WATER THINK TANK
MÉDITERRANÉE

DETERMINING
MITIGATING
ADAPTING

WATER & CLIMATE RISKS
IN THE MEDITERRANEAN

PRINCE ALBERT II OF MONACO FOUNDATION

unitar
United Nations Institute for Training and Research

Plan Bleu

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Fondation VEOLIA

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IN THE MEDITERRANEAN

CONTENTS

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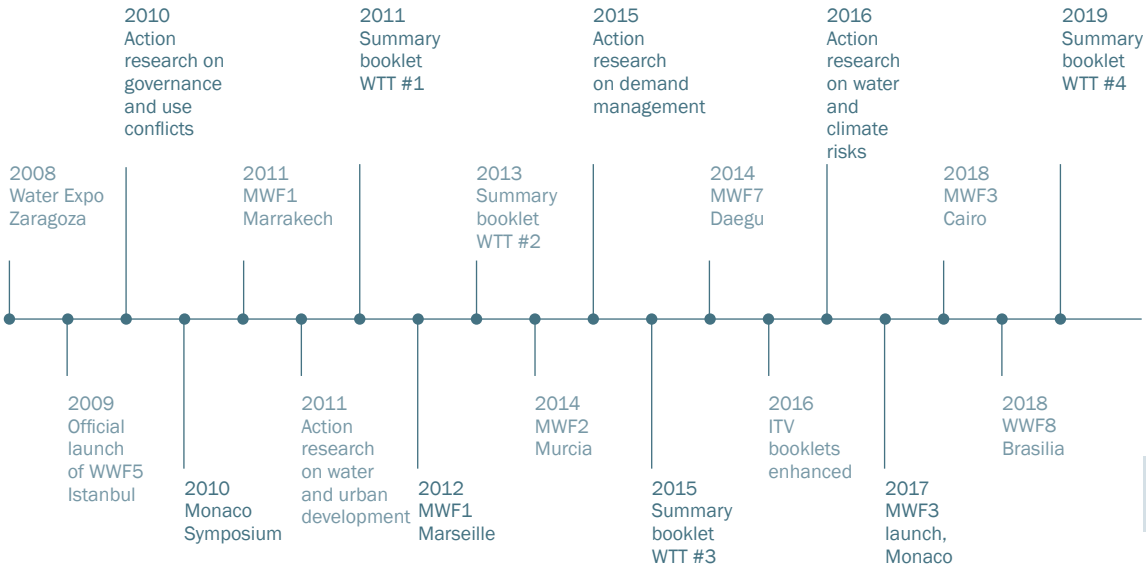
THE WATER THINK TANK

IN FEW WORDS

The Water Think Tank Méditerranée is an initiative that was launched by the Prince Albert II Foundation in March 2009 during the 5th World Water Forum in Istanbul. Founded in partnership with the United Nations Institute for Training and Research (UNITAR), Plan Bleu, the International Office for Water and the Veolia Environnement Foundation, it aims to foster dialogue in order to promote sustainable and integrated water resource management within the Mediterranean Basin. Understanding governance processes and the stakeholder ecosystem, which includes politicians, scientists, technical specialists and economists, is critical to incorporating the principles of sustainability, sharing and fairness. As such, we have sought, over the last decade, to accurately identify the problems associated with water, listening to local stakeholders and studying actual use as well as technical and institutional solutions.

Taking into account geographical, technical and political factors, as well as historical and symbolic aspects, has made it possible to consider mechanisms for water governance in the Mediterranean. Drawing on specific case studies produced by the Water Think Tank's partners, work has been done to help comprehend the wide range of local circumstances, while also establishing an overall, systemic view of regional challenges. The particular constraints that characterise each local context are also emphasised by the impact of climate change. Problems with water scarcity, a deterioration in the quality of untreated resources and even conflicts over use are being exacerbated.

Many civilisations were born on the shores of the Mediterranean. Today, however, there are increasing signs that a system founded on the unsustainable exploitation of nature and short-sighted management of our resources is rapidly running out of steam. Ten years of work have shown that the Water Think Tank's approach is effective. It is now time for the conclusions it has drawn to serve all those living around the Mediterranean, for whom water remains a key issue in the twenty-first century.



H.E. BERNARD FAUTRIER, PRINCE ALBERT II FOUNDATION

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At the global level, the majority of nations are now participating in international climate negotiations with the aim of mitigating the impact of climate change and adapting to the consequences. The issue of water, which is addressed in this fourth *Water Think Tank* booklet, is critical to both of these efforts, especially for countries around the Mediterranean. These countries will be particularly heavily hit by the consequences of global warming, since it will make fresh water resources on the southern shores increasingly scarce during summer and cause severe flooding on the northern shores during other seasons. This is a reminder of the extent to which the climate challenge requires more regional cooperation: the societies and economies that will suffer the most as a result of warming are those that have contributed the least, historically, to greenhouse gas emissions, who are currently the most lacking in the technical and financial resources needed to adapt to it, and whose future development prospects are most at risk.

Regional solidarity is therefore vital to ensure that all Mediterranean countries adopt more responsible development models focused *"towards a positive revolution"*[1], including by analysing in more detail the vulnerability of their territories and their communities to climate change.

However, going beyond the partial responses that each territory may be able to bring to bear, depending on their resources and risk exposure, there is a need for a joint reflection process in the Mediterranean, one which crosses borders and which concentrates specifically on the technology transfers that are needed to prevent climate risks (including the use of environmental engineering), resource transfers (including virtual water[2]) that exacerbate the situation in areas suffering from water stress, and the adoption of decisive regional strategies (including on energy efficiency and safeguarding biodiversity).

Institutional capacity building in the region's least developed countries must also be continued to enable these countries to benefit from international funding and put in place proven adaptation measures.

