## Project Topic A

Project Topic B

INDECIS- Integrated Approach for the Development across Europe of user oriented climate indicators for GFCS highpriority sectors: agriculture, disaster risk reduction, energy, health, water and tourism

ERA4CS Joint call 2016

A I	IDENTIFICATION	.2
B F	PROGRESS REPORT	.3
B.1	1 Objectives of the project	3
B.2	2 Work performed and results achieved in the period concerned	4
С І	IMPACT SINCE BEGINNING	.6
C.1	1 Indicators	6
C.2	2 Other valorisation activities	14
DF	FINANCIAL STATUS	23
E A	APPENDICES (IF NECESSARY)	24

This document is to be filled out by the coordinator in collaboration with the project partners. It must be sent by the coordinator within the deadlines specified in the acts of award to the ERA4CS

Unless otherwise indicated, it reports on the activity of all the project partners.

## **A IDENTIFICATION**

Project acronym	INDECIS
Project title	Integrated Approach for the development across
	Europe of user oriented climate indicators for GFCS
	high-priority sectors: agriculture, disaster risk reduction,
	energy, health, water and tourism
Project start date	15/09/2017
Project end date	30/06/2021
Period covered by the report	15/03/2019 – 30/06/2021
Project website if applicable	http://www.indecis.eu
Date of submission of the report	30/06/2021
Version	1

## **B PROGRESS REPORT**

### **B.1 OBJECTIVES OF THE PROJECT**

INDECIS, "Integrated Approach for the Development across Europe of user oriented climate indicators for GFCS high-priority sectors: agriculture, disaster risk reduction, energy, health, water and tourism" constitutes a pan-European effort focused on the development and production of climate indices, specifically targeting the priority sectors of the GFCS plus tourism and their conversion into climate services by engaging stakeholders in their definition and communication. The main objective of the project is to develop historical high quality and dense climate networks across Europe based on long-perspective time series of different stations-based meteorological variables from which accurate and robust climate indices can be calculated to create user-oriented climate products and services.

In pursuing this main aim INDECIS secondary objectives are:

- Improve the spatial and temporal availability of climate data, especially at the daily scale and in connection with the European Climate Assessment and Dataset (ECA&D)
- Create a quality controlled and homogenized version of the improved ECA&D dataset.
- Define and compute a set of sectorial-relevant climate indices and compare them to sectorial information.
- Study the temporal evolution of those indices and their relation to atmospheric circulation patterns.
- Compare station-based and gridded based sets of indices.
- Engage user, define and communicate climate products and services based on the indices previously defined.

#### **B.2 WORK PERFORMED AND RESULTS ACHIEVED IN THE PERIOD CONCERNED**

INDECIS' results through the second half of the project are detailed below, organized by Work Package and Deliverable. Appendix 1 shows a summary and identifies contributors.

#### Work Package 2. Identification and Catalogue of Climate Data Sets and Portal

Coordinadte by KNMI, D2.3, INDECIS Raw-Data Set and IDISP Portal, is a part of INDECIS web portal (INDECIS Data Portal) where all data sets rescued and built can be found. D2.4 is the first update of INDECIS Raw Data-set and IDISP portal

### Work Package 3. Data Quality and Homogeneity.

D3.3. Coordinated by AEMET-Illes Balears has released the INDECIS Homogeneization suite. Deliverable is split into three documents: D3.3A report summarizes the procedures followed to homogenize the ECA&D daily series needed for the INDECIS; D3.3B is the user manual of the software suite; finally, D3.3C is the link to download the software suite. D3.4 describes the new software for Quality Control INQC and its application conditions and results. D3.5 led by URV is a report on the uncertainty of the homogenization process with the aim to remove the detected inhomogeneities and approximate data to the real climate signal.

## Work Package 4. Indices Catalogue, Definition and Implementation.

D4.3's 20% missing indices has been calculated and published on webportal (http://www.indecis.eu/indices.php). D4.4, led by ARAID Foundation and CSIC-IPE, describes the latest analysis of the climate indices calculated in the frame of INDECIS European project. Also, ECTACI (European Climatology and Trend Atlas of Climate Indices) has been published in the frame of D4.4 (https://ectaci.csic.es/). D4.5 compares INDECIS indices with sectorial data (e.g.: streamflow in Spain, water, geo-hydrological and wildfire sectors in Calabria, groundwater in France).

## Work Package 5. Indices Time Evolution and relations with the atmosphere.

D5.2 and D5.3 are complete. D5.2, led by University of Reading (Uread) analyses the INDECIS-ISD climatology, temporal evolution, and assess their Time of Emergence (ToE) D5.3, also led by UREAD, reports the relation between INDECIS-QCHDS and INDECIS-ISD and atmospheric patterns from data developed in WP2 and WP3 and indices developed in WP4 to quantify the variability and change over the time with focus on agriculture-related metrics.

#### Work Package 6. Evaluation of gridded datasets, reanalyses and model output.

D6.2, D6.3 and D6.4, coordinated by MeteoRo, has been developed in the second half of the project. D.6.2 reports dataset intercomparisons with regard to selected ECV's and INDECIS-ISD. D6.2 has five annexes with diverse intercomparisons (Eg: ERA5 and MERRA compared with in-situ wind data). D6.3 reports the reliability and uncertainties associated with seasonal forecasts of selected indices (Eg: seasonal forecast for the wine sector). D6.5 reports the assessment of sectorial climate change impact based on INDECIS-ISD in climate change scenarios (Eg: representative of extremes for precipitation and temperature).

#### Work Package 7. Generation and Communication of Climate Services.

D7.2 was in process in the mid-term report. Already finalized, it summarizes the different workshops held with local tourism agents. In addition, it defines the methodological process for the development of co-created climate services. D7.3, coordinated by AEMET, contains the description of the software developed in the project and its integration into IDSIP. INDECIS has created or supports different software suites for climate data quality control and homogenisation, indices calculation, datasets inter-comparison and climate indices visualization. Deliverable D7.4 describes a set of basic semi-automated Climate Services and the protocol for requesting advanced climate services in the future. D7.4 has

two annexes: A) Demand for climate services in the French agricultural sector and B) R-Code for calculate INDECIS Sun and Beach Index.

#### Difficulties encountered and solutions

- Maximum 10 to 20 lines. Any difficulties encountered and the solutions envisaged.
  - In case of delay, please write four lines for justifying the delay and estimate risks for the project.
  - If you have encountered difficulties or made changes, please write four lines of explanation

INDECIS has had the most normal development possible at the time of the pandemic suffered in part of its second half. Issues related to the pandemic have been resolved through online meetings, teleworking and other general solutions. The pandemic has caused delays in the submission of some deliverables; which have been solved without further problem. Also, the pandemic has forced to adjourn events (as workshops with tourism stakeholders).

Table 1. Issues encountered and solutions adopted to ensure the completion of INDECIS' objetives (as 30/06/2021)

Problem	Solution
Pandemia	Meetings held on line. Schedules revised,
	which has not been too harmful thanks to the
	project extensions.

Source: INDECIS Consortium.

## **C** IMPACT SINCE BEGINNING

These section groups elements accrued since the beginning of the project, which will be monitored as its proceeds and taken up in the final project review.

### C.1 INDICATORS

#### - Work force statistics

Work force statistics provided by INDECIS Consortium are summarised in Table 2, as percentages of person/month for each partner by work package and totals during the second half of the project and regular and covid-extension (16/03/2019 – 30/06/2021). In general terms, the efforts dedicated by each partner for each work package is well related with the work force committed in the Consortium Agreement.. Partners with most of workforce committed in WP5, WP6 and WP7 present higher loads as the other partners, who focused their works on the first half of the project.

In general terms, INDECIS has managing well the efforts dedicated to the project and will make the necessary arrangements, to finalize all the tasks.

Partner	WP 1	WP 2	WP 3	WP 4	WP 5	WP 6	WP 7	TOTAL (2n)
URV	53	29	74	6	-	-	69	51
UREAD	-	25	-	-	75	-	-	78
FMI				113		83	49	82
BRGMI	-	-	-	2	-	22	4	132
CNR	-	32	64	19	114	-	170	51
UCH-IHC	-	-	-	9	75	68	-	59
SMHI	-	54	200	-	-	-	-	58
Met Éireann	-	12	22	-	-	87	-	41
AEMET	-	73	25	50	-	-	78	63
BSC	-	-	2	7	22	46	-	50
Fciencias.ID	-	-	38	-	81		113	76
CVGZ-GCRI	-	-	25	58	-	80	-	50
KNMI	-	50	80	-	-	-	-	65
RMI	-	-	-	-	67	-	-	67
METEORO	-	0	-	0	0	75	0	50
CSIC	-	2	-	55	-	-	8	58

 Table 2.- Work Force Statistics expressed in percentage of expected persons/months for second part of the project. (as 30/06/2021)

#### Source: INDECIS Consortium

Table 3 summarizes the work force expected in Consortium Agreement (CA) and the reported work by the partners. Due to the two extensions of the project, reported person/months are higher in some partners. Six partners reported more total efforts than expected in CA. In general terms, more efforts than planned at the beginning of the project have been dedicated.

Partner	Expected in CA (PM)	Reported (PM)	TOTAL (%)
URV	252	268	106
UREAD	53	58	109
FMI	102	102.8	100.8
BRGMI	26	37	142
CNR	78	89	114
UCH-IHC	148	149.4	101
SMHI	7	11	158
Met Éireann	12	11.5	96
AEMET	90	90	100
BSC	154	154	100
Fciencias.ID	40	46	115
CVGZ-GCRI	54	54	100
KNMI	12	12	100
RMI	10	10	100
METEORO	23	23	100
CSIC	115	115	100
Total	1176	1230.7	104

 Table 3.- Work Force Statistics expressed in percentage of expected persons/months for all project (as 30/06/2021)

Source: INDECIS Consortium

#### - Gender Aspects

Indecis takes in consideration gender balance. Two Work Package Leaders and members of the Executive Board (WP6 and WP7) are female as well as two members of the External Experts Advisory Board. Until April 2020 one female and one male did project management. In-cash contracts attached to INDECIS have followed a strict equal-opportunity policy. Table 4 provides a detailed information about gender aspects in contracts attached directly to INDECIS for each partner. In total 42 researchers have been contracted directly by INDECIS, which 57.4% are male and 42.6 female.

INDECIS activities, such as stakeholders/users' workshops, demand the participation in the discussions of a gender balanced group.

