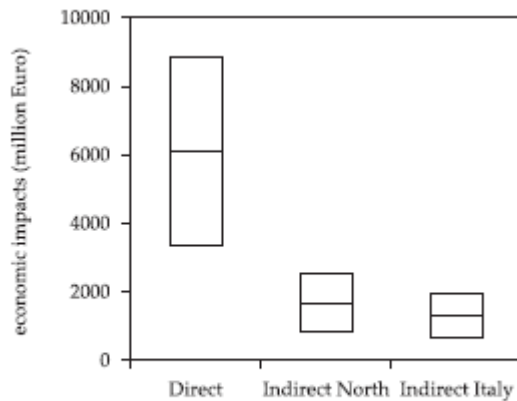


Fig. 6. Range of direct and indirect losses (in the North and Italy as a whole) using the flexible model. Values are given in million Euro 2000 value.

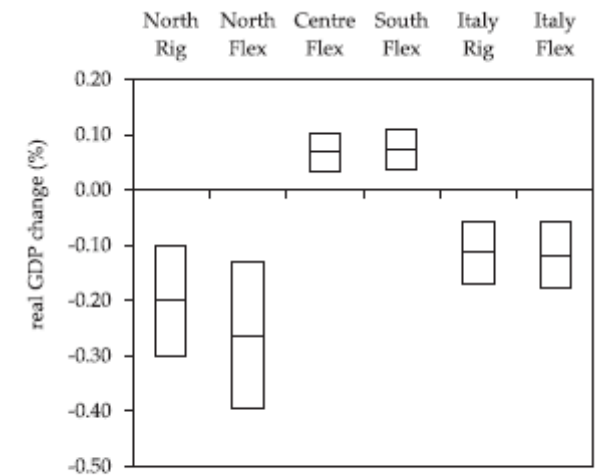


Fig. 3. Range of sub-national and national GDP variations (in percentage of real GDP) for different type of models: rigid – rig, flexible – flex, depending on the different duration of the impact. Centre and South Rig are not reported because the change is null.

$$Yield_{tfrd} = \mu_{tfrd} + u_{..r.} + u_{...d} + e_{tfrd}$$

where:

- $Yield_{tfrd}$: is the wheat yield observed for the year t -th in the farm f -th located in the r -th geographical region and in the d -th agrarian district;
- μ_{tfrd} represents the fixed part of the model;
- $u_{..r.}$, $u_{...d}$, e_{tfrd} represent the random components.

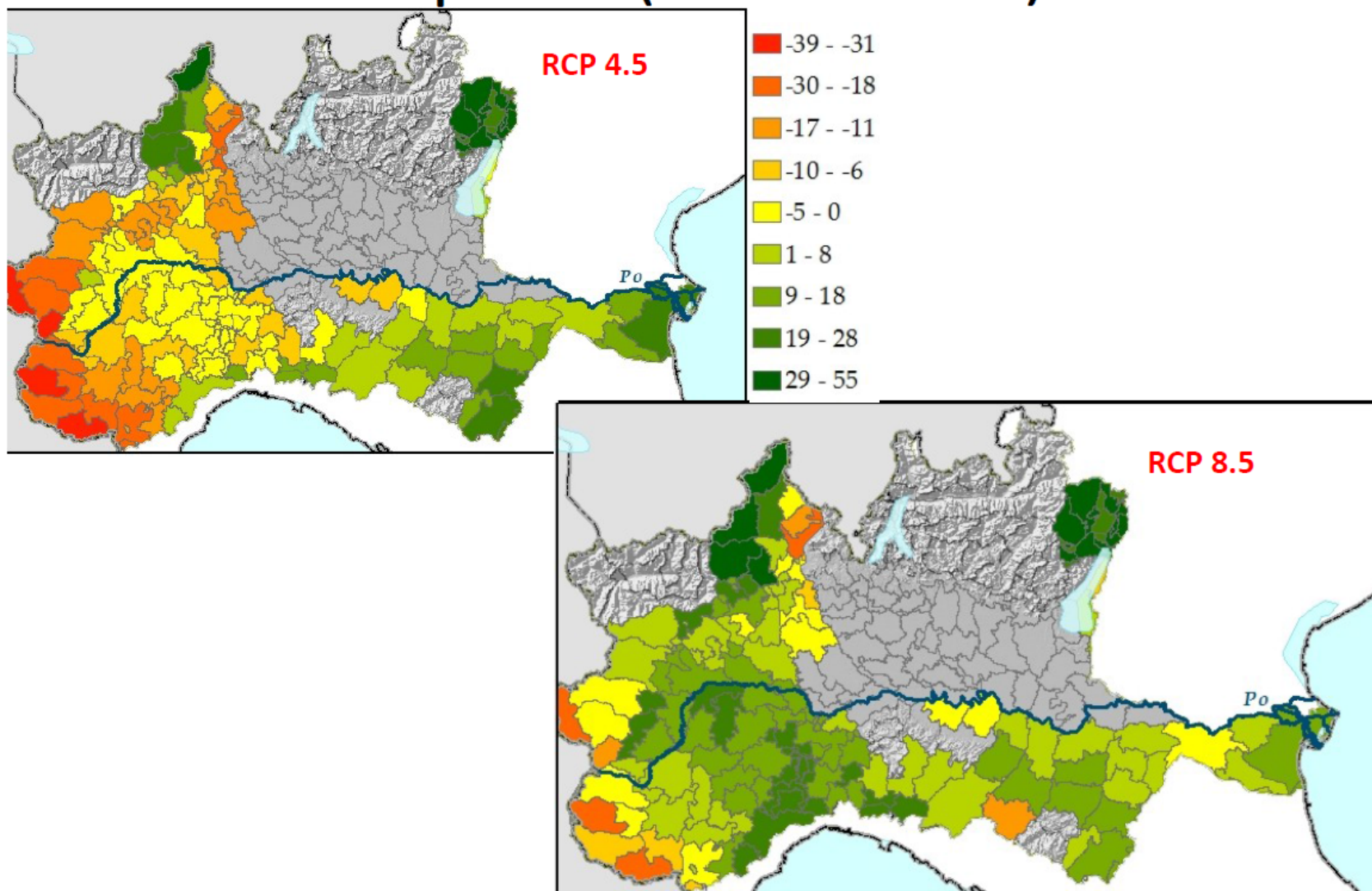
> Fonte dei dati:

