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Decision support tools of European Environment Agency

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Abstract: The European Environment Agency (EEA) is an agency of the European Union. Its task is to provide sound, independent information on the environment. EEA is a major information source for those involved in developing, adopting, implementing and evaluating environmental policy, and also the general public. Currently, the EEA has 33 member countries. The paper introduces updated decision support tools of the EEA which integrate information and communication technologies (ICT) and data management. There are discussed relevant Information and Communication Technologies (ICT), databases and sharing data with the European Copernicus programme, data centres of EEA, Eurostat and the Joint Research Centre including the Shared Environmental Information System and INSPIRE activities.

Keywords: Decision support, EEA, SEIS, INSPIRE, Copernicus.

1 INTRODUCTION

The European Environment Agency (EEA) (EEA, 2016) is one of the most important agencies of the European Union (EU) and provided sound, independent information on the environment with using efficient Information and Communication Technology (ICT). It is located in Copenhagen, Denmark. The EEA is a major information source for EU decision makers involved in developing, adopting, implementing and evaluating environmental policy on EU and Member States (MS) level, and also the general public. Currently, the EEA has 33 member countries (including accession countries to EU). The Regulation of the European Commission (EC) (EC, 2009) on the European Environment Agency and the European Environment Information and Observation Network (Eionet), has amended the past Regulation from 1990. EEA's mandate is to help the EU and member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability and coordinate the Eionet (Eionet, 2016) and Reportnet (Reportnet, 2015), which is Eionet's infrastructure for facilitating and improving data submission based on environmental reporting obligations.

The EEA, according to the 7th Environment Action Programme (EAP) visions (7EAP, 2013), aims to support sustainable development and to help achieve significant and measurable improvements in information about Europe's environment, through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

With the aim of using ICT to improve its core business, EEA intends to:

- Strengthen its role as a service provider;
- Improve information services delivery through partnerships;
- Improve access to its information services;
- Increase the efficiency of its information service delivery;
- Expand the use of its information services through dialogue instruments;

to enlarge the knowledge base for decision makers of environmental policy in Europe.

Advancements in ICT are crucial for the way in which the EEA fulfils its objective of giving "*Europe's decision makers and citizens the independent information they need to make informed choices about the environment*". From the outset, the EEA has had a strong focus on delivering products to decision makers in the EU and its MS. By embracing ongoing ICT opportunities the EEA has in parallel established its website as a key node for environmental information available for decision makers, scientists and interested citizens.

With the emergence of new web technologies, the EEA is moving into a new era aiming to engage in dialogue with multiple audiences by taking on and exploring various kinds of ICT tools and opportunities. In addition to conventional and already established publications and one way information channels, EEA will continue to explore and make use of more and more two-way communication.

The aim of the paper is an introduction of the recent updated strategy of the EEA to update decision support ICT and data management tools and discussion how EEA operates in a complex, multi-level and multi-actor governance setting at EU e.g. Copernicus (Copernicus, 2016), Eurostat, (Eurostat, 2016), INSPIRE (INSPIRE, 2016), Shared Environmental Information System (SEIS, 2016) and Data Centres of EEA, Eurostat and JRC (EDC, 2016) national, and global levels, which also include research institutes e.g. the Joint Research Centre (JRC) (JRC, 2016), businesses, and nongovernmental organizations. We discuss the specific role of the EEA to decision makers in EU MS, using the Eionet as its unique partner to generate two-way flows of quality-assured environmental data and information.

2   INFRASTRUCTURE FOR DECISION SUPPORT TOOLS

In the past few years the EEA's environmental information systems in general as well as shared environmental datasets of the EEA data centre (EDC, 2016), Eurostat (EDCW, EDCNR, 2016), the Join Research Centre (EFDAT, ESDC, 2016) and European union open data portal (EU Data, 2016) have been supporting decision making processes within the EU MS and have undergone rapid development and grew up to support the knowledgebase of European Commission and EU MS. Specifically, new infrastructure to support supply services (collection and sharing of environmental data); networking (knowledge management); workflows (planning, automation, quality management); development of final products and public services (reports, web sites, public data and information services) were put in place. EEA strengthens the infrastructure for environmental data and information sharing both at the EEA and in the Eionet with MS, taking into account the principles of the Shared Environmental Information System (SEIS) (SEIS, 2016) and the Infrastructure for Spatial Information in Europe (INSPIRE) developments (INSIRE, 2016). The paper follows Hřebíček et al. (2015) and presents the current EEA decision support ICT tools and information services accepted in the Multiannual Working Plan of the EEA for 2014 – 2018 (EEA, 2014) and its implication for ICT.