[1] A reference to the book Vers une révolution positive, 20 solutions citoyennes pour changer le monde (Towards a Positive Revolution: 20 People's Solutions to Change the World), Fayard 2018. Presented at the 13th G20 Summit in Buenos Aires, November 2018.

[2] All of the water consumption required to produce something (in agriculture, industry or services). May be used to assess the environmental footprint of trade between countries.

INTERVIEW
KEY OBSERVER

DR ERIC TARDIEU,
DIRECTOR GENERAL, INTERNATIONAL OFFICE FOR WATER (IOWATER)

In the face of climate risks – made worse by the overexploitation of water resources – to which the Mediterranean Basin is particularly vulnerable, the efforts expected on environmental transition are becoming ever more significant. The consecutive organisation by Mediterranean countries of COP21 (in France) and COP22 (in Morocco) provided an opportunity for state actors and representatives from civil society to reach agreement on a clear and up-to-date prognosis.

With the aim of defining regional climate challenges and identifying priority areas for action, the two MedCOPs[1] that met in Marseille and then Tangier point to the role that can be played by a new form of knowledge that is firmly rooted in interdisciplinarity and the use of fresh methodologies. The themes involved require the development of more cross-cutting visions such as sustainable coastal development, ecosystem approaches tailored to the natural environment, the integration of circular economy principles to derive value from and limit the environmental impact of by-products, and partnerships to promote an industrial ecology philosophy. Starting in the early stages (data collection networks) and moving downstream (water information systems), the process of acquiring and disseminating knowledge is becoming more collaborative and inclusive with the contribution of participatory science and the mobilisation of the advanced functionality offered by digital tools (hydroclimate modelling, smart city, smart agriculture, smart water, IoT-based[2] alert and warning systems, etc.).

Alongside its partners (governments, academics, businesses and watershed organisations), the International Office for Water is supporting the development of skills that will enable us to better manage water and to control climate risks against a background of environmental, social, political, regulatory, economic and technological change.

[1] A reference to the Mediterranean forums organised in Marseille on 4 and 5 June 2015 in preparation for the COP21 Paris Climate talks, and in Tangier on 20 July 2016 in preparation for COP22 in Marrakech on the solutions agenda.

[2] The Internet of Things. Internet-connected objects are increasingly being used in the roll-out of technology to detect and remotely transmit information within catchment areas, radar technology, sensor and water/weather warning systems, rainfall detection, remote control, and aerial (including drone) and satellite imagery.

Identification

OPTIONS FOR MANAGING NATURAL ENVIRONMENTS WHICH EXACERBATE OR MITIGATE THE IMPACT OF CLIMATE WARMING ON THE WATER CYCLE

"Combining ancestral memory of Mediterranean water systems with new climate intelligence "

The Mediterranean Basin is one of the regions most heavily impacted by climate change. The very specific prevailing conditions have led to the evolution of unique flora and fauna which are now endangered as a result of the disruption of natural environments, attributable largely to coastal development and global warming.

The vulnerability of these areas, and particularly of wetlands, is well known and is the subject of studies. Choices which have been made in terms of planning, urban development, soil artificialisation and drainage for agricultural purposes are causing a worrying reduction in the surface area of these zones and changes to the water systems on which they depend.

This environmental impact is all the more damaging because, in addition to being a repository of biodiversity, these natural areas also supply recognised ecosystem services, particularly regulating services which help to mitigate climate change (carbon sequestration) or limit its impact (low-water replenishment, flood retention, coastal

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USING HINDSIGHT: A HISTORY OF THE CORRELATION BETWEEN METEOROLOGICAL EVENTS AND CLIMATE WARMING IN THE MEDITERRANEAN

Certain rare or extreme bad weather events are sometimes wrongly attributed to climate change. This has been proved by a number of research studies which have documented the history of storms and rainfall over a period of decades and sometimes several centuries to determine whether the increase in their frequency or magnitude align, over the long term, with the rise in average global temperatures that can be fairly accurately estimated back to 1880.

In the Mediterranean Basin in particular, history and some of its auxiliary disciplines can be used to locate, date and very accurately describe many meteorological events before the introduction of precise measuring equipment, which provides further interpretable data on this type of event. Fluctuations in rainfall in Lebanon do not correlate with the rise in temperatures or sea level. Equally, the frequency and intensity of coastal storms in France's Gulf of Lion cannot be considered as true indicators of climate change. While the observed temperature rises confirm the warming trend, the influence of other natural climate variability complicates our understanding of when meteorological events occur and how they function. It is clear, however, that the increased frequency of high water levels and flooding arises from higher precipitation for which climate disruption is directly responsible.

management), to Mediterranean societies that are increasingly exposed to emerging climate risks.

Water in its various forms is one of the main vectors that can exacerbate or mitigate risk on the basis that a surfeit or lack of water lies at the heart of any climate hazard that occurs.

Reaching an understanding of the links between water and climate risks is a complex exercise, but it is an essential one if we are to get better at predicting phenomena. In particular, the ability to identify, for each event, what can be attributed to a one-off meteorological incident and what is probably associated with an increase in average temperatures or sea level, has now become a strategic requirement. This knowledge will first and foremost make it possible to rethink planned future facilities, launch relevant environmental rehabilitation projects, develop more effective operational crisis management techniques and, above all, raise the awareness of populations who may be affected and whose behaviours will be decisive in terms of the human and material consequences.

As with any type of risk, climate risks must be anticipated with a view to avoiding, reducing or, failing that, better managing them. In this case, the role of water in climate hazards is such that a better understanding of the major water cycle and of how wetlands operate is critical to this approach.