- Superfici coltivate e produzioni totali: ISTAT (2000-13)
- Statistiche economiche e finanziarie, struttura delle aziende: campione RICA (INEA) (2003-2007 e 2008-2011)
- Dati climatici
- Due periodi: 1980-2011 (baseline); 2021-2040
- Due scenari: RCP 4.5 e RCP 8.5

A.2.

Impatti del CC e della siccità sull'agricoltura

Impacts (2021-2041)



Mo

B. Modellizzazione delle politiche (Focus nel settore agricolo)

B.

Il modello: Come pensa il contadino?



- > Funzione di utilità in due tappe (livello aziendale/Regione Agraria):
 - > Prima si rivelano gli attributi rilevanti (*cosa si valuta?*)
 - > Secondo, si ottiene una funzione di utilità (*quanto si valuta?*)

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B.

Il modello: Come pensa il contadino?

$$\text{Max}_x U(x) = U(z_1(x); z_2(x); z_3(x) \dots z_m(x))$$

$$\text{s.t.: } 0 \leq x_i \leq 1$$

$$\sum_{i=1}^n x_i = 1$$

$$X \in F(x)$$

$$z = z(x) \in R^m$$

> Dati:

> Superfici coltivate e resa (RER; RICA-INEA)

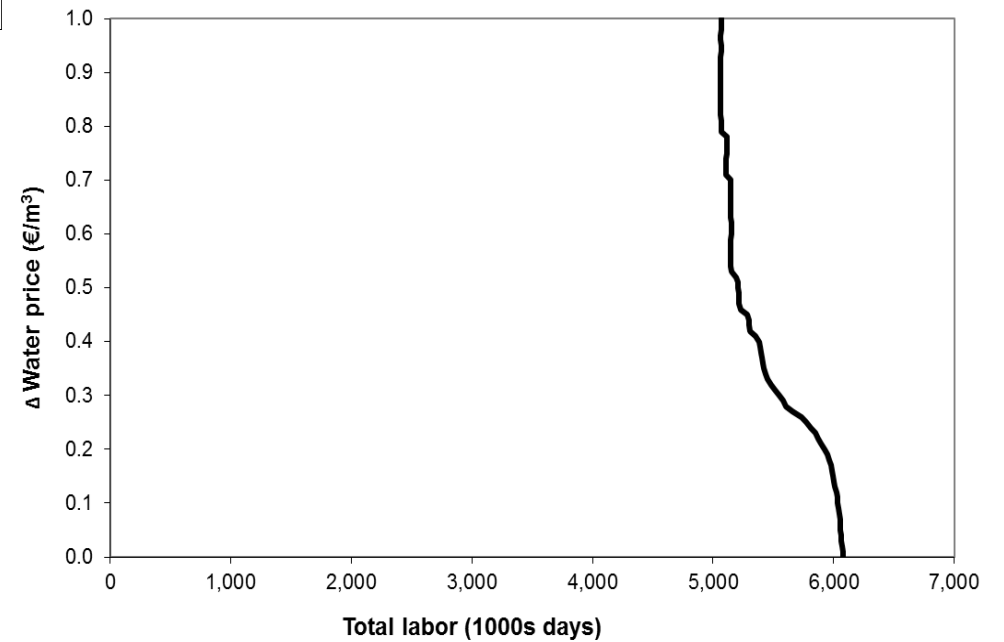
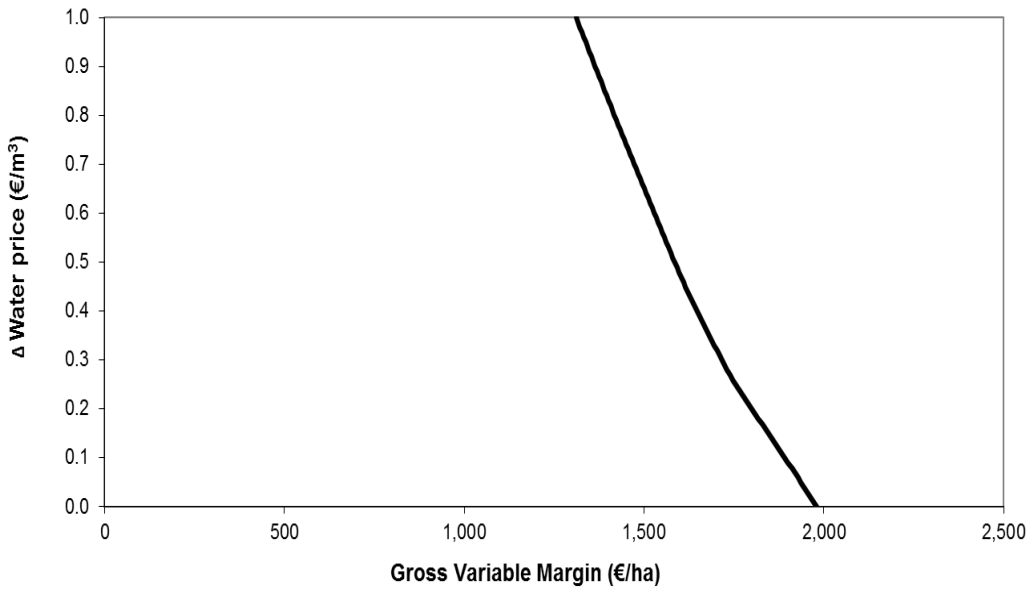
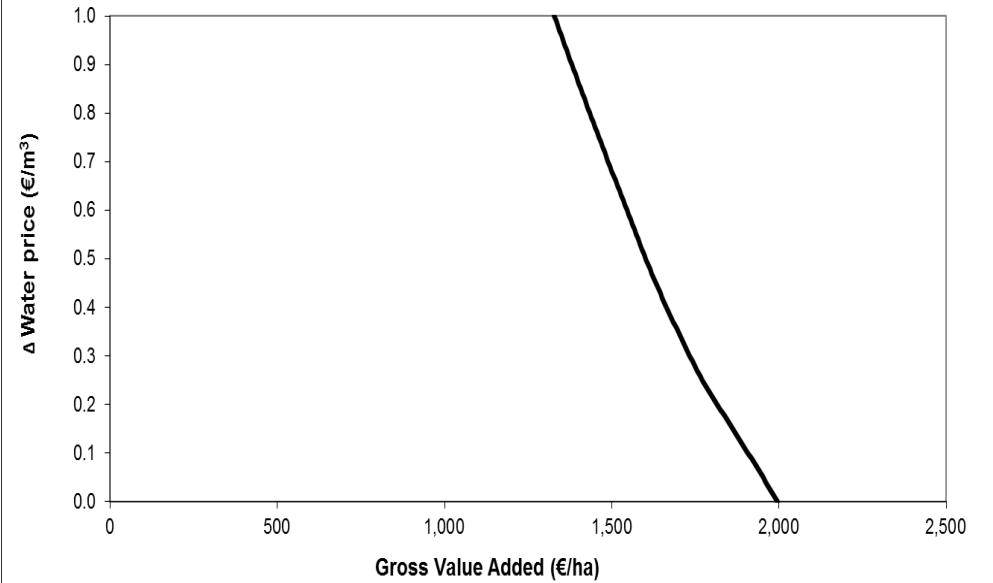
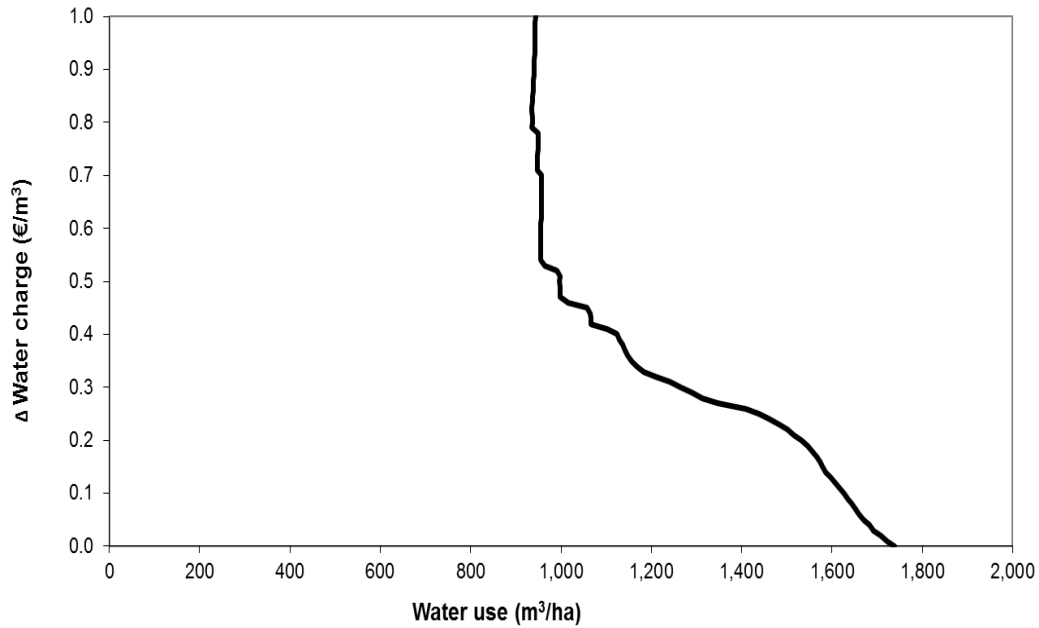
> Prezzi (ISMEA)

> Lavoro e altri costi (RICA/INEA)