Partner	Male	Female
URV	3	1
UREAD	1	0
FMI	0	0
BRGMI	1	0
CNR	1	0
UCH-IHC	0	0
SMHI	4	1
Met Éireann	0	2
AEMET	2	3
BSC	5	3
Fciencias.ID	2	1
CVGZ-GCRI	0	0
KNMI	1	0
RMI	1	0
METEORO	3	5
CSIC	1	1
Total	24	18

Table 4. Gender Balance in INDECIS' In-Cash contracts (as of 30/06/2021)

Source: INDECIS Consortium

#### - Engaging with Civil society and policy makers

INDECIS is a "from data to service" project. Its ultimate goal is to provide service and, thus, produce a positive impact over society. Although the first half of the project is intensive on the data management part (WPs 2, 3, 4) societal engagement is considered since early stages. This includes the nomination of an External Experts Advisory Board (EEAB), integrated by six members from different fields of expertise and geographical origins. Their role includes to assist INDECIS in reaching out and engaging with society. The list of the EEAB members are:

• Phillip D. Jones; Chair of the EEAB and retired Director of Climatic Research Unit (CRU), UEA, UK.

- Carlo Buontempo; Manager of the Sectorial Information System of Copernicus Climate Change Service at ECMWF, UK.
- Jose Luis Camacho; Scientific Officer/Agricultural Meteorology at World Meteorological Organization (WMO).
- Tanja Cegnar; Meteorological and Hydrological Office, Slovenian Environmental Agency, Slovenia.
- Florence Habbets; Director of Hydrology Research at French National Centre for Scientific Research (CNRS), France.
- Salvador Samitier; Director of Climate Change Office in Catalonia, Spain.

INDECIS engagement with civil society splits into three different axis

1. **Digital Image:** INDECIS' digital image is built using a traditional website and the social media and traditional media. Figure 1 shows INDECIS' website (<u>www.indecis.eu</u>). Web portal provides access to the project description and objectives, consortium, deliverables, products and services, host the access to data and services, and summarizes project's contributions at scientific level (conferences and papers) and society level (news on media).

The digital presence completes with accounts in Facebook (<u>https://www.facebook.com/Indecisproject/</u>), with 106 followers, and Twitter (@Indecisproject), with 241 followers, which disseminates INDECIS' news and achievements.



Figure 1. Front page of INDECIS' website. Source: INDECIS Project (<u>www.indecis.eu</u>)

Figure 2 shows the visitors to the INDECIS' website and its contents. Statistics for web site were provided in March of 2019, just when mid-term report was finalised. Since then, statistics of the web page are increasing achieving more than 7.000 pages visited on 2020. Most contents visited are the work done by the work packages, indices web page and data and software sites. Visitors are basically from European countries (EU and Non-EU states), but, also, web page has visitors from around the world. Clearly, visitors from Africa spend more time and perform more actions during their visits to the website.



Figure 2. Main statistics of the INDECIS' web site. Source: INDECIS' web site.

Also, INDECIS' researchers have appear in local and national traditional media for disseminate the results (see list of appears in: <u>www.indecis.eu/news.php</u>)

2. Face to face contact: the project dedicated through its second half efforts to engage with different agents with potential interest in INDECIS' products, services and results. These contacts helped to define some INDECIS' products (e.g.: tourism co-constructed indices developed in the frame of WP7 and it's co-creation methodology). Unfortunately, pandemic started in March 2020 stopped the majority of face to face contacts. Table 5 includes face to face actions and contacts developed in the second half of the project.

## Table 5.- INDECIS face to face actions in the second half of the project (as 30/06/2021)

		Organizations (Individual		
Action	Sector	Atendees)	Contacted Stakeholders	Achieved/Expected Imapcts
Workshop: Jaca (Spain). Organized by C3/URV. 25th April 2019	Tourism (Snow, Winter, and Mountain	11 (26)	-Observatorio Pirenaico de Cambio Climático. -Counties (Jacetania, Sobrarb) -Aragon Governement-Tourism Departament -Tourism Bussines Association and Private Corporations: - INTURPYR Project: Tourism innovation for a unique destination in the heart of the Pyrenees -Tourism Offices (Hecho, Jaca) of Hecho	The workshops allowed to understand especially which are adverse and favourable climate conditions for key products in exemplary destinations of the Mediterranean arc, one of the areas of highest tourist intensity or in other words economic dependency on the tourist sector. It is well known that climate change will affect this region's tourist future considerably, however in this research task we
Workshop: Calvià, Balearic Islands (Spain). Organized by C3/URV. 9th May 2019	Tourism (Sun and Beach, Outdoor)	10 (24)	<ul> <li>Municipalities (Calvià, Alcudia) <ul> <li>Baelaric Islands Governement</li> <li>departments (Tourism, Energy, Climate Change)</li> </ul> </li> <li>The Meteorological Agency State of Balearic Islands (AEMET – Mallorca) <ul> <li>Interdisciplinary Laboratory on</li> </ul> </li> <li>Climate Change (LINCC /University of Balearic Islands)</li> </ul> <li>Mallorca Preservation Fund (MAPF) <ul> <li>Ecologist Association "Amics de la Terra de Mallorca"</li> <li>Hotels &amp; Clubs-Resort (i.e. Meliá Claviá Beach)</li> <li>FEHM: Hotels Federation of Mallorca</li> </ul> </li>	wanted to bring more specific situations and the diversity of responses at the very local scale. We also looked at the ways and channels through which climate sensibility is 'transferred' from the ultimate customers to decision making at business and destination scale, and at the range of adaptive actions which could inform adaptation strategies. we have seen cases where excess specialisation in one product or 'season' would require a strong commitment to transition to more resilient models. These efforts though should be sustained by all stakeholders and use long-term investments and planning efforts by governments at multiple scales. Neither adaptation strategies not eventually mitigation
Workshop: Sila National Park (Calabria, Italy). Organizaed by CNR-IRPI. 30th May 2019	Tourism (Snow, Mountain and Water)	10 (36)	<ul> <li>Tourism departments of Cosenza Province and Calabria Region</li> <li>Sila National Park Authority</li> <li>Municipality of Spezzano della Sila</li> <li>Hotels &amp; Restaurants (i.e. Park Hotel 108, Hotel Biafora)</li> <li>Outdoor activties (i.e. Adventure Parks, Il Chiosco Rosso-Bike Point, Centro Sportivo Lorica)</li> <li>Nature tourism guides (i.e. Fondo Ambientale Italiano)</li> </ul>	policies should be left to chance or to the initiative of power-scarce individual operators, but big decisions require good, reliable, personalised information; our project, if anything, has brought up the urgency of this need. In this line, the co- construction of climate information with stakeholders becomes an important step to flesh out Climate Services which are useful and valuable. Workshops allow researchers to calculate tourism co-constructed indices with
Workshop: Barcelona (City and Coastal Area). Organizaed by C3/URV. 27th June 2019	Tourism (Beach, Urban and MICE)	16 (25)	<ul> <li>Generalitat de Catalunya: Tourism Department</li> <li>Generalitat de Catalunya (Tourism)</li> <li>Catalan Office of Climate Change</li> <li>Universities (Barcelona, Girona, Tarragona)</li> <li>Municipality of Barcelona: (Various departments</li> <li>Coastal Municipalities (Calella, Sitges)</li> <li>Tourism Agencies (Maresme)</li> <li>-Private Sector (e.g: Wineries, Consultancy)</li> </ul>	local agents (for snow tourism, beach tourism index), other are planned (eg:climbing index) and, also, co-construction methodology with local agents based in consensual mental maps built in focus groups was developed. Also, various contibutions to conferences are done (eg: INDECIS Snow Tourim Index at EGU 2020 https://meetingorganizer.copernicus.org/EGU20 20/EGU2020-8926.html?pdf ) and different papers are expected.

Workshop: FINAL INDECIS Workshop (Scheduled for April 2020, and June 2020 in Vila-Seca (Spain). Adjourned by COVID	Tourism		- All de participants in previous workshops had been invited	The aim proposed for the final workshop was define the economic value of the developed indices on the frame of INDECIS Project
Individual interviews with key informants and survey with climate change focal points in Chambers of Agriculture	Agriculture	13 (14)	Chambre d'agriculture du Gard Chambre d'agriculture des Bouches du Rhône Chambre d'agriculture du Loir et Cher Chambre d'agriculture de Haute Saône Chambre d'agriculture de Haute Marne Chambre Régionale d'Agriculture d'Occitanie Assemblée permanente des Chambres d'agriculture Chambre Régional d'Agriculture d'Auvergne Rhône Alpes Chambre d'agriculture de Dordogne Arvalis Institut du végétal Institut National de Recherche pour l'agriculture, l'alimentation et l'environnement Bz Collecte (grain collector) Soufflet (Grain collector)	<ul> <li>The interviews and the survey led to the identification of lessons for future climate services on Agriculture:</li> <li>Resolution of data should be reduced to be relevant for users.</li> <li>Instead of producing large number of indices, efforts should be put on strengthening the capacity of potential users to generate climate indices relevant for their sector/locality (indices calculator, simple training modules)</li> <li>Need to partner directly in the project with intermediate institutions to link with users and blend in expertise with climate services</li> <li>Large need for the integration of groundwater climate services for farmers, providing information on long-term climate change impact on underground water and seasonal forecasts (MetéEau Nappes project like)</li> </ul>

Source:	<b>INDECIS</b>	Consortium
---------	----------------	------------

3. **Service Delivery:** INDECIS provides society access to its products (indices, data, software, knowledge by publication) through INDECIS' Web Portal as reported in other sections of this same document.

#### - Training and capacity building

INDECIS' proposal does not specifically include training and capacity building activities, although they are implicit in the contacts with stakeholders and policy makers. In fact, the workshops conducted developed capacities to use climate services. Software Suites developed in the frame of the project (INDECIS QC Software [INQC]; QC Software for tall towers wind data [QCSS4TT]; MetQC; Software suite for Indices Calculations; Software suite of Atmospheric Circulation Indices Calculation; INDECIS software for intercomparison of reanalysis datasets [INTERDECIS]; fireDanger; and, INDECIS suite for Homogenization of ECA&D Daily Series) had a training session on 2<sup>nd</sup> General Assembly. Also, these specific actions are complemented by training-on-the job, which routinely transfers the skills and knowledge of the INDECIS' senior scientists to the in-cash personnel and practitioners. Finally, in the frame of URV's Bachelor Degree on Geography, Territorial Analysis and Sustainability, a course has been performed based on the co-creation of climate services with local agents on four activities (wine, fire, climbing and cycling). The INDECIS website and data were further exploited in MSc teaching through dissertation supervision at UREAD.

