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DROUGHTS IN NORTHERN ITALY: TAKEN BY SURPRISE, AGAIN

By **Lorenzo Carrera***, **Jaroslav Mysiak**° and **Jacopo Crimi**°

This article analyses origins and impacts of unexpected vulnerabilities revealed by a long-lasting period of drought events across the Po river basin district, in Northern Italy, from 2003 to 2012. The study reveals that climate change effects advance at the same pace of land and water over-exploitation, to the detriment of environmental quality and human well-being. Even if the district is water-rich under normal climate conditions, recurrent droughts continue to highlight the same vulnerabilities. Little improvements have been achieved. Four policy options are identified to turn these threats into adaptation opportunities.

Keywords: Drought, Climate Change, River Basin District, Water Management

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Imagine that you live in a fertile valley encircled by high mountains, where the climate is temperate, abundant freshwater resources satisfy all humans needs, whilst leaving enough for a healthy environment. A network of medium-to-large sized cities boost economic development and agriculture counts on thousands year-long irrigation traditions.

In many respects what you imagine holds true for the Po valley, situated in Northern Italy. The valley counts on more than one meter annual average precipitation over its surface. It is characterized by pronounced water retention capacity, provided by lakes, water reservoirs, aquifers, glaciers, and seasonal snow cover over the Alps and the Apennine mountains.

Given this water abundance, one would think that the valley will never face any water-related challenges. However it does. Over the past decade, in some areas precipitation levels declined and climate variability increased, prompting conflicts about water uses that undermine the economic and social strength of the valley. Looking further ahead, water scarcity becomes a palpable concern.

What has happened?

From the end of 2011 until the middle of 2012, a severe drought hit Central and Northern Italy, including the downstream part of the Po valley. Emergency for water crisis was declared in the Veneto Region, in Tuscany, Umbria and in Romagna's Provinces.This is the last event of a period during which Italy suffered from recurrent droughts: in 2003, 2006, 2007, 2008, and lastly in 2011 and 2012.

As the former Italian Ministry of Agriculture, Mario Catania, said, *"the gravity of the situation imposed by the increasingly cyclic nature of droughts across the Italian territory requires a different approach to water scarcity which goes beyond emergency"*. Even at the time of writing this document, recurring water-related natural hazards are showing their detrimental effects with floods over Central Europe.

Hence, this article offers food for thought on local climate changes and ensuing best practices for integrated water resource management. The analysis focuses on the Po River Basin District (Po RBD), the largest and most important river basin in Italy.*[Note 1]*

What are the causes of water scarcity? Is natural water availability really changing?

It is well established that temperature is increasing. Brunetti et al. (2006) measured an overall temperature increment in Italy of

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approximately 1°C degree per century since 1800. The steepness of the curve elaborated by Brunetti increases more rapidly since 1980 reaching today's value. The historical series elaborated by ISPRA over the last 30 years, from 1961 to 2011, shows an average temperature increase of around 1°C degree (Desiato et al., 2011).

The variation is more evident in spring and summer. Heat waves are also likely to increase, both in frequency and intensity(IPCC, 2007). On the other hand, local changes in precipitation patterns are not easy to interpret. The variation of average annual precipitation, both nationally and regionally, is controversial. Over the last 60 years, precipitation anomalies were surely recorded in Northern Italy, but their statistical significance in relation to the climatic timeline is difficult to confirm. However, in some areas of the Po RBD, precipitation changes are evident. The number of light rainy days is considerably smaller, whereas the frequency and intensity of extreme precipitation events is increasing.

These anomalies advance at the same pace asf increasing land and water exploitation, which affects the natural discharge of the Po river and its affluents. For instance, over the period 1975-2010, the Po river discharge, measured before the delta, recorded a 20 per cent average annual river flow reduction.

The flow reduction is greater in summer (June-August), reaching minus 40 per cent of the average flow of the period. Recent drought events recorded summer minimum flows at the closing section of the river, with a return period of over 200 years, whilst the flow discharge during the same events calculated at higher sections of the river towards the mountains, recorded return periods of 5 to 10 years.