> Struttura delle aziende (ISTAT - Censimento Generale dell'Agricoltura)

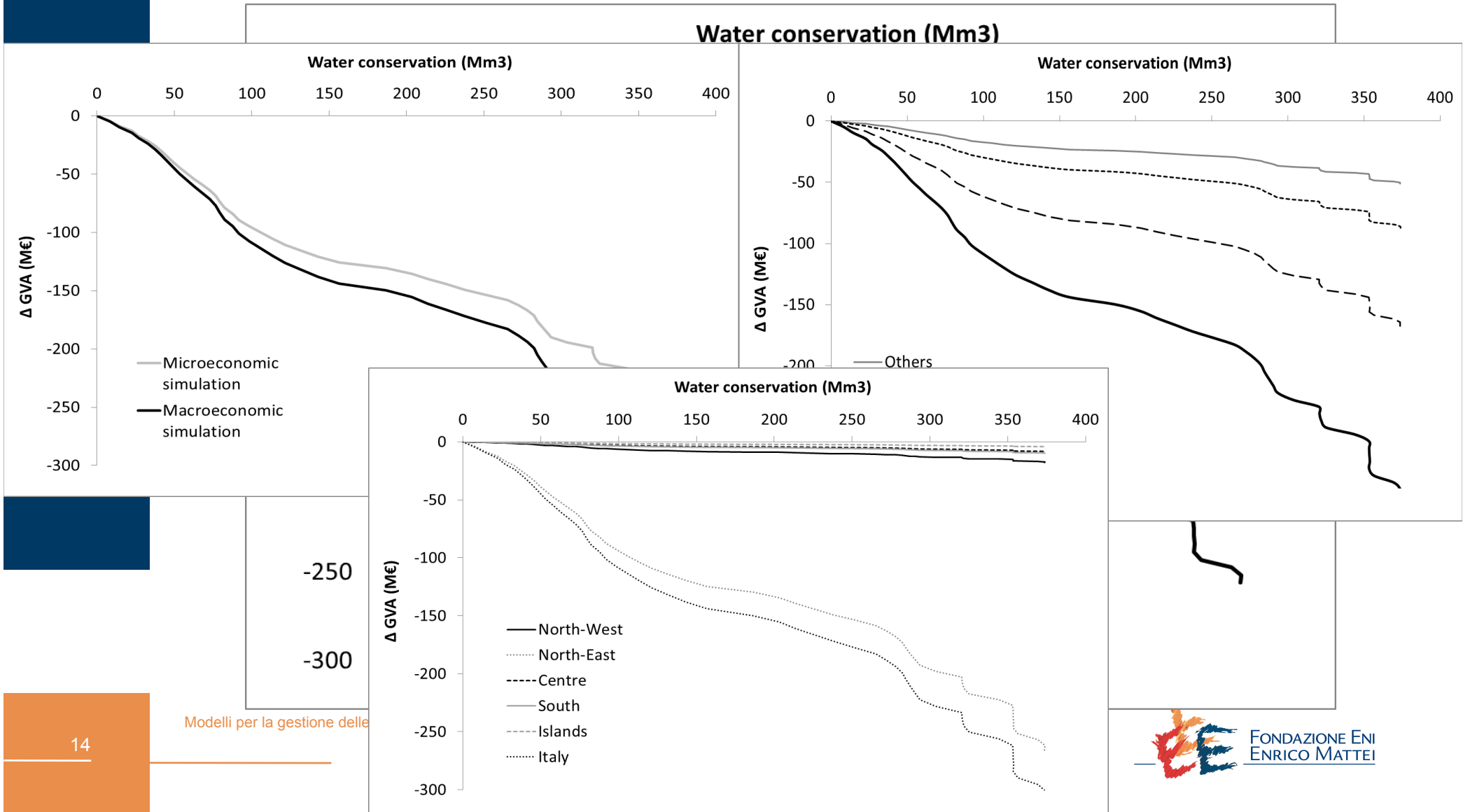
B.1.

