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The Water and Energy facilities InfoRmation System (WEIRS)

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Abstract: The Water and Energy Facilities are programmes from the European Commission for funding projects in African, Caribbean and Pacific countries. Their main objective is to help achieving the Millennium Development Goals in this region through the improvement of water/energy supply and sanitation coverage. The increasing number of project proposals and historical data from the different projects calls requires information infrastructure for evaluating and analysing call-related data. This paper explains the technical architecture specifications for an information system that facilitates the management of the water and energy project proposals, the WEIRS database. The system, based on open source software, allows the incorporation of external data sources and indicators in a very flexible way, enhancing the assessment of projects in their national contexts. The paper also describes the system design, interoperability, and adoption of Web Map Services standards. WEIRS is a decision support prototype tool for the European Commission services for defining and implementing sustainable policies as well as identifying priority needs for development. The system is accessible on-line for authorized users through the www.aquaknow.net and www.euei.net web portals.

Keywords: decision support; developing countries; Europe Aid; open source; GIS

1 INTRODUCTION

Access to safe water and energy is an essential requirement for development. In 2005, it was estimated that more than 1,100 million people in the world had no access to drinking water, and 2,600 million did not have access to adequate sanitation (WHO and UNICEF, 2005). It has also been estimated that about 20% of the world's population, 1,400 million people, have no access to electricity (OECD/IEA, 2010). In this context, and with the objective of reducing these numbers, two initiatives were launched in 2002 by the European Union (EU): The EU Water Initiative (EUWI) and the EU Energy Initiative (EUEI). The aim of these programmes is to contribute to poverty reduction through the achievement of the specific Millennium Development Goals and World Summit for Sustainable Development (held in Johannesburg in 2002) targets on water supply/sanitation and energy (Fourcaudot. et al. 2011).

As a result of these initiatives, the Development and Cooperation-EuropeAid (DEVCO) Directorate General of the European Commission launched a series of calls for funding projects in the African, Caribbean and Pacific (ACP) region: the so-called Water and Energy Facilities (Figure 1). The facilities aim at i) increasing access to safe, affordable and sustainable water and sanitation services through the provision of funding for infrastructure and services, ii) improving governance in water, sanitation and energy sectors, iii) improving access to modern energy

services by poor rural people and iv) facilitating future large-scale investment programmes in the energy sector.

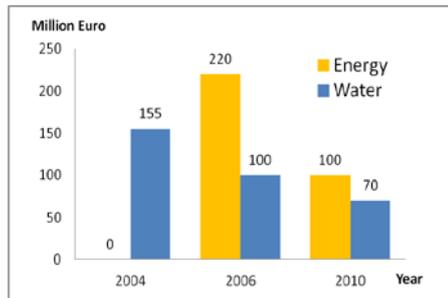


Figure 1. Funding to the different calls for proposals launched under the Water and Energy Facilities. In total, the Energy Facility has funded 156 projects and the Water Facility 241 projects.

Since the beginning of these programs, data management for the assessment of applicants and proposals has been carried out using the application documents—in "doc" and "xls" format—with the support of only internal databases in "xls" or "mdb" formats. However, data gathered has been ever increasing, making management and evaluation more and more difficult.

In this context, the Joint Research Centre (JRC) of the European Commission, by request of DEVCO, has developed an information system to support them in managing and analyzing this information, with the aims of centralizing the projects and applicants information, facilitating the assessment of project proposals and contributing with this information to the design of future calls for proposals on the basis of the knowledge gained. The main requirements of the system, as demanded by DEVCO, are detailed in Table 1.

System features required by DEVCO (and implemented in the WEIRS database)	
•	User friendly and web-based proposals database
•	Ability to easily import existing facilities data ("xls")
•	Inclusion of GIS tools, without installation of any GIS software in the user side, for enabling the user to locate the projects geographically and visualize other contextual variables (river basins, countries borders, ...)
•	Different privileges for accessing information and uploading data for different user profiles
•	Data content useful for the evaluation of the proposals of the Water and Energy Facilities
•	Tools for multi-criteria analysis, including information from other databases

Table 1. System user requirements.

In the rest of this paper, we: i) present the database created to manage the information regarding the Water and Energy facilities, including a description of the data gathering process; ii) describe the architecture of the system; and iii) discuss the lesson learnt to provide feedback for further information systems' developments.