This difference amongst return periods at different sections of the same river could be induced by two factors: 1) modeling tools for calculating return periods are not well fitted to different sections of the same river; 2) water abstractions strongly influence natural river discharge along the rivers, particularly during drought periods.

If the latter holds is climate change the only cause?

Climate change is surely a pressure. The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC, 2007) includes Po RBD amongst those European areas where climate change will modify precipitation patterns and increase extreme events (both floods and droughts). All global circulation models (GCM) locate the Po river basin within the European transition area, characterised by a high degree of uncertainty in respect to future precipitation patterns. At the same time, all models foresee a temperature increase from 2° Celsius to 5° Celsius over the next century depending on scenario and location, with higher increases along the Alps.

Recent regional studies over Northern Italy on future precipitations (Montesarchio et al., 2012) identified a higher level of uncertainty over the mountains and a more clear prevision capacity for the Paduan plain. Downscaling of GCMs forecasted a precipitation reduction of 20 per cent in summer periods and a small increase of 5 per cent in winter (Coppola and Giorgi, 2010). Spring and Autumn will probably see a stationary pattern of variation.

Other studies (Tomozeiu et al., 2011), focussing on a single region (Emilia-Romagna), show an increase of maximum and minimum temperatures, with a reduction of frostdays and an increase of heat waves.

Although it is still difficult to estimate the future climate in such a relatively small and orographically various area, it is evident that temperature and evaporation (estimated in plus 25 per cent over the century for northeast Italy (Baruffi et al., 2012) increase will surely modify the solid/liquid ratio (ice-snow-rain), the water retention capacity of soils and run-off characteristics. Therefore, the risk of increased variability in both groundwater and surface water availability is considerable.

However, climate change is not the sole cause of decreasing flow discharges in the rivers. In addition to climate trends, demand for water uses in the basin has increased over the last decades, inducing additional water abstractions from the Po river and its affluents. Moreover, existing water entitlements are often based on past practices and are tacitly renewed, without any optimization to meet real needs and changing availability.

As pinpointed by Francesco Puma (General Secretary of Po River Basin Authority) at the 13th Permanent Commission of the Senate on environmental issues (13a Commissione Permanente del Senato della Repubblica, 2005), the Po river at its closing section has a theoretical average flow of 1470 m3/s (on annual basis), while total water abstraction entitlements during the irrigation season (normally summer) amount to 1840 m3/s (25 per cent higher than average flow).

Moreover, considering that the natural reservoirs of freshwater for summer periods, like glaciers and snow cover over the Alps, are decreasing at alarming speed (minus 40 percent of glaciers since 1860, snowing accumulation period delayed and melting anticipated), the basin becomes more and more vulnerable. Without any concrete actions, the situation will rapidly deteriorate.

What are the actual impacts of droughts?

On top of increasing competition for water uses, droughts produce serious impacts on regional economies and human well-being. Amongst others, the reduced amount of water and the modification of the water cycle provoke costly economic impacts to the hydropower generation sector. It was estimated that the cost of missing hydropower production amounted to 280 million Euro in 2003 and 670 million Euro in 2007 (taking into account the green certification mechanism) (Water2Adapt, 2012).

Moreover, other studies (Water2Adapt, 2012) estimated that the 2003 drought caused 10 per cent reduction of maize production, and 6 per cent contraction of average farm income. It was also estimated that during the same year, agriculture production losses were turned to consumers through food prices increase (Massarutto and De Carli, 2009).

The effects on human well-being are difficult to estimate. Water restrictions have been applied to various municipalities in the basin. However, it is well known that prolonged restrictions in water supply could produce health issues induced by the degradation of environmental quality both in rural and urban contexts (e.g. city park, gardens, etc.).

What about future implications of water scarcity and drought?

