HyMeX Drought and Water Resources Workshop Report

P. Quintana Seguí, J. Polcher, Y. Tramblay, R. Coscarelli, S. M. Vicente-Serrano and Hadas Saaroni.

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Introduction

Work in drought, water resources and their impacts is not new within HyMeX, as research on these topics has been produced within Working Group 2 (Continental Water Cycle). However, in order to enhance the work done on these topics, it was decided to create a specific Science Team (ST). In September 2015, during the HyMeX workshop held in Mykonos, the general strategy of the new Science Team started to take shape and it was decided to organize a workshop in order to consolidate a strategy and foster the community.

The main objectives of this workshop were to present the state-of-the-art in drought and water resources research done in the Mediterranean region, coordinate and strengthen the HyMeX community in this area and discuss the future lines of work.

The workshop was structured by topics of priority:

- Description of Mediterranean droughts: datasets, models and societal impacts of past droughts
- Understanding of drought processes: drought propagation within the system, feedbacks, interactions with climate change and water resources, aerosols, vegetation, etc.
- Predicting drought: data assimilation, seasonal forecasting, model improvement, impacts of climate change, and links with policy.

The workshop was build around oral presentations and discussions of the three aforementioned topics. The program of the workshop is attached to this report as an appendix.

Organization

The workshop took place at the premises of the Spanish National Research Council at Zaragoza, it was co-organized by the Ebro Observatory (URL - CSIC) and the *Instituto Pirenaico de Ecología* (IPE, CSIC), with the financial support of HyMeX and MISTRALS.

The scientific committee was formed by:

Roberto Coscarelli	CNR, Italy	Pere QuintanaSeguí	OE, Spain
Hadas Saaroni	TAU, Israel	Yves Tramblay	IRD, France
Jan Polcher	CNRS, France	Sergio M. VicenteSerrano	CSIC, Spain

More details can be found at the workshop website :
http://www.hymex.org/drought-wr-workshop/

Participation

The workshop had 51 registered participants, who submitted 31 abstracts. The following table summarizes the main statistics. The complete list of participants can be found in the Appendix.

Country	Abstracts	Participants
Croatia	1	1
Egypt	0	1
France	11	13
Italy	3	3
Jordan	0	1
Malta	0	1
Morocco	2	3
Netherlands	3	4
Portugal	1	2
Spain	9	21
Tunisia	1	1
Total	31	51

Discussions

The following sections summarize the main points of the discussions.

Drought description

Data is the first important issue that arose in the conversation. In order to be able to analyze drought events and understand their links to atmospheric mechanisms it is necessary to have good quality databases. There is a need of more databases, both local and at the Mediterranean scale, that can be used for this purpose. Also, there is a need to make these databases comparable, if possible. The problem is that it is very difficult to aim for a common database, due to different policies in different countries and regions. Furthermore, these data policies may change with time. Furthermore, there is a quality problem with some datasets, mainly in the southern Mediterranean. One of the objectives of the ST could be to help these countries improve the quality of their datasets, by means of data control and homogenization techniques[1]. A common approach is necessary[2].

Another necessary field of work is the study of the relationship between drought indices and impacts. For instance, SPI and SPEI correlate well with many human relevant processes, such as cereal productivity but the physics they represent is not well understood. As the discussion on the processes showed these indices have methodological issues. Links can be found with hydrology, energy production, socioeconomic impacts, etc. In this regard, the collaboration with SICMED can be fruitful, as they have a focus on the role of humans in the agrosystems and they have very strong relationships with stakeholders.

Knowing the relationship between impacts and indices is very useful for drought prediction, as once the relationships are known and established, they can be leveraged, for example, for seasonal forecasting. However, this must be done hand in hand with physical studies. It is very important to understand the physical processes and causalities underlying the statistical relationships between indices and impacts. It is also important to maintain a multiscale approach, not forgetting the long term and the large scale. It is necessary to study how to bridge the gap between proxies and observed data and to use this knowledge in order to obtain a long term perspective. In fact, proxies also can help us to link with the impacts.