- Sharing of research infrastructure

INDECIS, in consonance with the integration philosophy of the ERA4CS projects, is keen to integrate research infrastructure from the partners and other European institutions and build upon previous results. In particular, INDECIS is benefiting from the research infrastructures used to produce:

- ECA&D and E-OBS data (KNMI and contributing partners) are both used by INDECIS. While ECA&D fulfills the role as the backbone of the Climate Data node of the WMO Regional Climate Centre for RA VI (Europe and the Middle East), INDECIS contributes to this dataset by providing additional data (both rescued and modern data) and enhances the quality of the data by applying an advanced Quality Control and homogenization to this dataset. INDECIS uses this dataset as the core dataset for indices computation. Furthermore, the E-OBS is funded by the Copernicus Climate Change Service and INDECIS contributes to this project by gathering series for daily global radiation data which are developed in a new E-OBS member. Similarly, the INDECIS funded QC'ed and homogenized station data in ECA&D are used to calculate future versions of the E-OBS (from v20.0e or v21.0e onward). These E-OBS data are made available to the C3S Copernicus Data Store. Likewise, the E-OBS is used by INDECIS for calculation of the INDECIS indices.

- ERA-5 Reanalysis (ECMWF) as input data for indices computation.

- UERRA Regional Reanalysis for Europe (Copernicus Climate Data Store) as dataset to be compared in WP6.

- Seasonal Predictions from C3S (Met Office, Météo-France, ECMWF, DWD and the Euro-Mediterranean Centre on Climate Change) to be used in WP6.

- INDECIS Indices Monitoring Tool (IPE/CSIC) designed specifically under INDECIS to visualize climate indices computed in WP4 and also used in WP7.

- In order to undertake the different tasks dealing with seasonal forecast data in the framework of INDECIS, UC and IHC will exploit the Santander Meteorology Group User Data Gateway (UDG) as the main entry point providing harmonized data access to state-of-the-art seasonal forecast datasets. Furthermore, data post-processing and analysis, including downscaling/bias correction and visualization will be done using the climate4R suite of tools, seamlessly integrated with the UDG infrastructure. This provides a comprehensive framework for end-to-end applications of seasonal predictions in the context of impact studies, including those involving sector-specific indices.

- Research knowledge and infrastructure (Science and Technology Park for Tourism and Leisure of Catalonia) shared with INDECIS to generate valuable innovation and knowledge related to tourism sector in WP7.

#### - Project's impact on society: participation in other arenas; elaboration of policy briefs

INDECIS is active publishing results and contributing to scientific knowledge in climate services. Logically, the second half of the project has seen more contributions than the first half marked in the mid-term report. In total, the project is acknowledged in 102 contributions (65 on second half period): 58 peer-reviewed publications (47on the second half period) and 44 contributions to international and national workshops and conferences (19 on the second period).

Some tourism agents of Catalonia (eg: Science and Technology Park for Tourism and Leisure of Catalonia [now, Eurecat Tourism Innovation Department] or Tourism department of Tarragona Province) showed they interest, as user, of INDECIS climate services and climate products. Also, COPATE (Ambiental Policies Consortium for Ebro Lands) has shown interest for develop tourism workshops and apply co-creation methodology for develop specific tourism (and other sectorial) indices for Ebro's Biosphere Reserve.

Regarding Calabria (southern Italy) some tourism agents of the Sila National Park territory, who participated at the 2019 INDECIS workshop, showed interest, as user, of INDECIS climate

services and climate products. Moreover, SORICAL (a semi-public Company that manages water resources in Calabria), that provided INDECIS data referred to spring discharges in Calabria, has shown interest in sharing Project results and products and to be available to provide and update further hydrological and management data of water resources. Also the Protection Civil Unity of the Regione Calabria had sent a letter of interest (attached at the Project) in sharing Project results and products.

INDECIS URV Team participates in European Scientific Night, held in Tarragona. INDECIS was represented by <u>LPI</u> and presented a summarized <u>poster</u>. Also, URV Team has applied for two local projects: first, to develop training materials for high schools and for administrations based on WP7's D7.2 co-creation methodology; and, second, to calculate the past-present-future impact of windpower also based on co-creation methodology with stakeholders and other research groups.

## **C.2 OTHER VALORISATION ACTIVITIES**

The valorisation factors are spin-offs other than publications. The following shall be detailed in particular: unexpected results

The work carried out in WP2 of the INDECIS project has made it possible to work on the European drought of 1921. Thus, the European drought of 1921 is evaluated in terms of its impacts on society and in terms of its physical characteristics. The development of the impacts of the drought is classified by a systematic study of newspaper reports from five European countries covering the area from England to the Czech Republic and other parts of Europe. This is coupled with a reconstruction of daily temperature and precipitation based on (rescued) meteorological measurements to quantify the severity and extent of the drought, and reanalysis data are used to identify its drivers. Part of the meteorological observations required for this study were sourced from the INDECIS rescued data and the study is done by using a team of authors from WP2 and WP5. This combines the various approaches within the project in one study. In this sense, This analysis shows that the first impacts of the drought began to appear in early spring and lasted well into the fall and winter, affecting water supply and agriculture and livestock.

The paper is open for discussion at: <u>https://cp.copernicus.org/preprints/cp-2021-41/</u>.

- national and international patents, licences, and other elements of intellectual property resulting from the project.

The generation of patents or licenses are not in accordance with the typology of this project. Thus, this kind of elements of intellectual property has not been contemplated in the INDECIS proposal.

#### - software and any other prototype

The development, management and analysis of large climate datasets require the use of specific software to make it possible. In mid-term document, we report five stand-alone software (INQC, IQCSS for Tall Tower Data, INDECIS MetQC, Software Suite for Indices Calculation, and INTERDECIS for comparisons of reanalysis datasets), now we can add five suites more (http://www.indecis.eu/software.php), described below:

- **INDECIS Software Suite of Atmospheric Circulation Indices Calculation** (<u>https://github.com/SantanderMetGroup/climate4R.indices</u>): Designed by Santander Metereology Group (UC-CSIC) is an open-source software, stand-alone and designed in R with capabilities to compute standard large-scale circulation indices. This package is integrated in the climate4R suite of climate analysis.

- **INDECIS Suite for Homogeneization of ECA&D Daily Series** (<u>http://indecis.eu/docs/Benchmarks/homogenECAD.tgz</u>): Designed by AEMET-Illes Balears compiles the functions used for the homogenization of the Daily ECA&D Series.
- fireDanger (<u>https://github.com/SantanderMetGroup/fireDanger</u>): Designed by Santander Meterology Group (UC-CSIC) is an R package for the calculation of fire danger indices, including INDECIS set of forest fire indices: Fire Weather Index, Finnish Forest Fire Danger Index, Keetch-Byram Drought Index, McArthur Forest Fire Danger Index, Modified Nesterov Index.
- Cut-netCDF (<u>http://indecis.eu/docs/Software/Cut\_netCDF.zip</u>). Designed by AEMET-Extremadura. The software consists of three R scripts that cut the netCDF files containing the climate indices defined in WP4, from all over Europe, and from the entire time period into smaller files for each of the European regions (NUTS) and for each of the indices, years and accumulations that are chosen. Thus, the resulting files are easier to manage and userfriendly due to their greater specificity and their smaller size. The package have been developed by AEMET team and can be found here.
- **INSBIN Calculator (INSBIN-C) R Code (**<u>http://indecis.eu/docs/Software</u>**).** Designed by C3/URV. This R package allows to download the data and calculate the INDECIS Sun and Beach Index (INSBIN) for specific coordinates. From the workshops held with local agents of sun and beach tourism, the variables and their values have been defined, allowing to calculate the index

- standardization actions

ECA&D and E-OBS, to which INDECIS is contributing strongly, are de-facto standard datasets to gain a high resolution observation-based pan-European view of climate variability and climate change. This adds to having a uniform source for climate information.

The Centre for Climate Change (C3/URV), as coordinating institution of the project, has joined the network of climate service provider in the Climate knowledge HUB (available at: https://www.climate-knowledge-hub.org/) and attempts to be involved in future standardization activities to transfer them to INDECIS.

- launching of product or service, new project, contract, etc.

Products derived from the INDECIS project are related to the creations of different datasets

#### Reported datasets mid-term report

In mid-term report were reported The INDECIS Core Climate Datasets, based on existing ECA&D dataset (http://www.ecad.eu/dailydata/index.php) which contains series for the Essential Climate Variables sourced directly from European National Meteorological Services from over 15.700 stations in Europe. Tall Towers Dataset (https://talltowers.bsc.es/) was reported as an unique archive containing meteorological observations from instrumented tall towers measuring winds at heights above 10 meters (311 potential sites were identified, and 222 were processed, [See Figure 3]). INDECIS Benchmark Datasets (http://www.indecis.eu/benchmarking.php), based on KNMI's Climate Regional Model, identifies the capabilities, strengths and weakness of the different quality control and homogenization approaches as well as the associated uncertainties. Last dataset the half reported at of the project was **INDECIS** Indices Datasets (http://www.indecis.eu/indices.php). This dataset is a set of sectorial relevant climate indices defined and inventoried to determine the response and sensitivity of the INDECIS targeting sectors to the climate tendencies. The set is composed by 136 climate indices computed applying the INDECIS Software Suite for Indices Calculation.



Figure 3. Distribution of Tall Towers and definition of processed towers on dataset Source: Obtained from Work Package 2 and provided by BSC

#### New datasets reported at the end of the project.

#### Recovered station data

Recovered station data are available due to work in the frame of the INDECIS project (<u>http://www.indecis.eu/datarescued.php</u>).

Rescued dataset for Balkans and Central Europe has around 610K meteorological stationbased observations for the main climate variables (maximum and minimum temperature, rainfall, sunshine duration and snow depth) along the 20th century at daily scale. Digitizing was carried out by using a strict "key as you see" method, meaning that the digitizers type the values provided by data images, rather than using any coding system. Digitizers carefully cross-checked the typed values against original sources for the 10th, 20th and 30th day of each month to make sure that no days were skipped or repeated during the digitizing process. Monthly totals and statistical summaries were computed from transcribed data and were compared with monthly totals and summaries provided by data sources to check accuracy as preliminary quality control. This dataset is considered as raw data since any consistent quality control and homogenisation test was not applied to identify potential errors and data biases.

In the frame of Work Package 2 of INDECIS datasets for other stations in other countries were also rescued. Figure 4 shows two examples of these rescued datasets: on the left for Phoenix Park in Dublin (data rescued from 1866 to 1959) and on the right for Carloforte in Sardinia (data rescued from 1901 to 1947). Other datasets were rescued: for polish stations before 1920. These datasets, (among others the release of UK's historical observations or Czech observations provided by GCRI) have allowed reconstruction of a preliminary E-OBS for 1920 and 1921 (see Figure 5).