CLIMATE RISK: AN EQUATION THAT GOES BEYOND THE NATURAL SCIENCES

The concept of risk is inherently complex. It takes account of the probability that a dangerous event – a natural hazard – will occur and of the severity of the potential consequences: the exposure and vulnerability of populations. The anthropisation of an environment, the nature of urbanisation, the quality of infrastructure and the habitat, the age, health and poverty level of populations and their preparedness for extreme events are all key influencing factors. Moreover, risks are interpreted subjectively by different cultures, depending on their resilience, the individuals that make them up and their aversion to risk. The different categories of risk which a society faces are then prioritised in accordance with certain collective perceptions. The same risk can therefore be considered to be intolerable or acceptable depending on the time period or the Mediterranean country which is exposed to it.

Finally, the climate risk is multiple: beyond the direct consequence of rising average temperatures, the disruption of major geochemical cycles, the pressure on ecosystems and the loss of biodiversity could lead to indirect risks which are more or less perceptible and immediate. Indirect risks in terms of health have already been identified and thinking is underway in economic circles to anticipate the transformations in climate-dependent sectors (certain types of electricity generation, the food processing industry, forestry, wine-growing, tourism, etc.). In the longer term, migratory flows resulting from the consequences of climate change – floods, droughts and coastal flooding – could be a source of geopolitical instability in the Mediterranean region.

WATER STRESS IN THE MEDITERRANEAN AND CLIMATE CONTINGENCY

Although there are significant geographical disparities in terms of the availability of fresh water, the Mediterranean Basin as a whole is facing a problem with water scarcity. The majority of countries along the southern and eastern coasts are suffering from water stress and the water exploitation index for some aquifers in these countries exceeds 100%. Climate warming is undoubtedly exacerbating the recurrent shortages in the Mediterranean, but it is not the primary cause. Pressure on water resources in the region is rooted first of all in the rapid increase in demand driven by demographic growth, urbanisation and the growth of farming and industry. For several decades, the only response to this rising demand has been policies to increase supply that are not rational from an environmental perspective.

Deemed non-sustainable and risky under the Barcelona Convention in 2005, this supply-based approach, with a particular focus on major inter-basin transfer projects, was gradually supplemented by significant water demand management efforts as part of a Strategy for Water in the Mediterranean. This new approach aims to reduce distribution network losses, optimise agricultural, industrial, domestic and tourist use, and better allocate the available resources. Climate disruption means that even greater efforts to introduce technical modernisation and raise awareness regarding water scarcity will be required.

WAJDI NAJEM
Director of the Regional Centre for Water and the Environment (CREEN), Saint Joseph University, Beirut, LEBANON

"Climate change will likely have a significant impact on river basins in Lebanon but, given current knowledge, it is still very difficult to accurately assess the changes that we might see in water systems. A group of researchers at CREEN are analysing data relating to the Nahr Ibrahim basin. This principally involves collecting the relevant data and building a tool that will be able to produce simulations for several different scenarios. The tool is based on several interlinked models, including MEDOR, a conceptual daily rainfall-runoff model adapted to the Mediterranean climate, which has been developed using data from six French and Lebanese basins. In short, it combines a model dealing with accumulation and snowmelt, and a rainfall-runoff model for the rest of the watershed which is not affected by snow cover. The model works and the results are clear: in terms of rainfall, we did not obtain conclusive results demonstrating a clear evolution linked to climate change. Rain is a natural phenomenon which experiences very random variations, and it is thus extremely difficult to establish a connection between these fluctuations and climate change. On the other hand, when it came to temperature our research showed that there has been an undeniable increase in Lebanon since 1975. We also observed temperature rises of nearly two or three degrees in summer, in excess of IPCC forecasts."

Debate

Within the scientific community itself, a debate is going on regarding the significance of greenhouse gases. Although the IPCC dedicates specific chapters in its publications to supporting research carried out in this field, the different frames of reference currently used for calculations are liable to produce highly contrasting results. For example, there are three coexisting approaches which do not allocate the same role to reducing emissions of various gases in the fight against climate change.

1. GWP (Global Warming Potential) aims to quantify the greenhouse effect caused by greenhouse gases relative to that produced by CO_2.
2. GTP (Global Temperature Change Potential) expresses a change in average and global temperatures caused by the specific emission of a gas.
3. GDP (Global Damage Potential) is calculated as the ratio between the relative costs of reducing emissions for each gas for the emissions strategy obtained following the optimisation calculation.

Peat bogs, for example, store carbon dioxide (CO_2) but also emit methane (CH_4), which has a strong greenhouse effect. Quantifying the carbon sequestration service provided by these environments depends primarily on the difference between these two processes (subtracting the impact of gases emitted from the impact of gases captured makes it possible to determine whether the area functions as a carbon sink or a carbon source). The relative value attributed to them in terms of greenhouse effect is decisive. Depending on the frame of reference used (GWP, GTP or GDP), the impact of this type of natural environment in mitigating climate change will be more or less acknowledged and quantified.

It therefore remains difficult to determine precisely and unambiguously the climate risk and the role natural environments can play in mitigation.

KEY FIGURES

63 million
Mediterraneans will have access to 500 m^3 of water per person per year by 2025

180 million
Mediterraneans are experiencing water stress

60 %
The Mediterranean is home to 60% of people deemed to be "water poor"

between 25 and 60 cm
the sea level in the Mediterranean will rise between 25 cm and 60 cm by 2100

between 2 and 4 °C
The average water temperature will rise between 2 °C and 4 °C by 2100

1,5 °C
The Mediterranean Basin has already experienced a 1.5 °C rise in temperature

Mitigation

LARGE-SCALE NATURE-BASED SOLUTIONS ARE POSSIBLE IF THE ECOSYSTEMS ON WHICH THEY ARE BASED ENJOY GOOD ENVIRONMENTAL STATUS

"Wetlands provide regulating services that help to prevent and manage climate risks"

The IPCC has put forward several scenarios to try and prevent an effective increase of the global energy footprint as a result of the changes in our societies and the choices we make with regard to consumption, use and generation. Striving for the best-case scenario requires better control of atmospheric concentrations of carbon dioxide, the main greenhouse gas in real terms and, ultimately, in actual warming potential. The countries in the Mediterranean Basin face different challenges with regard to the impact of their economies on climate change, since there are significant disparities in the stages of development found in the north, east and south. Their efforts to combat climate change entail low-carbon lifestyles (lower energy consumption and the development of renewable energy) and strategies to promote the natural storage or artificial capture of greenhouse gases (also known as "negative emissions").

