Integrated Drought Management Programme in Central and Eastern Europe



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1. Introduction and overview

Drought is a natural phenomenon occurring in all climates. It is a temporary, negative and severe deviation along a significant time period and over a large region from average precipitation values, which is defined as meteorological drought and might lead to agricultural, hydrological and socioeconomic drought, depending on its severity and duration.

One part of drought mitigation strategies is drought management platform. It is information architecture and an intelligent infrastructure that enables exchange of data, relevant for drought analysis, as well as continuous automated sensing, monitoring and decision support for drought risk management operations.

Drought management platforms are used by drought monitoring centers:

- Bureau of Meteorology (BOM): <u>http://www.bom.gov.au/climate/drought/</u> Australia,
- IGAD clima prediction and application center (ICPAC): <u>http://www.icpac.net/</u> Africa,
- Global Drought Monitor (GDM): <u>http://drought.mssl.ucl.ac.uk</u> UK,
- SPEI Global Drought Monitor: <u>http://sac.csic.es/spei/map/maps.html</u> South America,
- Chile drought monitor: http://sac.csic.es/spei/map/maps.html Chile,
- The National Integrated Drought Information System (NIDIS) and National Drought Mitigation Center (NDMC): <u>http://drought.unl.edu/</u> USA,
- European Drought Observatory (EDO): <u>http://edo.jrc.ec.europa.eu/</u> –Europe¹,
- Drought Management Centre for Southeastern Europe (DMCSEE): <u>http://www.dmcsee.org/</u> – South-East Europe,
- Integrated Drought Management Programme (IDMP): http://www.droughtmanagement.info/

Drought is often represented in terms of drought indices. One of most popular is SPI (Standardized Precipitation Index²). It is an index based on the probability of occurrence of a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount. The index is negative for deficit of precipitation and positive for suficit. Value of -1 is often used as indicator for drought onset. Also popular, particularly in USA, is PDSI (Palmer Drought Severity Index³), which measures the departure of moisture supply. Besides precipitation it also takes into account temperature. Palmer also developed some other indices: PHDI (Palmer Hydrological Drought Index³), CMI (Crop Moisture Index⁴) etc. One of the oldest indices is HTC (Hydrothermal Coefficient⁵), which is widely used in Eastern Europe. In recent years also popular is SPEI (Standardized Precipitation Evapotranspiration Index⁶).

There are also many indicators based on satellite data. One of them is fAPAR (fraction of Absorbed Photosynthetically Active Radiation⁷). It represents the fraction of the solar energy absorbed by the vegetation canopy which is a biophysical variable directly related to the primary productivity of the

¹ Similar platform for Africa is *African Drought Observatory (ADO, <u>http://edo.jrc.ec.ecuropa.eu/ado/ado.html</u>). ² McKee et al. (1993)*

³ Palmer (1965), <u>http://en.wikipedia.org/wiki/Palmer_Drought_Index</u>

⁴ Palmer (1968)

⁵ Selianinov (1928)

⁶ Vicente-Serrano et al. (2010), <u>http://sac.csic.es/spei/home.html</u>

⁷ Baret et al. (2007), <u>http://en.wikipedia.org/wiki/FAPAR</u>



vegetation. Also popular are NDVI (Normalized Difference Vegetation Index⁸), NDWI (Normalized Difference Water Index⁹) and NDDI (Normalized Difference Drought Index).

In recent years also quite popular are indices which combines different other indices. One of these indices is CDI (Combined Drought Indicator¹⁰), which is based on SPI, soil moisture and fAPAR. Another one is VegDRI (Vegetation Drought Response Index¹¹), which uses satellite-based observations of vegetation conditions, climate data, and other biophysical information.

More information on above mentioned drought monitoring centers¹² and their available products is listed in Table 1.

product\monitor	BOM Australia	ICPAC Africa	GDM UK	South America	Chile	NDMC USA	EDO Europe	DMCSEE South-East Europe
meteorological parameters	~	√	~	*	~	✓	~	~
complex indicators	×	SPI, drought index	SPI, PDSI	SPEI	SPI, CDI	SPI, CMI, PDSI	SPI, CDI	SPI
NWP ¹³ products	×	×	×	×	×	×	×	✓
remote sensing data	NDVI	×	×	×	fAPAR, NDVI, NDWI	VegDRI, NDVI	fAPAR, NDWI	~
field reports	×	×	×	×	×	✓	×	✓
impact data	×	×	×	×	×	✓	×	✓
bulletins	\checkmark	✓	×	×	×	✓	✓	✓

Table 1: Drought monitor and their available products.

⁸ Tucker (1997), <u>http://en.wikipedia.org/wiki/Normalized_Difference_Vegetation_Index</u>

⁹ Gao (1996)

¹⁰ Sepulcre-Canto et. al (2012)

¹¹ Brown et. al (2008), <u>http://vegdri.unl.edu/FAQ.aspx</u>

¹² droughtmanagement.info is not mentioned in the table since currently it not real data exchange drought management platform; it is a platform where guidance material and information on all aspects of drought management can be found.