Canone di concessione – simulazioni



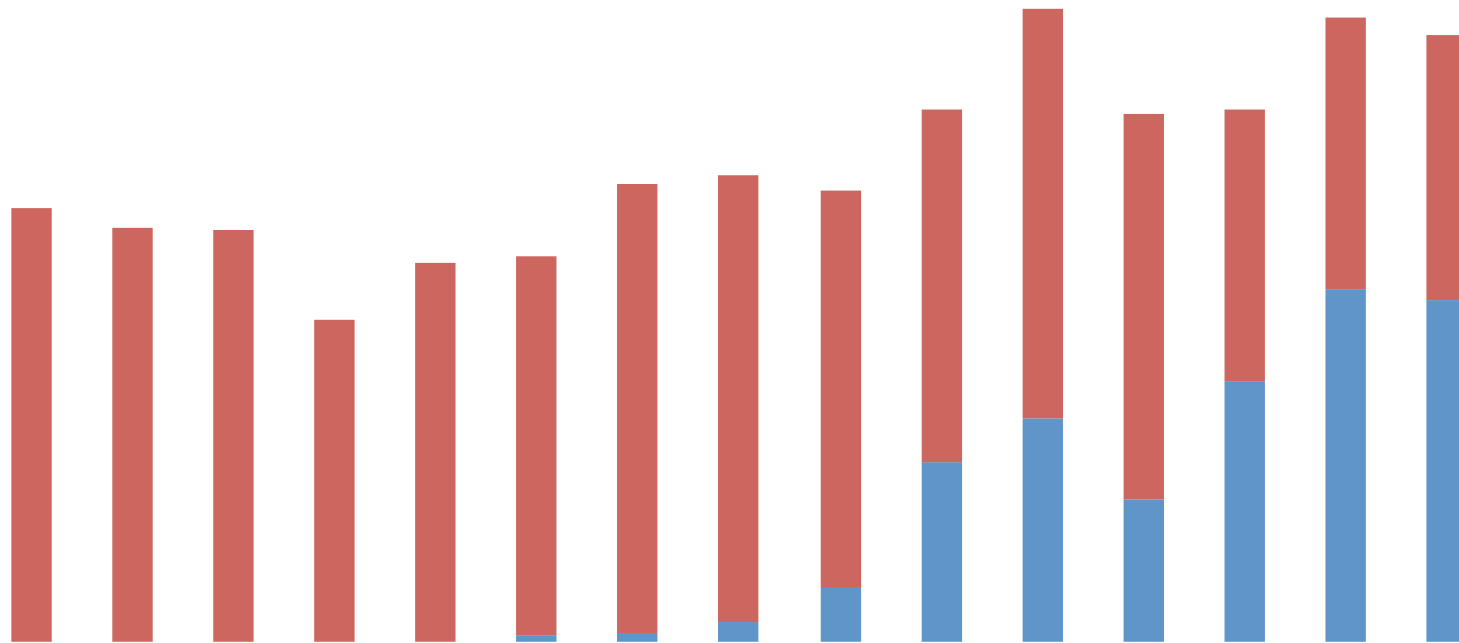
B.1.

Canone di concessione – simulazioni



B.2.

Assicurazione agricola

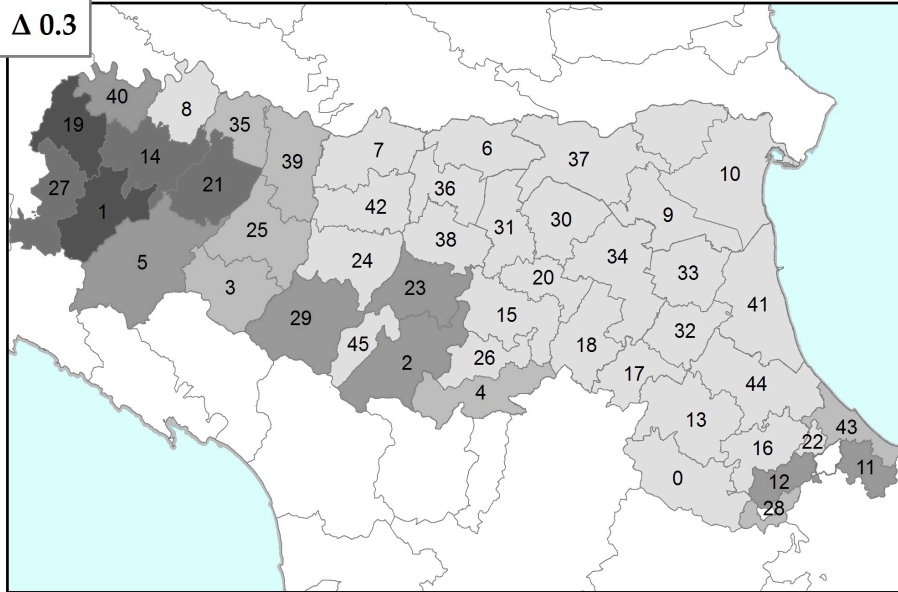


> Fonte: Sicuragro (ISMEA)

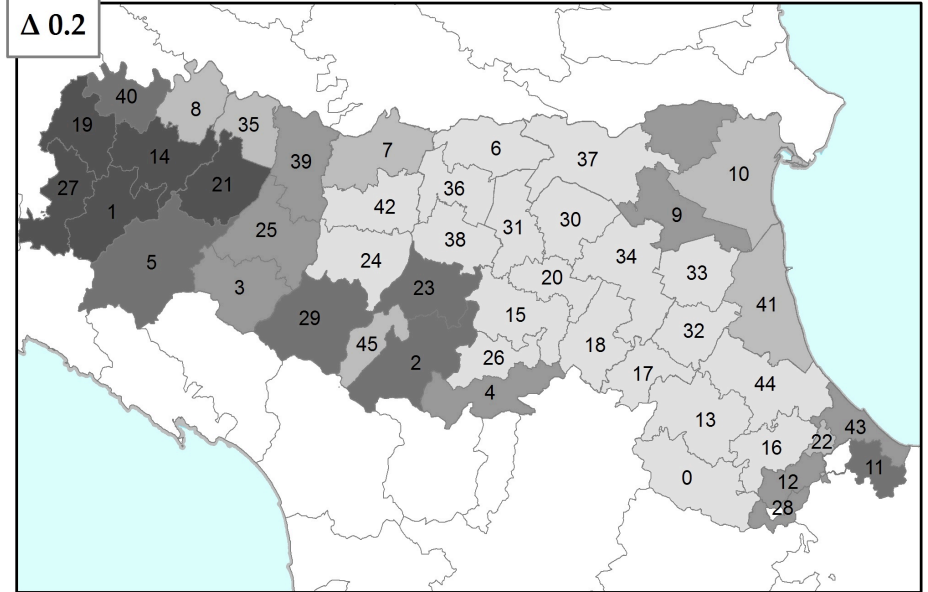
B.2.