Geological carbon sequestration is the subject of numerous projects (where carbon dioxide is compressed until it becomes a liquid, then transported and injected beneath an impermeable cap rock, usually an old hydrocarbon deposit), but these techniques are applicable where it is possible and profitable to capture CO_2 in factories or power stations. Very large-scale sequestration of atmospheric carbon is a job for nature. Underground reserves of oil and gas are the fossilised remains of ancient natural environments. It is in precisely these natural environments that plants, through the process of photosynthesis, capture CO_2, which then reacts with water to produce the sugars that allow them to grow.

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PHYSICAL PROTECTION AGAINST THE RISK OF COASTAL STORMS AND FLOODING

The lagoons and ponds found along the Mediterranean coastline regulate water flow in the event of coastal flooding thanks to their high storage capacity, while their dune ridges act as upstream physical barriers during coastal storms. These ridges evolve naturally and can yield during extreme events, leading to the opening of a temporary or permanent inlet. Following the storm, this paralic ecosystem provides a buffer effect against the salinity of the water.

This type of natural environment, which is particularly productive and rich in terms of biodiversity, can also help to combat coastal erosion due to its plant life. All of these elements play an important role as environmental amenities. In addition, these environments provide other ecosystem services, including recreational services due to their tourist appeal. The Palavasian ponds lagoon system in Southern France's Gulf of Lion helps to protect the coastline. The French Conservatoire du Littoral (Coastal Conservatory), which identifies, acquires and develops natural spaces that are strategic from the point of view of environmental preservation, is responsible for more than 2,300 hectares of this land and has a management plan that addresses the significant pressure that the area faces in light of urban development in the conurbations of Montpellier and Sète. A recent study comparing simulations of biennial (frequent) and hundred-year (rare) storm scenarios emphasised and gave an accurate description of the coastal protection service provided by one of these lagoons, Vic Pond.

Wetlands therefore play an important role in mitigating the amount of carbon dioxide that accumulates in the atmosphere. These ecosystems, which are rich in biodiversity and particularly productive, provide numerous regulating services and offer excellent functional spaces for reconciling the fight against climate change and environmental conservation. They are nonetheless endangered by droughts, over-abstraction and, in the case of intertidal zones, by sharp fluctuations in the salinity of their waters. Wetland conservation guarantees the operation of these services which mitigate the consequences of climate events such as flooding and coastal storms.

Environmental engineering must be deployed to restore the affected areas and develop management techniques that optimise regulating services. Such green infrastructure and nature-based solutions will, in the short term, provide services that protect the integrity of people and property against extreme climate events and, in the longer term, help to mitigate these risks through carbon sequestration.

NATURAL RESERVOIRS TO REDUCE FLOOD PEAKS AND PROTECT AGAINST FLOOD RISKS

Some wetlands, depending on their nature, their position within the watershed and the storage capacity of their retention areas, play a key role in protecting against the flood risk to people living downstream. This role can be evaluated according to several criteria on the basis that the flood risk is characterised by three parameters: the water level, the speed of the current and the immersion time. Mitigating these aspects does not depend on the absolute characteristics of the wetland alone, but also on how saturated it is at the time of flooding, the maximum flow and numerous aspects related to the complexity of the catchment basin. Consequently, in some zones, such as the Lonjsko Polje alluvial plain in Croatia, improvements mean that it is possible to envisage real-time management of flooding of the Sava River and its tributaries.

Knowledge of the terrain, strategic decisions and the capacity of operational teams to intervene are thus decisive, with the aim of limiting, delaying or displacing the flood peak to protect downstream urban areas, particularly the city of Zagreb, as far as possible. All studies on the impact of climate change in this catchment area predict an intensification of these events in the future, and improvements have been made to the plain to address these problems. Conversely, soil sealing associated with urban sprawl on other Mediterranean coasts means that the ground is no longer able to fulfil this function.

ATMOSPHERIC AND ORGANIC CARBON SINKS AT RISK OF CHANGE

With regard to climate change and the medium- and long-term risks that it poses, carbon sequestration is the most interesting regulating ecosystem service in terms of mitigating climate risks. The presence of stagnant water limits mineralisation of the plant litter by depriving soil bacteria of dioxygen. The carbon therefore remains in the litter in organic form and does not re-enter the atmosphere. Scientists estimate that peat bogs cover 3% of the planet's total land surface, but depending on their latitude, altitude and composition, they can function as carbon sinks or carbon sources. Since rising temperatures themselves have an impact on the state of peat bogs' plant cover, the scientific community is trying to determine the role that they will play in the carbon cycle in future, and to assess the risk that these environments will become primarily carbon sources.

In the rural region of Bolü in Turkey, peat bogs surround Yeniçağa Lake. They currently provide a regulating service for both the global and local climate given the accumulated carbon that is stored in the soil and annual flows. Measures are being taken in the region to limit exploitation of the peat, an organic fossil material that, depending on its composition, can be used as a fuel or as an agricultural substrate and fertiliser. Peat bogs are not, however, the only wetlands that can capture carbon. Sediments in Burullus Lagoon in Egypt play the same role. Located in the Northern Nile Delta, the lagoon stretches along 65 kilometres off the Egyptian coast, to the west of the Baltim region.

More than 185,000 people interact with the lagoon on a daily basis. It is an important fishing and aquaculture resource for local people, and a migratory area for many bird species. Its role in storing atmospheric carbon is being studied, and the carbon from water with a high content of organic matter that is discharged into the lagoon by human activity is contributing to this sequestration phenomenon. There is a need for a better understanding of the intensification of extreme climate events (sandstorms, heatwaves, offshore storms) and changing anthropogenic pressure on the environment.

