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Article · October 2009

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WATER USE IN ITALIAN AGRICULTURE: ANALYSIS OF RAINFALL PATTERNS, IRRIGATION SYSTEMS AND WATER STORAGE CAPACITY OF FARM PONDS

UTILIZZO DELLA RISORSA IDRICA NEL SETTORE AGRICOLO ITALIANO: ANALISI DELLE PRECIPITAZIONI, DEI SISTEMI DI IRRIGAZIONE E DELLA CAPACITÀ DI IMMAGAZZINAMENTO DEI LAGHETTI COLLINARI

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Abstract
This note describes some aspects regarding the management of water resources in Italy. The study in-cludes the analysis of rainfall patterns in the last years (2003-2007), considering the trend of annual and seasonal precipitation. Furthermore, an other issue is the irrigation systems: the more diffuse methods and the modality of water supplying adopted by farmers in the North, Centre and South of It-aly are evaluated. The role of farm ponds as water storage reservoir is an important aspect: the study takes into account the ponds distribution, management and their use for aid irrigation. Some examples about the possible use of farm ponds are described for different regions of Italian territory.

Keywords: precipitation anomalies, watering, farm ponds, water resources, climate change

Riassunto
Questa nota tecnica affronta diversi aspetti riguardanti la gestione della risorsa idrica in Toscana. Lo studio include l'analisi delle precipitazioni negli ultimi anni (2003-2007) considerando i trend delle anomalie annuali e stagionali. Vengono analizzati, inoltre, i principali metodi di irrigazione diffusi nel territorio italiano e le modalità di approvvigionamento di acqua da parte degli agricoltori. Un ultimo aspetto affrontato è quello dei laghetti collinari: la loro distribuzione e la valutazione del loro ruolo nell'approvvigionamento della risorsa idrica da utilizzare in caso di irrigazione di soccorso. Diversi esempi sul possibile utilizzo dei laghetti collinari sono descritti in differenti regioni della Penisola.

***Parole chiave**: anomalie di precipitazione, laghetti collinari, risorsa idrica cambiamento climatico*

Introduction
A large number of studies attests and describes the consequences of global change. The increase of temperature, the greater variability of precipitation, the rise in intensity of tropical cyclone and in frequency of extreme events are the main consequences of the global change in the world (IPCC, 2007).

In Italy, high temperatures and drought imply a higher frequency of fires and an increase of desertification, water salinization and eutrophication, all processes with negative effect on availability of water resources. In the