Assicurazione agricola

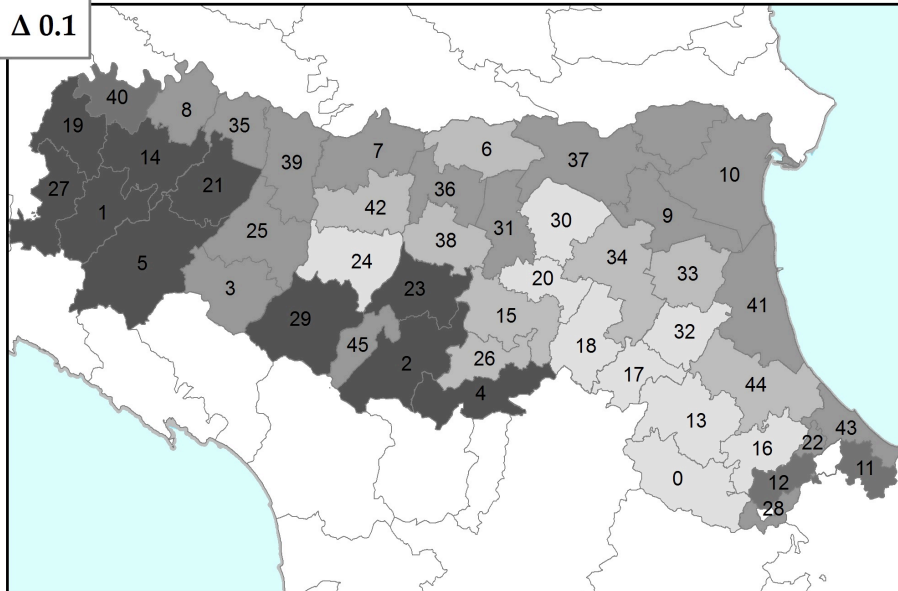
$\Delta 0.3$



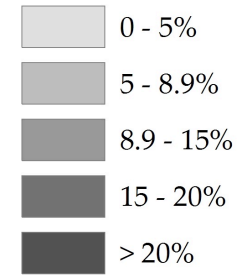
$\Delta 0.2$



$\Delta 0.1$



Delta



Conclusioni



- > Il cambiamento climatico cambierà la dinamica delle risorse idriche
- > La gestione delle risorse idriche deve adattarsi
- > La modellizzazione è uno strumento imprescindibile per informare politiche
- > Una statistica omogenea, continua e pubblica è necessaria
 - > Anche per i microdati (Regione Agraria, mappe alluvionali, etc.)

Grazie per l'attenzione



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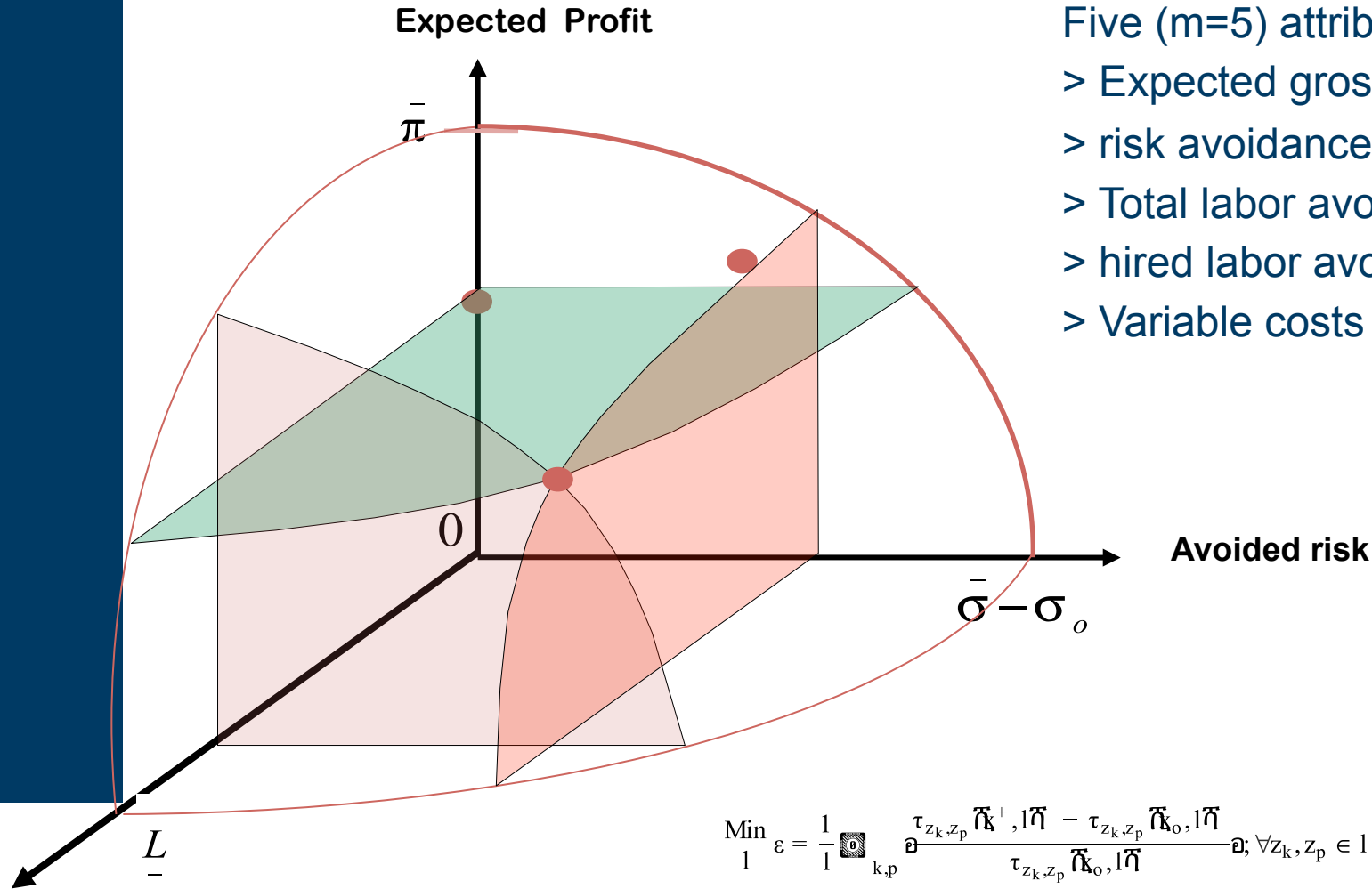
Annex



