WATER

Ressources and natural environment

PLAN BLEU NOTES

#25

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Plan Bleu

IN LIGHT OF CLIMATIC AND ANTHROPOGENIC CHANGES

will water demands still be met in the Mediterranean basin by the 2050 horizon?

The Mediterranean basin has been identified as one of the most sensitive region to climate change and anthropogenic pressures. This basin is particularly vulnerable to water shortage. A prospective study considering the complex relationships between climate change, human pressures and water resources was carried out across all Mediterranean catchments. This work aims to evaluate water resources availability and their capacity to meet future water demands, as well as to identify the catchments that are most likely to face water shortage. Moreover, it highlights the need to go beyond the objectives set out in the Mediterranean Strategy for Sustainable Development in order to be able to satisfy current and future water needs of societies.

The Mediterranean basin: a region subject to climatic and anthropogenic pressures

Towards an aridification of the Mediterranean climate

The Mediterranean basin is one of the most vulnerable regions to climatic and anthropogenic changes. Since the late 1970s, mean annual temperatures have increased by 0.1°C per decade and precipitation have decreased by 25 mm per decade (Xoplaki *et al.*, 2004). These trends are set to continue between now and 2050. Temperatures should rise by 1.5–2.5°C and annual precipitation should decrease by 5 to 20% (IPCC, 2007; Milano *et al.*, 2012a). These changes should cause an aridification of the Mediterranean climate, with reduced snow cover in the Alps, Pyrenees and Atlas mountains, faster and earlier snow melting and an expansion of arid climate in the Iberian plains and coastal regions, in Italy, in the Balkans, in Greece and in Turkey (IPCC, 2007).

Water resources should decrease by more than half over the southern Mediterranean rim

Water resources in the Mediterranean basin currently account for 1.2% of the world's renewable water resources, i.e. approximately 550km³ per year. Most of these resources are located in the Mediterranean basins of France, Italy, Greece and Turkey. Catchments of the southern and eastern rims produce respectively only 4% and 2% of the Mediterranean water resources.

By the 2050 horizon, a significant decrease (25–50%) in freshwater resources is projected over the whole Mediterranean basin, based on the most pessimistic greenhouse gas emission scenario set up by the Intergovernmental Panel on Climate Change (SRES A2; cf. *Figure 1*). Catchments in southern Spain, Morocco, Algeria and south-eastern Mediterranean should be the most affected with a reduction by more than half of their current water resources. Over the northern rim, water resources should decrease between 15 and 35% and by 40% in Turkey. Only catchments in Libya and southern Tunisia should experience a 10% increase in water resources, which, in reality, equates maintaining runoff volumes to their current level, i.e. between 0 and 15mm per year (cf. *Figure 1*).

Increasing anthropogenic pressures

Catchments over the southern and eastern rims should be the most prone to anthropogenic pressures. Between 1993 and 2003, irrigated areas increased by 2% and 4.5% per year in Tunisia and Morocco, respectively (Hamdane, 2007; Oubalkace, 2007), whereas they decreased by 25% in European Mediterranean countries, especially in Italy (Garrido & Iglesias, 2006). Furthermore, Mediterranean valleys and coastal areas should have to deal with major urban expansion due to population concentration and to the development of tourism resorts. According to the United Nations Population Division's projections of 2009, by 2050, the total population of the Mediterranean basin could reach around 270 million people, compared to 187 million in 2001.

Water resources of the Mediterranean basin are already subject to significant climatic and anthropogenic pressures. The question then arises whether it will be possible to satisfy future water demands in this region.

Assessing the impacts of climatic and anthropogenic changes on water resources using an integrated approach adapted to the Mediterranean context

Climatic and anthropogenic increasing pressures on water resources are recognised as a global issue. Decisions need to be taken on how to improve water resources and water demands management. This suggests developing approaches that aims to evaluate future freshwater availability and water demands. Their main objective is to assess the capacity of water resources to meet water demands under climatic and water use prospective scenarios. Such approach was developed over the Mediterranean basin taking into account:

- the impacts of climate change on renewable water resources availability and on crop water needs;
- changes in water demands according to population growth, expansion of irrigated areas and progress in water use efficiency;
- the efficiency objectives adopted by the Mediterranean countries based on the Mediterranean Strategy for Sustainable Development (MSSD), in an alternative scenario;
- the exploitation index of renewable water resources recommended in the MSSD in order to assess the current and future pressures of annual water withdrawals on renewable natural freshwater resources.