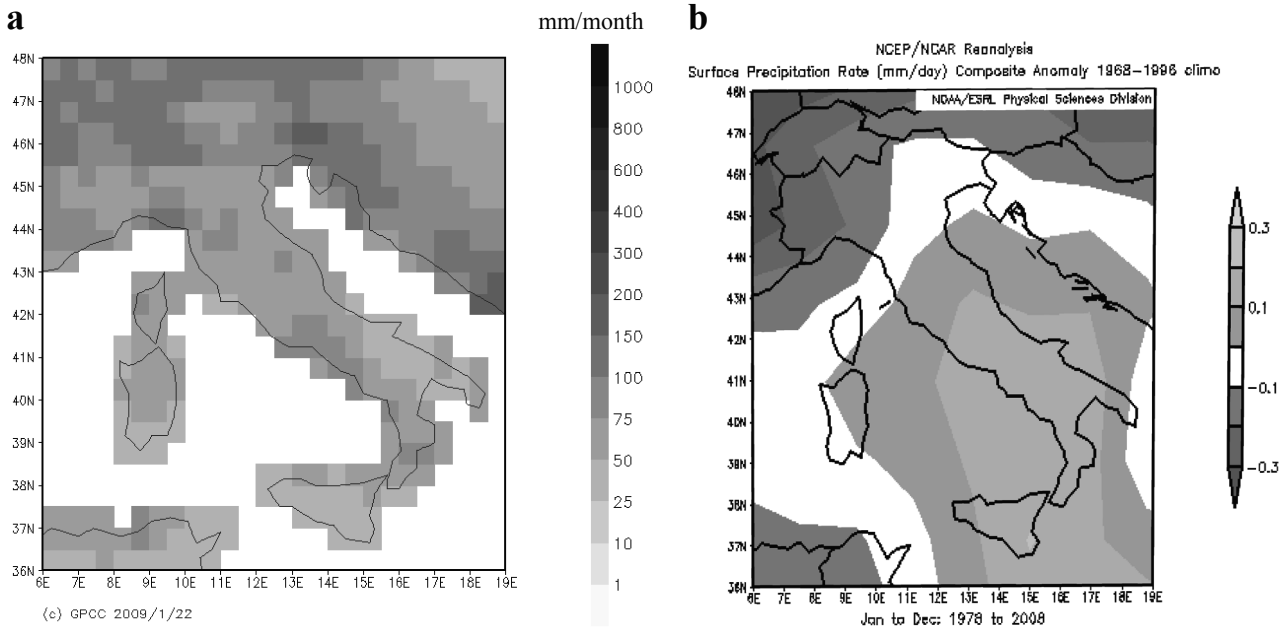

Fig. 1 – Average precipitation 1951-2000 (a), precipitation anomalies 1978-2008 (b) in Italy (Source GPCC Visualiser and NOAA)
***Fig. 1 –** Precipitazioni medie 1951-2000 (a) e anomalie di precipitazione 1978-2008 in Italia (Fonte GPCC Visualiser and NOAA)*