¹³ Numerical weather prediction



2. Selection of IDMP platform

There are several options for selection of data exchange platform for IDMP project. Main consideration was in decision to develop new services or to attach IDMP project to one of existing systems. If decision to develop new services was taken, the logical choice would be to upgrade platform, developed specially for IDM program – droughtmanagement.info. Applying DMCSEE platform and services would require similar resources as building services within droughtmanagement.info platform, therefore DMCSEE platform was not considered. The other option was to profit from past developments and to merge GWP partners and their data with existing services; in that case according to our opinion the logical choice is European Drought Observatory (EDO).

We have considered arguments for both options. Arguments for and against use of each option can be found in Table 2.

Table 2: Pros and cons for selecting droughtmanagement.info and EDO as IDMP platform	fo and EDO as IDMP platform.
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	Droughtmanagement.info	EDO
Pros	 new drought management platform developed specially for the IDMP program and is therefore tailored to its goals 	 central point/platform regarding drought in Europe long term commitment to European countries (also not limited to European Union members) and users continuity of outcomes of the projects (data are available after the end of the project) large past investments into infrastructure (platform has been extensively tested, it is stable and provides many features) relatively easy to integrate, support from JRC staff
Cons	 in early development stage, user services (such as access to data, mapping tools etc.) are inexistent a lot of resources needed to implement drought data exchange platform 	 user interface is very technical and too complicated for users outside of scientific community

Developing a new platform would take time and resources, also after the project end. Since we don't have such resources available within this project, the decisive factor were needed resources for the establishment of platform and EDO platform was chosen. EDO (Fig. 1) is developed by Institute for Environment and Sustainability (IES¹⁴) of Joint Research Centre (JRC¹⁵), a department of the European Commission providing independent scientific and technological support for EU policy-making.

EDO provides:

- continental overview of information on drought,
- visualization and analysis,
- seamless access to regional and national drought information.

¹⁴ <u>http://ies.jrc.ec.europa.eu/index.php</u>

¹⁵ <u>http://ec.europa.eu/dgs/jrc/</u>





Figure 1: EDO homepage (http://edo.jrc.ec.europa.eu/) with map of current droughts based on combined index CDI.

As many continental and global monitoring platforms, EDO also intensely uses modelling systems for drought status assessment. However, many meteorological variables (above all precipitation amount) are very difficult to accurately simulate using only remote sensing measurements and conventional measurements available in global exchange. Thus country drought products prepared from local measurements are crucial for drought status assessment.



3. Geographical information system¹⁶

A geographical information system (GIS) is a system designed to capture, store, manipulate, analyze, manage and visualize all types of geographical data. Two groups of GIS data types can be distinguished: raster and vector, which is then divided to points, lines and polygons.

Outputs of GIS are saved into special formats, which also usually include information about coordinate system, resolution, boundaries, etc.

3.1 Raster

A **raster** data type is, in essence, any type of digital image. Its type consists of rows and columns of cells, with each cell storing a single value (Fig. 2). Raster data can be images with each pixel/cell containing a color value. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors and other options. The resolution of the raster data set is its cell width in ground units. Example of raster file type is map of drought index.



Figure 2: Example of raster data type (figure from http://kmlear.files.wordpress.com/2010/01/raster.gif)



Figure 3: Example of vector data types (figure from http://hds.essex.ac.uk/g2gp/gis/fig42.jpg).

3.2 Vector

A vector data type can be divided into three groups (Fig. 3):

• Points

Points are used for geographical features that can best be expressed by a single point (location). Example is value of drought index on the stations.

- Lines or polylines One-dimensional lines or polylines are used for linear features such as rivers, roads, railroads, trails, and topographic lines.
- Polygons

Two-dimensional polygons are used for geographical features that cover a particular area of the Earth's surface. Example is value of drought index for region.

¹⁶ Mostly based on <u>http://en.wikipedia.org/wiki/Geographic_Information_System</u> and <u>http://en.wikipedia.org/wiki/GIS_file_formats</u>.



Creating raster from vectors is done with interpolation. Different interpolation methods are known: the nearest neighbor method, triangulation, inverse distance weighting method, interpolation with splines, geostatistical methods (various implementations of kriging¹⁷, autocorellation models etc.). Kriging family is commonly used method for preparing maps of drought indexes from station data, since some methods can also take into account different physiographic parameters.

3.3 Mapping¹⁸

In the process of map making the surface of the Earth is usually represented with ellipsoidal surfaces, which is then projected on a map formed into a cylinder, cone or flat plane (Fig. 4). Since a map is a small-scale representation of the Earth's surface it is necessary to apply some kind of scale reduction.



Figure 4: The process of representing the Earth on a flat map (figure from http://kartoweb.itc.nl/geometrics/Bitmaps/Intro%201.6a.gif)

An Earth ellipsoid¹⁹ is a mathematical figure approximating the shape of the Earth. The parameters determined are usually the semi-major axis, a, and either the semi-minor axis, b, or the inverse flattening, 1/f (Fig. 5). There are many different ellipsoids defined in the world, some well-known are the WGS84, GRS80 and Bessel.