DR ÖZGE BALKIZ
Species Conservation Programme Coordinator, Nature Conservation Centre (DKM), TURKEY

"Protecting sensitive natural areas in the way that we envisaged some 30 years ago is no longer an option today. The areas affected by environmental degradation are now too vast to propose radical conservation solutions. Turkey, for example, is a highly populated country, and quite densely so, including in rural areas. It is inconceivable that we should take measures to protect the environment that would run counter to the needs or aspirations of the local populations living and working in these areas. Organisations working to protect biodiversity have therefore adopted a new approach: they focus on the ecosystem services derived from these sites. DKM led a project to this effect in Central Anatolia, a steppe region with particularly low rainfall. Entitled 'Agriculture of the Future', the project ran from 2013 to 2016 and received assistance from the European funding programme LIFE+. In this region, we analysed supply services in wetland areas, particularly drinking water services, but also other regulating services which contribute in multiple ways to sustaining local agriculture (microclimate regulation, combating soil erosion, flood retention, etc.) and thereby improve the quality of life for locals who are generally relatively insensitive to environmental issues. Involving them is the best thing to do: they will become aware not only of how this initiative can help to improve their everyday lives, but also of the fragility of these environments and the need to protect them."

Debate

Ecosystem services like the ones described by Özge Balkiz are quantifiable. Various economic methods may make it possible to assign a value to them, with the aim of rationalising decisions regarding the management of natural environments and justifying the expenditure required to maintain good environmental status in these areas. Assigning value would also help to evaluate the importance of these natural services against development projects which could alter them. The advantage of this kind of approach is that it attracts the attention of politicians and economists to the scale of these services in terms of their contribution to local development (supply services), costs avoided in the event of a natural disaster (regulating services) or more broadly in terms of benefits for a society's wellbeing (cultural services). Nonetheless, even the principle of attributing an economic value to these services – in other words to nature – and particularly the idea of expressing this value in monetary terms is not uncontroversial.

There are numerous philosophical or politically engaged works which stand in fierce opposition to a fringe of society which believes that nature has an intrinsic value. They essentially point to the risk of confusion between monetisation and its spin-offs towards the financialisation or commodification of nature. These are three very different concepts, but may be perceived as stages in a process of gradual monopolisation: assign a value to these services, put in place financing tools, and then introduce them to a market. While the economic valuation of ecosystem services is an interesting approach for highlighting the benefits of conserving natural environments to day in order to prevent much more substantial damage in the future, a very high degree of vigilance is required. Moreover, economic valuation is itself still a difficult exercise which does not always produce consensus, since the assumptions and methods used can result in huge differences between the values that are eventually assigned.

KEY FIGURES

From 270 to 400 ppm
the rise in CO_2 concentrations within a century

68,000 euros
per year and per hectare: the value of the flood retention service provided by the Lonjko Polje flood plain

2°C
by 2100

Reduce greenhouse gas emissions to 30% les of current levels by 2050 to keep global warming below **2°C by 2100**

90%
of the water entering Burullus Lagoon is made up of the overflow from surrounding agricultural runoff

46 000 ha
the surface area of Burullus Lagoon in Egypt

2013
launch date of the Med-ESCWET project, which is seeking to evaluate the efficiency of natural infrastructure compared with artificial infrastructure

150
dams are located along the lower reaches of the River Ebro in Spain

Adaptation

ADAPT TO THE CONSTRAINTS ASSOCIATED WITH A SHORTAGE OF WATER RESOURCES AND AN INCREASE IN THE FREQUENCY OF EXTREME WEATHER EVENTS

"There is no need to make the Earth a paradise: it is one. It is for us to adapt in order to inhabit it."

Mitigating climate change is not sufficient. According to some experts, mitigation could come too late in that a rise in average temperatures has already been recorded, along with the first manifestations of climate disruption. Its impact on the water cycle and the resulting socio-economic repercussions are already noticeable. People living in the Mediterranean Basin are already implementing adaptation strategies. These may be technological, scientific or regulatory in nature, or may draw inspiration from traditional building and development methods, and more broadly from more resilient lifestyles.

The combination of all of these practices should provide responses that are often sustainable, if cumbersome to put in place: beyond technical innovation, adaptation requires behavioural changes on a large scale and therefore buy-in from populations or long-term trade-offs based on the political courage of national and local leaders. The issue of water is key to the adaptation strategies which need to be deployed in the Mediterranean. The variations in peak availability period, for example, require a rethink of all climate-dependent sectors, such as agriculture and tourism. Gradually but steadily, shifting seasons are likely to cause significant disruption to the social and economic organisation of traditional aspects of life in Mediterranean societies. Droughts, heatwaves, rises in sea level, the visible appearance of new plant and animal species which are on the move, the less visible disappearance of species that are not able to adapt to the sometimes very drastic changes taking place at their level... It is critical that these disruptive events are controlled and that support is provided, since climate disruption produces uncertainty around the occurrence of extreme events and their knock-on effects, including with respect to water management.

Research is of primary importance in implementing adaptation measures. An initial challenge is to improve forecasting of events, for while tremendous progress has been made, forecasts still come too late and without sufficient accuracy in terms of location to inform people in time and put the necessary measures in place. A second challenge relates to developing the knowledge required for innovation that would promote longer-term adaptation.

THE UNCERTAINTY SURROUNDING WATER MANAGEMENT REQUIRES EFFORTS TO BE MADE TO INNOVATE AND INTRODUCE NEW TOOLS

The increase in temperature due to climate change is worrying because it will alter the calendar of the water cycle. In Lebanon, 20% of precipitation falls as snow. The water available in summer comes in part from snowfall which occurs two or three months later than the rain. The evaporation and reduction in snow reserves will lead to more runoff and less snow, resulting in a gap of around six weeks' worth of total precipitation. While precipitation has been concentrated in May, it will now peak during March. This shift in the seasons will make irrigation more difficult in summer.