The discussion also demonstrated the difficulty in defining drought, which is a multifaceted and complex concept. It is not possible to have a single definition of drought, thus it is necessary to work with different definitions, which must be related to the context. On one

[1] José A. Guijarro (AEMET, Spain) could not attend the workshop, but he is an expert on data quality and homogenization and he is willing to help in such effort.

[2] Two weeks later, during the EGU General Assembly we learned that EURO Friend Water is facing similar problems and, thus, some coordination could be established. In their case, they are analyzing river flow drought. As it is often not possible to share the data, they share a common R library, in order to process the data locally and share the results.

side there are the physical definitions of drought, such as SPI, anomalies in the Soil Wetness Index, etc. On the other hand, there are the impacts, which are local and related to decision procedures. It is important to be able to use both physical and more general definitions and to be able to link them with more local and specific impact indices. An added difficulty is that the relevant time scales are also very dependant on the context of the specific impact that is being studied.

Drought Prediction

We should work on drought prediction at several spatial and temporal scales, from local to Mediterranean spatial scales and from seasonal to climate scales. The scale issue is a very interesting problem. For example, is the scale of drought the same as the scale of seasonal forecasts? Is it larger? More studies are needed in order to correctly understand the scales of variability of drought and our capacity to predict them.

Seasonal forecasting is difficult at our latitudes, but recent studies show that progress is possible in the Mediterranean. Furthermore, the return of investment can be very high in socioeconomic terms. We can draw from the experience already gathered in the USA, where seasonal forecasting is often used for decision making, for instance in areas where snow is an important factor. A first step could be to show the feasibility of our methodologies, in order to generate interest from decision makers. It is also very important to be honest and to correctly explain where the value is in the forecasts and where the uncertainties are too high. Maps of predictability of different parameters are needed. Also, it is important to think in terms of economic value.

However, in order for these seasonal forecast to be useful, it is important to understand the needs of the users, which may be very different from sector to sector. Thus, there must be a strong link between the seasonal forecasters and the impacts. Top-down strategies are not enough in this context. Generic projections should not be our main aim, it is more important to think about which are the more relevant indicators for each application. The projections should come after the definition of the drought indicators and the understanding of the drought mechanisms, relevant to the applications in mind. Thus, it is important to have iterative discussions with stakeholders. Combining bottom-up and top-down approaches is necessary and this must be done taking into account the needs and uncertainties of each sector.

Finally, the role of the scientist is to put the manager in the situation to take a decision, since decisions cannot not be made by scientists, thus it is important to show to the relevant actors what can be done, so they can adapt their strategies to the existence of seasonal forecasts and climate scenarios. However, this is not easy as often the decision making is very slow and has to integrate a much wider range of constraints. For example, water management rules are severely affected by the slow process of policy and decision making. Thus, these rules are often tuned to the current climate and do not take into account that climate will change, nor take into account that, sometimes, seasonal forecast could inform the decision process.

Data availability is also a problem. Seasonal forecasting data is not always open and accessible and, thus, a lot of work is being done behind closed doors. Fortunately, Copernicus will give access to these data that are now closed.

Drought Processes and Water Resources

Probably, real evapotranspiration is the most elusive process relevant to drought and water resources. Many studies work with potential evapotranspiration but for which many different definitions exist. Real evapotranspiration over larger areas can only be calculated by physical models because it is difficult to observe it and is thus affected by the uncertainties of models. These estimations should be validated by means of the measurements obtained in experimental catchments and/or eddy covariance towers. In fact, the Mediterranean is one of the places in the world where atmospheric demand (potential evaporation) and the real evapotranspiration are most decoupled, thus we should aim to improve the simulation of the processes related to evapotranspiration. In this regard, vegetation related processes are crucial. For example, current LSM do not correctly represent vegetation processes in semi-arid areas, which are very common in the Mediterranean. Furthermore soil moisture stress on plants has been identified for some time as a major knowledge gap and modelling uncertainty.

Not only is there a need to improve the representation of the role of vegetation in our models, it is also very important to improve our vegetation maps, as they do not correctly represent, if they represent it at all, land use and land cover change (LULCC). Land cover maps covering different periods would be very useful for LSM. Also, soil maps are not trustworthy enough. However, remote sensing offers us new opportunities and Copernicus will represent a dramatic change. We are living a silent resolution now, with many new datasets that will appear in the coming years.