Figure 4. Example of original datasets rescued by INDECIS project Source: INDECIS Consortium provided by Met Éireann and CNR-IRPI



Figure 5.- Reconstruction of TX on July 28, 1921 Source: INDECIS Consortium provided by WP2

## Quality controlled and Homogenized Station Datasets

INQC and Climatol Homogeneization software suites developed in the frame of INDECIS Project had allowed to apply Quality Control and Homogenization to ECA&D daily series. INQC has consolidate the Essential Climate Variables of ECA&D (http://www.indecis.eu/ecad\_data\_series.php): Daily Cloud Cover (CC), Daily mean wind speed (FG), Daily Humidity (HU), Daily Mean Sea Level Pressure (PP), Daily Precipitation Amount (RR), Daily Minimum Temperature (TN), Daily Sunshine Duration (SS), Daily Snow Depth (SD), Daily Mean Temperature (TG), and Daily Maximum Temperature (TX). Variables with quality control and homogenized by Climatol homogenization version are: Daily Cloud Cover (CC), Daily Mean Wind Speed (FG), Daily Humidity (HU), Daily Mean Sea Level Pressure (PP), Daily Amount of Precipitation (RR), Daily Sunshine Duration (SS), Daily Minimum Temperature (TN), and Daily Maximun Temperature (TX). Homogenized dataset based on ECA&D daily data are available in: http://www.indecis.eu/ecad\_data\_homog.php

## - development of a new partnership

The development of INDECIS Project is in consonance and requirement of new alliances and international work networks, such as the collaboration with Copernicus

(https://www.copernicus.eu/en), ECA&D (https://www.ecad.eu/), PANGAEA

(https://www.pangaea.de/) or PIRAGUA POCTEFA project (<u>https://www.opcc-ctp.org/en/piragua</u>). In addition, INDECIS organized different workshops focused on coastal and mountain destinations.

The workshops demonstrate that a participatory process for co-creation of climate services is crucial for the adequacy and endorsement of them at the scale of destinations.

#### - creation of a platform available to a community

Climate products and services developed in INDECIS project (datasets, software, climate indices, climate services and reports) are stored and available in the INDECIS portal: <u>http://www.indecis.eu</u>. The Portal is conceived to give information and tools to direct users, to our partners and other infrastructures which support and host INDECIS' products and to host or mirror other products. INDECIS' Web Portal points to:

 Work Packages (Figure 6): WP's sections have the description, the objectives, the results and the deliverables of each Work Package of the project (<u>http://www.indecis.eu/workpackages.php</u>).



Figure 6: Work Packages main site (left) and example of site for WP5 (right). Source: INDECIS web portal (<u>http://www.indecis.eu</u>)

 Data Portal: It allocates daily station-based data across Europe and quality controlled and homogenized datasets, including also the rescued datasets. From INDECIS Data Portal (<u>http://www.indecis.eu/data.php</u>) (Figure 7), European daily data are accessible through ECA&D at <u>https://www.ecad.eu/dailydata/predefinedseries.php</u>.



Figure 7: INDECIS Data Portal where daily station data across Europe; quality controlled and homogenized data; and, rescued data are available Source: INDECIS Web Portal (<u>http://www.indecis.eu</u>)

- INDECIS Climate Index monitoring tool reported in mid-term report (<u>http://www.indecis.eu/indices.php</u>) has evolved onto European Climatology and Trend Atlas of Climate Indices (ECTACI). ECTACI (Figure 8), developed by CSIC-IPE, is a fundamental key to understand climate change and its implications. These are available and with wide spatial coverage, over a long period of time, with constant updates, and high spatial resolution. ECTACI contains four statistical parameters (climatology, coefficient of variation, slope and significant trend) from 125 standard climate indices for the whole Europe at 0.25° grid intervals from 1979-2017 at various temporal scales (monthly, seasonal and annual). In addition, ECTACI shows, for the first time, the general trends of a wide variety of updated standard climate indices at seasonal and annual scale for the whole of Europe, which could be a useful tool for climate analysis and its impact on different sectors and socioeconomic activities. The dataset and ECTACI map viewer are available at: <a href="https://ectaci.csic.es/">https://ectaci.csic.es/</a>



Figure 8. Sample visualization of European Climatology and Trend Atlas of Climate Indices (ECTACI) Source: European Climatology and Trend Atlas of Climate Indices (<u>http://ectaci.csic..es</u>)

Software Suites: INDECIS web portal also has a section for download all software suites (http://www.indecis.eu/software.php) developed in the frame of the project (Figure 9). Each suite has a brief description of the package, link for download, and contact person. Suites included in web portal are: INDECIS QC software (INQC, published as R packages in CRAN), QC software for tall towers wind data (QCSS4TT), MetQC, INDECIS Software Suite for Indices Calculation, INDECIS Software Suite of Atmospheric Circulation Indices Calculation, INDECIS Software for intercomparison of reanalysis datasets (INTERDECIS), R Package for calculation of fire danger indices (fireDanger), and INDECIS Suite for Homogenization of ECA&D Daily series, INSBIN-C for calculate Indecis Sun and Beach Index, and CutnetCDF for cut the netCDF files containing the climate indices defined in WP4.

## Software

INDECIS has created or supports different software suites for climate data quality control and homogenisation, indices calculation, datasets inter-companison and climate indices visualization.

## INDECIS QC software (INQC), created by C3/URV

INOC is designed to quality control European Climate Assessment and Dataset (ECA&D) daily data of maximum minimum and average temperature, precipitation sea level pressure relative humidity, wind speed, snow depth, cloud coverage and sunshine duration. INOC is in beta version (ingc\_beta R) available from GitHub.

INQC software link, designed by Center for Climate Change(C3)/University Rovira i Virgili Contact Person

#### QC software for tall towers wind data (QCSS4TT), created by BSC

A tall tower or met mast consists of a high vertical structure (often reaching heights up to 100 meters above ground) with several booms distributed along the vertical mast. Those booms are instrumented with meteorological sensors that record wind speed, wind direction and other parameters at multiple heights above ground level. The special nature of this observational sites allows to perfrom some non-standard quality control techniques.

INDECIS-OCSS4TT software link, designed by Barcelona Supercomputing Center (BSC) Contact Person

#### MetQC software, created by GCRI

Original QC functions converted from ProClimDB into R software (called MetQC) form the basis of the presented software in order to be better usable by various users and applicable standalone. The main script (MetQC\_frameR) uses three main steps of the data processing, and is divided into functions accordingly getting information about data, finding neighbours for subsequent data quality control and data quality control itself.

MetOC software link, designed by Global Change Research Institute of the Czech Academy of Sciences (GCRI) Contact Person

#### INDECIS Software Suite for Indices Calculation, created by CSIC

Open-source software, stand-alone and designed in R with capabilities to compute the 136 indices defined in the INDECIS project. Each index corresponds to a single function with options to be calculated on different time scales annual, monthly and seasonal. Some of the indices only show an annual functionality, but most of them can be calculated at the three different time scales. The functions can be adapted to any format of data inputs and they can be adapted to calculate iteratively the climate indices from large datasets (e.g. gridded netcdf files). The software has been tested by using oridded climate data from ECA&D and

#### INDECIS Software Suite of Atmospheric Circulation Indices Calculation, created by UC-CSIC

Open-source software, stand-alone and designed in R with capabilities to compute standard large-scale circulation indices. This package is integrated in the <u>climatezR suite of climate analysis</u>

Software Suite of Atmospheric Circulation Indices Calculation Link: designed by Santander Meteorology Group (UC-CSIC) Contact Person

#### INDECIS software for intercomparison of reanalysis datasets (INTERDECIS), created by MeteoRo

Interdecis is an open-source software, standalone and designed in R with capabilities to analyse the various climatic datasets performance using as reference E-OBS gridded dataset and ERAs reanalysis product. The functions can be applied to any NetCDF files, as long as they are regularly spaced in the lat/lon grid format. Accuracy measures can be computed from the values extracted from the cells (grids) of the reference (E-OBS/ERA6) and analysed datasets, in which a given coordinates (points) fall. The development version of the

Figure 9. Section of the Web Portal for software suites developed in the frame of INDECIS Source: INDECIS web portal (<u>http://www.indecis.eu/software.php</u>)

**Web mapping application for Climate Services Delivery**: AEMET is developing a new platform through a web mapping application (Figure 10). This platform, still in an initial stage, will be able to store, show and download climate services developed during the project. It will be available at: <u>www.indecis.aemet.es/monitor</u>.



Figure 10. Web mapping application for climate services delivery. Sample based on spatial distribution of dry days across Europe in 2017. Source: Provided by AEMET

#### - company creation, spin-off companies, fund-raising

The initial INDECIS' proposal does not include company creation among its objectives and actions.

#### - international cooperation

INDECIS also contributes to the Copernicus Climate Change Service contract C3S\_311a\_Lot4 which develops the E-OBS, by adding data (rescued data and modern data), an alternative Quality Control and Homogenization. In addition, station records for global radiation data are collected within INDECIS which are used in C3S\_311a\_Lot4 to produce a new member of the E-OBS family. These E-OBS datasets are made available to the general public through the Copernicus Climate Data Store. INDECIS is also collaborating with the Project IMDROFLOOD (2014 JPI-Water Era-Net) (https://imdroflood.csic.es/), which planned different actions to improve the mitigation of the impact of droughts and floods at the catchment level for Europe and South Africa. INDECIS will cooperate with the PIRAGUA POCTEFA project (https://www.opccctp.org/en/piragua). It focuses on the evaluation and integrated management of the hydrological cycle in the Pyrenees, with the main goal of improving the adaptation capacity to the consequences of climatic change. PIRAGUA will support the already existing investments dedicated to adaptation to climate change with respect to water resources. Also, from partners from INDECIS project start to collaborate in Erasmus ++ Project a new project, 'Multilevel Local, Nation- and Regionwide Education and Training in Climate Services, Climate Change Adaptation and Mitigation -ClimEd', 619285-EPP-1-2020-1-FI-EPPKA2-CBHE-JP, 2020-2023) to develop specific training materials in Climate Services for Ukraine (http://climed.network/).

#### - others (international opening, etc.).

The initial INDECIS' proposal does not include patents and licensces among its objectives and actions

In this table, give details of the national and international patents, licensces, and other valorisation factors resulting from the project, the know-how, any other spin-offs from the project, any partnerships, etc.

