

D.5.6: Documentation of Added Research Capabilities

Title	D.5.6: Documentation of Added Research Capabilities
Creator	Barbara Hofer
Creation date	12/07/2011
Date of last revision	25/08/2011
Subject	Drought IOC, validation, research capabilities, user feedback
Status	<input type="checkbox"/> Draft <input checked="" type="checkbox"/> Final
Publisher	EuroGEOSS
Type	Text
Description	Analysis of added research capabilities
Contributor	WP5 partners
Format	Doc
Source	
Rights	<input type="checkbox"/> Restricted <input checked="" type="checkbox"/> Public
Identifier	EuroGEOSS_D5_6_FINAL
Language	En
Relation	WP5, related to WP2 and WP6
Coverage	Not applicable

These are Dublin Core metadata elements. See for more details and examples <http://www.dublincore.org/>

TABLE OF CONTENTS

1	Introduction	5
2	Drought Research Questions Targeted in EuroGEOSS and beyond	5
3	Ongoing Research in WP5	7
3.1	Comparison of Drought Indices on Different Scales	7
3.2	Impact of meteorological droughts on hydrological droughts in the Ebro basin: capability of the meteorological drought indices to monitor hydrological droughts	7
3.3	Assessment of the capability of different drought indices to monitor agricultural drought in Slovenia	8
3.4	Evaluation of Drought Conditions in Forest Fire Areas – Multidisciplinary Research	8
4	Tools Supporting Researchers in the Drought IOC	9
4.1	Integration of Multi-scale Drought Indices	9
4.2	Metadata Catalogue	9
4.3	Comparison of Drought Indices	10
4.4	Extended Functionality for Viewing Graphs of Time-Series Data	10
4.5	Integration of the European Media Monitor	10
4.6	Data Download Option	10
5	Feedback on Drought IOC from Researchers	10
6	Requirements for Extending the Research Capabilities Across Scales and Disciplines	14
7	Summary and Conclusions	14
	References	16

FIGURES

Figure 1:	Replies regarding desired functionality in EDO.	11
Figure 2:	Diagrams showing the replies on the metadata catalogue.	12
Figure 3:	Feedback on the EDO map viewer	13

TABLES

Table 1:	Research topics in the scope of the EuroGEOSS project.	6
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ACRONYMS AND ABBREVIATIONS

Abbreviation	Name
AIP-2	Architecture Implementation Pilot, Phase 2
AOC	Advanced Operating Capacity
CHE	Confederación Hidrográfica del Ebro, Spain
CNIG	Centro Nacional de Información Geográfica, Spain
CSIC	Consejo Superior de Investigaciones Científicas (Spanish National Research Council), Spain
CSW	Catalogue Services for the Web
DMCSEE	Drought Management Centre for Southeastern Europe
DoW	Description of Work
DOPA	Digital Observatory of Protected Areas
EC-JRC	European Commission, Joint Research Centre
EDO	European Drought Observatory
FGDC	Federal Geographic Data Committee
FGUA-OSE	Fundación General de la Universidad de Alcalá, Observatorio de la Sostenibilidad en España
IDE	Infraestructura de Datos Espaciales de España (Spatial Data Infrastructure of Spain)
IDEE	Infraestructura de Datos Espaciales de España (National Spanish Spatial Data Infrastructure) Spatial Data Infrastructure of Spain
IOC	Initial Operating Capacity
MARM	Ministerio de Medio Ambiente y Medio Rural y Marino (Ministry of Environment, Rural and Marine Affairs), Spain
ONS	Observatorio Nacional de Sequía (National Drought Observatory), Spain
OWS	OGC Web Services

RDF	Resource description framework
SAIH	Sistema Automático de Información Hidrológica (Automated hydrology information system for Spain)
SBA	Societal Benefit Area
SEE	Southeastern Europe
SIA	Sistema de Información del Agua (Water Information System), Spain
SKOS	Simple Knowledge Organization System
SLD	Styled Layer Descriptor
ULBF	Univerza v Ljubljani
UMN	University of Minnesota
UNEP	United Nations Environment Programme.
UNIZAR	Universidad de Zaragoza
WCMC	World Conservation Monitoring Centre
WCS	Web Coverage Service
WCTS	Web Coordinate Transformation Service
WFS	Web Feature Service
WMC	Web Map Context
WMS	Web Map Service
WP	Work Package

1 INTRODUCTION

This report analyses the extension of research capabilities in the subject area of drought thanks to the development of the Drought Initial Operating Capacity (IOC). The Drought IOC (see EuroGEOSS, 2010e) consists of the following main components: a metadata catalogue, the EDO map viewer and data download services.