Significant research is therefore now underway in the field of phenology, studying the impact of climate variations on periodic plant and animal life cycle events. Agricultural research is attempting to select species that consume less water and are more resistant to heat shock, using, among other things, genetic selection in the laboratory and hybridisation. In general terms, agricultural water management is a key part of climate change adaptation efforts. Agriculture accounts for up to 80% of water use and is highest in countries where there has been little modernisation of water systems.

It is also essential to implement techniques that will improve soil management, since plants are grown according to different water management regimes, depending on soil tillage and by optimising the available water through promoting increased humidity around plant roots. Agroecology seeks to promote sustainable agricultural production systems for climate change adaptation, and relies in part on an understanding of the soil and weather conditions and the biodiversity of each area.

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Transfers of knowledge and expertise highlight the vital role of international cooperation in adapting to climate change. The Mediterranean region is doubly interesting in this respect, in the sense that its specific vulnerabilities on the issue of water, and its unique climate and biodiversity mean that such cooperation is especially productive, and in the sense that the knowledge acquired is increasingly benefiting bordering regions, particularly further north in Europe, who are experiencing a "Mediterraneanisation" of their climate, with an acceleration of the water cycle and increased frequency of flooding and droughts on an alternating basis. According to the IPCC, average temperatures in the region have risen by 2°C since the 1970s, causing it to become more arid. Mediterranean climate change adaptation solutions are therefore expected, studied and replicated.

TO LIMIT LOSSES AND PROMOTE BETTER REUSE OF WASTEWATER, REGULATORY DEVELOPMENTS ARE EXPECTED

In accordance with their physical, chemical and bacteriological properties, different types of domestic, agricultural and industrial wastewater can undergo appropriate treatment, allowing the water to be reused for several purposes: irrigation, depending on the types of crop involved, watering of urban green spaces, various industrial procedures (which can require very different levels of water quality), appropriate discharge into the natural environment to replenish groundwater, and so on. For each use, there is an appropriate level of treatment to prevent damage to the natural environment, for example, as well as health risks and disruption to manufacturing processes. Each of these levels requires regulation in accordance with the demand for water and the constraints associated with the activity concerned.

Horticulture, agriculture, arboriculture and forestry all present different constraints. In industry, some recommendations can be drafted at a cross-sectoral level if the water quality required appears to be applicable across the board, for example in the case of coolant water. Conversely, some directives have to be drawn up separately for each type of industry when it comes to process water. One of the things which has been noted as slowing down the development of these techniques for reusing water is a lack of support in terms of regulating implementation. In Greece, for example, the water expert community is disappointed that there is no European directive on wastewater treatment: every European country has its own legislation in this area. The countries of Northern Europe, which have more abundant water resources, have less interest in recycling waste water. This may go some way to explaining the legislative delay at the European Union level from the point of view of countries that have greater exposure to water stress. Climate change adaptation therefore requires solidarity between countries at different levels of development and with different levels of vulnerability. Specifically, the need for European solidarity on regulating water is strongly felt.

THE MAIN SOURCES OF INSPIRATION FOR ADAPTATION MEASURES ARE ALL AROUND US, IN THE HERITAGE OF THE MEDITERRANEAN BASIN

Urban planning is a critical part of climate change adaptation strategies. Soil artificialisation exacerbates the impact of climate hazards and contributes particularly to an increased risk of flooding. The insurance and reinsurance sectors have thus begun to look at introducing rewards and penalties calculated on the basis of analysing regional resilience, to encourage cities to rethink their urban planning by learning lessons from extreme climate events. The victims of economic damage resulting from some natural disasters benefit from national assistance as long as they maintain their exceptional nature, but in a number of Mediterranean cities, blocks affected by heavy flooding and then rebuilt exactly as they were before have suffered a similar fate several years later.

Highlighting the responsibility of local decision-makers, these repeated events have led to the areas losing their exceptional status. Vernacular buildings and traditional approaches to construction in areas which are vulnerable to flooding, coastal flooding and drought offer an insight into the efforts societies have made over centuries to adapt to their environment. While they have become more intense, warming and cooling cycles did not begin with climate disruption. Tunisian buildings where part of the construction is buried underneath the sand to take account of climate conditions is just one example among innumerable others of resilient construction systems that have been abandoned over time. Innovation can therefore be based on the lessons of the past. The inclusion of plants in traditional buildings or the use of natural ventilation techniques as part of a bioclimatic approach to construction make it possible to achieve thermal comfort so that the use of energy-intensive air conditioning processes is not essential. In terms of water management, adding plants to an urban space so that rainwater is stored without directly returning to the system is a way of optimising use and recycling of this resource. In Turin, the experimental project by 25 Verde is a house in which the incorporation of numerous plants gives a better insight into the benefits of such an approach.

DR. MARIJAN BABIĆ
Head of Flood Protection Equipment, Croatian Waters (Hrvatske vode), CROATIA

"Croatia has adopted a series of structural and specific measures, with implementation accelerated following the major flooding seen in May 2014. Initially, these were immediate planning and prevention measures such as:

- Improving flood forecasting through the collection and processing of hydrological data, mathematical modelling, simulations, warning systems, risk mapping, etc.;
- Tightening the monitoring of flood protection infrastructure;
- Strengthening Flood Defence Centres at the national and regional levels with more resources, equipment and staff.

Over the longer term:

- Carrying out in-depth catchment studies as a prelude to developing flood prevention projects;
- Adopting natural, environmentally friendly water retention measures (rehabilitation of water courses, restoration of rivers, flood zones, etc.) where technically and economically feasible;
- Building or rebuilding flood protection infrastructure, including sea walls, natural dams, pumping stations, etc.