#### Table 6

List of factors. Indicate the titles, years and comments				
International patents obtained	1. 2.			
International patents pending	1. 2.			
National patents obtained	1. 2.			
National patents pending	1. 2.			
Operating licences (obtained / transferred)	1. 2.			
New collaborative projects	1. 2.			
Scientific symposiums	1. 2.			
Others (specify)	<ol> <li>Final workshop in tourism co-creation indices with local stakeholders</li> <li>(adjourned by COVID in April and June of 2020)</li> </ol>			

## **D FINANCIAL STATUS**

Give an indicative account of the grant budgets spent by the partners. Indicate how this complies with the forecasts and explain any significant divergences.

Grant budgets spent provided by INDECIS Consortium is summarised in Table 7. It reports percentages of total budgets spent for each partner, divided into in kind and in cash, for all the project (from 14/09/2017 to 30/06/2021). Overall, the efforts dedicated by each partner for each work package (shown in table 2) fits well with the expected budgets spent justified in the Consortium Agreement. As occurred when describing work force statistics (in section C1), most of the partners which their major efforts are basically allocated in WP5, WP6 and WP7 spent more in this second half of the project.

			<b>T</b> 1
Partner	Grant budgets	In Kind (%)	In cash
	spent (Total in %)		(%)
URV	58	26	74
UREAD	51	54	46
FMI	98	100	0
BRGMI	91	67	33
CNR	41	75	25
UCH-IHC	113	100	0
SMHI	77	88	74
Met Éireann	20	100	0
AEMET	59	23	56
BSC	50	70	30
Fciencias.ID	61	91	9
CVGZ-GCRI	52	70	30
KNMI	57	30	70
RMI	60	80	20
METEORO	47	76	77
CSIC	145	158	85

Table 7 Grant budget spent by the partners	(expressed in	percentages)	for the reporting	g period. (as
	30/06/2021)			

Source: INDECIS Consortium

## E. APPENDICES (IF NECESSARY)

APPENDIX 1. Status of Deliverables in INDECIS Project for each Work Package.

# Appendix 1: Summary of deliverables for each Work Packages and Contributors (underlined deliverables are linked to document)

WP	Deliverable	Definition	Status	Contributors
WP1	<u>D1.1</u>	Kick-off Meeting Report	1	URV
	<u>D1.2</u>	Dissemination and Exploitation Plan	$\checkmark$	URV
	<u>D1.3</u>	Mid-Term Report	$\checkmark$	All Partners (coordinated by URV)
	D1.4	End Project Report	End Project	All Partners (coordinated by URV)
WP2	<u>D2.1</u>	Inventory and Catalog of Climate Datasets	V	KNMI, MeteoRO, CNR, BSC
	<u>D2.2</u>	Report on Data Rescue Missions	$\checkmark$	KNMI, URV, CNR, BSC, Met
	D2 2	- INDECIC Davy Data Cat and IDICD Dantal	al	
	D2.5	Undate of the INDECIS Raw Data set including recoved	v	KINIVII, AEIVIET
	D2.4	data	$\checkmark$	
WP3	D3.1	INDECIS Quality Control Software and Manual	1	
	<u>A)</u>	INDECIS QC software	V	URV
	<u>B)</u>	QC software for tall towers wind data	$\checkmark$	BSC
	<u>C)</u>	MetQC software	√	CVG-GCRI
	D3.2	Report on Recommended Homogenization Techniques	V	
	• • •	based on Benchmarking Results		
	<u>A)</u>	Background Produced in a second	N	URV, AEMET, SMHI, Met Eireann
	<u>B)</u>	Denchmurking results	N	
	D3 3	Release of the INDECIS Homogenization Suite and Manual		
	A)	Homogenization Suite	V	
	B)	Manual	V	URV, AEMET
	<u>C)</u>	Homogenization Suite Software	$\checkmark$	
	D3.4	Release of INDECIS-QCHDS (Station data and gridded versions)	٧	URV, AEMET
	<u>D3.5</u>	Report on the uncertainty of the homogenization process	1	URV, AEMET, CNR, CSIC/IPE
	<u>D4.1</u>	Report on the Inventory and Catalog of Indices Datasets	$\checkmark$	CSIC/IPE, CNR, BSC
	<u>D4.2</u>	Report on indices of INDECIS-ISD, including definitions, and	$\checkmark$	CSIC/IPE, BRGM, CNR, BSC
14704	D4 2	accompanying sectorial data	al	CSIC/IPE
VVI <del>1</del>	<u>D4.5</u>	Release of the Software Suite for Indices Calculation		CSIC/IPE, AEMET, URV, KNMI,
	<u>D4.4</u>	INDECIS-ISD released and integrated into the IDISP	٧	UNIZAR, ARAID
	D4.5	Report on comparison of the ISD with sectorial data	٧	CSIC/IPE, CNR, BRGM, FMI
	D5.1	Inventory and Catalog of Indicators of circulation variability for	V	UREAD, BSC
14705		comparison with the INDECIS-ISD	1	
WP5	<u>D5.2</u>	Report on temporal evolution of the INDECIS-QCHDS and INDECIS-ISD	N	UREAD, RMI, UCAN/UC, CNR
	<u>D5.3</u>	atmospheric patterns	$\checkmark$	CNR
	D6.1	Release of the datasets comparison software suite	1	MeteroRO
		Report on the datasets inter-comparisons with regard to selected ECVs and		
WP6	<u>D6.2</u>	INDECIS-ISD	N	Coordinated by MeteoRO
		European Reanalysis ERA5, UERRA MESCAN-SURFEX, COSMO_REA6	1	MeteoRO
		compared to station-based data	•	meteorie
	<u>B)</u>	Met Eireann Regional Reanalysis (MERA) compared to station data and other	$\checkmark$	Met Éireann
	C	FRA5 and MFRRA2 commared to in-situ wind data	1	BSC
		Report on the datasets inter-comparisons with regard to selected ECVs and	,	bbe
	<u>D)</u>	INDECIS-ISD	N	UC
	<u>E)</u>	Intercomparison of selected ECVs and indecis for the area of the Czech Republic	√	CVG-GCRI
	D6.3	Report on the reliability and uncertainties associated with the (hindcast-	V	Coordinated by MeteoRO
		type) seasonal forecasts of selected sectorial INDECIS indices		
	A) B)	Seasonal predictions of wind-power-derived indices: A case study in the North Sea	N	BSC
	<u>b)</u>	Applications of seasonal forecasting for agriculture, winter tourism and	,	
	<u>C)</u>	hydropower – a case study in Finland	V	FMI
	נת	Seasonal predictability of Fire Weather Index(INDECIS-ISD 128) components over	V	UC/IHC
	<u>D)</u>	Europe	1	00/110

	<u>D6.4</u>	Report on the assessment of sectorial climate change impact based on	V	MeteoRO, UC/IHC
	<u>A)</u>	Climate change projections for INDECIS-ISD indices representative of extremes for precipitation and temperature	$\checkmark$	UC/IHC
	B)	Temperature-based climate indicators relevant for agriculture sector in the context of climate changes in Romania	$\checkmark$	MeteroRO
	C)	A French spatially distributed hydrological model as a demonstrator for a national groundwater management tool	V	BRGM
	<u>D7.1</u>	Document Communication Strategy for Delivering Effective Climate Services	V	URV
WP7	<u>D7.2</u>	Document Business Cases Study for the Delivery of Climate Services in the Tourism Sector	V	URV, CNR
	D7.3	Release of the software suite and integration into IDSIP	$\checkmark$	AEMET
	D7.4	Basic semi-automated Climate Services and protocol for requesting advanced climate services launched at IDISP	V	
	A)	Demand for climate services in the French agricultural sector	V	BRGM
	<b>B</b> )	R-Code for INDECIS Sun and Beach Index	V	C3-URV

Source: INDECIS Consortium

## List of publications in which INDECIS Project is acknowledged

- Allan, R. P., Blenkinsop, S., Fowler, H.J. & Champion, A. J. (2019). Atmospheric precursors for intense summer rainfall over the UK. *International Journal of Climatology*. DOI: 10.1002/joc.6431
- Bedia, J., Baño-Medina, J., Legasa, M. N., Iturbide, M., Manzanas, R., Herrera, S., Casanueva, A., San-Martín, D., Cofiño, A. S., and Gutiérrez, J. M.: Statistical downscaling with the downscaleR package (v3.1.0): contribution to the VALUE intercomparison experiment, *Geosci. Model Dev.*, 13, 1711–1735. DOI: 10.5194/gmd-13-1711-2020, 2020
- Caloiero, T., Caroletti, G. N. & Coscarelli, R. (2021) IMERG-Based Meteorological Drought Analysis over Italy. *Climate*, 9, 65, DOI: 10.3390/cli9040065
- Caloiero, T., Filice, E., Coscarelli, R. & Pellicone G. (2020) A Homogeneous Dataset for Rainfall Trend Analysis in the Calabria Region (Southern Italy). *Water*, 12, 2541; doi:10.3390/w12092541
- Caroletti, G. N., Coscarelli, R., & Caloiero, T. (2021) A sub-regional approach to the influence analysis of teleconnection patterns on precipitation in Calabria (southern Italy). International Journal of Climatology, DOI: 10.1002/joc.7087.
- Caroletti, G. N., Coscarelli, R., & Caloiero, T. (2019). Validation of Satellite, Reanalysis and RCM Data of Monthly Rainfall in Calabria (Southern Italy). *Remote Sensing*,11(13), 1625. DOI: 10.3390/rs11131625
- Coscarelli, R., Antronico, L., De Pascale, F., Boqué Ciurana, A., Font Barnet, A., Russo, P. A., Saladié Borraz Ò. (2021); Tendenze climatiche e flussi turistici: prime analisi tratte dal Progetto europeo "INDECIS". Quaderni della Società Italiana di Scienze del Turismo, Aracne Editrice, Roma, Vol. II. ISBN: 978-88-255-3918-9.
- Coscarelli, R., Caloiero, T. & Caroletti, G. N. (2019). Valutazioni di condizioni di siccità in Calabria. In Technologies for Integrated River Basin Management (40th ed., pp. 777–790). Cosenza: Edibios. ISBN: 978-88-97181-71-2

Craig, P. & Allan, R.P. (2021) Role of teleconnection patterns in the variability and trends of growing season indices across Europe, International Journal of Climate, provisionally accepted

- Diez-Sierra, J., & del Jesus, M. (2019). Subdaily Rainfall Estimation through Daily Rainfall Downscaling Using Random Forests in Spain. *Water*, *11*(1), 125. DOI: 10.3390/w11010125
- Domínguez-Castro, F., Gallego, M. C., Vaquero, J. M., García-Herrera, R., Peña-Gallardo, M., El Kenawy, A., Vicente-Serrano S. M., Twelve years of daily weather descriptions in North-America in the 18th century (Mexico City, 1775-1786). Bulletin of the American Meteorological Society. 100: 1531-1547. DOI: 10.1175/BAMS-D-18-0236.1