This approach is in line with the promotion at the Mediterranean level of:

- an integrated water resources management at the catchment scale in order to protect hydrosystems and improve their capacity to meet societies and ecosystems' water needs;
- a dynamic management of water demands, including "*all activities and organisation systems that aim to increase the technical, social, economic, institutional and environmental efficiency of different water use*" (Plan Bleu, 2005);
- and a fair distribution of water resources.

Significant increases in water withdrawals but possible water savings

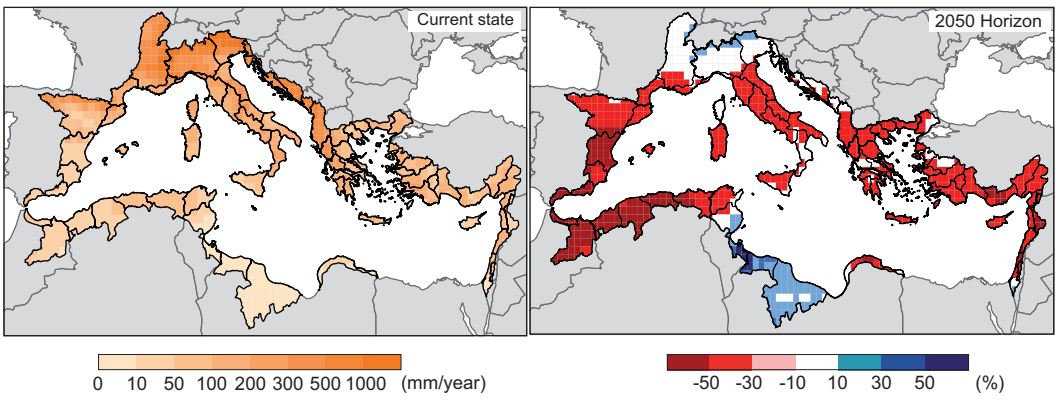
Water withdrawals could triple according to a business-as-usual scenario

According to a business-as-usual scenario, whereby current water use efficiency (spills, waste, and irrigation techniques) is maintained until 2050, water withdrawals could double or even triple in catchments of the southern and eastern rims of the Mediterranean basin (cf. *Figure 2b*). This trend should be due to a high population growth, an expansion of irrigated areas, and warmer and drier conditions thus increasing crop water needs. In catchments of the northern rim, total water withdrawals should mostly increase due to a rise in agricultural water withdrawals linked to warmer and drier conditions as well as a significant expansion of irrigated areas in Greece and the Balkans.

Improving water use efficiency as a way of saving water

Improving the efficiency of water supply networks (reduction of spills and waste) and of agricultural plots (improvement of the added value per cubic metre of water used), as proposed by the MSSD, could help countries like Italy, Turkey, Syria and Morocco to significantly reduce water withdrawals and could enable

Figure 1: Current freshwater resources availability over the Mediterranean basin and evolution rate by the 2050 horizon



Source: Milano et al., 2012b

Mediterranean catchments of the southern rim to hold down their withdrawals (cf. *Figure 2c*) in comparison to a business-as-usual scenario (cf. *Figure 2b*).

Still according to the alternative scenario, over the northern rim, total water withdrawals should only increase in Greece and over the Ebro catchment in Spain in line with a 25% increase in agricultural water withdrawals. Domestic water withdrawals should remain constant or decrease as water access systems are already adequate (few spills) and as population is projected to stabilise over the northern rim by the medium term. For most catchments of the southern rim and of south-eastern Mediterranean, the increase in total water withdrawals should be less pronounced than under the business-as-usual scenario, despite the fact that they should still double due to the expansion of irrigated areas and the high projected population growth (cf. *Figure 2c*).