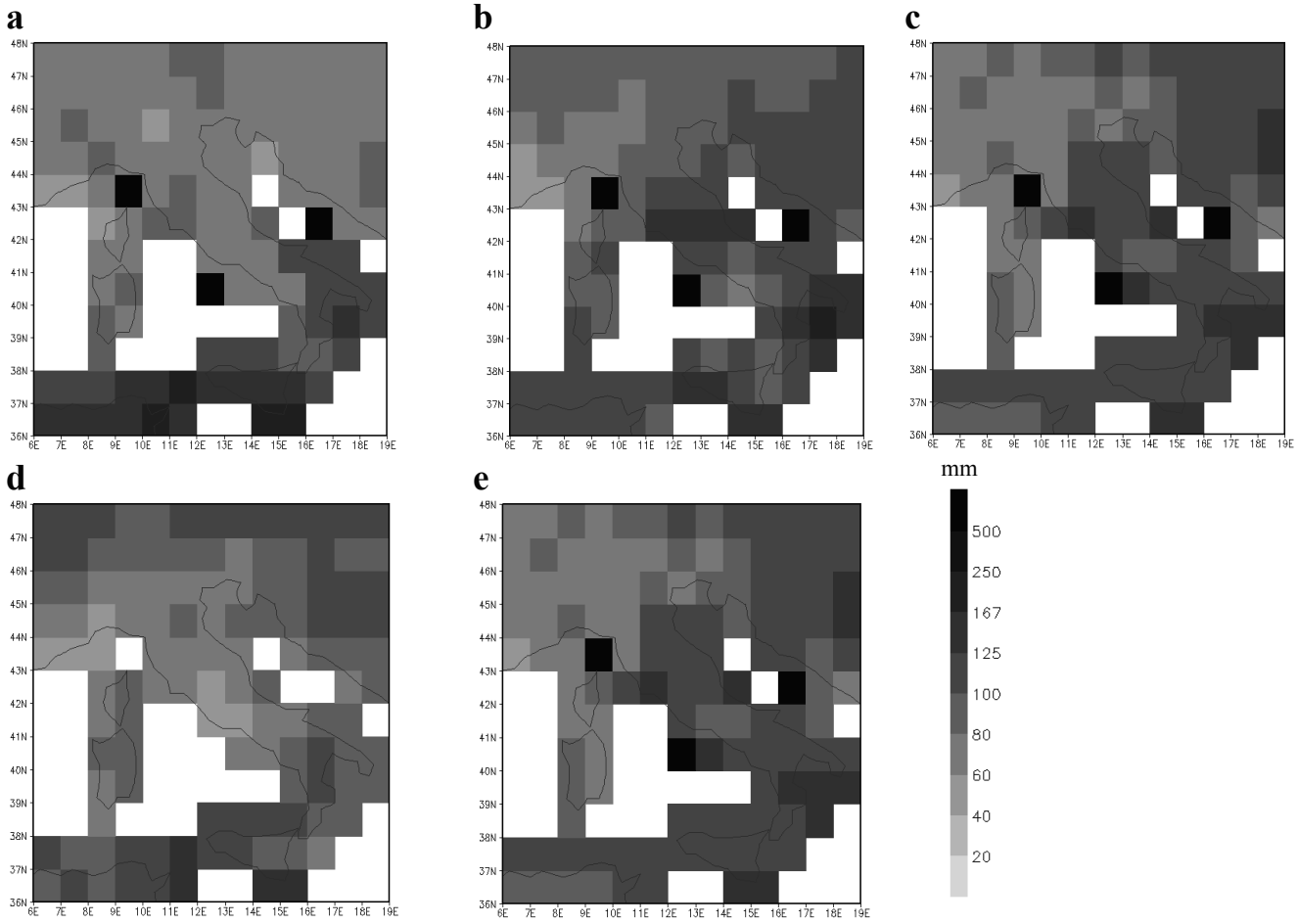

Fig. 2 – Precipitation anomalies 2003 (a), 2004 (b), 2005 (c), 2006 (d), 2007 (e) (Source: GPCC Visualizer)
Fig. 2 – *Anomalie di precipitazione 2003 (a), 2004 (b), 2005 (c), 2006 (d), 2007 (e) (Fonte: GPCC Visualizer)*

Mediterranean countries, the main impact of climate is represented by a change in the precipitation trends and on availability water amounts. The analysis of trend (1951-2000) shows as the reduction of the total precipitation amounts is not significant while the number of the rainy days and the rainfall intensity have changed more evidently (Brunetti et al., 2001). In the last ten years, the irrigated surfaces of Mediterranean basin show a low increase with the consequence of a higher human pressure on water-table that is at risk of exhaustion (Climagri, 2006).

The sector of agriculture has a considerable water footprint; the Italian irrigated surface represents a consistent part of total cultivated area (more of 20%). For this reason, the choice of a suitable and efficient irrigation method is important to save the effective resources.

The lower availability of water and the different trend of precipitation due to climate change and the increasing of water demand by agricultural sector impose a reflection regarding the management of water resources.

The aim of this note is to analyse the trend of precipitation in the last years, the main irrigation methods and the water storage capacity in Italy. In particular, the diffusion and the utility of the farm ponds were considered. Finally the work contains some examples about the use of farm ponds as resources for aid irrigation.

Precipitations in Italy

In Italy the average yearly precipitations are 300 billion m^3 corresponding to about 1000 mm/year. This value is higher than the European mean value (about 650 mm/year).

Only 53 billion (about 18%) of the 300 billion m^3/year of precipitations are used for civil, agricultural or industry needs. The water availability limitation is mainly due to the irregular distribution, in space and time, of the rainfall.

The analysis of the trend on Italian territory underlines as the precipitation distribution is not homogeneous and the rainfall decreases from North to South (fig. 1a).

Observing the anomalies map of the last 30 years respect to the mean precipitation (1968-1996), the values are negative in the North and positive in the South of Italy (fig. 1b).

Analysing the last five years, the precipitation in 2003, 2006 and 2007 results lower than the mean value and the negative anomalies extended from North to South of Italy (fig 2).

The seasonal anomalies are evaluated respect to the mean value (1951-2000) in the last years (2003-2008, data not shown). The spring of 2003, 2005 and 2006 was drier respect to climatological mean; in summer the pre-