Amongst other issues the alterations of the water cycle in the basin could increase exposure to water-related extreme events (both droughts and floods), reduce soil retention capacity and aquifer recharge, induce higher salt intrusion over the delta (2-3 km in the '50, 20 km in 2000), provoke additional water quality deterioration because of lower dilution capacity and higher river temperature, turn existing hydraulic infrastructure obsolete and, finally, increase susceptibility of some areas to soil desertification.

Is desertification a real risk for the Po basin?

The soil has never been so dry as in 2012. After the "*annus horribilis*"- as the year 2003 is commonly referred to - whose return period was estimated higher than 10,000 years (Schär et al., 2004), after the harsh drought of 2006-2007 and the large anomaly of 2010, the summer of 2012 has further contributed to turning the last decade into one of the driest ever recorded. Recent studies from ARPA-EMR show that during the last drought, high level of evapotranspiration coupled with long lasting (from winter 2011) precipitation deficit caused fast humidity decline in the soils, easily reaching the withering point and jeopardizing non-irrigated vegetation.

Although it has never been common in the past, during the last droughts, spontaneous vegetation and forests started to suffer from water stress. Indeed satellite observations measured a consistent and extended reduction of vegetation activities. In addition to this, further studies on the soil-atmosphere coupling identified a relation between increasing heat waves and soil humidity (Grazzini, 2012).

The "memory" capacity of the soil during a drought, induces bottom layers -always wet- to dry out. At that time, when upper layers are large and dry for long periods, it is increasingly more difficult for bottom layers to get wet. Dry soils increase air temperature which further affects the humidity of soils, in a coupling detrimental effect. If this process becomes frequent, the mechanism of dry-bottom-layers could turn irreversible, and initiate desertification mechanisms (Fischer et al. 2006).

So, what can we do to tackle this negative trend?

Since the 2007 EC Communication on water scarcity and drought (WS&D), which set seven policy options - i.e. right water price, efficient water and funding allocation, improved risk management, additional water supply infrastructures, efficient technologies, water-saving culture, improved knowledge and data collection - **small progresses have been made**. *[Note 2]*

The more recent Blueprint for Safeguard Europe's Water resources (2012) *[Note 3]* still stresses the presence of several gaps on WS&D dynamics in Europe, such as the understanding of relations between drivers, pressures, states and impacts, and knowledge-based gaps, such as a coherent European dataset of impacts and very limited information available so far on current and future water availability, water demand and climate change uncertainty.

At national level, the situation is even more misty. Besides being fragmented, the Italian legislation reforms concerning water management are not implemented timely. Delays and fragmentation created a muddy institutional environment that weakens efficiency. As of today, there are five core issues that undermine governance at River Basin District (RDB) level: the installation of RBDs' Authorities required by the Water Framework Directive 2000/60/EC (not fully established yet); the radical process of reorganisation of Land and Water Reclamation and Irrigation Boards; the suspension and reorganisation of Optimal Territorial Areas Authorities on provincial and regional bases (not fully implemented yet); the establishment and functioning of the "Vigilance Committee for water uses" which has been abolished and restored with different names several times in the past (under construction); and the unsolved issues on water utilities financing capacity and ownership, further increased after the National Referendum held on 13th June 2011, which abolished the 7 per cent utility "overhead" on domestic water tariffs, and the transfer to the private sector of public water services, which is still cause of large uncertainty in private sector investments.

Under these evidences, actions shall be prompt and determined.

Firstly, **water efficiency** shall be enhanced in the civil supply sector, agriculture production, industry, and energy production. For example, water efficiency targets in buildings, reduced water losses in civil water supply and irrigation, dry cooling for energy production, adoption of water saving policies in domestic water, rain water harvesting in buildings, and water re-use in agriculture and industry are feasible policies, which could be successfully implemented in view of this objective.