2 METHODS

The WEIRS information system uses project data from the Water and Energy Facilities calls for projects funded in the ACP region. Data is integrated into the system following the processes illustrated in Figure 2. Firstly, applicants were asked to send an application form and a series of annexes containing information about the project and the implementing parties (actors). The annexes were sent to DEVCO in "xls" format. Some fields were numerical or categorical, others could be filled freely with text. Some of the information contained in the proposals was then included by DEVCO in the Common RELEX Information System (CRIS). This

database stores administrative information from the financial and technical annexes with the purpose of managing contracts. Some of the annexes of the applicants and data from CRIS database, both supplied by DEVCO, were used by the JRC team to create the WEIRS database. This information can be access only from the working teams, since the data was considered as sensitive by DEVCO, particularly for ongoing calls.

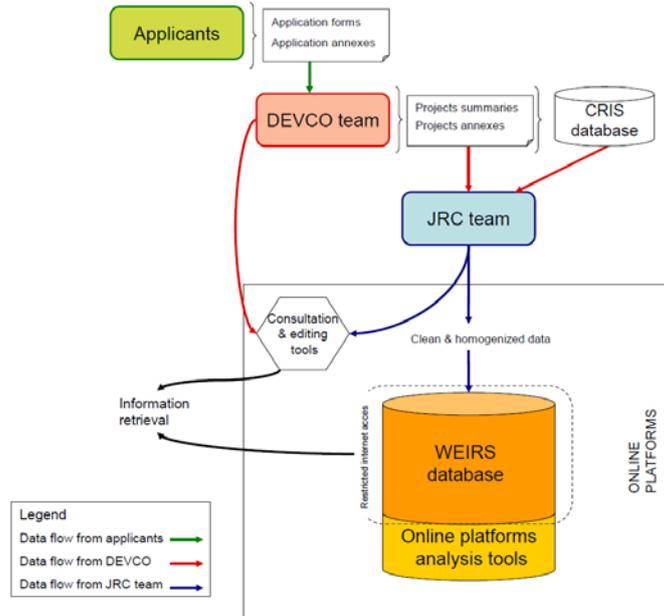


Figure 2. Diagram showing data flow from the applicants to the WEIRS database.

Information fields contained in this database were jointly selected by the DEVCO and JRC teams, taking into account which fields were relevant to the proposals' selection procedure and the options of codifying the different information types. Some of the fields that can be found in the database (see Table 2) include: actors involved in each proposal, funding request, total budget, activities and technologies proposed, project location, expected impact on local water sanitation and supply, and the success of the applicant in being funded at the end of the selection procedure. In order to guaranty the consistency and reliability of data contained in this database, a data cleaning process was carried out on all this information.

Information codified into the WEIRS database (selection)
• Applicant origin region: Pacific, Western Africa, Eastern Africa, Southern Africa, Central Africa, Caribbean, non ACP region.
• Applicant legal status: international organization, local authority, state actor, private company, financial institution, foundation, NGO, etc.
• Project activities: generation, new system, transmission, distribution, efficiency, etc (for energy projects); basic sanitation, basic water supply, health education, etc (for water projects).
• Project duration: ranging between 36 and 60 months, according to the call specifications.
• Contribution to project financing: total economic contribution of the applicant.
• Total project costs: ranging between 500,000 and 2,500,000 euro, according to call guidelines.
• Number of project beneficiaries: population reached by the project activities.
• Cost per beneficiary: ratio between total cost and number of project beneficiaries.
• Type of actors involved: local partner, non local partner, associate, co-donor.
• Expected impact on local water supply and sanitation coverage: change in water sanitation and/or drinking water supply coverage derived from the project implementation.
• Eligibility: rejected, awarded.

Table 2. Selection of data fields contained in annexes sent by applicants and included in the WEIRS database.

3 RESULTS

The WEIRS system consists of two databases accessible through online platforms, AquaKnow (<http://www.aquaknow.net/>) for water related project proposals, and EUEI (<http://www.euei.net/>) for energy proposals.

AquaKnow is a collaborative online work space dedicated to technical and scientific knowledge for the sustainable development of the water sector (Leone et al., 2010). The system provides a set of tools to analyze, manage and share information coming from the WEIRS database. For instance, the system includes tools for uploading and editing data sheets projects, a query table builder interface from which data can be filtered using different fields, and a web GIS tool for visualizing analyzing data, and creating customized maps (Figure 3). It also allows the creation of specific working groups with different user profiles that determine the information they will have access to. For instance, and as mentioned above, only members from a specific group (the Water Facility group), which includes the professionals responsible for evaluating the proposals, can access and edit the information stored in the WEIRS database.