Planning is being gradually decentralised and moved from the national to the local level, focused on the different basins. In the event that a flood occurs, a whole series of measures will be set in motion at the local and national levels, in accordance with three estimated risk levels:
Level 1 – Ordinary flooding
Level 2 – Extraordinary flooding
Level 3 – Catastrophic flooding

Croatian Waters is responsible for Level 1 and Level 2 flooding, but delegates crisis management to local authorities and regional protection centres in the event of a catastrophe.
Today, flood management in Croatia is satisfactory, however despite all of the precautions which have been taken, the risk cannot be reduced to zero and floods continue to present a greater threat than fires or earthquakes."

Debate

To adapt to climate risks, much more use must be made of nature-based solutions. While it is sometimes necessary to build artificial infrastructure, the multiple services provided by green infrastructure – for example, in terms of phytopurification, improving air quality, carbon sequestration, etc. – must be taken into account. If we consider the example of a water treatment plant, the artificial, or "grey" infrastructure has the advantage of fulfilling a very specific task – cleaning up polluted water – with a high degree of efficiency, but natural environments are capable of providing society with multiple ecosystem services. Even though they may appear to carry out these tasks less precisely and less thoroughly, and even though it may sometimes be more difficult to get society to accept them, due to a series of potential inconveniences that they can cause for the local area, they nonetheless remain the best way to reconcile environmental protection and the battle against climate change. This is why many planners are now opting for green infrastructure of the kind that the DRAVA Life project is seeking to promote in Croatia – the aim of this project is to restore the banks of the Drava to a natural state.

KEY FIGURES

55%

In Italy, 55% of water losses are due to weaknesses in the irrigation system

2 months

the shift in peak water availability that has been noted in Lebanon

10 cts/m^3

1 €/m^3

8 €/m^3

Production costs for conventional resources are in the region of **10 centimes/m^3**. These costs fluctuate between **1 euro/m^3** (for seawater desalination) and **8 euros/m^3** for supply via container from the continent

KEY CONCEPTS

Representative Concentration Pathway (RCP)

Scenarios illustrating changes in greenhouse gas concentrations (CO_2 equivalent) and their impact on the increasing global energy footprint. The benefit lies in combining RCPs with the relevant consumption and production patterns and defining trajectories with a view to establishing best-case, stable and worst-case scenarios.

Water cycle

A natural phenomenon in which water is transferred between the three sources of liquid water, solid water or water vapour on Earth.

Coastal erosion

A natural process in which the coastline retreats, which may be increased by artificial development of the coast and a rise in water level due to climate warming. The risks that it poses to coastal habitats and activities often require relocation upstream.

Hydroelectric power

A process which converts the potential energy of water into kinetic energy in order to generate electricity. It is a form of renewable energy that can help achieve objectives relating to security of supply. In addition, the dams and water retention ponds required to produce this type of energy guarantee better flood control. Although they represent a valuable low-carbon source of electricity, hydroelectric power projects do not reconcile the battle against global warming and environmental protection, and have been excluded from the clean development mechanism (CDM29) by the Executive Committee of the United Nations Framework Convention on Climate Change.

Ecosystem or environmental services

Benefits that humans draw from the functioning of ecosystems. The expression was coined in the 1970s in the field of biological sciences to highlight humanity's dependencies on natural environments.

Lagoon

A stretch of often brackish water, separated from the sea by a barrier beach. Intrusions across this barrier contribute to water mixing. They are sources of rich biodiversity.

Peat bog

Ecosystem in which, due to specific climate and topographical conditions, a layer of water stagnates at the bottom of plants (primarily sphagnum). This creates anaerobic conditions for the bacteria that are supposed to decompose the plants and so the decomposition process is incomplete. Peat bogs store organic carbon and emit methane.

Undersea freshwater sources

In karstic regions, rainwater that contains carbon dioxide dissolves the limestone. Underground basins full of fresh water can be carved out down to a great depth and are sometimes covered by sea water. This process, which takes millions of years, produces undersea sources of fresh water. Due to the different densities of fresh water and salt water, the two do not mix. The Mediterranean is particularly well-supplied with such sources, but extracting the fresh water can allow salt water to intrude into undersea basins.

Low-water level

This is the period of the year during which the level of a watercourse is at its lowest, and therefore represents the minimal annual flow. Drought and often higher temperatures are the weather conditions that characterise the low-water level period. Such conditions promote evaporation. Excessive pumping for agricultural purposes also plays a role in reaching the low-water level.

Water treatment and climate change

Wastewater is an important and little-known source of greenhouse gases. Wastewater emits a huge amount of methane and nitrous oxide as a result of the anaerobic decomposition of organic matter. Demographic growth coupled with weaknesses in developing countries' sanitation systems leads to an increased volume of untreated wastewater.

Resilience

The capacity of social, economic and environmental systems to deal with a hazardous event, trend or disruption, by responding or reorganising in such a way as to maintain the ability to adapt, learn and transform (based on the IPCC definition).

INTERVIEW
KEY OBSERVER

DR THIERRY VANDEVELDE
Executive Officer, Veolia Foundation

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Adapting to the effects of climate change requires regions to define and put in place genuine resilience strategies. Through its skills sponsorship programme, the Veolia Foundation deploys specialist teams and sends volunteer employees from the group to carry out emergency and post-emergency operations in the field. Following hurricane Mitch and its tragic consequences in 1998, numerous interventions, including some in the Mediterranean, provided vital aid to those affected by flooding and other extreme events. We are therefore aware of the extent to which the ability to overcome crises and get back to normal depends on the initial quality of natural ecosystems and local governance systems. Maintaining and restoring coastal environments and marine life to a good environmental status is part of this approach, and is precisely the focus of the REMORA[1] project, involving the submersion of reefs to enable a damaged marine environment to rediscover its full potential and biodiversity to reclaim it. Located at Cap Sicié, at the far edge of the Bay of Toulon, this pilot initiative led by Pôle Mer-Méditerranée has already achieved tangible results and will inspire new technical solutions to reduce manmade pollution and restore ecosystems.

