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Free and Open Source Software underpinning the European Forest Data Centre

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Worldwide, governments are growingly focusing [1] on free and open source software (FOSS) as a move toward transparency and the freedom to run, copy, study, change and improve the software [2]. The European Commission (EC) is also supporting the development of FOSS (see e.g., [3]).

In addition to the financial savings, FOSS contributes to scientific knowledge freedom in computational science (CS) [4] and is increasingly rewarded in the science-policy interface within the emerging paradigm of *open science* [5–8]. Since complex computational science applications may be affected by software uncertainty [4,9–11], FOSS may help to mitigate part of the impact of software errors by CS community-driven open review, correction and evolution of scientific code [10,12–15]. The continental scale of EC science-based policy support implies wide networks of scientific collaboration. Thematic information systems also may benefit from this approach within reproducible [16] integrated modelling [4]. This is supported by the EC strategy on FOSS: "for the development of new information systems, where deployment is foreseen by parties outside of the EC infrastructure, [F]OSS will be the preferred choice and in any case used whenever possible" [17].

The aim of this contribution is to highlight how a continental scale information system may exploit and integrate FOSS technologies within the transdisciplinary research underpinning such a complex system. A European example is discussed where FOSS innervates both the structure of the information system itself and the inherent transdisciplinary research for modelling the data and information which constitute the system content.

The information system. The European Forest Data Centre (EFDAC, http://forest.jrc.ec.europa.eu/efdac/) has been established at the EC Joint Research Centre (JRC) as the focal point for forest data and information in Europe to supply European decision-makers with processed, quality checked and timely policy relevant forest data and information (see also [18]). A set of web-based tools allow accessing the information located in EFDAC. The following applications – running on GNU/Linux platforms – are the core elements of EFDAC:

$$\textbf{(a)}\quad \text{EFDAC} = \begin{cases} \text{Metadata Catalogue} \\ \quad \text{implementation of GeoNetwork [19],} \\ \quad \text{INSPIRE compliant [20,21]} & \text{(a.1)} \\ \text{EFDAC Forest Map Viewer Application} \\ \quad \text{customized web map service} \\ \quad \text{based on GeoExt/ExtJS, OpenLayers [22], Django [23]} & \text{(a.2)} \\ \text{European Forest Fire Information System (EFFIS)} & \text{(a.3)} \end{cases}$$

In (a.1) a metadata client allows users to search for EFDAC related spatial datasets while (a.2) is a customized web map service that allows the user to visualize, navigate and query available maps and derived geo-datasets on several forest-related topics. The database system currently relies on ORACLE and PostgreSQL [24] with PostGIS [25]. EFFIS (a.3) [26–33] is a comprehensive system covering the full cycle of forest-fire management. The system supports forest-fire prevention and fighting in Europe, North Africa and Middle East countries through the provision of timely and reliable information on forest-fires [29,30,32].

Within EFFIS, UMN Mapserver [34] is used for the management and publication of the fire behavior forecast and the other fire-related layers in a wide range of formats including INSPIRE and Open Geospatial Consortium (OGC) standards such as:

$$\textbf{(b)}\quad \text{OGC standards in EFDAC} = \begin{cases} \text{Web Map Services (WMS) [35] which render map data in a pictorial image format over the internet} & \text{(b.1)} \\ \text{Web Feature Services (WFS) [36] that encode vector data using Geographic Markup Language (GML) [37]} & \text{(b.2)} \\ \text{Web Coverage Services (WCS) [38] that disseminate gridded or raster data} & \text{(b.3)} \end{cases}$$

Transdisciplinary modelling research. The EFDAC portal [39] provides data and information which rely on coordinated research [40–50] on wide-scale transdisciplinary modelling for environment (WSTMe) [51]. This contributed to advanced computational modelling approaches such as morphological spatial pattern analysis (MSPA) [52–54] and geospatial semantic array programming (GeoSemAP) [51,55]. FOSS is here essential. For example, GeoSemAP is based on a semantically-enhanced [56,57] joint use of geospatial and array programming [58] tools **(c)** where semantic transparency also implies FOSS use.

$$\textbf{(c)}\quad \text{FOSS tools in EFDAC} = \begin{cases} \left.\begin{array}{l}\text{GRASS GIS [59–61]}\\ \text{GDAL [62]}\\ \text{OpenLayers [63]}\\ \text{PostGIS [64]}\end{array}\right\} & \text{Geospatial tools for GeoSemAP [51]} \\ \left.\begin{array}{l}\text{GNU Octave [65,66]}\\ \text{GNU R [67]}\\ \text{GNU Bash [68]}\\ \text{Mastrave [56,57]}\\ \text{Python [69] (Numpy [70], Scipy [71])}\end{array}\right\} & \text{Array programming} \\ \left.\begin{array}{l}\text{Conefor Sensinode [72]}\\ \text{Django [73]}\\ \text{jQuery [74]}\\ \text{GeoServer [33]}\\ \text{MapServer [34]}\\ \text{MapProxy [75]}\\ \text{pktools [76]}\\ \text{EFDAC E–Forest Platform [77]}\end{array}\right\} & \text{Task specific tools} \end{cases}$$

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