2.1   Shared Environmental Information System

The SEIS (Hřebíček et al., 2015; SEIS, 2016) is already in action in various forms. Since the EC's Communication on SEIS in 2008, numerous efforts have been made to create SEIS and implement its principles and pillars throughout EU and even beyond. During this time, EEA has been a leading proponent of SEIS, and has increasingly applied SEIS to its own work. EEA also encourages external organisations, networks and processes to do the same, and manages or participates in on-going European and global initiatives contributing to the implementation of SEIS. SEIS is not only about making information available for people, it is also about making the data available for machine-to-machine communication via standard APIs (application programming interfaces) and open data formats. Implementing and supporting SEIS-friendly technology is one of the core activities of the EEA. SEIS-friendly technology allows several organisations to automatically interconnect, exchange data and stay synchronised in an effective way. Therefore removing inefficiency often created by cumbersome and repetitive manual data exchange steps.

For these reasons the EEA main portal (EEA, 2016) has been extended with semantic web technology also known as Linked Data. The technology is open and standardised by the W3C consortium, the leading organisation behind most open standards that makes what today we call the Web. The same technology is widely used to implement SEIS within Eionet (Eionet, 2016) and Reportnet (Reportnet, 2015). The Linked Data technology allows external systems to connect to our servers and extract any data / information in a systematic way.

Basically, everything you see on the EEA's website (EEA, 2016) is harvestable via external systems and linked data spiders, so the data and information can be easily re-used, integrated and re-distributed by to a wider network of users (Hřebíček et al., 20150. As a practical example, organisations are now able to easily exchange their catalogues of datasets creating more complete federated dataset catalogues, also knows as Open Data Catalogues. The technology makes it effortless for the Agency to contribute to the EC Open Data Portal (ODP, 2016).

2.2 Copernicus and INSPIRE

The European Copernicus programme (Copernicus, 2016), previously known as Global Monitoring for Environment and Security (GMES) is an EU-wide flagship programme that aims to support decision makers, business and citizens with improved environmental information. Copernicus integrates satellite and in-situ data with modelling to provide user-focused information services. 'In-situ data' are all data from sources other than Earth observation satellites (e.g. ground-based, air-borne, and ship/buoy-based observations and measurements).
EEA today coordinates the operational Copernicus in-situ component. This follow the earlier activity undertaken by the GMES In-Situ Coordination (GISC) project (GISC, 2016). GISC and the Copernicus in-situ work aims at linking data providers and service providers using the principles of SEIS and INSPIRE. GISC started proposing sustainable mechanisms for in-situ data delivery/access, based on existing information capacities (e.g. national systems, European networks). The ultimate goal is to build up an Initial Framework (IF) that comprises tools and methods necessary for an efficient and sustainable interface between in-situ data providers and the Copernicus services. The role of the in-situ component of Copernicus is to effectively manage this interface.

2.3 INSPIRE

The INSPIRE (INfrastructure for SPatial InfoRmation in Europe) (INSPIRE, 2016) laid down the general rules establishing the spatial data infrastructure (SDI) in the EU countries in support of EU environmental policies and policies or activities that may have an impact on the environment since 2007. This is very important for the development of environmental software systems of the EEA and the EU countries (Hřebíček et al., 2015). INSPIRE aims to support European public authorities (and others) by making available relevant, harmonised and quality geographic information that support policies and activities impacting the environment. It requires EU MS to provide data related to 34 different spatial data themes through a network of 'services'. INSPIRE also requires the adoption of 'Implementing Rules' which set out how the system will operate and how the data will be formed and presented. The EEA has been continuously involved with INSPIRE since its preparatory phase and will continue to further develop its spatial data infrastructure in line with the INSPIRE guidelines for metadata, interoperability of spatial data and network services (discovery, view, download).