Remora© Alexis Rosenfeld

The climate risks facing humanity are significant and we bear responsibility for them. We are therefore obliged to take action to protect ourselves and also to ensure the resilience of natural ecosystems which we have weakened in the past, and on which we are dependent.

[1] The REMORA project is funded by the Rhône Mediterranean and Corsica Water Agency and the Veolia Foundation, and led by the Toulon Var Technologies innovation association.

INTERVIEW
KEY OBSERVER

DR CÉLINE DUBREUIL
Water and Climate Change Manager, Plan Bleu

The Mediterranean Basin has been identified as one of the planet's 34 hotspots for water, climate and biodiversity. Climate change and its impact on the environment will be particularly strongly felt in this region, but nature offers us a fantastic range of solutions. Healthy ecosystems (wetlands, forests) reduce the exposure of populations to natural risks. Such nature-based solutions[1] are today recognised as sustainable alternatives with multiple objectives, and they are often less expensive over the long term than traditional grey infrastructure that is designed to provide a single service (a water treatment plant to treat water, a sea wall to protect against flooding, etc.). Nature-based solutions offer responses that can help us to mitigate climate change (for example, carbon storage by peat bogs) and to adapt to it (e.g. a dune offering protection from coastal erosion). The use of these new types of environmental engineering nonetheless depends on long-term investment. Such solutions often take up a lot of space, and so introducing them requires the development of land use strategies that promote the safeguarding of biodiversity and demands better knowledge and buy-in from various stakeholders and decision-makers. Nature-based solutions can be combined with institutional and technical solutions in response to the specific needs and constraints in a particular area.

Evaluating the many ecosystem services (supply, regulating[2], cultural) that lagoons, peat bogs and forests are likely to provide simultaneously may make it possible to clarify how relevant they are on a case-by-case basis or, failing that, to determine the value in promoting hybrid solutions. With respect to the vulnerability of a region and sectors that are especially climate dependent, nature-based solutions help to deliver resilience in Mediterranean regions.

[1] Nature-based solutions are defined by the IUCN as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits".
[2] The economic contribution made by Mediterranean wetlands through climate regulation has been studied as part of the Med-ESCWET project, led by Plan Bleu and co-funded by the Prince Albert II Foundation.

PARTNERS OF THE WATER THINK TANK

WTT presentation at the World Water Forum in Korea, 2015

Prince Albert II of Monaco Foundation

PRINCE ALBERT II OF MONACO FOUNDATION

HSH Prince Albert II of Monaco set up his Foundation in June 2006 in order to address our planet's alarming environmental situation.
The Prince Albert II of Monaco Foundation is dedicated to the protection of the environment and the promotion of sustainable development. The Foundation supports initiatives in the fields of research and technological innovation, and activities focused on the social issues at stake.

The Foundation funds projects in three main geographical regions: the Mediterranean Basin, the Polar Regions and the Least Developed Countries. The Foundation concentrates its efforts in three main areas: climate change and renewable energies, biodiversity and water management.

www.fpa2.com

Plan Bleu

Plan Bleu

Plan Bleu is a Regional Activity Centre of the Mediterranean Action Plan, established under the aegis of the United Nations Environment Programme. It serves all the countries bordering the Mediterranean Sea and in the European Union that are contracting parties to the Barcelona Convention (1976). It also works in partnership with the Marseille Center for Mediterranean Integration and the Union for the Mediterranean. Its mission is to produce information and knowledge in order to alert decision-makers and stakeholders to the environmental risks and sustainable development issues facing the Mediterranean, and to forecast future scenarios to guide decision-making processes. As a key resource for development – agricultural development in particular – water has always been a major issue for Plan Bleu.

www.planbleu.org

International Office for Water

For 20 years, IOWater has supported international stakeholders in capacity building and developing a framework for better water management through:

- **Studies, advice and twinnings**
  - Strengthening skills at local, national and international level.
  - Drawing up strategies and supporting policies of good water resource governance and pollution control in the main sectors (water supply and sewerage, industry, energy and agriculture).

- **Professional training**
  - Catalogue-based and tailored training programmes.
  - Assistance with establishing water training centres.

- **Data and information management**
  - Implementing solutions for managing information about water and making it accessible.
  - Standardising data exchange.

IOWater is responsible for the administration of the International Network of Basin Organisations (INBO) and runs EMWIS (Euro-Mediterranean Water Information System).

www.oieau.fr

United Nations Institute for Training and Research

The United Nations Institute for Training and Research (UNITAR) delivers capacity building to thousands of beneficiaries around the world through training and research in the fields of the environment, peace, security and diplomacy, and governance.
Within the Governance Unit, the Local Development Programme (LDP) builds the capacity of local stakeholders towards sustainable development in order to help them meet the many challenges they face at local level.
The Programme is an international platform for knowledge exchange, and for the sharing and dissemination of best practice and innovations implemented by towns and cities. It facilitates partnership building between the public sector, private sector and civil society at local, national and international level.

www.unitar.org

Veolia Foundation

Around the globe, Veolia helps cities and industries to manage, optimize and make the most of their resources. The company provides an array of solutions related to water, energy and materials – with a focus on waste recovery – to promote the transition toward a circular economy. Veolia's 179,000 employees are tasked with contributing directly to the sustainability performance of customers in the public and private sectors, allowing them to pursue development while protecting the environment.

Created in May 2004, the Veolia Foundation supports non-profit community-oriented projects contributing to outreach, workforce development and environmental conservation, in France and internationally. It is unique in that every project that it supports is accompanied by a sponsor, who is a Company employee, and in that it provides the expertise of employee volunteers, joined together in Veoliaforce, in the areas of emergency aid and development.

fondation.veolia.com