The Drought IOC, which is at the same time the prototype of a European Drought Observatory (EDO), serves the purposes of discovering data and services related to drought, visualizing and analyzing drought-related data. The analysis can be done online in the EDO map viewer or offline after downloading the data.

EDO serves several user groups:

- a) Commission services in need of up-to-date information on the occurrence, extent and severity of drought events throughout Europe,
- b) international organizations and NGOs,
- c) large companies and organizations interested in water availability throughout Europe,
- d) the general public, including journalists interested in current information on the drought situation in Europe, and
- e) researchers contributing to the development of drought indices and their interpretation and using this information to evaluate different research issues like the drought atmospheric mechanisms or the assessment of the drought impacts over a variety of systems (agriculture, ecology, water resources) and economic sectors.

Due to the focus of the report on added research capabilities, this report contains an analysis of the Drought IOC from the perspective of researchers in the field of drought. A more general assessment and validation of the infrastructure will be provided in report D5.8.

The report covers a series of aspects to understand the contribution of the Drought IOC to the advances of drought research. First research questions posed at the beginning of the EuroGEOSS project are revisited (Section 2). The subsequent section summarizes research that is currently ongoing and covers aspects of drought-data having different scale levels and coming from a multi-disciplinary context (Section 3). After indicating the type of research questions of interest in the drought community, Section 4 discusses the tools that were implemented in the Drought IOC to facilitate these research tasks. Researchers from workpackage 5 provided comments on their understanding of the Drought IOC which are summarized in Section 5. Section 6 goes through required extensions to make the drought infrastructure more useful.

2 DROUGHT RESEARCH QUESTIONS TARGETED IN EUROGEOSS AND BEYOND

At the beginning of the project a series of research questions were defined as objectives for the drought infrastructure and the collaboration during the project runtime. The research topics that are in the scope of the project and beyond are listed in Table 1:

Table 1: Research topics in the scope of the EuroGEOSS project.

Topic	Spatial domain and scale	Potential partners	Relation to EuroGEOSS	Timeframe
1. Inter-comparison of (a) selected drought index (indices) such as SPI, derived e.g. from gridded continental-scale, representative national or station data, and high-density regional network data	Ebro catchment and Slovenia;; regional, national, continental	CHE, OSE/SIA, JRC, ULBF, CSIC, BRGM-Water	Supported by EuroGEOSS approach; within scope; within timeframe; coincident representation for comparison available through WPS	By 2011
2. Improving the dissemination of drought information, benefitting from DMSEE and EDO experience and existing IDE Ebro	Ebro catchment area; regional	CHE, JRC, ULBF	Not core objective of EuroGEOSS, but partly supported through EuroGEOSS; achievable within timeframe	By 2011
3. Identification of common drought indices for all scales and hydrological systems as starting point for multi-scale comparison	All Europe; continental to regional	OSE/SIA, CSIC, EDO, ULBF, BRGM-Water	Supported by EuroGEOSS approach; within scope; within timeframe	By 2011
4. Application of drought information for improved assessment of sustainability (to be specified); derivation and application of drought hazard and risk maps as input to sustainability analysis	Spain; National	OSE/SIA, EDO, CHE, CNIG	Supported by EuroGEOSS approach; marginal to scope; achievable within timeframe; might require additional R&D resources	Within few years
5. Inter-comparison of drought indices between national, international, and continental scale; evaluation of international/sub-continental focal point and respective information.	SE Europe, national to continental	ULBF, EDO, BRGM-Water	Supported by EuroGEOSS approach, within scope; first results achievable within timeframe, to be continued for all DMCSEE MS	First results by 2011, to be continued

These research questions also give an indication of the tools and functionality required for drought researchers. A central aspect is the accessibility of drought indices for the comparison of data from different providers (research questions 1, 5). The required drought indices are current data as well as data referring to past drought situations. The detailed analysis of the drought indices requires the offline availability of the data in most cases.