To measure locations accurately, the selected ellipsoid should fit the area of interest. Therefore a horizontal datum (also called geodetic datum²⁰) is established, which is an ellipsoid but positioned and oriented in such a way that it best fits to the area or country of interest (Fig. 6). There are a few hundred of these local horizontal datums defined in the world. However in recent years most popular are global (or geocentric) datums, such as WGS84²¹.

¹⁷ Cressie (1993), <u>http://en.wikipedia.org/wiki/Kriging</u>

¹⁸ Mostly based on <u>http://kartoweb.itc.nl/geometrics/index.html</u> and <u>http://resources.arcgis.com/en/help/main/10.1/index.html</u>.

¹⁹ <u>http://en.wikipedia.org/wiki/Earth</u> ellipsoid

²⁰ http://en.wikipedia.org/wiki/Geodetic_datum

²¹ http://en.wikipedia.org/wiki/World Geodetic System





Figure 5: A cross section of an ellipsoid, used to represent the Earth (figure from <u>http://kartoweb.itc.nl/geometrics/Bitmaps/Intro%201.</u> <u>7a.gif</u>)



Map projections²² are typically classified according to the geometric surface from which they are derived. The three classes of map projections are cylindrical, conical and planar or azimuthal (Fig. 7). Examples for cylindrical projection are equirectangular projection²³ (also called geographic or "latlong") (Fig. 8), Mercator²⁴ (Fig. 9) and its derivates, for conic Lambert Conformal Conic projection²⁵ and for planar Stereographic projection²⁶.

Furthermore map projections can be classified by preservation of a metric property. Equal-area projections correctly represent area sizes, equidistant map projections correctly represent distances (in certain directions), while conformal map projections correctly represent angles and shapes (of small areas).



Figure 7: The three classes of map projections: cylindrical, conical and azimuthal (figure from http://kartoweb.itc.nl/geometrics/Bitmaps/Intro%204.10a.gif)

²² <u>http://en.wikipedia.org/wiki/Map_projection</u>, list of map projections: <u>http://en.wikipedia.org/wiki/List_of_map_projections</u>

²³ <u>http://en.wikipedia.org/wiki/Equirectangular_projection</u>

²⁴ <u>http://en.wikipedia.org/wiki/Mercator_projection</u>

²⁵ <u>http://en.wikipedia.org/wiki/Lambert_conformal_conic_projection</u>

²⁶ http://en.wikipedia.org/wiki/Stereographic projection





Figure 8: Equirectangular projection (figure from http://upload.wikimedia.org/wikipedia/commons/thu mb/8/83/Equirectangular_projection_SW.jpg/800px-Equirectangular_projection_SW.jpg .)



Figure 9: Mercator projection (figure from http://upload.wikimedia.org/wikipedia/commons/f/f4 /Mercator_projection_SW.jpg).

A coordinate system enables every location on the Earth to be specified by a set of numbers or letters. Most popular coordinate system is latitude-longitude coordinate system (also called geographic coordinate system²⁷), where position on Earth is given by latitude and longitude. Also commonly used coordinate system is Universal Transverse Mercator coordinate system (UTM²⁸), which divides Earth into sixty zones (UTM zone number), each 6 ° of longitude in width. Each of the 60 zones uses a transverse Mercator projection that can map a region of large North-South extent with low distortion. A position on the Earth is given by the UTM zone number, East and North coordinate in meters. The Gauss–Krüger system²⁹, popular in Central Europe, is similar to the universal transverse Mercator system, but the central meridians of the Gauss–Krüger zones are only 3° apart, as opposed to 6° in UTM.

In GIS, coordinate reference systems and coordinate transformations can be defined with European Petroleum Survey Group (EPSG) Geodetic Parameters Dataset³⁰, a list of univocal four-digit numbers.

Web mapping³¹ is the process of designing, implementing, generating and delivering maps on the Internet and its product. In recent years there has been an explosion of web mapping applications (also called Web GIS), such as Google Maps³².

For web mapping, the Open Geospatial Consortium (OGC³³) has defined standardized services, such as the *Web Map Service (WMS*³⁴). WMS is mainly a view service, displaying geospatial information in a raster format.

- ²⁸ <u>http://en.wikipedia.org/wiki/Universal_Transverse_Mercator_coordinate_system</u>
- ²⁹ http://en.wikipedia.org/wiki/Gauss%E2%80%93Kr%C3%BCger coordinate system
- ³⁰ http://www.epsg.org/ ; List of all EPSG codes: <u>http://spatialreference.org/ref/epsg/</u>.
- ³¹ Based on <u>http://en.wikipedia.org/wiki/Web mapping</u>.

³³ http://www.opengeospatial.org/

²⁷ http://en.wikipedia.org/wiki/Geographic coordinate system

³² <u>https://maps.google.com/</u>

³⁴ http://www.opengeospatial.org/standards/wms, http://en.wikipedia.org/wiki/Web_Map_Service



4. European Drought Observatory (EDO)

Two main tools on EDO are EDO MapViewer³⁵, a web mapping service (Fig. 10), and Drought Metadata Catalogue³⁶ (Fig. 11), a web application for searching and updating the drought metadata catalogue.



Figure 10. EDO MapViewer showing SPI1 for October 2013 from external source DMCSEE.