2.4 Copernicus Land Monitoring Service

The Copernicus Land Monitoring Service provides information on land cover and land use change, and on variables related to vegetation state and the water cycle. It supports applications in a variety of domains, such as spatial planning, forest management, nature conservation, water management and agriculture. Services are targeted to a broad user community with data at global, the European as well as the local level. EEA is coordinating the implementation of the Copernicus Land Monitoring Service (Copernicus, 2016). This extends the earlier work on GIO land - focussed on Corine Land Cover (CLC) - with pan-European high-resolution image products as well as with a local component currently focussing on Urban Atlas (for almost 700 European cities and functional urban areas) and Riparian Zones.
To prepare the work, EEA is doing continuous assessments of user needs involving a wide range of stakeholders on a regular basis. The bulk processing of the satellite is contracted to the industry. For the quality control of the local and European land monitoring service, EEA makes sure that local and national authorities can participate in the verification and validation of the end products, such as through the Eionet. EEA is also giving special attention to the dissemination and archiving of the products. Finally, it makes sure that we have the relevant monitoring in place for the use and fit for purpose of the Copernicus Land Monitoring Service.

2.5 Interactive map viewers

EEA continuously produces new web-based map viewers and applications for various 'environmental thematic information services' for decision makers of EU and MS, using the latest ICTs. Some are

developed in response to requests from DG Environment of the EC. For example Data and maps web (EEA, 2016a), which stores many thematic datasets, maps, interactive maps, indicators and graphs from many different themes, is often used to focus on one theme and to present and assess how that theme interacts with other themes (e.g. a focus on water will also show how it is affected by land use). Interactive map viewers also include:

- Water Information System for Europe (WISE, 2016): Integrates reporting data flows from many water-related directives as well as water-relevant statistical data.
- Biodiversity Information System for Europe (BISE, 2016): single entry point for data and information on biodiversity in the EU.
- European Climate Adaptation Platform (Climate-ADAPT, 2016): Aims to support Europe in adapting to climate change.
- European Pollutant Release and Transfer Register (E-PRTR, 2016): Europe-wide register that provides easily accessible key environmental data from industrial facilities.

2.6 Environmental Data Centres

The step-wise implementations of the Common Workspace for in-house and external data processing (since 2014) lead to increased efficiency and quality of data handling. A cloud based infrastructure is used to allow external consultants, ETCs, and EEA experts to work directly with the same data and tools in a common file system (remote desktop). This will also improve transparency especially with changing external partners and leads through common software and documentation to quality improvements. The Common Workspace also enables a more efficient use of data cleansing tools. The Environmental data centre website (EDC, 2016) is the coordinated entry point for European data relevant to the selected environmental theme and ICT products related to the environmental indicators. It provides users with easy searching, viewing and download functions. It also gives links to involved partners and supporting documents.

There are criteria requested by the EEA for the integration of data into the Environmental data centres (EDCs) and their hosting infrastructure:

- Use of open standards and formats, which implies that data must allow processing with freely available tools;
- Microsoft Access Databases should be delivered in mdb Access 2002-2003 file format;
- Dataset structure and fields should be well-documented;
- Methodology for production of the data should be well-documented;
- Metadata for spatial data must fulfill INSPIRE compliant metadata guidelines (INSPIRE, 2016a) and guidance for countries on geospatial data reporting for national experts (Eionet, 2016a).

The European data centres (EDCs) consist of EDCs under responsibility of EEA, Eurostat and JRC.

There are five EDCs under responsibility of EEA. EEA uses common ICT tools for all data centres and thus creates uniform entry points for the users::

1. *European air pollution data centre* provides access to data and information related to the amount of air pollutants emitted into the atmosphere from different anthropogenic (human-made) sources as well as measured ambient air pollution at monitoring stations across Europe. The air pollution data centre also provides access to related products for air pollution indicators and assessments. Priority is given to policy-relevant data and information for European and national institutions, professionals, researchers and the public.
2. *European biodiversity data centre* provides the coordinated entry point for data on species, habitat types and sites of European interest. The data and information maintained here are used in biodiversity indicators and assessments. Priority is given to policy-relevant data and information for European and national institutions, professionals, researchers and the public.
3. *European climate change data centre* provides access to data and information on greenhouse gas emissions, climate change impacts, vulnerability and adaptation in Europe. Priority is given to policy-relevant data and information for European and national policy makers, influencers (such as NGOs, business, media and scientists) and the general public.
4. *Environmental data centre for land use* provides data to understand the relationship between land use and environmental impacts. Information is provided at different scales combining European coverage with global and in situ survey data. The core of data centre activities is related to dissemination of operational services in connection with key land cover/land use datasets, relevant indicators and derived products based on spatial analysis and change detection.