Humans are also fully part of the system. Thus, even though our strength lies mostly in the study of the physical component of the system, we should aim at integrating socioeconomic science in our work. This could be achieved, in part, by linking with other research programs, such as SICMED. However we need to learn how to work and collaborate with socio-economists and end-users, which requires different methodologies and procedures. The usual workshops, as we organize them, do not work in this context. There is a very large gap in vocabulary and methods, between these communities.

Our Science Team should be an integrator between communities (climate, hydrology, socio-economic sciences and end-users), without losing sight of where our strengths lie. HyMeX is a coupled program that aims at studying the Mediterranean water cycle as a whole and which has a strong interest in the impacts of the related extremes.

Global Discussion on Future Orientations and Actions

In this workshop we have seen a wide range of studies, from global to local, from physical problems to impacts. Different methodologies have also been exposed: models, remote sensing, etc. The challenge, and the opportunity, is to put these things together in order to obtain impactful results.

It is important to be practical and, thus, to try to coalesce around areas where existing work is in progress. This will allow us to develop and test our methodology. Later, we will be able to expand knowing and being able to demonstrate that our methodology is sound.

Concerning the scales involved, we should follow a nested approach, being the Mediterranean the first level. The second level, at this moment, is a box that would include France, Spain and Morocco. This is a North-South transect of three countries that represent a climatological and a socio-economic gradient and where we already have the tools and the contacts to work effectively from day one. Of course, in the future, there should be more transects like this one in other areas of the Mediterranean. A third level would be the national one (Croatia, France, Israel, Italy, Morocco, Spain, etc.; more contacts on the eastern side are necessary). Finally, we have specific basins and regions in these countries where data is available and work is already in progress. In Spain, the Ebro basin is a good example. In Morocco there is on-going work on the Tensift and the Oum Er Rbia basins. With such a nested approach it will be possible to bridge with climatologists and oceanographers on one side (large scale) and with impacts at the other side (regional and local scales).

It is necessary to develop a strategy that allows us to make significant progress on drought, water resources and impacts. There are several opportunities such as the new Earth Observation datasets being produced or improved models. Another avenue for new relevant science is the inclusion of the humans as part of the system, at all scales, from the Mediterranean scale to the impacts scale: land-use and land-cover changes, irrigation, dams, etc. This opportunity has been framed in a recent paper by Van Loon et al. (2016)[3] who state that:

> *Drought management is inefficient because feedbacks between drought and people are not fully understood. In this human-influenced era, we need to rethink the concept of drought to include the human role in mitigating and enhancing drought.*

Our science team presents a good opportunity to answer such questions in the Mediterranean context, linking humans to physical system and, also, to the socio-economic one. This has also been identified as a priority area by GEWEX for the study of the continental water cycle and will be the topic of a specific workshop to be held in September 2016.

[3] Van Loon, A. F., Gleeson, T., Clark, J., Van Dijk, A. I. J. M., Stahl, K., Hannaford, J., … Van Lanen, H. A. J. (2016). Drought in the Anthropocene. *Nature Geoscience*, *9*(2), 89–91. http://doi.org/10.1038/ngeo2646

Finally, our science team has very strong capabilities for studying the physical perspective on drought and water resources. Concerning the impacts part, we are acquiring knowledge and capacity and also contacts with other programs such as SICMED. Our ST can manage the interaction between HyMeX and SICMED. HyMeX can provide SICMED with climate data and forcings, large scales models and scenarios, seasonal forecasting, etc. SICMED can help guide HyMeX in tailoring such results towards the needs, for instance, of agriculture and help in the development of bottom-up strategies.

eartH2Observe Mediterranean case study meeting

During the workshop, a special FP7 eartH2Observe meeting was organized. The aim of this meeting was to discuss research collaboration between the WP6 Spanish and Moroccan case studies, and enhance the links with HyMeX.