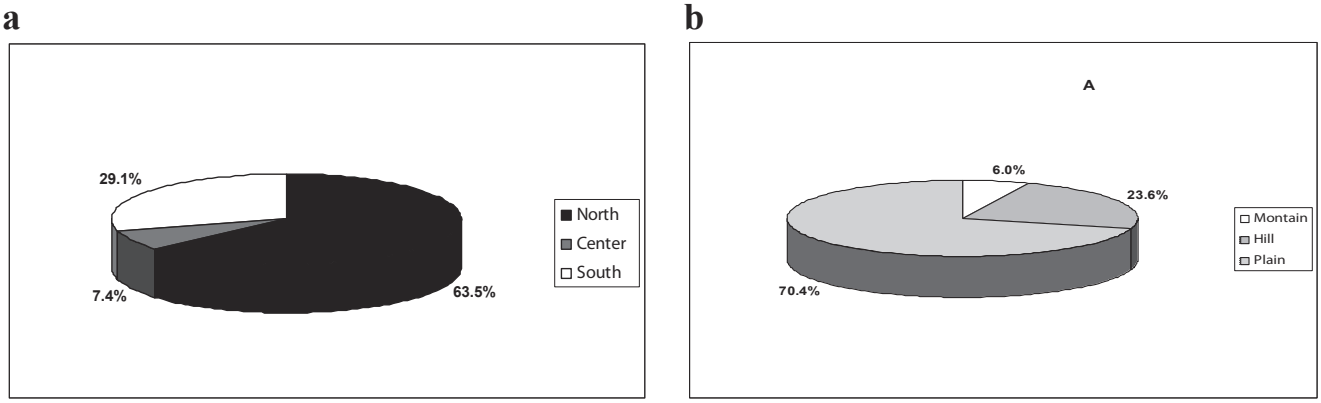

Fig. 3 – Distribution (a) and altimetry (b) of irrigated surface in Italy (ISTAT, 2005)
Fig. 3 – *Distribuzione (a) e altimetria(b) delle superfici irrigate in Italia (ISTAT, 2005)*

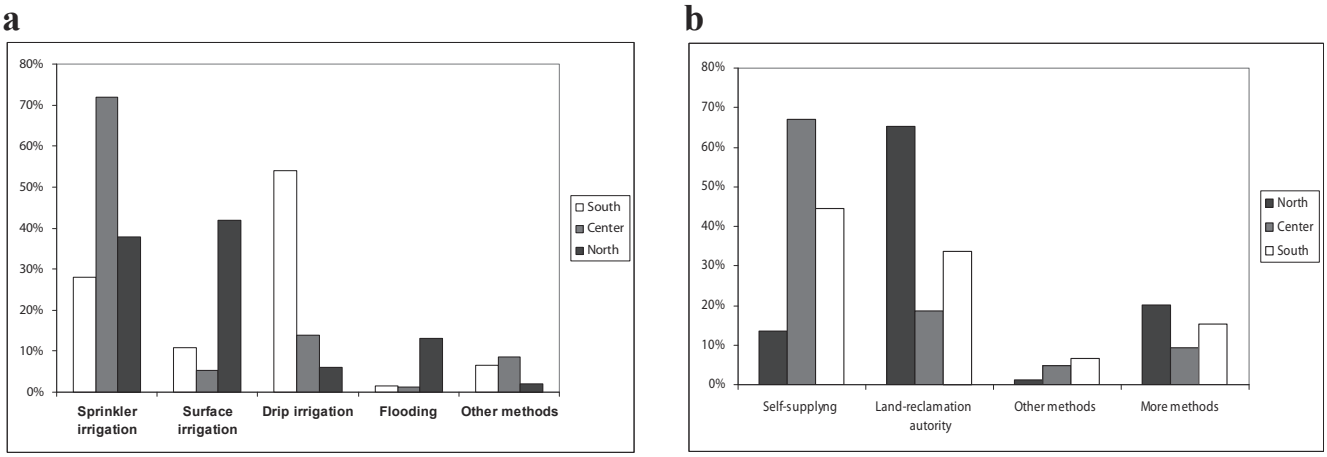

Fig. 4 – Irrigation methods (a) and supplying water methods (b) in Italy (INEA, 2006)
Fig. 4 – *Metodi di irrigazione (a) e modalità di approvvigionamento (b) diffusi in Italia (INEA, 2006)*

cipitation was always lower than the mean value in the North, mainly in 2004 and 2006. The autumn of the last tree years (2006-2008) and the winter of the last two years (2007 and 2008) were drier: this is a considerable and critical phenomenon taking into account that the rainfall of these seasons are important to increase water storage in the soil.
Considering the years from 1982 to 2004, the trend of snowfall has changed with a decrease of 2% in Apennine and Alpine station; for this reason the water availability from snow dissolution is lower in spring (data not shown).
It's important to evaluate not only the quantity of rainfall but also its distribution. It has changed in space and in time: the rainy days are reduced of 10% in a century and rainfall intensity is increased of 5% (Nanni et al., 2007).