 ³⁵ <u>http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1120</u>
 <u>http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1103</u>



EDO MapViewer enables the visualization, overlay/comparison and interrogation of spatial datasets over the Internet, using also WMS protocol. More examples of usage of EDO MapViewer can be found in the Appendix A.

Drought Metadata Catalogue was developed by the University of Zaragoza for EuroGEOSS FP7 Project³⁷. The Catalogue is INSPIRE (Infrastructure for Spatial Information in the European Community)³⁸ compliant. The catalogue functionalities were improved including a "Drought Vocabulary"³⁹, defined and implemented during the project. The catalogue provides search, discovery and preview facilities of spatial and non – spatial metadata. More information about Drought Metadata Catalogue search functionalities can be found in the Appendix A.

³⁷ EuroGEOSS demonstrated the added value to the scientific community and society of making existing systems and applications interoperable and used within the GEOSS and INSPIRE frameworks. EDO was greatly upgraded during this project.

More information about project: <u>http://www.eurogeoss.eu</u>.

³⁸ INSPIRE is an EU initiative to establish an infrastructure for spatial information in Europe.

More information: <u>http://inspire.ec.europa.eu/</u>.

³⁹ More information available in <u>http://www.eurogeoss.eu/Documents/D%205%202b_final.pdf</u>, keywords can be found in the Appendix B.



5. Integration of new data into EDO

Partners are expected to collect existing national data (SPI and any other indicators that are used in partner's countries for identifying or forecasting drought) and make them available through EDO. Data can be in raster or vector format (shared via WMS protocol), links to documents (field reports, bulletins etc.) or national web pages providing drought information.

IDMP project description will be added to EDO webpage⁴⁰ as shown on Figure 12.

Sitemap Legal notice Contact Search
JOINT RESEARCH CENTRE
EDO - European Drought Observatory
European Commission > JRC > IES > EDO > EDO Home > Projects
EDO HOME CURRENT DROUGHTS DATA & TOOLS
Drought Projects
We are currently involved in four different projects that are directly or indirectly linked to the European Drought Observatory (EDO). The EuroGEOSS and CARPATCLIM projects focus on Europe. EuroGEOSS is directly linked to EDO as a whole, while CARPATCLIM is expected to contribute to the improvement of meteorological data used for the Carpathian region in EDO. The DEWFORA and EUROCLIMA projects also share EDO's philosophy in terms of product development and data access through a web management system, but the focus of these projects focus is on Africa and Latin America respectively.
EuroGEOSS
The EuroGEOSS project aims to enhance collaboration and data exchange in the thematic areas of drought, forestry and biodiversity. The infrastructures developed in the project are based on GEOSS and INSPIRE regulations for interoperability (GEOSS is the Global Earth Observation System of Systems and INSPIRE is the directive on an Infrastructure of Spatial Data of the European Commission). The objective is to enhance the reuse of existing data collections and applications and derive new insights through the analysis of the data made available.
The drought group of the EuroGEOSS project works on the integration of drought-related data from continental, national, regional and local organisations. The ultimate goal is improving the decision making capabilities of the European Drought Observatory by complementing continental overview data with data from more detailed scales. The EuroGEOSs infrastructure guides its users through the following steps: data discovery, data visualization, data analysis, data download. The website provides the relevant tools and links in the "Data & Tools" section.
More information on the EuroGEOSS project can be found here



5.1 Drought Metadata Catalogue

In Drought Metadata Catalogue information about drought can be added with abstract (description of variable), keywords, link and contact. This information can be data (raster or vector), links to documents (field reports, bulletins etc.) or national web pages providing drought information. Real-time or near real-time information is preferred, however climatological information can also be added.

This task is obligatory for partners.

5.1.1 Metadata

Metadata⁴¹ can be simply described with "data about data". In the Drought Metadata Catalogue metadata are descriptive: data providing information about of the data with standard language. Example of metadata is indicator name, indicator description, organization, availability etc.

⁴⁰Under Home -> Projects: <u>http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1004</u>.



Metadata are stored in a service called metadata catalogue which allows easily browsing of summary of all the data. Other users, organizations or companies can also find the data if catalogues are publicly available. Metadata catalogues are essential to enable interoperability.

5.1.2 Needed information

Needed information can be divided into few subsections:

- Organization
 - Name of the organization responsible for the indicator.
- Contact (e-mail)
- Indicator name
- Indicator description
 - How is the indicator created? Which software was used for preparation? Is it done manually or automatically through a spatial model or GIS analysis?
 - How the component was assessed: Monitored, Calculated, Estimated.
 - What is calibration period?
 - What is the frequency of updating information?
- Availability of information
 - Is the information available to the public? If so, link to the webpage.
- Data Range Available
 - Indicate the range of data from which information is available.
- Geographic extent
- Keywords⁴²
 - o Type of drought
 - Which is the type of drought that the indicator assesses?
 - o Etc.

5.1.3 Preparing metadata

Metadata are saved in XML⁴³ (Extensible Markup Language) file format. This is a textual data format, therefore it is both human-readable and machine-readable. It is widely used for the representation of arbitrary data structures, for example in web services.