So far, all the work of these two Mediterranean case studies has been done in isolation. But, at the start of the eartH2Observe project the idea was to have a joint workshop in which collaboration between the two countries could be discussed and initiated. The HyMeX meeting has been used for this purpose.

During a fruitful discussion of about two hours it was agreed to work jointly on two topics:

1. Model comparisons for the Oum Er Rbia and the Ebro rivers. In this study the intention is to test how good a specific hydrological model used in one case study river basin works in the other case study river basin. Also a comparison with the WRR Tier 1 data of river flows will be made to evaluate how good the global models simulate discharge in the Oum Er Rbia and Ebro rivers. The activity is coordinated by Pere Quintana Segui (Spanish case study) and Stefan Strohmeier (Moroccan case study).
2. Evaluation of different drought indices for water management decisions in the Oum Er Rbia and Ebro river basins. The aim of this study is to evaluate a number of drought indices, calculated from the 30 year water resources re-analysis Tier 1 ensemble or the local river basin models. It will be tested how different drought indices, or a combination of indices, can be used for reservoir management decisions. This work is coordinated by Micha Werner (Spanish case study) and Mohammed Karrou (Moroccan case study). This work is closely related to the PhD study of Clara Lines Diaz who works on both the Spanish and Moroccan case studies.

The intention of both studies is to produce a scientific article with authors from both case studies.

Conclusions and perspectives

The workshop was a success, in terms of participation, scientific quality and, also, in terms of the quality of the discussions, which show that there is enough energy in our community in

order to sustain it in time and to deliver sound and innovative scientific results. The workshop has been very useful in strengthening the community and in developing a common view on the state-of-the art, the areas where scientific progress is needed, the opportunities that are arising, the capacity already in place, and the future orientations.

However, in order for the ST be successful, it is necessary to sustain the momentum, define realistic short and mid term objectives and work towards the obtention of specific results that show that this ST's methodologies are sound, able to generate scientific progress and able to obtain funds for the ST's research.

The ST faces some challenges, including the development of creative methodologies, that allow us to successfully link top-down and bottom-up approaches, improve our knowledge of the real system, including role of the humans, and also the production of impact related results well tailored to different kinds of stakeholders. Another challenge is to expand the ST to the Eastern Mediterranean, as only very few of the scientists in the area participate in HyMex.

Concerning the relationship with other initiatives and programs, it is important to actively collaborate with initiatives, such as the GHP and GLASS panels of GEWEX, SICMED, MEDFRIEND and EURO-FRIEND WATER.

Appendix

Workshop program

The workshop program can be downloaded from the following URL: http://www.hymex.org/public/contents/drought-wr-workshop/Program.pdf

Attendees

Name	Surname	Affiliation	Country	e-mail
Sandrine	**Anquetin**	LTHE-CNRS	France	sandrine.anquetin@ujf-grenoble.fr
Anaïs	**Barella-Ortiz**	UCLM & OE (URL-CSIC)	Spain	Anais.Barella@uclm.es
Santiago	**Beguería**	EEAD-CSIC	Spain	santiago.begueria@csic.es
Aaron	**Boone**	CNRM Météo-France	France	aaron.a.boone@gmail.com
Jean-Christophe	**Calvet**	Meteo-France / CNRM	France	jean-christophe.calvet@meteo.fr
Ksenija	**Cindric Kalin**	Meteorological and Hydrological Service	Croatia	cindric@cirus.dhz.hr
Jordi	**Corbera**	Institut Cartogràfic i Geològic de Catalunya	Spain	jordi.corbera@icgc.cat
Roberto	**Coscarelli**	CNR-IRPI	Italy	coscarelli@irpi.cnr.it
Patrice	**Dumas**	CIRED/CIRAD	France	dumas@centre-cired.fr
Christophe	**Duroure**	CNRS LaMP OPGC UBP	France	c.duroure@opgc.univ-bpclermont.fr
Ebtesam	**Farid**	Space Weather Monitoring Center	Egypt	Ebtesam_Farid@science.helwan.edu.eg
Miguel Angel	**Gaertner**	Universidad de Castilla-La Mancha (Toledo)	Spain	Miguel.Gaertner@uclm.es
Rogelio	**Galván Plaza**	Confederación Hidrográfica del Ebro	Spain	rgalvan@chebro.es
Ricardo	**Garcia-Herrera**	UCM / Instituto de Geociencias (CISC-UCM)	Spain	rgarciah@ucm.es
Sébastien	**Garrigues**	INRA	France	sebastien.garrigues@paca.inra.fr