Besides the required access to the data, the drought research questions and tasks for improved drought monitoring also make an increased collaboration among the institutions involved necessary (research questions 2, 3). The exchange of expertise, learning from partners and agreement on common indices for drought monitoring are part of the main benefits of interoperability in the drought thematic area.

Research questions that exceed the timeframe of the project and need additional resources for research are the derivation of hazard and risk maps as well as the assessment of impacts of droughts (research question 4). These topics show the focus of the drought thematic area for the coming years.

The following sections introduce the research that is currently conducted by colleagues of the drought WP. The research focuses on tasks 1 and 5.

3 ONGOING RESEARCH IN WP5

The drought experts from WP 5 (CSIC, ULBF, JRC) started to work on the following research questions. They are supported from other WP5 partners with data. The results of these research tasks will be provided in the report D5.7.

3.1 Comparison of Drought Indices on Different Scales

Given the variety of drought indices obtained from various datasets at different spatial and temporal scales, a useful task in the frame of the EuroGEOSS project is to inter-compare drought indices obtained from different datasets and spatial resolutions in the same region in terms of how they quantify droughts in time and space or to check how the same drought index may differ as a function of the spatial resolution of the input datasets.

For this purpose two regions in Europe have been selected, in which available drought datasets will be analysed: The Ebro basin, in the North-East of Spain and the region of South-Eastern Europe.

Different time-series statistics will be used to assess the relationship between the temporal evolution of the drought datasets, especially to identify areas with a high variability in terms of drought severity as quantified by the different drought indices. In addition, each drought episode will be isolated and quantified in terms of duration, magnitude and surface extent to determine possible differences among the indices. Differences in drought trends and drought severity from the different drought datasets will be also assessed as well as the areas of low agreement between drought datasets identified.

Expected results are the identification of the most reliable spatial resolutions to identify drought episodes, quantify their characteristics and monitor in real-time droughts.

3.2 Impact of meteorological droughts on hydrological droughts in the Ebro basin: capability of the meteorological drought indices to monitor hydrological droughts

The most evident impacts of meteorological droughts are observed throughout the different parts of the hydrological system. Nevertheless, given the complex interactions between the climate system, hydrological responses and water management it is difficult to isolate the drought impact on river flow and the impact propagation through the entire hydrological cycle. It is commonly accepted that drought is a multi-scalar phenomenon since the time period from the arrival of water inputs to availability of a given usable resource differs considerably. Nevertheless, few studies have analysed the response of stream flows in different catchments to multi-temporal drought indices. Given the spatial diversity of climate, hydrological regimes, surface conditions, demand and management practices, it is expected to detect a spatially diverse response of the different hydrological basins (headwaters, medium course of rivers, etc.) to different time-scales of climatic droughts.

The aim of this task is to develop methodologies to quantify the conveyance of a meteorological drought through the hydrological system, including processes of spatial and temporal propagation that consider river discharges in different parts of a large basin. For such purposes, it is essential to explore the complex physical processes that govern the lag-time between the occurrence of precipitation and the subsequent response of different rivers.

The main outcome of this task is to understand and quantify the influence of meteorological droughts on hydrological droughts and their characteristic time-lag in the Ebro catchment. Some issues related to the main outcome are: i) to understand the propagation of droughts through the different hydrological sub-systems; ii) to assess the spatial differences in the hydrological response to meteorological droughts of different magnitudes; and iii) determining the spatial and temporal lags between the occurrence of meteorological droughts and hydrological deficits. The purpose is to develop an objective methodology that allows to quantify all these aspects in the Iberian Peninsula, but also to be transferable to other regions.

3.3 Assessment of the capability of different drought indices to monitor agricultural drought in Slovenia

The objective of this task is to compare the capability of different drought indices to monitor agricultural drought in Slovenia. Agricultural drought is a result of the interaction of various climatic characteristics during the vegetation season. For the identification of agricultural drought it is important to consider precipitation as well as temperature time series. Agricultural drought usually results in lower crop yields, which is the main reason for higher social vulnerability of farmers in agricultural regions. Lower crop yield is a direct indicator of weather conditions during the vegetation season. It is therefore important to identify the periods and areas, where crop growing is most vulnerable to drought conditions. For this purpose measured yield data and water balance data will be compared to various drought indices on different time scales.