There is a variety of free, commercial and on-line software tools available to support metadata development:

- CatMDEdit (<u>http://catmdedit.sourceforge.net/</u>, free),
- INSPIRE Metadata Editor (http://inspire-geoportal.ec.europa.eu/editor/, free, online),
- ESRI ArcCatalog (part of ArcGIS: <u>http://www.esri.com/software/arcgis/</u>),
- ISO Metadata Editor (http://www.crepad.rcanaria.es/metadata/en/index_en.htm, free),
- Altova XML Editor (http://www.altova.com/xml-editor/),
- Etc.

⁴¹ <u>http://en.wikipedia.org/wiki/Metadata</u>

⁴² Possible keywords can be found in the Appendix B.

⁴³ <u>http://en.wikipedia.org/wiki/XML</u>



For Drought Metadata Catalogue two options are preferred: CatMDEdit and online INSPIRE Metadata Editor. Both have some advantages and disadvantages. CatMDEdit includes all the sections of interest for metadata (keywords) however it is not easy to use. On the other hand INSPIRE Metadata Editor is easy to use, moreover it is fully compliant with INSPIRE directive, but it has low number of groups for metadata (keywords). However due to simplicity *INSPIRE Metadata Editor is recommended*.

Example how to prepare metadata with INSPIRE Metadata Editor can be found in the Appendix B.

5.2 EDO MapViewer

Raster maps can be added to EDO MapViewer under new section IDMP (example on Figure 2 for DMCSEE). Maps can be real-time or near real-time (daily, weekly, monthly or yearly). Data must be provided using WMS protocol. Raster data are preferred, however also vector data can be added. This task is not obligatory however it is highly desirable.

5.2.1 WMS

WMS (Web Map Service) is one of standard protocols defined by OGC which serves georeferenced map images over the Internet (Fig. 13).



Figure 13: Schematic idea behind WMS.

There are a lot of WMS servers available on the market, for example:

- GeoServer <u>http://geoserver.org/</u>,
- OSGeo MapServer <u>http://mapserver.org/</u>,
- QGIS Server (previously Quantum GIS) <u>http://qgis.org/</u>,
- ArcGIS Server <u>http://www.esri.com/software/arcgis/arcgisserver/</u> (non-free).

One of the first and well known WMS servers is OSGeo Mapserver, which was launched in the mid-1990s. It is lightweight, runs on different platforms and supports many file formats. It is easy to install however more difficult to configure.

Maps can be added to existing WMS server. Because of the INSPIRE directive these service should be available at national level. Partners can also check availability of WMS service in IT departments of their institutions. If partners would like to establish their own WMS server, <u>help can be only offered for OSGeo MapServer</u>.



Appendix A

EDO MapViewer functionalities

EDO MapViewer contains all the basic functionalities typical for web mapping service (Fig. 14). It provides view on continental and regional scale with data from external sources (Fig. 15). Additional it is also possible to compare up to four different indicators at the same date (Fig. 16) or compare the same indicator at up to four different dates (Fig. 17).



Figure 14: EDO MapViewer - basic functionalities.



Figure 15: EDO MapViewer - multiscale approach example for external DMCSEE.





Figure 16: EDO MapViewer – compare four different indicators together at the same date.



Figure 17: EDO MapViewer – compare the same indicator at four different dates.

Drought Metadata Catalogue search functionalities⁴⁴

Drought Metadata Catalogue can be searched by:

- location (with bounding box) (Fig. 18),
- keywords or text (Fig. 19),
- Societal Benefit Area (SBA) (Fig. 20),
- SBA sub-categories (Fig. 20),
- temporal parameters (Fig. 21).

⁴⁴ Based on <u>http://www.eurogeoss.eu/Documents/EuroGEOSS_D_5_2.pdf</u>.



UROGEOSS: DROUGHT CATALOG - Mozilla Firefox			
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Figure 18. Drought Metadata Catalogue – search criteria: location.

RUROGEOSS: DROUGHT CATALOG - Mozilia Fire	col Herramientas Anuda	
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AREA	Results	
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bola 🖻	Catálogo de servicios de información pregráfica de la IDIZ	Catalogo de território de información peoprática OGC CSW 2.8.2 de la Defenementara de dante espaciales de España-
Clevelology/Metorslogy/Metosphere economy	(turopa)	DGFB/DCDOH: Demandia enseptitos de los procesos que utilizan esergía para obtener un servicio o un bien experiêncida con final. Endi nel del concenso anargénies de un qui i grantem de anargía primaria), viños na pares de la energía linga a utilizarse en un soco final, pares la esta parte se parde en los diferencies procesos de interformatión energína. Der tanta el concenso final que concerto que do concerto que do concerto de interformatión energína. Der tanta el concenso final que concerto que do con energína administra de concerto final que concerto que do concerto que do concerto que do con-
environment naming Strategistic Information	Emisiones de gases de electo invernadero generatios por el transporte (suropa)	DEFINICION: Envisione de grate de elvers inventadero (EED, especialez en 1.00 manifaita de la contaminación en CO2 exprésionante (CO2-expl. index exprésionante y en procumente del costos inspecifiéros. Réglatoria: Chara espectado es las companies nos el prover de la companies resultas comunia e fin de complet el objetivo de reductos para 2000-2012 astantido por la Unión exemp
E. Search Dean		1 2 3 4 5 6 7 8 9 10 Navt >>

Figure 19. Drought Metadata Catalogue – search criteria: keywords or text.