4.

The model: 1) Revealing the attributes

- Five (m=5) attributes explored:
 - > Expected gross variable margin (z1)
 - > risk avoidance (z2)
 - > Total labor avoidance (z3)
 - > hired labor avoidance (z4)
 - > Variable costs avoidance (z5)



$$\text{Min}_l \varepsilon = \frac{1}{l} \sum_{k,p} \frac{\tau_{z_k, z_p} \bar{\pi}_k^+ - \tau_{z_k, z_p} \bar{\pi}_k}{\tau_{z_k, z_p} \bar{\pi}_k}, \forall z_k, z_p \in l$$

Where: $x^+ = \text{ArgMax}_x \sum_{z_k, z_p} \tau_{z_k, z_p} \bar{\pi}_k - \tau_{z_k, z_p} \bar{\pi}_k$, $0 \leq x_i \leq 1$; $\sum_{i=1}^n x_i = 1$; $X \in F(\bar{\pi}_k) \forall \tau \in Z(\bar{\pi}_k)$

Management complexity

5. The model: 2) Calibrating the Utility function

> In equilibrium the MTR equals the MSR

$$\beta_{kp} = \text{MTR}_{kp} = \text{MSR}_{kp} = - \frac{\partial U / \partial z_p}{\partial U / \partial z_k}; p, k \in (1, \dots, l); p \neq k$$

> Efficiency frontier is known -enough to integrate a utility function (observed decision = optimal decision)

> Taking a CRE Utility Function (Cobb-Douglas)

$$U(\tau) = \prod_{r=1}^l z_r^{\alpha_r}; \quad \sum_{r=1}^l \alpha_r = 1$$
$$- \frac{\partial U / \partial z_p}{\partial U / \partial z_k} = - \frac{\alpha_p z_k}{\alpha_k z_p}$$