- Domínguez-Castro, F., Gonzalez, F., García-Herrera, R., El Kenawy, A., Peña-Gallardo, M., Vicente-Serrano, S. M., González, E. New documentary evidence of the Tunguraghua eruption on 23rd April 1773, Ecuador. *Natural Hazards*. 94, 1463-1473. DOI: 10.1007/s11069-018-3474-x
- Domínguez-Castro, F., Reig, F., Vicente-Serrano, S.M. Aguilar, E., Peña-Angulo, D., Noguera, I., Revuelto, J., van der Schrier, G., El Kenawy, A., A multidecadal assessment of climate indices over Europe. Sci Data 7, 125 (2020). DOI: 10.1038/s41597-020-0464-0
- Dominguez-Castro, F., Vicente-Serrano, S. M., López-Moreno, J. I., Correa, K., Avalos, G., Azorin-Molina, C., El Kenawy, A., Tomas-Burguera, M., Navarro-Serrano, F., Peña-Gallardo, M., Gimeno, L., Nieto R. (2018) Mapping seasonal and annual extreme precipitation risk over the Peruvian Andes. *International Journal of Climatology 38*, 5459-5475. DOI: 10.1002/joc.5739
- Domínguez-Castro, F., Vicente-Serrano, S. M., Tomás-Burguera, M., Peña-Gallardo, M., Beguería, S., El Kenawy, A., Luna, Y., Morata, A., (2019) High spatial resolution climatology of drought events for Spain: 1961-2014. *International Journal of Climatology*. 39, 5046-5062. <u>DOI:</u> <u>10.1002/joc.6126</u>
- Domínguez-Castro, F., Vicente-Serrano, S. M., Tomás-Burguera, M., Peña-Gallardo, M., Beguería, S., El Kenawy, A., Luna, Y., Morata, A., (2019) High-spatial resolution probability maps of drought duration and magnitude across Spain. *Natural Hazards and Earth System Science*. 19, 611-628. DOI: 10.5194/nhess-19-611-2019
- Fowler H, Lenderink G, Prein A, Westra S, Allan RP, Ban N, Barbero R, Berg P, Blenkinsop S, Do H, Guerreiro S, Haerter J, Kendon E, Lewis E, Schaer C, Sharma A, Villarini G, Wasko C, & Zhang X (2021) Anthropogenic intensification of short-duration rainfall extremes, *Nature Reviews Earth and Environment*, 2, 107–122, doi: 10.1038/s43017-020-00128-6.
- Fowler H, H Ali, RP Allan, N Ban, R Barbero, P Berg, S Blenkinsop, NS Cabi, S Chan, M Dale, RJH Dunn, M Ekstrom, JP Evans, G Fosser, B Golding, SB Guerreiro, GC Hegerl, A Kahraman, EJ Kendon, G Lenderink, E Lewis, X Li, PA O'Gorman, HG Orr, KL Peat, AF Prein, D Pritchard, C Schar, A Sharma, PA Stott, R Villalobos-Herrera, G Villarini, C Wasko, MF Wehner, S Westra and A Whitford (2021) Towards advancing scientific knowledge of climate change impacts on short-duration rainfall extremes, Phil. Trans. R. Soc. A., 379, 20190542, doi: 10.1098/rsta.2019.0542.
- Gazol, A., Camarero, J. J., Vicente-Serrano, S. M., Sánchez-Salguero, R., Gutiérrez, E., de Luis, M., & Galván, J. D. (2018). Forest resilience to drought varies across biomes. *Global Change Biology*, 24 (5), 2143–2158. DOI: 10.1111/gcb.14082
- Geirinhas, J.L., Russo, A., Libonati, R. et al. Heat-related mortality at the beginning of the twentyfirst century in Rio de Janeiro, Brazil. *Int J Biometeorol* (2020). DOI: 10.1007/s00484-020-01908-x
- González-Hidalgo, J. C., Vicente-Serrano, S. M., Peña-Angulo, D., Salinas, C., Tomas-Burguera, M., & Beguería, S. (2018). High-resolution spatio-temporal analyses of drought episodes in the western Mediterranean basin (Spanish mainland, Iberian Peninsula). *Acta Geophysica*, 66(3), 381–392. DOI: 10.1007/s11600-018-0138-x

- Hawkins, E., Frame, D., Harrington, L., Joshi, M., King, A., Rojas, M., Sutton, R. (2020); Observed Emergence of the Climate Change Signal: From the Familiar to the Unknown; *Geophysical Research Letters; Volume47, Issue6*. DOI: 10.1029/2019GL086259
- Hyvärinen, O., Venäläinen, A., and Vajda, A.: Bias-adjusted seasonal forecasts of soil moisture for forestry applications in Finland, *Adv. Sci. Res.*, *17*, 23–27, DOI: 10.5194/asr-17-23-2020, 2020.
- Iturbide, M., Bedia, J., Herrera, S., Baño-Medina, J., Fernández, J., Frías, M. D., Gutiérrez, J. M. (2019). The R-based climate4R open framework for reproducible climate data access and postprocessing. *Environmental Modelling and Software*, 111, 42–54. <u>DOI:</u> <u>10.1016/j.envsoft.2018.09.009</u>
- Khorchani, M., Vicente-Serrano, S. M., Azorin-Molina, C., Garcia, M., Martin-Hernandez, N., Peña-Gallardo, M., Domínguez-Castro, F. (2018). Trends in LST over the peninsular Spain as derived from the AVHRR imagery data. *Global and Planetary Change*, 166, 75–93. <u>DOI:</u> <u>10.1016/j.gloplacha.2018.04.006</u>
- Ossó, A., Allan, R.P., Hawkins, E., Shaffrey, L., & Maraun, D. (2021) Emerging new climate extremes over Europe, Climate Dynamics, provisionally accepted.
- Peña-Angulo D., Vicente-Serrano S.M., Domínguez-Castro F, Murphy C, Reig F., Tramblay Y., Trigo R.M., Luna M.Y., Turco M., Noguera I., Aznárez-Balta M, García-Herrera R., Tomas-Burguera M., El Kenawy A. (2020) "Long-term precipitation in Southwestern Europe reveals no clear trend attributable to anthropogenic forcing", Environmental Research Letters, 15, 094070, DOI: 10.1088/1748-9326/ab9c4f
- Peña-Gallardo, M., Vicente-Serrano, S. M., Beguería, S. Domínguez-Castro, F. The impact of drought on the productivity of two rainfed crops in Spain. *Natural Hazards and Earth System Science*. 19: 1215-1234. DOI: 10.5194/nhess-19-1215-2019
- Peña-Gallardo, M., Vicente-Serrano, S. M., Camarero, J. J., Gazol, A., Sánchez-Salguero, R., Domínguez-Castro, F., El Kenawy, A., Beguería-Portugés, S., Gutiérrez, E., de Luis, M., Sangüesa-Barreda, G., Novak, K., Rozas, V., Tíscar, P. A., Linares, J. C., Martínez del Castillo, E., Ribas Matamoros, M., García-González, I., Silla, F., Camisón, A., Génova, M., Olano, J. M., Longares, L. A., Hevia, A., Galván, J. D. (2018) Drought sensitiveness on NDVI and forest growth in peninsular Spain and the Balearic Islands. *Forests. 9, 524 DOI: 10.3390/f9090524*
- Peña-Gallardo, M., Vicente-Serrano, S. M., Hannaford, J., Lorenzo-Lacruz, J., Svoboda, M., Domínguez-Castro, F., Maneta, M., Tomas-Burguera, M., El Kenawy, A. (2019) Complex influences of meteorological drought time-scales on hydrological droughts in natural basins of the contiguous Unites States. *Journal of Hydrology*. 568: 611-625. DOI: 10.1016/j.jhydrol.2018.11.026
- Peña-Gallardo, M., Vicente-Serrano, S. M., Quiring, S., Svoboda, M., Beguería, S., Hannaford, J. (2018) Analysis of the performance of drought indices to identify drought impacts in different crops over United States. *Climate Research*, 75: 221-240. DOI: 10.3354/cr01519
- Peña-Gallardo, M., Vicente-Serrano, S. M., Quiring, S., Svoboda, M., Hannaford, J., Tomas-Burguera, M., Martin-Hernandez, N., Domínguez-Castro, F., El Kenawy, A. (2019) Response of crop yield

to different time-scales of drought in the United States: spatio-temporal patterns and climatic and environmental drivers. *Agricultural and Forest Meteorology.* 264: 40-55. DOI: 10.1016/j.agrformet.2018.09.019

- Ramon, J., Lledó, L., Bretonnière, P.-A., Samsó, M., and Doblas-Reyes, F. J. (2021). A perfect prognosis downscaling methodology for seasonal prediction of local-scale wind speeds. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/abe491
- Ramon, J., Lledó, L., Pérez-Zanón, N., Soret, A., and Doblas-Reyes, F.J. (2020). The Tall Tower Dataset: a unique initiative to boost wind energy research, *Earth Syst. Sci. Data*, 12, 429– 439. DOI: 10.5194/essd-12-429-2020
- Ramon, J., L. Lledó, V. Torralba, A. Soret, & F. J. Doblas-Reyes (2019). What global reanalysis best represents near-surface winds? *Quarterly Journal of the Royal Meteorological Society*, 145,3236– 3251. DOI: 10.1002/qj.3616
- Slette, I. J., Smith, M. D., Knapp, A. K., Vicente-Serrano, S. M., Camarero, J. J., Beguería, J., (2020) Standardized metrics are key for assessing drought severity. *Global Change Biology 26: e1*e3. DOI: 10.1111/gcb.14899
- Sousa, P. M., Barriopedro, D., Ramos, A. M., García-Herrera, R., Espírito-Santo, F., Trigo, R. M. (2019); Saharan air intrusions as a relevant mechanism for Iberian heatwaves: The record breaking events of August 2018 and June 2019; Water and Climate Extrems, 26, 2019. DOI: <u>10.1016/j.wace.2019.100224</u>
- Sousa, P. M., Trigo, R. M., Barriopedro, D., Soares, P. M. M., Ramos, A. M., & Liberato, M. L. R. (2017). Responses of European precipitation distributions and regimes to different blocking locations. *Climate Dynamics*, 48(3–4), 1141–1160. DOI: 10.1007/s00382-016-3132-5
- Sousa, P. M., Trigo, R. M., Barriopedro, D., Soares, P. M. M., & Santos, J. A. (2018). European temperature responses to blocking and ridge regional patterns. *Climate Dynamics*, 50(1–2), 457– 477. DOI: 10.1007/s00382-017-3620-2
- Sousa P., Barriopedro D., Ramos A.M., García-Herrera R., Espirito-Santo F., Trigo R.M. (2019) Saharan air intrusions as a relevant mechanism for Iberian heatwaves: The record breaking events of August 2018 and June 2019, *Weather and Climate Exetremes*, 26, 100224, DOI 10.1016/j.wace.2019.100224
- Udristioiu, M. T., Rosca, D., Velea, L., Bojariu, R., Sararu, S. C., Rosca, A. (2019): Surface temperature during summer days in Craiova, Romania, from satellite observations and infrared thermovision measurements, AIP Conference Proceedings, 2075, 130009; <u>https://doi.org/10.1063/1.5091294</u>
- Van de Vyver, H., & Van den Bergh, J. (2018). The Gaussian copula model for the joint deficit index for droughts. *Journal of Hydrology*, *561*, 987–999. DOI: 10.1016/j.jhydrol.2018.03.064
- Van de Vyver, H., Van Schaeybroeck, B., De Troch, R., Hamdi, R., & Termonia, P. (2019). Modeling the Scaling of Short-Duration Precipitation Extremes With Temperature. *Earth and Space Science*, 6(10), 2031–2041. DOI: 10.1029/2019EA000665
- van der Schrier, G., RP Allan, Ossó, A., Sousa, P. M., Van de Vyver, H., Van Schaeybroeck, B., Coscarelli, R., Pasqua, A. A., Petrucci, O., Curley, M., Mietus, M., Filipiak, J., Štěpánek, P., Zahradníček, P., Brázdil, R., Řezníčková, L., van den Besselaar, E. J. M., Trigo, R., and Aguilar,