Luis	**Garrote**	Technical University of Madrid	Spain	l.garrote@upm.es
Lucía	**GESTAL-SOUTO**	AEMET - Agencia Estatal de Meteorología	Spain	lgestals@aemet.es
Célia	**Gouveia**	Instituto Dom Luiz (IDL) U. de Lisboa	Portugal	cmgouveia@fc.ul.pt
Lahoucine	**Hanich**	University Cadi Ayyad of Marrakech	Morocco	l.hanich@uca.ma
Taoufik	**Hermassi**	INRGREF	Tunisia	taoufikhermassi@yahoo.com
Lionel	**Jarlan**	IRD/CESBIO	France	lionel.jarlan@ird.fr
Mohammed	**Karrou**	ICARDA	Morocco	m.karrou@cgiar.org
Mohammed-Said	**Karrouk**	Université Hassan II	Morocco	ClimDev.Morocco@gmail.com
Makki	**Khorchani**	IPE-CSIC	Spain	
Clara	**Lines Diaz**	UNESCO-IHE	Netherlands	c.lines@unesco-ihe.org
Maria Carmen	**Llasat**	University of Barcelona	Spain	carmell@am.ub.es
Patricia	**López**	Deltares	Netherlands	Patricia.Lopez@deltares.nl
Raül	**Marcos**	University of Barcelona	Spain	rmarcos@am.ub.es
Paolo	**Martano**	CNR ISAC	Italy	P.MARTANO@ISAC.CNR.IT
Natalia	**Martin**	IPE-CSIC	Spain	nmartin@ipe.csic.es
Stefano	**Materia**	CMCC	Italy	stefano.materia@cmcc.it
Gonzalo	**Miguez-Macho**	Universidade de Santiago de Compostela	Spain	gonzalo.miguez@usc.es
Marina	**Peña-Gallardo**	IPE-CSIC	Spain	marinapgallardo@ipe.csic.es
Mário	**Pereira**	CITAB/UTAD	Portugal	gpereira@utad.pt
Maria	**Piles**	ICM-CSIC	Spain	mpiles@icm.csic.es
Luca	**Pipia**	Institut Cartogràfic i Geològic de Catalunya	Spain	luca.pipia@icgc.cat
Jan	**Polcher**	LMD/IPSL/CNRS	France	jan.polcher@lmd.jussieu.fr
Pere	**Quintana Seguí**	Observatori de l'Ebre (URL-CSIC)	Spain	pquintana@obsebre.es
Florian	**Raymond**	University of Burgundy	France	florian.raymond@u-bourgogne.fr
Jose Manuel	**Redondo Apraiz**	UPC Barcelona Tech.	Spain	redondo@fa.upc.edu
Denis	**Ruelland**	CNRS HydroSciences Montpellier	France	denis.ruelland@um2.fr
Enrique	**Sanchez**	UCLM	Spain	e.sanchez@uclm.es
Juan Carlos	**Sánchez Perrino**	AEMET	Spain	jsanchezp@aemet.es
Marc	**Stefanon**	LSCE / IPSL	France	marc.stefanon@lsce.ipsl.fr

Geert	**Sterk**	Utrecht University	Netherlands	g.sterk@uu.nl
Stefan	**Strohmeier**	ICARDA	Jordan	s.strohmeier@cgiar.org
Daniel	**Sultana**	University of Malta	Malta	daniel.sultana@um.edu.mt
Yves	**Tramblay**	IRD -HSM	France	yves.tramblay@ird.fr
Sergio M.	**Vicente-Serrano**	Spanish National Research Council	Spain	svicen@ipe.csic.es
Jean-Philippe	**Vidal**	Irstea	France	jean-philippe.vidal@irstea.fr
Micha	**Werner**	UNESCO-IHE	Netherlands	m.werner@unesco-ihe.org

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