BURDCEOSS DROUGHT CATALOG - Macilla Fir Arthyo Editar Ver Historial Macadores V	don. Acci Henamentas Anala		1012
CURDEEDIN DROUGHT CATALOS			T
GEOSS Eurogeoss: DI	ROUGHT CATALOG		
AREA	R Results		
ETWORDS (* as weldcard) P TTYE Constrate Bookstrat ABEA © Abountary • Observations	Results list Results 1 to 10 fc JRC DDD (screpper Area toronget for Generations) Baser Cartage Add DE WES Mersona a tracket del Plan Nacional de Ortef (charge allo Adress de trackates de la tracket partie allo Adress de trackates del Plan Nacional de Ortef (charge allo Adress de trackates del Plan Nacional de De Adress de trackates del Plan Nacional de del Plan Nacional de trackates del Plan Nacional de del Plan	al Benefit Area (SBA) ub-categories www.geoportal.org)	1.1.6 Anadrochi- de la lociar del ano Georgidio Nucleos al a parti fido y neinstalo parto de argo en el del MTHOE, que cobre parto de rise cianos es di solari de decorgen el montene en di adato, de decorgen de MTHOE, que cobre parto de res cianos en di adato. El montene en de decorgen de decorgen de MTHOE, que cobre parto de res cianos en di adato. El montene de una nuestra, que el forma el ma nuestra, que el forma el ma nuestra, que el forma el montene en la cience.
+ Daabers + Ecosystems	Latilogo de servicios de información presentifica de la 1015	Confederaciones Hologophicas Catalogo de consister de información geográfica OGC CSIV 2:8.2 de la Estiment Estaña	umara de datos espaciales de
i Drungy i Haukh	Consumo de energía final por sectores (turopa)	DEFINICION: Demanda energitica de los protectos que utilizan energía para ol específico da sea final. Cod estas del conserva energíates da una sea Servanere de de la energía flega a collectora en un toto final, poro la teta parte ta pierte en los transformación energitica. Per tatas, el conserva final se comerço en con- transformación energitica. Per tatas, el conserva final se comerço per el co-	tenerun servicis olar ben recepto primeria, elle ora purto d'henerat processe de
HROM DATE TO DATE	Envisiones de gases de electo invernadero generados por el transporte (Europa)	DEFEIDECION: Envisioner de gener de vênte inversadere (SEE), expresader en contaminación en CO2 expresadere (CO2-eq), isolide aquivalente y en precom Macanymercius a endoción en las investestés en el activo es transpilar en estada elsettivo de reductión para 2005-2012 asumido por la Unión europa.	1.800 runeladoz de la Inst del rezue trapodièries, voenciet a lin de compler et
TUPE CATEGORY (ISO 19115)		123 ± 5678910 64000 xx	

Figure 20. Drought Metadata Catalogue – search criteria: Societal Benefit Area (SBA) categories and sub-categories.

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Archivo Editar Ber Higorial Marcadores Suho	of Herranterijas Ayışda		
GEOSS EUROGEOSS: DRO	DUGHT CATALOG		
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	Results list Results 1 to 10 f 38C EDG (everage over through A	al parameters	hida Yugalla da anarek a la derologisko da las bojat del el del 1971, por el forenzo, Ropoliko Hustened a parte romboro de disco concider y atentado parte
EEYWORDS (* as wildcard) *	CHEWES Posseco a escala 1:50.000 de másema recolación de la hoja 0410 de actolotografia del Pian Nacional de Ortolstografia Aérea de Janués	Web Parton Server maintained by the CPE Monitor do maintaine replacin do othercognities con la Committee do Anagin. El transito de parte es de en RRB y está conferencia par logia PUTRID on ET 44 (CPR) a (Performa estatod) formate staged con 1	respondences a la hoja 0400 del PITIGO, que oder parte de 50 on y el año de capitus de las deste se el 2005, El nocaso Ristr (muna ICOS), Se essentros en la página de descargas en unitara da la parto.
TYPE 2 - dry-	Moseico a escala 1:50.000 de máxima actualidad de la heja 0410 de entefotografia del Plan Nacional de Ortofotografia Aérea de España.	Mocatos de máxima actualidad de emoletoporfas co la Comunitad de Acepin. El termide de pinal es de en RisB, y está compresido por hogos PITAS de ET del Cristis, el fichere vectorial (benars chape) con la	engandiantes a la hoja 0428 del MEVRE, que colera parte de 30 om y el são de captura de las desta estal 2006, El monaios REM Remando ECHE, Sa encuentra en la página de decempos o monarco de las zon
FRUMDATE	Indicadores de sostenibilidad 2007 del OSE	π.	
	Índice de calidad general de las aguas (España-CEAA)	DEFERCIÓN: Valor admensional, obrenido a part tables lo calidad de las aguas maperfutidas contraents remanentado, RELEVINCIAN (E) yas tede ador de EM Confederaciones Philosphilis es	in de 23 paraimeerot analitiost de una muestra, que informa líne. Varia entre 8 (aquas may contaminador) y 130 (aquas sin ado, ha sale empleado deole la década de los sofrenta per las
* + january 2018 S M T W T	 * tálogo de servicios de información € 5 ográfica de la IDEE 	Catiloge de services de información geográfica OO España	IC CSM 2.0.2 de la Señaestructura de clutos espaciales de
LL Search 10 1 4 5 6 7	9 meano de energia linal por sectores 5 16	DEFIDICIÓN: Denverda exemplitos de los proceso específico de cos final. Del total del concurso energo de la exempla llega a utilizate en en uto final, para transformación amergiática. Por tanto, el concurso fin	e que utilizer energia para albonar un tervicio o un bian álico de un paíz (concurso de energia pelmania), tobo una parte la otra guerra se glavale en los diferentes procesos de al es mator que el co
17 18 13 20 21 2 24 25 25 27 28 2 31 1 2 1 4	2 23 5 30 nerados por el transporte (turopa)	DEFERCION Environes de gases de effecto inven- cemaninación en CO2 equivalente (CO2-eq), ácile REIEVANCIA: La reducción de las embienes en el adjutivo de reducción para 2000-2002 acurida por	radere (981), espresados en 1.000 toxeladas de la o españolentes y en penarmons del econo trapolónica. Sector del transporte reculta esencial a fin de complir el la Unión europ
18 4 4 4 H	2 (10)	1 2 3 4 5 6 7 8 9 10	biot 22