Irrigation methods

The agriculture is considered as one of the sector that consumes the major quantity of water. The Italian agriculture uses about 26 billion m^3 of water each year; this value represents the 49% of the total water needs in Italy.
The 40% of agricultural production comes from irrigated crops; the total irrigated area is 2.613.419 ha, that is the 20.4% of total cultivated area (ISTAT, 2005).
The irrigated area is more present in the North of Italy (70%) and it is spreaded in plain territory (fig. 3a and 3b)
The water is distributed using sprinkler irrigation (37,5% of irrigated surface), followed to surface irrigation (30,2%), drip irrigation (20,6%), flooding (8,8%) and others method (3,8%).
The drip irrigation is more diffused in South territory where it is more important to save water (fig 4a).
The 45.4% of farms (corresponding to 733.775 ha) takes water from wells, the 40.4% (corresponding to 1.452.335 ha) is irrigated from land-reclamation authority. The self supplying is more diffuse in the Centre and South of Italy, while the farmers of the North recur to land-reclamation authority for irrigation (fig 4b).

The role of farm ponds

For the irregular precipitation trend of the last years, the farm ponds become a emergency water reservoirs very precious, not only to preserve the mean agricultural production, but also to assure the survival of quality cultiva-

Tab. 1 – Volume of stored water in some region of the South Italy (INEA, 2006).

***Tab. 1** - Volume dell'acqua immagazzinata in alcune regioni del Sud Italia (INEA, 2006)*

	Storage capacity (million of m3)	Water available (million of m^3)		
		2002	2003	2004
Basilicata	755	152	508	698
Puglia	434	86	341	357
Sicilia	732	249	401	570
Sardegna	1718	410	1176	1605

tions, like olive trees and vineyards (Schweizer and Falciai, 2007).

In according to the last data in literature, in Italy there are 1.726 farm ponds in the North, 4.249 in the Centre and 2.255 in the South including islands, for a total number of 8.220 farm ponds (Benedini, 2000).

The Italian farm ponds have a mean volume of 30.000 m^3 with some differences between North and South. In the North of Italy the average dimension of farm ponds is 24.000 m^3, while in the South is 84.000 m^3.

The data about some regions of the South Italy are more recent; the volume of stored water includes big dams (tab. 1).

In these regions, there are 2023 farm ponds, corresponding to a storage capacity of about 170 million m^3; this value represents the 4.6% of total storage capacity (including big dams).

The irrigated surface in these regions is 514.498 ha (ISTAT, 2000), the farm ponds provide 330 m^3/ha of water. Considering that the hilly areas represent about 25% of irrigated surface, farm ponds can provide 1300 m^3/ha of water for hilly irrigated surface.

The water stored in farm ponds can be used in emergency situation as aid irrigation.

For example in Tuscany the number of farm ponds is 2462 (ARSIA, 2006); the estimation considered that all farm ponds are in a good condition of use. The mean volume of each farm pond is 24000 m^3, that corresponds to about 60 million of m^3. In a vineyard an aid irrigation of 60 mm/ha were usually distributed in a dry period. The amount corresponds to 780 m^3/ha of water including losses and a rate of efficiency. Considering that 62.600 ha of vineyard are present in the region (ISTAT, 2006), the farm ponds could provide water to carry out an aid irrigation on all vineyard of Tuscany.

The costs of building and maintenance increase with the infrastructure dimension then a local use and small farm pond shall be better.

Conclusions

The present note offers a description and shows some data about the trend of precipitation of the last year, the irrigation methods practised in Italy and the role of the farm ponds as water reservoirs. The paper doesn't have the claim to deal with the arguments exhaustively, but only to provide some indications to attempt a first technical approach.

The analysis of precipitation underlines a big variability of seasonal anomalies in the last years and a relevant change in the rainfall distribution: rainy days are reduced of 10% in a century and intensity is increased of 5%.

About the irrigation method, the sprinkler irrigation is more diffused in the North while drip irrigation in the South of Italy where it is more important to save water.

The North regions recur to land-reclamation authority for irrigation while the self supplying is carried out in the Centre and in the South. The water amount utilized in agriculture sector is not clearly established: many studies estimate the water necessary for the crops considering evapotranspiration or cultural coefficient and data regarding the effective drawing don't exist .

The farm ponds are an important water reservoirs for emergency; the water stored can be used in emergency situation as aid irrigation.

An important aspect to consider is the impact of energy policies and regulation on water demand and availability. The use of water in agriculture implies a energy cost for pumping, transport and distribution. In the future the evaluation of energy footprint of irrigation and the link between water and energy could be an interesting topic to study.

Acknowledgements

The authors wish to thank Servizio Idrologico - Regione Toscana for the support in the project: "Progetto per il rilevamento e il monitoraggio dei consumi della risorsa idrica in Toscana".

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