5. *European water data centre* provides the European entry point for water related data as part of the Water Information System for Europe (WISE, 2016). It contains the input (reporting mechanisms) and output (visualisation of results) for compliance information under several water EU legislation as well as voluntary information as reported e.g. under the EEA regulation through the Eionet. The information compiled and maintained here is used in indicators, assessments and policy developments that are further accessible through the thematic links in WISE.

There are EDCs under responsibility of Eurostat:

1. *European data centre for waste* (EDCW, 2016) is the central entry point for reporting of data under EU legislation on waste and providing information on waste and the associated environmental impacts.
2. *Environmental Data Centre on Natural Resources* (EDCNR, 2016)) is an online repository for a broad range of data on Natural Resources in Europe. The EDCNR provides information on Resource Efficiency Indicators (Eurostat, 2016a), as well as basic statistics and indicators on Natural Resources (Eurostat, 2016b).

There are EDCs under responsibility of JRC:

1. *European soil data centre* (ESDAC, 2016) acts as the primary data contact point for the EC's DG Environment in order to fulfil its soil information needs.
2. *European forest data centre* (EFDAC, 2016) is a focal point for policy relevant forest data and information by hosting and pointing to relevant forest products and by providing web-based tools for accessing and updating information located in EFDAC.

3   UPDATED DECISION SUPPORT ICT TOOLS

The scope of the updated ICT strategy is to address the two main objectives of the EEA multi-annual work programme 2014-2018 for technical systems development (strategic area 3.2) and monitoring, data and information management (strategic area 3.3) (EEA, 2014):

- To ensure that EEA ICT systems continually meet the needs of the organisation, enabling it to efficiently implement its work programme.
- To ensure the availability, quality, accessibility and sustainability of monitoring, data and information needed for the knowledge base supporting environment and climate policies.

The number of supported software tools and applications will be limited in proportion to the necessary support and training that can be provided to relevant EEA staff and Eionet. A list of available software that is allowed to be used within the EEA will be established and regularly updated by ICT and data management (IDM) leaders of EEA. A track of recommended training courses and necessary competences covering all available ICT tools supported by the IT helpdesk of EEA website (EEA, 2016) will be established.

A limited number of standard software will be used for publishing data on the EEA website. The introduction and use of new ICT technology and new software tools will be based on a business case that will be put forward for endorsement to the IT Steering Committee which was established in 2014 to assists the EEA to prioritise available resources and ensure appropriate forward planning to meet agreed future requirements and manage existing investments properly. Since 2015, the IT Steering Committee includes representatives from all EEA Programmes. The IT Steering Committee continues to address the emerging ICT topics to support the work programme (EEA, 2014), develop procedures for improved ICT governance, evaluates and monitors ICT projects and provide advice to the Senior Management Team (SMT) of EEA for ICT related investments that need to be included in the annual work programmes of the EEA.

The EEA will continue to use existing freeware as well as commercial of the shelf (COTS) software in the most cost efficient and effective way.

The ICT strategy is complemented by two new frameworks, a data and information management framework (EEA DIMF, 2016) and a data quality framework (EEA DQF, 2016).

4   CONCLUSION

More specifically, the EEA's overall business strategy for decision support ICT tools development and related data and information management is:

- to provide the ICT infrastructure and services needed for efficient delivery of the work programme (EEA, 2014);

- to support network and knowledge management i.e. data and information sharing with Eionet and other stakeholders;
- to support workflows for planning, automation and quality management i.e. to maintain and improve the efficiency of existing data flows, quality assessment / quality controlling processes, indicator management and maps and graphs production;
- to support the development and maintenance of EEA products and public services such as reports, web sites, public data and information platforms;
- to strengthen the infrastructure for data and information sharing both at the EEA and in the Eionet member countries taking into account the SEIS principles and INSPIRE developments.
- to provide free and open access to online data and information services in accordance to the EEA data policy (EEA data policy, 2016);
- to improve the timeliness of European data delivery including up-to-date and near real time;
- to contribute to the implementation of the Copernicus programme and the Group on Earth Observations (GEO) common infrastructure especially in the domain of data sharing.

The EEA will continue to operate a flexible, scalable, efficient, reliable and secure ICT infrastructure using innovative and economically viable ICT technologies. To achieve this, part of the hardware administration will be outsourced where relevant. Cloud computing services will be used as well for relevant data storage and processing. Auto-scaling the load on EEA ICT systems i.e. websites, will be implemented by making use of cloud computing technologies. The use of cloud services will be based on their compliance with the EU data protection regulation and any other regulation for EU institutions on cloud computing.

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