Figure 21. Drought Metadata Catalogue – search criteria: temporal parameters.



Appendix B

TheDrought Vocabulary⁴⁵

The Drought Vocabulary was developed within EuroGEOSS project. It contains 103 keywords related to drought which have been translated into 15 languages, among them also in English, French, German, Spanish and Italian. Keywords in English are listed in next subsection.

Keywords

agricultural drought alert anomaly arid climate arid zone climate climate change climate variability composite drought indicator cumulative departure from normal or climatologically expected precipitation cumulative precipitation deficit desertification discharge DMCSEE Drought drought control drought duration drought early warning drought end drought forecast drought frequency drought hazard drought impact drought indicator drought intensity drought management drought map drought mitigation drought monitoring drought monitoring system drought onset drought overview drought plan

drought product drought region drought resilience drought risk drought severity drought spatial extent drought status drought stress drought threshold dry season EDO emergency European drought product evaporation evapotranspiration **f**APAR GPCC data groundwater heat stress hydrological drought hydrological drought index hydrological status Hydrology low flow meteorological drought meteorological drought index meteorological state Meteorology National/multinational drought product Natural hazard NDWI normality PDSI piezometric level

⁴⁵ Based on http://www.eurogeoss.eu/Documents/D%205%202b_final.pdf.



- potential evapotranspiration pre-alert precipitation precipitation anomaly precipitation deficiency (amount, intensity, timing) precipitation deficit precipitation percentile rainfall rainfall anomaly Regional/local drought product Remote sensing remote sensing product reservoir reservoir volume semiarid climate semiarid zone snow snow pack
- Soil soil moisture soil moisture deficit spatial assessment of drought SPI Statistics timeseries trend type of drought vegetation productivity vegetation state index vulnerability to drought water deficit water runoff water scarcity water stored in reservoir water stress weather extremes

Example of preparing metadata with INSPIRE Metadata Editor

INSPIRE Metadata Editor is online metadata editor (<u>http://inspire-geoportal.ec.europa.eu/editor/</u>). Main page is shown on Figure 22. Editor has menu and tabs with different topics. Under each topic there are several forms which need to be completed. Instructions which forms to complete inside each topic and what to write/select are in next subsection. More information is available under Help in the menu or by pushing the information button (shown as Help on Fig. 22) next to each form.

INSPIRE GEOPORTAL		
Enhancing access to European spatial data		
OPEAN COMMISSION > INSPIRE > INSPIRE GEOPORTAL > Metadata Editor	Menu.	
New Open Validate Save Save as template Help About MSP/RE Spatial Dataset - en by os da de el el el el el el el e	t f f hu t t lv m	guide What's new nl pl pt nosk sl sv
Metadata on metadata Metadata point of contact (*) Point of contact 1 Organisation name (*) E-mail (*) E-mail (*) Metadata date 2014-04-20 Metadata ianguage (*) english (*) This field is mandatory	labs.	

Figure 22. Drought Metadata Catalogue – main page.