Secondly, on-going reforms and re-organization of **water governance** shall be completed. Integrated water service authorities, RBD's authorities, Land and Water Reclamation Boards should be equipped with sufficient resources (self-financing mechanism) and appropriately organized in order to function effectively. Former basin authorities received more responsibilities and functions compared to their operative and financial capacities. The dispute shall be tackled providing adequate funding and giving RBD Authority the necessary coordination capacity amongst the actors which are involved in territorial planning (i.e. Regions, Provinces, Municipalities, new ATOs, Land and Water Reclamation Boards, Ministry of Agriculture, Ministry of Environment, Land and Sea Protection, etc.).

Thirdly, the **water abstraction entitlement** mechanism in the basin is not sufficiently transparent and far from optimal. Very often, water abstractions are based on historical practices, licences for abstraction are tacitly renewed and they are not explicitly adjusted on the needs. The total sum of maximum potential water abstraction rights authorized (in m3/s) go well beyond the total average natural availability. For this reason a reform of the water abstraction system is absolutely necessary. Moreover real-time water abstractions are not formally measured. Real-time water abstractions shall be measured, recorded and communicated to relevant authorities, in order to have real-time information about the basin's water budget. Data should be publically available, for scientific research purposes and regulation transparency.

Fourthly, **climate change** is a grave threat to the sustainable use of water resources, which shall be taken into account for future planning. Although variability of natural water resources is increasing, water is still abundant in the basin, both for agriculture, human consumption, industrial production and environmental needs. However, given the current trends, this abundance shall not be taken for granted. Climate change scenarios, coupled with socio-economic ones, shall be embraced in decision-making. Downscaling at regional levels of existing climate scenarios leads to high levels of uncertainty, particularly in terms of precipitation. Whereas no-regret, low-regret, and win-win strategies have been exploited in the past for adaptation processes, there is increasing confidence that adaptation will proceed acting under high levels of uncertainty about climate change, its impacts and real adaptation needs. Therefore, adaptation requires iterative and continuous processes of assessment, action, monitoring, reassessment, and revision. Given the current level of uncertainty, this cycle may need to be applied for decades. Therefore monitoring and evaluation processes shall be activated. Meteo-climatic observations recorded at local and regional level shall be stored, disseminated , and possibly elaborated at RBD's level (e.g. by the Po RBD Authority). The contribution of an "independent" authority, such as the Po RBD Authority, will strengthen the need for reassessment and revision processes at National and Regional levels. Lastly, in order to be policy relevant, modelling efforts shall work in reducing their uncertainty to tolerable levels.

In conclusion, even though the basin is under average climate conditions water rich, recent events highlighted its vulnerability to drought and water scarcity, the latter in medium-to-long term. Climate change is not the sole reason of increased water scarcity. Water over-exploitation, besides affecting environmental quality, poses the entire socio-ecologic system of the basin at intolerable risk of WS&D. As highlighted in the last Communication of the European Commission (COM(2012)672) small improvements have been made to reduce WS&D risk. To this aim, the four recommendations proposed in this document could be effectively implemented to reduce such a risk at RDB level, to tolerable, if not acceptable levels.

Notes

[Note 1] This article summarizes the outcomes of a workshop connected to the IWRMnet project Water2Adapt (Resilience enhancement and water demand management for climate change adaptation). The event was organized in September 2012, by Fondazione Eni Enrico Mattei (FEEM) and sponsored by Istituto Superiore per la Protezione e la Ricerca

Ambientale (ISPRA). Extended summary of the event (in Italian language only) is available at the project website: www.feem-project.net/water2adapt. This article is also based on the work made by the authors for the Special Chapter on the Po RDB's water management, part of the National Climate Change Adaptation Strategy, currently under preparation by The Ministry of the Environment and Protection of Land and Sea of Italy and the Euro-Mediterranean Centre for Climate Change (CMCC).

[Note 2] Commission's Review of the Policy on Water Scarcity and Droughts (COM(2012)672)

[Note 3] (COM(2012)673)

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13ª Commissione Permanente del Senato della Repubblica, 2005. Seduta n. 444, indagine conoscitiva sull'emergenza idrica nell'area del lago di Garda e nel bacino del Po. Intervento di Francesco Puma.

Links

Water2Adapt Project Web Site