Different meteorological datasets and drought indices will be used to identify the intensity and duration of agricultural drought in Slovenia. For this purpose drought indices on different time scales, estimated from different datasets, will be correlated with standardised drought damage indicators. Agricultural water balance data during the vegetation season will be compared with meteorological drought indices to determine monthly correlation curves in order to be able to identify the main temporal features of drought stress impact on selected crops. Multivariate statistics are going to be employed to identify the optimal combination of various drought indicators in describing agricultural drought.

The main outcome of this task is to understand and quantify the influence of meteorological and agricultural droughts and their characteristics on the agricultural productivity in several agricultural regions in Slovenia. This activity could serve as a pilot for broader research in the region of the South-Eastern Europe, provided appropriate data becomes available.

The most interesting results expected from the study are:

- 1) Better understanding of the impact of drought to agricultural productivity
- 2) Characterisation of the temporal lags between occurrence of meteorological drought and water deficits for agricultural production
- 3) Identification of the periods during the growing season, when the plants are most vulnerable to drought stress.

3.4 Evaluation of Drought Conditions in Forest Fire Areas – Multidisciplinary Research

One aspect that extends the research activities specifically for drought is multidisciplinary research. The drought WP is currently collaborating with the forest WP for performing a joint analysis. The idea of the research is to evaluate the influence of forest fire risk in the months before the main forest fire season.

As a study area the Iberian Pen-insula has been selected. The data that are jointly analysed are the Standardized Precipitation Index (SPI), which quantifies the deviation from statistically expected precipitation, and the location and extent of burnt areas in 2009. The idea is to see if there is a correlation between the drought index and the area affected by forest fires.

This research topic is of interest to evaluate whether drought indices would provide added value to the calculation of forest fire risks. Up-to-now the forest fire risk calculation does consider current weather conditions and the wetness of the vegetation; prolonged drought conditions are not yet taken into account in the forest fire risk assessment conducted by the FOREST Action of the Joint Research Centre.

4 TOOLS SUPPORTING RESEARCHERS IN THE DROUGHT IOC

The initial operating capacity of the drought WP follows the aims of the project for enhancing interoperability, data exchange and the derivation of new information content by improved tools for analysis. The tools developed are discussed below.

4.1 Integration of Multi-scale Drought Indices

Decision making should be based on the best available data. Following this motivation, the principles of interoperability with open services are applied to link multi-scale data from different providers. The objective of the drought WP of the EuroGEOSS project was that, as a first step, data-providing partners publish their data with open standards, preferably WMS. The second step is to provide additional open services for providing time series graphs and data download services. These objectives have been achieved and the result is available in the MapViewer of the European Drought Observatory.

There is a series of issues that need to be considered regarding the linkage of the data. One point is that the web map services should be extended with the time dimension to improve the representation of the time series data in the drought context. Web map services with time were implemented by some partners and in the course of their establishment also automatic updating of the related services was implemented.

An issue that is not implemented yet, is the representation of raster data in one map. The map viewer does however allow presenting one map layer at the time that is the most appropriate for the selected scale level.

The main contribution of the map viewer is the interface to the drought data that are available in the project. The map viewer allows viewing the drought data from different providers quickly and thus helps the researcher to get a first idea of the suitability of the data for her research tasks.

4.2 Metadata Catalogue

The discovery of drought data is the first step of many research tasks. The metadata catalogue is the interface to drought-related data and services from EuroGEOSS partners and beyond. The drought metadata catalogue can be seen as customized interface for the search of data and

services related to drought, thus differing from more generic catalogues like the EuroGEOSS broker.

A series of optimizations have been implemented to enhance the usefulness of the drought metadata catalogue for its expert users. The metadata descriptions contain the metadata elements foreseen in the INSPIRE Directive as well as additional fields needed by drought researchers to assess the suitability of the datasets for their research. The interface of the catalogue includes a series of parameters that can be used for specialized searches. The search for metadata takes also drought-specific keywords into consideration. These keywords have been selected to be part of the 'drought vocabulary', thus supporting more accurate searches by the drought community.

4.3 Comparison of Drought Indices

Since raster images cannot easily be compared by overlaying them in one map window, it was decided to extend the functionality of EDO with a map comparison function. This tool shows map windows next to each other containing different drought indices specified by the user. Map windows are synchronized showing the same part of the map.