Instructions

The whole process can be summarized in 13 steps:

- **STEP 1:** Navigate to online metadata editor (<u>http://inspire-geoportal.ec.europa.eu/editor/</u>). Under tab *Metadata* insert organization name and e-mail address. Please leave language set to English (see Fig. 23).
- **STEP 2:** Switch to *Identification* tab. Insert full name of your data or product under Resource title and short unique code (see Fig. 24 for suggestion). According to Fig. 24, write short description, insert link to data resource (or to institution that provides it) and indicate language in which the resource is available.
- **STEP 3:** Switch to *Classification* tab. Select one or more topics (see Fig. 25 for suggestions).
- **STEP 4:** Switch to *Keyword* tab. Ignore first two insert fields (Keyword from INSPIRE Data Themes and Keywords from repositories) and move to Free keyword entry. Choose keyword from Appendix 6.3 and insert it as Keyword value. Insert the rest of the entries as it is shown in Fig. 26. Press Apply button. You are encouraged to insert as many keywords as you find relevant.
- **STEP 5:** Switch to *Geographic* tab and select your country (rest is filled in automatically; see Fig. 27).
- **STEP 6:** Switch to *Temporal* tag. Under Starting date, insert the date from which the data is available (see Fig. 28 for suggestions).
- **STEP 7:** Switch to *Quality&Validity* tab. Under Lineage entry, insert information about the data (see Fig. 29 for suggestions).
- **STEP 8:** Switch to *Conformity* tab. Click to Specifications entry and press ENTER. Choose first option (as suggested in Fig. 30), rest is filled in automatically.
- **STEP 9:** Switch to *Constraints* tab. Here you can set limitation to use your data (you can get suggestions by clicking on an entry and pressing ENTER). Most desirable is that you allow free use of the data (see Fig. 31 for suggestions).
- **STEP 10:** Switch *to Responsible party* tab (depending on screen resolution, it might be hidden; in that case, rescale the right window). Insert name of responsible institution (probably same as in Identification tab), contact address and role (see Fig. 32 for suggestions).
- **STEP 11:** Click *Validate* in the navigation bar. If everything is OK, you should get only two error messages, shown in Fig. 33.



- **STEP 12:** Click *Save* in the navigation bar. Save the file to your computer.⁴⁶
- **STEP 13:** Rename file to Country-Name_of_the_indicator.xml (e.g. SI-Drought_bulletin.xml) and send it to <u>luka@bo-mo.si</u>.

New (Open Valida	ate Save	Save as	template	Help A	bout	INSPIRE Spa	itial Dataset - en	bi		a de e	l <mark>en</mark> e
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english	•											
) This field	is mandatory											

Figure 23. INSPIRE Metadata Editor – Tab Metadata.

⁴⁶ File can be reedited using Open button in the menu and selecting saved file from computer.



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	Classification Keyword Geogra	aphic Temporal Quality&Validity Conformity Constraints Responsible
Resource title (*)	0	Name of indicator or bulletin (in English!).
Identifier (*) Identifier 1 (*) Code (*)	0	Unique code, suggested is Country- Name_of_the_indicator (e.g. SI- Drought_bulletin).
Resource abstract (*)	<	Description of the resource (add also calibration period, frequency of updating information etc.).
		1
Resource locator	0 0	
Resource locator Resource locator 1 Linkage (*)		Link, where this resource is available. If resource is available on request, link from the institution.

Figure 24. INSPIRE Metadata Editor – Tab Identification.

New Open Validate Save Save as template	Help About INSPIRE Spatial Dataset - en bg cs da de el <mark>en</mark> es
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CLASSIFICATION OF SPATIAL DATA AND SERVICE	ES
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climatologyMeteorologyAtmosphere	selections, preferred is Climatology
Climatology / Meteorology / Atmosphere 🔻	/ Meteorology / Atmosphere).
(*) This field is mandatory	

Figure 25. INSPIRE Metadata Editor – Tab Classification.



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* Keyw	ord value (*) 🧲		0		(Chap	ter 6.3).	om the App	Jenuix	
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2011	-04-19		Dat	e of publicatio	n 🔻				
	/				Add k	eyword.			
Analy									

Figure 26. INSPIRE Metadata Editor – Tab Keyword.

Metadata Id	lentification (Classification	Keyword	Geographic	Temporal	Quality&Validity	Conformity	Constraints	Responsible pa
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Countries	<			L					
select a v	alue		•						

Figure 27. INSPIRE Metadata Editor – Tab Geographic.



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										b	g cs da de el <mark>en</mark>
letadata	Identificat	ion Cla	ssification	Keyword	Geographic	Temporal	Qualit	y&Validity	Conformity	Constraints	Responsible par
Fempor Individua	al referen	nce ral refere	nce elemen	ts are cond	tional but one o	or more temp	ooral rei	erence mus	t be provided.		
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* Sta	rting date	←		▼ En	ding date						
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Date of	publication										
Date of	last revisior		Ĩ)							

Figure 28. INSPIRE Metadata Editor – Tab Temporal.

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letadata	Identification	Classification	Keyword	Geographic	Temporal	Qualit	ty&Validity	Conformity	Constraints	Responsible part
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Figure 30. INSPIRE Metadata Editor – Tab Conformity.







Figure 32. INSPIRE Metadata Editor – Tab Responsible party.



	INSPIRE validation errors: 2
	 The metadata element "Inspire Spatial Data Theme" is missing, empty or incomplete but it is required
	The metadata element "Conformity" is missing, empty or incomplete but it is required. Hint: "Expected citation: Commission Regulation (EU) No 1089/2010 of 23 November 2010
_	implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services"
	INSPIRE validation warnings: 0
	Close

Figure 33. Drought Metadata Catalogue – expected errors after validation.