Finally, attaining the MSSD objectives should enable total savings of 30 billion cubic metres of water per year between now and 2050 in comparison with the business-as-usual scenario.

The southern and eastern rims of the Mediterranean basin are increasingly vulnerable to water shortage

A limited exploitation capacity of renewable water resources

According to the estimates of the exploitation index of renewable water resources, 112 million people are currently under high to severe water stress, i.e. under water shortage conditions. Total water withdrawals account for more than 40%, or even more than 80%, of the catchments' renewable water resources. The most vulnerable regions to water shortage are southern Spain, Tunisia, Libya and the south-eastern Mediterranean (Israel, Lebanon, Syria and Palestine; cf. *Figure 3a*). These regions are characterised by high water demands and limited water resources. In these areas, non-conventional water resources and fossil groundwater resources are often used to supplement surface water resources. Water withdrawals in catchments in northern Italy and western Greece, and in the Ebro catchment in Spain represent 20 to 40% of the catchments' renewable water resources. These basins are subject to localised or short-term pressures, whereas conditions in the Mediterranean catchments in France and the Balkans are stated as "comfortable", with water withdrawals making up less than 20% of available freshwaters (cf. *Figure 3a*).

Risk of water shortage in 2050

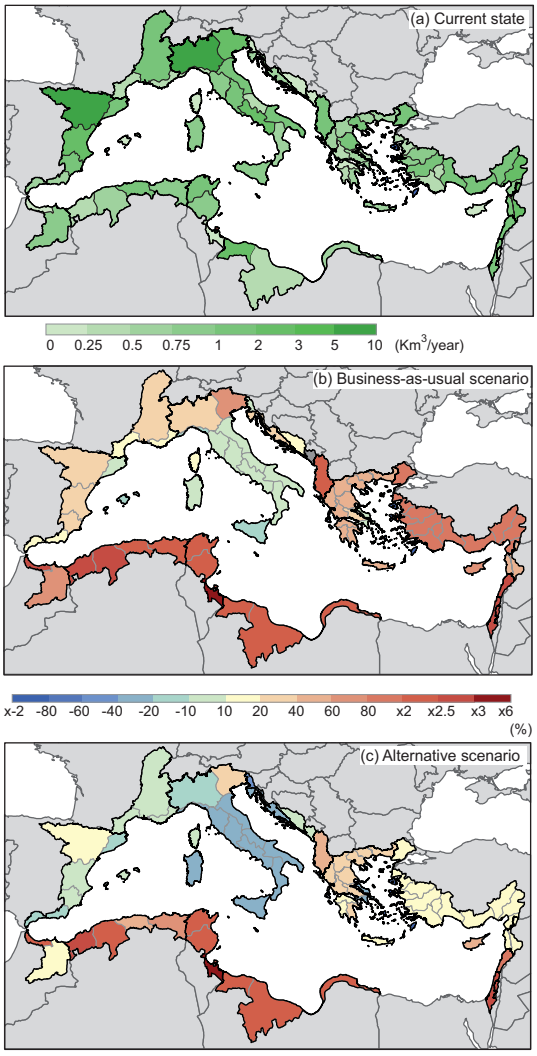
The exploitation index of renewable water resources will increase by 2050 due to climatic and anthropogenic changes. Most Mediterranean basins should be subject to high to severe water stress (cf. *Figure 3b*). Catchments currently under severe water stress should remain so. Catchments in Morocco, Algeria and Turkey should experience severe water stress as well. The Mediterranean basins in Italy and Greece and the Ebro basin in Spain should also be subject to high water stress. Current low water stress conditions should only be maintained in Mediterranean catchments in France and the Balkans.

Promising but insufficient water use efficiency objectives

Nevertheless, if water use efficiency objectives set by the MSSD are met (alternative scenario), the occurrence of severe water stress situations could be moderated, especially in Albania, Greece and Turkey (cf. *Figure 3c*). Current water stress should be maintained in Italy by the 2050 horizon. Catchments in France and the Balkans should still be under no stress conditions. Indeed, even though water withdrawals would not be as large as under a business-as-usual scenario, thanks to reduced spills within water supply networks and improved irrigation techniques for more efficient water consumption, water shortage over the southern and eastern rims should remain and Mediterranean catchments in Morocco and Algeria should experience severe water stress as well (cf. *Figure 3c*).