The visual comparison of the drought situation as represented by different drought indices is a first step in the analysis of the drought situation. The JRC is currently evaluating possible extensions of the comparison tool to allow the display of maps of drought indices from the past.

4.4 Extended Functionality for Viewing Graphs of Time-Series Data

Besides images providing an overview of the drought situation, temporal graphs of the drought indices are important for the analysis of the drought situation. In the IOC, the partner BRGM provides graphs of the piezometer levels through the GetFeatureInfo option of the web map service. The data from the JRC can be visualized in graphs presenting the evolution of several indicators over long time spans as well.

4.5 Integration of the European Media Monitor

One way to cross-check the information provided in the drought IOC is the linkage to current reports in the media, to assess if droughts reported in the news are present in the drought indices of EDO.

The inclusion of the European Media Monitor, a service of the European Commission providing a constantly updated collection of news, will be carried out in the new version of the EDO portal, being this functionality currently under development.

4.6 Data Download Option

Visual inspection of drought indices and graphs of time series is not sufficient for specific analyses as currently addressed in the research questions of the drought WP, making offline availability of data necessary. The technical approach to download raster data in the interoperable infrastructure is based on the provision of web coverage services.

JRC and DMCSEE are working on setting up web coverage services for the download of raster drought indices. The effective download of data series by drought experts still needs more development and is being addressed in WP2 (data access broker) In the meantime, the data that had to be exchanged for the on-going research tasks have been exchanged in more traditional ways.

5 FEEDBACK ON DROUGHT IOC FROM RESEARCHERS

A questionnaire was sent to the partners of WP5 with the objective to get an evaluation of the interoperable infrastructure of the drought IOC from the perspective of researchers. The questions were rather general since it was necessary to introduce the components of EDO.

The following discussion of the questionnaire is based on the answers of six researchers, of whom two work regularly on the analysis of droughts. Despite the fact that the population is very small, it provides us an indication of how the interoperable infrastructure of EDO is perceived by its users.

The general outcomes of the questionnaire show that the expectations of scientific users of a Drought Observatory differ. Question 4, which was asking for the desired functionality of EDO, shows that the users accept any functionality that is offered as a possibility; no alternative functionality has been proposed (see Figure 1):

Question 4: Which functionality would you expect to be part of a European Drought Observatory?

- A map viewer for visualizing drought indices
- Access to data from institutions providing drought-related data on different scales, in different countries.
- A report on the current drought situation.
- Links to other organizations dealing with drought monitoring.
- Access to time series graphs.
- Data download for offline analysis.
- A metadata catalogue for searching drought-related data and services.
- Current drought news reports from the media.
- Other

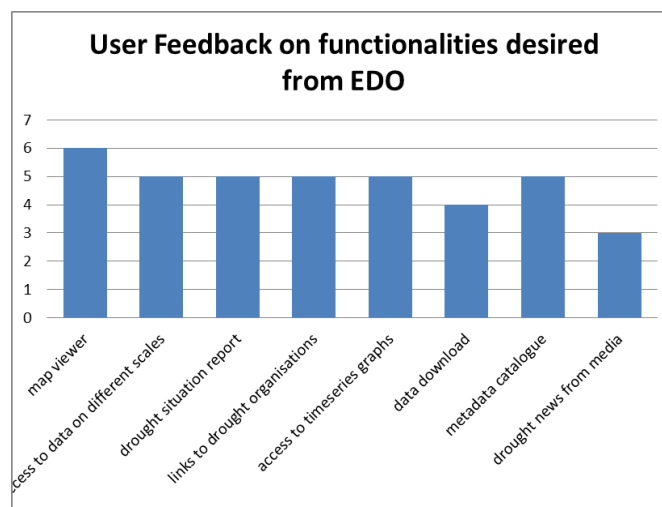


Figure 1: Replies regarding desired functionality in EDO.

