Water Resources in Italy: The Present Situation and Future Trends

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Considering the assessment on water resources shown in Table 1 and a consumption of 92 m^3 per capita annually for the period 1996–2007 (more than the 85 m^3 average in the EU27 countries), Italy seems to be highly vulnerable to any reduction in its water availability.

Besides the temporal variability in water resource availability/demand, there are also differences at sub-national spatial level. The interaction between the climatic, topographic and geological characteristics and human activities makes the Italian context highly heterogeneous. While the northern regions, despite increased water exploitation due to their predominantly intensive farming and industrial concentration, can rely on plentiful and regularly available water resources, in the south this availability is approximately half of the need because of a combination of low rainfall and high temperatures which increase hydrological losses due to evapotranspiration. Apulia, Sicily and Sardinia receive 40–50 % less rainfall than the wetter regions and just covering 10–20 % of their water needs.

There are different factors that influence both current and future water resource availability:

- high and growing consumption due to the combination of an increase in demand (for example due to population growth, estimated at about 4 million over the last 30 years) and a decrease in natural recharge caused by natural and human factors;
- pollution of water reserves;

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Table 1 Water resource data in Italy

Area	30.134	km^2
Population	60,789,000	inhabitants
Average annual rainfall	832	mm/year
Internal renewable water resources	182.5	km^3/year
External renewable water resources (Switzerland, France, Slovenia)	8.8	km^3/year
Total renewable water resources	191.3	km^3/year
Potential water availability per capita	3,147	m^3/year
Water resources effectively available and useable	123.0	km^3/year
Water loss distribution	36.2	%
North	33.7	%
Centre	39.1	%
South and Islands	55.0	%
Water resources effectively used	45.4	km^3/year
Water resources effectively consumed per capita	747	m^3/year
Water use*		
Agriculture	44–60	%
Industry	25–36	%
Domestic use	15–20	%
National withdrawals for drinkable water use	9–11	km^3/year
Drinkable water origin		
Groundwater	85.6	%
Surface water	14.4	%

Source: AQUASTAT, March 2015; ISTAT, 2011; CONVIRI, 2011.
* The range comes from a data analysis: AQUASTAT; Conferenza Nazionale delle Acque (1972) and further updating by the Italian Ministry for Agriculture and Forestry (1990); ISTAT (1991); IRSA-CNR (1999); Legambiente (2007); Italian Ministry for Agriculture and Forestry (2004).

- changes in types of consumption (Italy leads by far in the consumption per capita of mineral water, accounting for 70 % of the total);
- the weakness in the system of water distribution, recycling and reuse (only 0.2 % of water actually available comes from desalination plants).

Despite the inter-annual variability in water resource availability over the 30-year period 1971–2000, a general trend can be clearly identified in terms of decreasing rainfall and effective infiltration—that is, the percentage of rainfall percolating through the soil and potentially feeding the underground water resources (Fig. 1).

The analysis of the climate projections, based on short- and long-term simulations, reveals a worsening in water resource availability affecting agriculture in the short term, and the groundwater recharge in the long term.

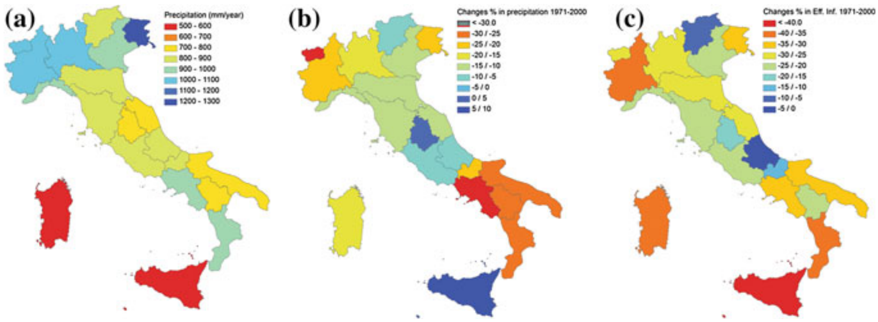

Fig. 1 Maps of the annual average rainfall (**a**), percentage variation in rainfall (**b**) and percentage variation in effective infiltration (**c**) along the period 1971–2000 for the different Italian regions. *Source* Venezian Scarascia et al. (2006)

Situated at the centre of the Mediterranean basin, Italy is particularly susceptible to climate change presenting climate shift towards warming (following the global trend) and progressive drying and desertification (Giorgi 2006).