E. (2021), The 1921 European drought: Impacts, reconstruction and drivers, Clim. Past Discuss. in review, doi: doi.org/10.5194/cp-2021-41.

- Velea L. and Bojariu, R. (2018): Summer thermal discomfort conditions in Romania under climate change scenarios, Carpathian Journal of Earth and Environmental Sciences, Vol. 13, No. 2, p. 595 - 603; DOI:10.26471/cjees/2018/013/050
- Velea, L., Tinca-Udristioiu, M., Sararu, S.C., Bojariu, R., Gothard, M. and Dascalu, S.I. (2019): Assessment of summer thermal comfort using the net effective temperature index over Romania, AIP Conference Proceedings, 2071, 040004; <u>https://doi.org/10.1063/1.5090071</u>
- Vicente-Serrano, S.M., Azorin-Molina, C., Peña-Gallardo, M., Tomas-Burguera, M., Domínguez-Castro, F., Martín-Hernández, N., Beguería, S., El Kenawy, A., Noguera, I., García, M., A highresolution spatial assessment of the impacts of drought variability on vegetation activity in Spain from 1981 to 2015. *Natural Hazards and Earth System Science*. 19: 1189-1213. DOI: 10.5194/nhess-19-1189-2019
- Vicente-Serrano, S. M., Domínguez-Castro, F., McVicar, T., Tomas-Burguera, M., Peña-Gallardo, M., Noguera, I., López-Moreno, J. I., Peña, D., El Kenawy, A. (2020) Global characterization of hydrological and meteorological droughts under future climate change: The importance of time-scales, vegetation-CO2 feedbacks and changes to distribution functions. *Int. J. Climatol.* 40: 2547-2557.
- Vicente-Serrano, S. M., Martín-Hernández, N., Camarero, J. J., Gazol, A., Sánchez-Salguero, R., Peña-Gallardo, M., El Kenawy, A., Domínguez-Castro, F., Tomas-Burguera, M., Gutiérrez, E., de Luis, M., Sangüesa-Barreda, G., Novak, K., Rozas, V., Tíscar, P. A., Linares, J. C., Martínez del Castillo, E., Ribas, M., García-González, I., Silla, F., Camisón, A., Génova, M., Olano, J. M., Longares, L. A., Hevia, A., Galván, J. D. (2020) Linking tree-ring growth and satellite-derived gross primary growth in multiple forest biomes. Temporal-scale matters. *Ecological Indicators* 108,105753. DOI: 10.1016/j.ecolind.2019.105753
- Vicente-Serrano, S. M., Martín-Hernández, N., Reig, F., Azorin-Molina, C., Zabalza, J., Beguería, S., Domínguez-Castro, F., El Kenawy, A., Peña-Gallardo, M., Noguera, I., García, M. 2020.
   Vegetation greening in Spain detected from long term data (1981-2015). *International Journal of Remote Sensing*. 41: 1709-1740. DOI: 10.1080/01431161.2019.1674460
- Vicente-Serrano, S. M., McVicar, T., Miralles, D., Yang, Y., Tomas-Burguera, M. (2020): Unravelling the influence of atmospheric evaporative demand on drought under climate change. *WIREs Climate Change 11: e632*.
- Vicente-Serrano, S. M., Miralles, D. G., Domínguez-Castro, F., Azorin-Molina, C., El Kenawy, A., Mcvicar, T. R., Peña-Gallardo, M. (2018). Global assessment of the standardized evapotranspiration deficit index (SEDI) for drought analysis and monitoring. *Journal of Climate*, 31(14), 5371–5393. DOI: 10.1175/JCLI-D-17-0775.1
- Vicente-Serrano, S. M., Nieto, R., Gimeno, L., Azorin-Molina, C., Drumond, A., El Kenawy, A., Peña-Gallardo, M. (2018). Recent changes of relative humidity: regional connections with land and ocean processes. *Earth System Dynamics*, 9, 915–937. DOI: 10.5194/esd-9-915-2018
- Vicente-Serrano, S. M., Peña-Gallardo, M., Hannaford, J., Murphy, C., Lorenzo-Lacruz, J., Dominguez-Castro, F., López-Moreno, J., Begueria, S., Noguera, I., Harrigan, S., Vidal, J. P. 30/35

(2019) Climate, irrigation and land-cover change explain streamflow trends in Western Europe. *Geophysical Research Letters*, *46*, *10*,*821-10*,*833* DOI: <u>10.1029/2019GL084084</u>.

- Vicente-Serrano, S. M., Quiring, S., Peña-Gallardo, M., Shanshui Yuan, Domínguez-Castro, F. (2020) A review on environmental droughts: Increased risk under global warming? *Earth Science Reviews*. 201, 102953. DOI: 10.1016/j.earscirev.2019.102953
- Vicente-Serrano, S. M., Tomas-Burguera, M., Beguería, S., Reig, F., Latorre, B., Peña-Gallardo, M., González-Hidalgo, J. C. (2017). A High Resolution Dataset of Drought Indices for Spain. *Data*, 2(3), 22. DOI: 10.3390/data2030022
- Zabalza-Martínez, J., Vicente-Serrano, S. M., Ignacio López-Moreno, J. I., Borràs, G., Savé, R., Pascual, D., Plá, E., Morán-Tejeda, E., Domínguez-Castro,F., Tague, C. L. The influence of climate and land-cover scenarios on dam management strategies in a high water pressure catchment in North-east Spain. *Water*. 10, 1668 DOI: 10.3390/w10111668

#### List of Contributions to Conferences and Workshops

- Velea, L., Bojariu, R., Burada, C., Udristioiu, M.T., Paraschivu, M., Burcea, R.D. (2021): Characteristics of extreme temperatures relevant for agriculture in the near future (2021-2040) in Romania, USAMV conference, Bucharest, 3-5 June 2021
- Velea, L., Bojariu, R., Burada, C., Udristioiu, M.T., Colan, M. (2020): Temperature-based climate indicators relevant for agriculture sector in the context of climate changes in Oltenia, Internationla Symposium 'Durable agriculture –agriculture of the future, Faculty of Agronomy,, Craiova, Romania, 20 Nov. 2020
- Caroletti, G. N., Caloiero, T., Joelsson, M., & Coscarelli, R. (2021) A validation scheme for homogenization techniques on a Swedish temperature network using artificial inhomogeneities (1950-2005). General Assembly 2021 online, 19-30 April 2021, https://meetingorganizer.copernicus.org/EGU21/EGU21-6680.html;
- Coscarelli, R., Aguilar, E., Vicente-Serrano, S., & Zimbo, F. (2021) Analysis of dry conditions compared with wildfires: an application in Calabria (Southern Italy). General Assembly 2021 online, 19-30 April 2021, <u>https://meetingorganizer.copernicus.org/EGU21/EGU21-466.html</u>
- Petrucci, O., Aguilar, E., Pasqua, A.A., Vicente-Serrano, S., Zimbo, F., & Coscarelli, R. (2021) Comparison of climatic indices with landslide occurrences in Calabria (Southern Italy). General Assembly 2021 online, 19-30 April 2021, https://meetingorganizer.copernicus.org/EGU21/EGU21-405.html
- Caroletti, G. N., Coscarelli, R., & Caloiero, T.; A sub-regional approach for the analysis of atmospheric teleconnection influence on precipitation in Calabria (southern Italy). EGU General Assembly 2020 online, 5-9 May 2020 <u>https://meetingorganizer.copernicus.org/EGU2020/EGU2020-3078.html</u>
- Caloiero T., Coscarelli R., Caroletti G.N.; Evaluating the skill of satellite data on the individuation of extreme precipitation events in Calabria (southern Italy); EGU General Assembly 2020 online,