The satisfaction of the researchers with the existing metadata catalogue is not completely given (see Figure 2). Interestingly, only 50% of the researchers discovered data of interest when browsing through the metadata catalogue. The discovered data are, however, new to most of the researchers. **A critical question deriving from these results is: are the data descriptions in the metadata catalogue adequate to the needs of drought researchers?**

The satisfaction with the search results of the catalogue is neutral for 50% of the subjects. This low satisfaction rate may point to issues regarding the retrieval of results in the metadata catalogue. If a couple of search criteria are set, the result list remains empty in some cases. The provided

search criteria seem to be acceptable since they are sufficient for nearly three quarters of the subjects.

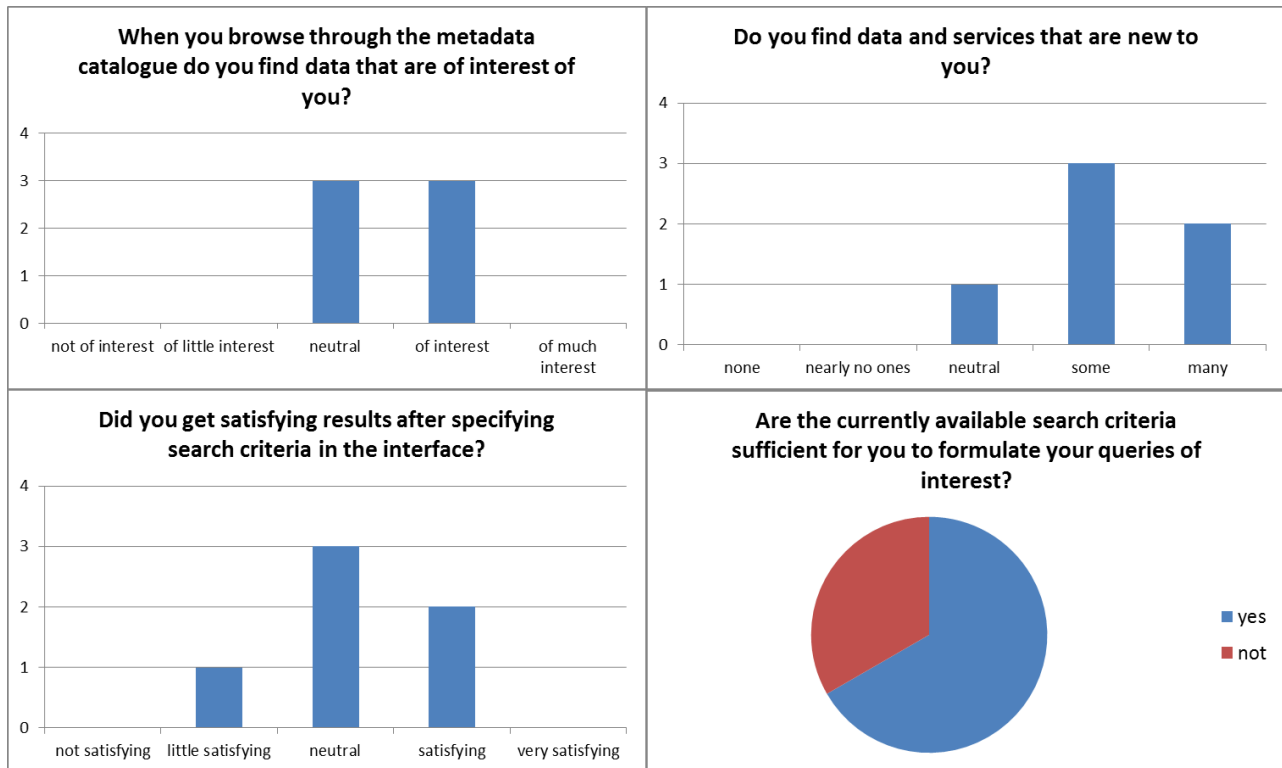


Figure 2: Diagrams showing the replies on the metadata catalogue.

After the discovery of data in the metadata catalogue, the users of EDO visualize the data in the map viewer. The questions/answers regarding the integration of a service of interest in EDO and the usage of the EDO map viewer are shown in Figure 3.

The majority of researchers were successful with the integration of a selected service from the metadata catalogue into the EDO map viewer. Only one user mentioned that (s)he could not find the button for the integration of the service. From our perspective it was important to check, if the users are able to switch between metadata for data and services and then integrate the services in the map viewer, because this separation of metadata sets as foreseen by INSPIRE has some potential to hinder catalogue users at getting quick access to data. A series of users mentioned that they would like to have the option to directly include data in the map viewer after reviewing metadata descriptions. This is already possible for data that have a service linked in the metadata.