6. Model calibration

Agricultural District	Alpha Values					Errors			
	a_1	a_2	a_3	a_4	a_5	e_f	e_a	e_d	e
Pianura di Rimini	55.2%	1.0%	0.0%	42.8%	1.0%	13.3%	1.1%	14.6%	6.6%
Pianura di Reggio Emilia	68.3%	6.2%	0.0%	25.4%	0.0%	10.9%	2.6%	10.4%	5.1%
Pianura di Modena	84.5%	15.5%	0.0%	0.0%	0.0%	5.4%	1.2%	5.4%	2.6%
Pianura Forlivese e Cesenate	85.1%	6.6%	0.0%	8.3%	0.0%	3.2%	1.5%	2.9%	1.5%
Pianura di Ferrara	80.7%	2.8%	0.0%	16.5%	0.0%	1.7%	1.3%	1.4%	0.8%
Pianura di Carpi	82.6%	10.6%	0.0%	6.8%	0.0%	7.9%	1.3%	6.6%	3.5%
Pianura del Senio e del Lamone	99.0%	1.0%	0.0%	0.0%	0.0%	14.3%	5.4%	14.3%	7.0%
Pianura dell'Idice e del Santerno	94.9%	5.1%	0.0%	0.0%	0.0%	4.6%	2.7%	2.4%	1.9%
Pianura del Lamone	81.9%	1.5%	0.0%	16.7%	0.0%	4.2%	2.4%	4.3%	2.1%
Pianura di Ravenna	97.6%	2.4%	0.0%	0.0%	0.0%	9.6%	5.7%	9.6%	4.9%
Pianura di Busseto	86.3%	1.0%	0.0%	12.7%	0.0%	3.8%	0.1%	3.8%	1.8%
Pianura a sinistra del Reno	80.8%	7.1%	0.0%	12.1%	0.0%	7.4%	1.1%	7.4%	3.5%
Pianura a destra del Reno	90.4%	5.9%	3.7%	0.0%	0.0%	20.5%	6.4%	19.5%	9.7%
Bonifica Ferrarese Occidentale	82.9%	9.4%	0.0%	7.7%	0.0%	9.1%	2.0%	11.4%	4.9%
Bonifica Ferrarese Orientale	85.8%	3.6%	0.0%	10.6%	0.0%	13.7%	2.7%	14.0%	6.6%
Basso Arda	75.1%	0.7%	0.0%	24.2%	0.0%	3.4%	1.8%	4.7%	2.0%
Bassa Reggiana	76.3%	1.4%	0.0%	22.3%	0.0%	7.6%	2.1%	7.0%	3.5%
Bassa Modenese	80.7%	4.8%	0.0%	14.5%	0.0%	2.6%	0.5%	2.7%	1.3%
Pianura di Parma	86.1%	1.3%	0.0%	12.6%	0.0%	6.3%	0.9%	6.0%	2.9%
Pianura di Piacenza	87.5%	1.9%	0.0%	10.6%	0.0%	2.2%	0.9%	0.0%	0.8%
Colline del Nure e dell'Arda	84.5%	3.7%	0.0%	11.7%	0.0%	2.9%	4.3%	3.9%	2.1%
Colline del Montone e del Bidente	88.6%	0.7%	0.0%	10.7%	0.0%	1.9%	2.1%	1.4%	1.1%
Colline int. Rubicone	89.9%	10.1%	0.0%	0.0%	0.0%	6.6%	2.0%	6.6%	3.2%
Colline Savio	90.2%	0.7%	0.0%	9.1%	0.0%	13.7%	5.2%	13.7%	6.7%
Collina del Senio e del Lamone	85.2%	1.3%	0.0%	13.5%	0.0%	8.4%	4.1%	8.5%	4.2%
Colline del Sillaro e del Santerno	99.7%	0.3%	0.0%	0.0%	0.0%	4.5%	5.7%	4.5%	2.8%
Colline di Bologna	98.9%	1.1%	0.0%	0.0%	0.0%	9.9%	4.2%	9.9%	4.9%
Colline di Salsomaggiore	75.4%	8.7%	0.0%	15.9%	0.0%	7.2%	0.3%	0.1%	2.4%
Colline Modenesi	88.9%	11.1%	0.0%	0.0%	0.0%	8.3%	3.7%	8.3%	4.1%
Colline tra Enza e Secchia	99.5%	0.5%	0.0%	0.0%	0.0%	3.7%	0.2%	0.1%	1.2%
Medio Parma	98.9%	1.1%	0.0%	0.0%	0.0%	4.1%	2.9%	4.0%	2.1%
Colline del Conca	97.3%	1.1%	0.0%	1.6%	0.0%	0.7%	0.4%	0.4%	0.3%
Colline del Trebbia e del Tidone	81.3%	4.9%	0.0%	13.8%	0.0%	0.8%	4.5%	2.0%	1.7%
Colline del Reno	99.0%	1.0%	0.0%	0.0%	0.0%	7.0%	5.7%	7.0%	3.8%
Colline del Montefeltro	98.1%	1.9%	0.0%	0.0%	0.0%	2.3%	1.2%	2.1%	1.1%
Valli del Dragone e del Rossenna	79.6%	0.5%	0.0%	19.9%	0.0%	2.2%	3.6%	2.0%	1.5%
Alto Taro	97.6%	2.4%	0.0%	0.0%	0.0%	4.6%	0.5%	0.1%	1.5%
Alto Reno	83.5%	16.5%	0.0%	0.0%	0.0%	25.0%	2.3%	0.1%	8.4%
Alto Parma	98.8%	0.7%	0.0%	0.5%	0.0%	4.7%	0.6%	0.1%	1.6%
Alto Panaro	86.3%	13.7%	0.0%	0.0%	0.0%	9.6%	3.3%	9.6%	4.7%
Montagna del Medio Trebbia	99.9%	0.1%	0.0%	0.0%	0.0%	20.6%	3.5%	0.1%	7.0%
Montagna del Medio Reno	97.2%	2.8%	0.0%	0.0%	0.0%	8.5%	3.3%	9.0%	4.3%
Montagna del Montefeltro	99.0%	1.0%	0.0%	0.0%	0.0%	2.4%	0.1%	0.3%	0.8%
Montagna tra l'Alto Enza e Alto Dolo	99.2%	0.8%	0.0%	0.0%	0.0%	1.2%	0.1%	0.1%	0.4%
Alto Nure	94.0%	1.0%	0.0%	4.7%	0.0%	10.1%	1.4%	7.0%	4.1%

Error terms

-Distance between the observed (x_i^0) and calibrated crop portfolio (x_i^*):

$$e_x = \frac{1}{n} \sigma_{i=1}^n \left| \frac{x_i^0 - x_i^*}{x_i^0} \right| \quad [\text{AII.1}]$$

-The distance between the observed attributes and their efficiency frontier presented in equation [6]:

$$e_f = \varepsilon \quad [\text{AII.2}]$$

-Distance between the observed (z_r^0) and calibrated attributes (z_r^*):

$$e_\tau = \frac{1}{m} \sigma_{r=1}^m \left| \frac{z_r^0 - z_r^*}{z_r^0} \right| \quad [\text{AII.3}]$$

-Mean calibration error:

$$e = \frac{e_x + e_\tau + e_f}{3} \quad [\text{AII.4}]$$