- Colan M., Velea L., Burada C., Constantinescu, E., Bojariu R., Udristioiu. M, Bacescu, A.; Assessement of thermal regime in Oltenia using temperature-based climate indicators relevant for agriculture sector; Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, Vol. XLIX/2019 <u>Conference paper</u>
- R. Coscarelli, L.Antronico, A. Boqué Ciurana, F. De Pascale, A. Font Barnet, A. P. Russo and Ò.Saladié Borraz; Climate trends and tourist flows: first results of the case study in the Sila National Park (southern Italy) within the INDECIS Project; EGU General Assembly 2020 online, 5-9 May 2020 <u>https://meetingorganizer.copernicus.org/EGU2020/EGU2020-2978.html</u>
- Olano Pozo J.X.; Boqué Ciurana, A.; Font Barnet, A.; Russo, A.; Saladié Borraz, O.; Anton-Clavé, S.; Aguilar, E.; Co-developing climate services with local agents: The INDECIS Snow Tourism Index; EGU General Assembly 2020 online, 5-9 May 2020 https://meetingorganizer.copernicus.org/EGU2020/EGU2020-8926.html
- Hans Van de Vyver and Joris Van den Bergh; Drought assessment in a changing climate with the joint deficit index; EGU2020, 3-8 May
- Dascalu S., Gothard M., Bojariu R., Dumitrescu A., Velea L., Barbu A., Burada C.; European reanalysis datasets as alternative data sources for agro-meteorological studies Conference "Durable agriculture – agriculture of the future', Craiova (Romania), 7-8 Nov. 2019
- Coscarelli R., Antronico L., Boqué A., De Pascale F., Font A., Russo P. A. and Saladié O. (2019). Tendenze climatiche e flussi turistici: prime analisi tratte dal Progetto europeo "INDECIS". Congress "Turismo, Paesaggio e Beni Culturali: prospettive di tutela, valorizzazione e sviluppo sostenibile", 11th Scientific Meeting Sistur, 24-26 October, Rende - Cosenza (Italy). Oral presentation
- Vajda A. and Hyvärinen O. (2019). Development of seasonal climate indices for agriculture in Finland. EMS 2019, 9-13 September, Copenhagen (Denmark). <u>Oral presentation</u>
- Hyvärinen O. and Vajda A.(2019). Exploring bias adjustment methods of seasonal forecasts for applications in Northern Europe. EMS 2019, 9-13 September, Copenhagen (Denmark). <u>Oral presentation</u>
- Hans Van de Vyver (2019). A multiscaling intensity-duration-frequency model for extreme precipitation. 11th International Conference on Extreme Value Analysis, 1-5 July, Zagreb (Croatia). Oral presentation.
- Coscarelli, R., Caloiero, T. & Caroletti, G. N.; Valutazioni di condizioni di siccità in Calabria; 40° Corso in Tecniche per la Difesa del Suolo e dall'Inquinamento, 19-22 June 2019, Guardia Piemontese - Cosenza (Italy)

- Prades-Tena, Jordi (2019). Communication Strategy for Delivering Effective Climate Services: The INDECIS project. European Climate Change Adaptation Conference. 28-31 May, Lisbon (Portugal). Oral presentation.
- Erik Engström, Javier Sigró and Mary Curley (2019). Testing daily homogenisation methods in parallel series data base. EGU 2019, 7-12 April, Vienna (Austria) <u>Oral presentation</u>
- José A. Guijarro, Enric Aguilar, Peter Domonkos, Javier Sigró, Petr Štěpánek, Victor Venema, and Pavel Zahradníček (2019). Benchmarking results of the homogenization of daily Essential Climatic Variables within the INDECIS project. EGU 2019, 7-12 April, Vienna (Austria) <u>Oral</u> <u>presentation</u>
- Rebeca Álvarez, Marcelino Nuñez, and Yolanda Luna (2019). The data and climate indicators suite within the INDECIS project. EGU 2019, 7-12 April, Vienna (Austria) <u>Oral presentation</u>
- Hans Van de Vyver, Bert Van Schaeybroeck, Rafiq Hamdi, and Piet Termonia (2019) Statistical methods for the scaling of precipitation extremes with temperature. EGU 2019, 7-12 April, Vienna (Austria). <u>Oral presentation</u>
- Enric Aguilar and José Antonio Guijarro (2019). INDECIS Quality Control Software Suite (INQC). EGU 2019, 7-12 April, Vienna (Austria) <u>Poster presentation</u>
- Joan Ramon Coll, Enric Aguilar, Gerard van der Schrier, Roberto Coscarelli, Erik Engström, Yolanda Luna, Sergio Vicente-Serrano, Petr Stepanek, Liliana Velea, Richard Allan, Ricardo Trigo, Ali Nadir Arslan, Manuel del Jesus, Yvan Caballero, Patrick Fournet, Albert Soret, and Hans van de Vijver (2019). Integrated approach for the development across Europe of user oriented climate indicators for GFCS high-priority sectors: agriculture, disaster risk reduction, energy, health, water and tourism (INDECIS). EGU 2019, 7-12 April, Vienna (Austria). <u>Poster</u> <u>presentation</u>
- José A. Guijarro, Enric Aguilar, Tommaso Caloiero, Giulio Caroletti, Silvia Carvalho, Roberto Coscarelli, Mary Curley, Erik Engström, Llorenç Lledó, Jaume Ramon, Gerard van der Schrier, Javier Sigró, Petr Stepanek, Maria A. Valente, and Pavel Zahradnicek (2019). Benchmarking and Homogenisation of daily Essential Climate Variables within the INDECIS Project. 7th International Conference of Meteorology and Climatology of the Mediterranean, 4-6 March, Palma de Mallorca (Spain). Oral presentation.
- Ramon J., Lledó Ll., Soret A., Aguilar E., (2018). Towards a new tall tower database: building a quality controlled and homogenized database of wind observations from existing tall towers. EMS 2018, 3-7 September, Budapest (Hungary) <u>Poster presentation</u>
- José A. Guijarro, Enric Aguilar, Tommaso Caloiero, Roberto Coscarelli, Mary Curley (2018). Benchmarking and Homogenisation of daily Essential Climate Variables within the INDECIS Project. EMS 2018, 3-7 September, Budapest (Hungary) <u>Oral presentation</u>
- Stepanek P., Zahradnicek P., Meitner J., Squintu A., van der Schrier G. (2018) New data quality control tolls for operational use in ProClimDB software. EMS 2018, 3-7 September, Budapest (Hungary). <u>Poster presentation</u>

- Velea L., Bojariu R. (2018) Long-term variability comfort conditions based on the Universal Thermal Climate Index over Romania. EMS 2018, 3-7 September, Budapest (Hungary). <u>Oral</u> <u>presentation</u>
- Hans Van de Vyver, Bert Van Schaeybroeck, and Rafiq Hamdi (2018) Qualitative climatological features of observed intense precipitation extremes over Western and Northern Europe. EMS 2018, 3-7 September, Budapest (Hungary). <u>Oral presentation</u>
- Aguilar E., van der Schrier G., Guijarro J.A., Stepanek P., Zahradnicek P., Sigró J., Coscarelli R., Engström E., Curley M., Caloiero T., Lledó Ll., Ramon J., Valente M.A., Pérez-Zanón N., Carvalho S. (2018) Quality control and homogenization benchmarking-based progress from the INDECIS project. EGU 2018, 8-13 April, Vienna (Austria). <u>Poster presentation</u>
- Aguilar E. (2018) INDECIS. Integrated approach for the development across Europe of user oriented climate indicators for GFCS high-priority sectors: Agriculture, disaster risk reduction, energy, health, water and tourism. EGU 2018, 8-13 April, Vienna (Austria) <u>EGU-PICO session</u>
- Coll J.R., van der Schrier G., Aguilar E., Bishop A. (2018) Data rescue activities in the INDECIS project. Spanish Climatology Association Congress, 17-19 October, Cartagena (Spain). <u>Short communication</u> & Oral presentation.
- Guijarro J.A., Aguilar E., Caloiero T., Carvalho S., Coscarelli R., Curley M., Engström E., Lledó Ll., Pérez-Zanón N., Ramón J., Sigró J., Stepanek P., Valente M.A., van der Schrier G., Zahradnicek P. (2018). Evaluación de métodos de homogenización de series climáticas diarias en el marco del proyecto INDECIS. Spanish Climatology Association Congress, 17-19 October, Cartagena (Spain). <u>Oral presentation & Short comunication</u>
- Coscarelli R., Caloiero T., van der Schrier G., Aguilar E., Coll J.R., Fusto F., Niccoli R. (2018) Assessing the Italian climate and the European perspective. 1st Congresso Nazionale AISAM, 10-13 September, Bologna (Italy). <u>Poster presentation</u>
- Santos-Lacueva R., Clavé S.A., Russo A., Saladié O., Aguilar E. (2018). Tourism Stakeholders involvement for climate services co-creation: A pilot experience. 5th International Conference on Climate, Tourism and Recreation, 25-27 June, Umea (Sweden). <u>Oral presentation</u>
- Prades J. (2018). From climate change information to climate services communication: The INDECIS project. 24th International Sustainable Development Research Society Conference, 13-15 June, Messina (Italy). Oral presentation.
- Prades J., Luna Y., Santos-Lacueva R. (2018). Climate services for ecological and climate justice: The INDECIS Project. International Environmental Law Colloquium, 17-18 May, Tarragona (Spain). Poster presentation.
- Zabalza-Martínez, J., Vicente-Serrano, S.M., Juan Ignacio López-Moreno, Gabriel Borràs-Calvo, Robert Savé, Diana Pascual, Eduard Plá, Enrique Morán-Tejeda, Christina L. Tague (2017). The influence of climate and land-cover scenarios on dam management strategies in a high water pressure catchment in North-east Spain. The 1st International Electronic Conference on

Hydrological Cycle (CHyCle-2017), 12-16 November, Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>

- Domínguez-Castro, F., Vicente-Serrano, S.M., Jaak Jaagus, Miquel Tomas-Burguera, Makki Khorchani, Marina Peña-Gallardo, Tim McVicar (2017). Influence on atmospheric evaporative demand in Estonia (1951-2015). The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November, Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>
- Domínguez-Castro, F., Vicente-Serrano, S.M., Jaak Jaagus, Makki Khorchani, Marina Peña-Gallardo (2017). Spatial and temporal variability of droughts in Estonia (1951-2015). The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November, Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>
- Vicente-Serrano, S.M., Juan Ignacio Lopez-Moreno, Kris Correa, Grinia Avalos, Cesar Azorin-Molina, Ahmed El Kenawy, Miquel Tomas-Burguera, Francisco Navarro-Serrano, Marina Peña-Gallardo, Luis Gimeno, Raquel Nieto (2017). Seasonal and annual daily precipitation risk maps for the Andean region of Peru. The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November, Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>
- Vicente-Serrano, S.M., Diego Miralles, Fernando Dominguez-Castro, Cesar Azorin-Molina, Ahmed El Kenawy, Tim McVicar, Miquel Tomas-Burguera, Santiago Begueria, Marco Maneta, Marina Peña-Gallardo (2017). A proposed robust approach for calculating the Standardized Evapotranspiration Deficit Index (SEDI) at the global scale. The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November, Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>
- Vicente-Serrano, S.M., Marina Peña-Gallardo, Jamie Hannaford, Jorge Lorenzo-Lacruz, Mark Svoboda, Steven Quiring, Fernando Dominguez-Castro, Marco Maneta, Miquel Tomas-Burguera, Ahmed El Kenawy (2017) Complex spatial and temporal influences of climatic drought time-scales on hydrological droughts in natural basins of U.S. The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November. Sciforum Electronic Conference Series, Vol. 1. <u>Conference paper</u>