In question 4 all users stated that they are interested in a map viewer as part of a drought observatory. Looking at the existing map viewer, only 50% of the users find some interesting data for them in the map viewer, the remaining half of the subjects is undecided about the value of the presented data. Regarding the usefulness of the functions of EDO, most users are undecided. Since the functions are thought to constitute standard functionality of a map viewer, it is not very clear how to interpret the opinion of the users: **Do they want more functions, or less, which functions are missing for them to be content with the functionality of the map viewer?**

Most users would like to have the data available for download. This is interesting, because they state at the same time that the data are not of high interest to them. **Do the data increase in**

value when people can download them and analyze them in the software tools they use normally?

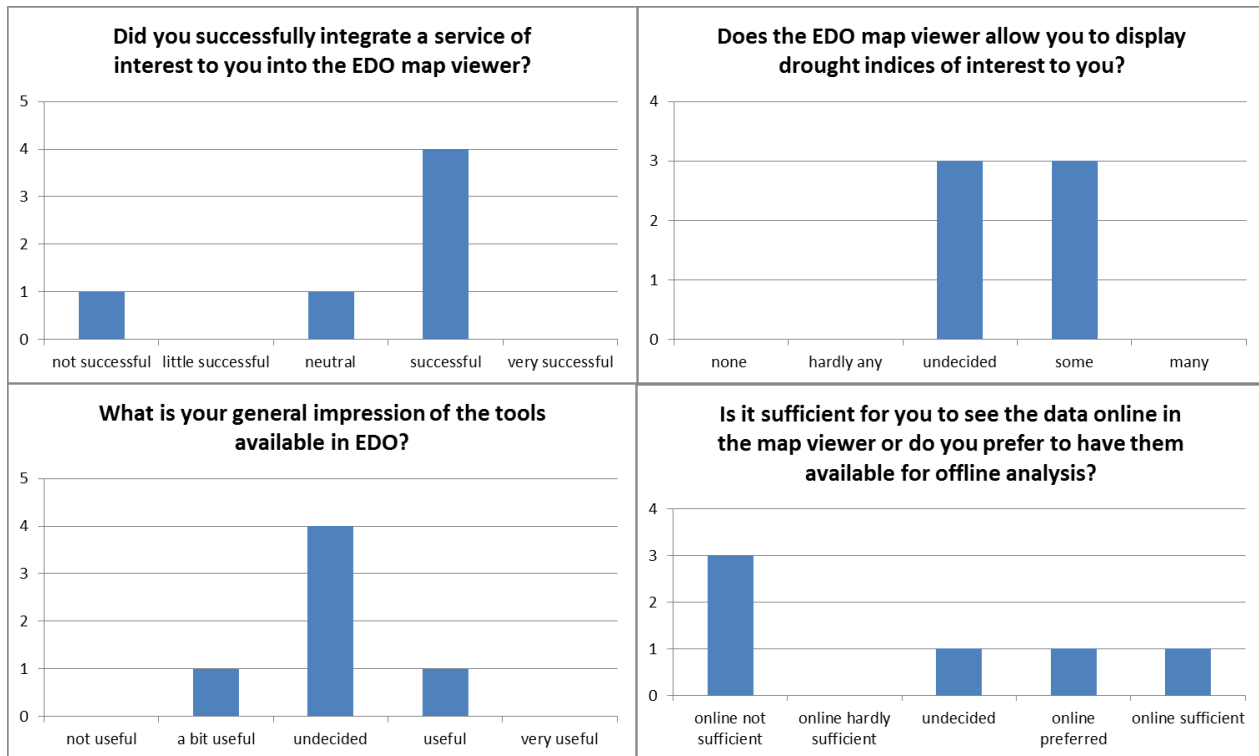


Figure 3: Feedback on the EDO map viewer.