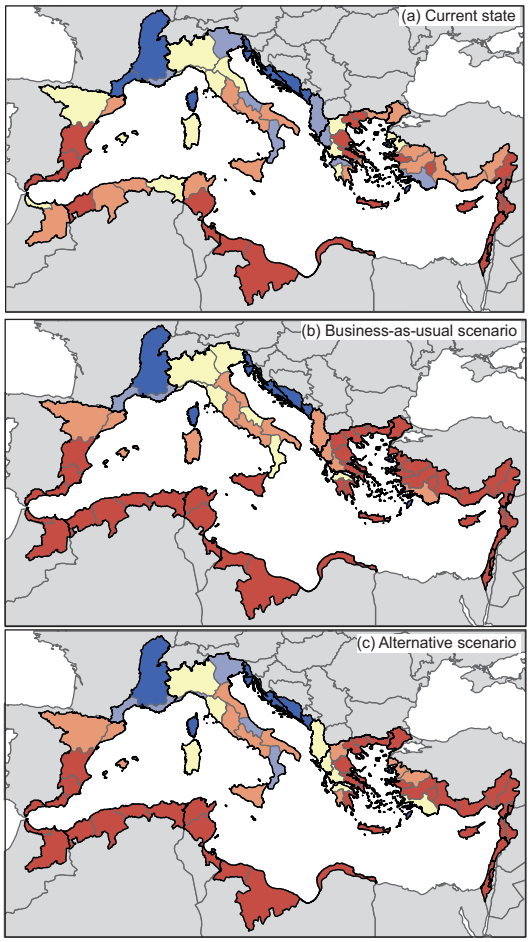
Therefore, water shortages over the Mediterranean basin should increase and discrepancies between rims are likely to increase. Improvements of water use efficiency, alone, would not be able to significantly reduce water tensions.

Figure 2: Current state of water withdrawals over the Mediterranean basin (a) and change by the 2050 horizon under a business-as-usual scenario (b) and an alternative scenario (c)



Source: Milano et al., 2012a ; Milano et al., 2012b

Figure 3: Current water stress over the Mediterranean basin (a) and changes by the 2050 horizon according to a business-as-usual scenario (b) and an alternative scenario (c)



Source: Milano et al., 2012a; Milano et al., 2012b

Recommendations

- The development of an integrated approach on water resources adapted to the Mediterranean context reflects the spatial variety of pressures and the spatial variability of water resources availability. It also supports, at a local level, the consideration of which sustainable development strategy to adopt according to the geographical and anthropogenic specific issues of the area;
- It is noteworthy to promote water use efficiency objectives as advocated by the MSSD, i.e. reduce spills in water supply networks and improve agricultural water use, in order to evaluate its capacity to partially reduce water tensions;
- It is nevertheless necessary to identify other sustainable development strategies. Studies considering the impacts of climatic and anthropogenic changes on agricultural production and on the satisfaction of population's food needs could highlight the potential of adapting different crops to climate change. The proportion of rainfed and irrigated agriculture as well as the type of crop produced depend on freshwater availability. They also depend on external factors such as food security strategies related to the volatility of international agriculture prices and geopolitical relationships with exporting countries;
- Nowadays, for water demand management to become fully effective in managing water tensions, it is crucial to "move out of the water sector" and to promote tools which influence sectorial policies and stimulate countries' economic and social development. This means moving from technical efficiency to economic and social efficiency, and from efficiency within sectors to efficiency across sectors;
- Finally, the technical feasibility and the cost of such developments in terms of water supply should be considered. The cost of implementing different sustainable development strategies is a supplementary key element to help decision process.

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Plan Bleu
Building the Mediterranean future together

PLAN BLEU
Centre d'activités régionales du PNUE/PAM
15 rue Beethoven - Sophia Antipolis
06560 Valbonne - FRANCE
Tél. : +33 4 92 38 71 30
Fax : +33 4 92 38 71 31
e-mail : planbleu@planbleu.org
www.planbleu.org

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