It should be remembered that, where climate change is concerned, there is a widespread scientific debate on the reliability and uncertainty of climatic projections for a given region. This is due to the fact that many quite different models exist (GCMs—global circulation models) to simulate coupled atmosphere–ocean dynamics even under different greenhouse gas emission forcing based on alternative IPCC development scenarios. In the analyses presented by Giorgi (2006), the uncertainty related to future climatic trends is quite reduced thanks to the probabilistic analysis relying on an ensemble of simulations conducted by combining 20 different GCMs and 3 different greenhouse gas emission scenarios. Indeed, the agreement among the different ensemble simulations was evaluated and the likelihood of climate scenarios was assessed. Therefore, the resulting maps from simulation ensembles show the findings in terms of consensus among the different members in reproducing a decreasing rainfall trend (García-Ruis et al. 2011; Giorgi and Lionello 2008) and, consequently, a decreasing surface run-off, more marked in the southern Mediterranean regions and concentrated in the summer period.

Climate simulations carried out by the Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) over Italy with high spatial resolution models confirm that the summer season will be more likely suffering from increased temperatures and reduced rainfall (Comegna et al. 2012), with obvious consequences for the hydrological cycle.

Added to these climatic trends, it is expected a probable rise in water demand due to increases in population and production use, particularly for agriculture. The ISTAT projections for 2065 (http://www.istat.it/it/archivio/48875/), taking into account plausible trends in birth/mortality rates and immigration (compared to 2010), foresee a demographic growth of almost one million to about 9 million people, respectively, for two of the three scenarios considered (Fig. 2).

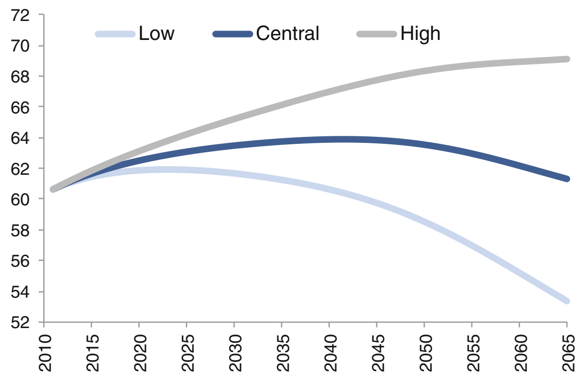

Fig. 2 Resident population in Italy (mill.) according to different ISTAT demographic scenarios

Moreover, Flörke and Alcamo (2004) estimated an increase in irrigated areas of up to 27 % from 2000 to 2030 in the base scenario case, if assuming a continuation of the same current environmental conservation (including water resource) policies.

An ensemble of 24 simulations carried out by the CMCC using a dynamical model on potential vegetation (LPJ; Sitch et al. 2003), which also takes into account the water balance in the simulations, and combining different model configurations and parameterisations with alternative climate projections up to 2050 (all under the IPCC-AIB scenario, with a very rapid global economic growth, a global population reaching a peak mid-century and then decreasing, a rapid introduction of new and more efficient technologies and a balanced distribution among the different energy sources), led to analysing the likelihood of the expected variation in the water balance components like run-off, evapotranspiration and soil moisture, considering the statistical distribution of the simulation results (e.g. Santini et al. 2014). A high spatial variability in the hydrological cycle components was revealed, reinforcing the need to differentiate the future water resource management choices for the various regions, considering both their water availability and degree of vulnerability. Similar spatiotemporal analyses, obtained by combining sophisticated models simulating climate and hydrological dynamics with projections of socio-economic and land-use trends, contributed to an increase of scientifically sound information about the likely effects of future scenarios on water resource allocation among the different uses (agriculture, industrial, civil) and on the feedbacks between this allocation and the hydrological cycle. In particular, in such a diversified and vulnerable country as Italy, this type of analysis, when able to differentiate water availability, deficit, demand and supply at national to sub-national level, and in the short to long term, could be very useful for stakeholders and policy-makers in identifying and prioritising regulations, initiatives, and/or investments towards adaptation to climate and socio-economic changes and/or mitigation of their impacts.

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