The last question of the questionnaire served to collect general comments. It was asked to give an opinion on the strengths and weaknesses of the European Drought Observatory: Are data layers, general information, analysis functions, etc. missing in EDO? What needs to be improved to make the infrastructure of EDO more useful for your purposes? Did you encounter difficulties when using EDO? The users criticized specific functionality of EDO, which will be analyzed further in the Validation and Assessment Report D5.8. The feedback received that relates to added research capabilities is summarized best in the following comment of a researcher:

“As a scientist I felt it very difficult to answer to the questionnaire. The problem is that to perform my research analysis I need to download drought related data, develop and improve drought indices, and do offline comparisons. In addition, I would like to have links to other organizations dealing with drought monitoring, to access to data from institutions providing drought-related data on different scales, in different countries, and to have a metadata catalogue for searching drought-related data and services. However, I think that the goal of a European Drought Observatory should be to resume the information (from different sources and scales) on drought in Europe and provide it in a clear and easy fashion to decision makers and public in general. The scientific work should be an input to the EDO portal and not an output.”

From this statement it follows that researchers would like to do their research on their own and then see the EDO as a platform for communicating the results and insights gained. In addition, the EDO functionality would have to be extended heavily for actually meeting the needs of the researchers and their tasks.

One possible conclusion is that EDO should be a tool for end users rather than drought researchers. Achieving the completeness and sophistication of the functions required for researchers may exceed the scope of a European Drought Observatory.

The critical questions marked in bold will undergo further analysis in the validation and assessment report D5.8.

6 REQUIREMENTS FOR EXTENDING THE RESEARCH CAPABILITIES ACROSS SCALES AND DISCIPLINES

The drought WP developed a prototype of an interoperable infrastructure with the objective to support drought researchers and to provide timely drought information to the general public. In the course of developing the interoperable infrastructure, different types of open services were tested for their suitability for the drought thematic area; the main services used are WMS and WCS services for visualizing and downloading raster data and CSW (Catalogue Service for the Web) for providing the metadata catalogue.

A series of issues can be improved in the interoperable infrastructure of the drought WP:

- The infrastructure developed contains only data and services of partners of the EuroGEOSS project. In the remaining months of the project, the practical integration of the EuroGEOSS broker and the drought metadata catalogue need to be discussed to reach a more complete overview of available data and services.
- Drought researchers require the drought indices for offline analysis in many cases. The download of data is not sufficiently well supported yet, due to legal and technical reasons.
- Drought data are generally time series of data, because they regularly provide an update of the drought situation. The time dimension adds complexity to the interoperable infrastructure. There is potential for the improvement of the functionality of the interoperable infrastructure for accounting for the time dimension. This is being developed in WP2 of the project.

The discussions with the biodiversity work package and first joint analysis with the forest work package allow first insights in the requirements of multidisciplinary collaborations. It turned out that the data that are currently available in the EDO infrastructure are not yet satisfying the requirements of these interactions. The reasons are that on the one hand, EDO is not an operational product yet and some data are still undergoing revisions; on the other hand, the data need to be customized for the specific question at hand. Whether the production of the required data and the exchange of the data should be automatized depends on how many users require a specific customized data and whether the production needs to be done once or repeatedly.

Thanks to interoperable tools, the integration of data from different continents is possible as well. A global drought monitoring system is currently under development and has substantial political value.

7 SUMMARY AND CONCLUSIONS

The objective of this report was to analyze added research capabilities deriving from increased access to distributed databases and systems at local, national, continental and global levels. For these purposes the report looked at added research capabilities from different points of view. Starting with a review of general research questions in the drought domain and research questions currently under investigation, the report also presented the tools for supporting researchers. The picture was complemented with feedback from researchers on the EDO infrastructure and a summary of requirements for extending the infrastructure.

In short, the main contributions of the Drought IOC to research on droughts are:

- establishment of collaborations between researchers of different European countries and beyond,
- exchange of data among researchers and provision of access to drought-related data,
- development of new tools for the online analysis of drought situations.

By publishing the drought services both on the web and on the EuroGEOSS broker, drought partners can cooperate with other disciplines to exchange knowledge on resources, i.e., datasets, services, and models. The feasibility and value of such collaborations are currently tested in the joint analysis of forest fires and drought with the Forest work package (see 3.4).

One of the main questions raised by researchers was, whether the drought IOC should actually be a tool for researchers. Depending on the needs and legal and technical limitations it may be advisable to focus the tool and its functionality on the requirements of decision makers, administrative users and the general public. The positioning of the drought IOC, i.e., the European Drought Observatory, needs to be further discussed over the coming months.

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