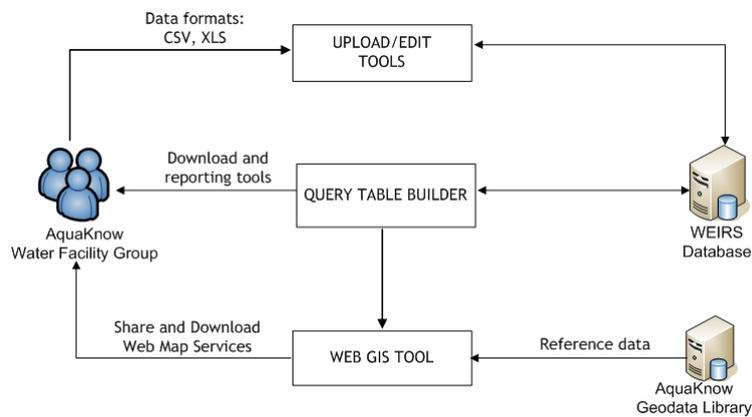


Figure 3. WEIRS system architecture for the water dataset showing the main tools developed, which can be accessed through the Aquaknow platform.

As shown in Figure 3, the WEIRS Database is the central repository of data for water projects proposals and plays an important role within the AquaKnow system. Users from the AquaKnow Water Facility group can upload projects into the database in “xls” or “csv” formats according to a predefined structure. Once data has been uploaded, it can be easily modified or queried through the web interface (Query Table Builder) using different search filters. Download and reporting tools are also available for the query results in a variety of formats such as “PDF”, “KML” and “xls”. This includes project synopsis and project reports, which display information on different predefined fields such as actors, funding or technologies.

Additionally to the up/downloading as well as the editing and reporting tools, the system allows users to display the results from a query through different thematic maps or graphs at country/region levels within the web GIS tool (Figure 4). The GIS tool provides users with a navigation bar for zooming in and out, distances tools etc., as well as other functionalities for printing and exporting maps, and the possibility to save the map settings (layers displayed, opacity, etc.).

In addition to the WEIRS database information, the platform includes the AquaKnow Geodata Library, which serves as a big repository of information. It is meant to complement and facilitate the assessment of the proposals, which can be displayed along with the WEIRS data within the web GIS tool. The repository

includes reference maps with geographical regions, river basins, and protected areas, among other layers. It also includes data maintained by different organisations like FAO, CIESIN, UNDP, etc. Finally, it gives access to a set of development related indicators, selected based on the work by Dondeynaz et al. (2012), covering environment, governance and human development. As mentioned above, all these datasets provide background information, which facilitates the assessment of the proposals in their national and regional contexts.

So far, the system does not allow carrying out statistical analysis, but rather concentrates on storing and summarizing the available information. This allows personalized data queries and exports, and supplies visual background information. However, the GIS tool can additionally display some layers of processed information such as funding and total number of projects of each call at national and ACP region level (see example in Figure 4).

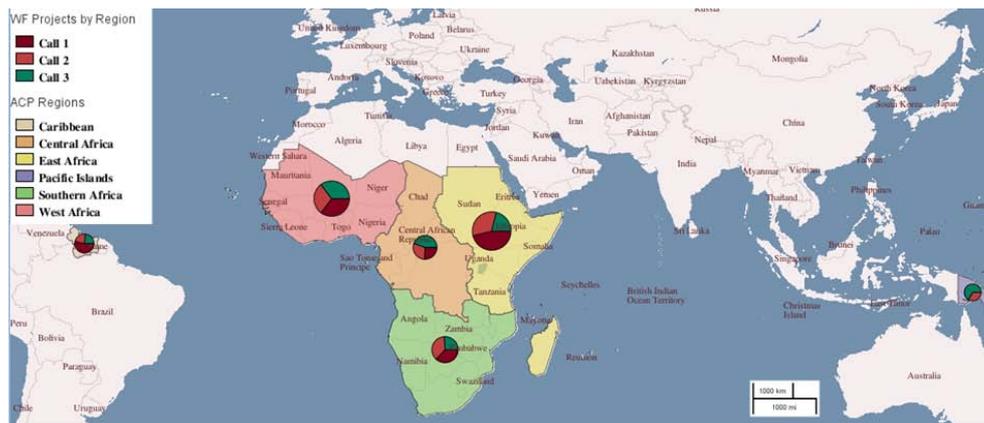


Figure 4. Example of map showing the awarded projects by ACP region of the three Water Facilities calls, as provided by the AquaKnow platform.

Due to the capacity of the system for combining, updating, querying and exporting, the water and energy facilities data provides the user with appropriate information for carrying out extra offline analysis. For instance, analysis of the project proposals have been recently carried out to better understand factors involved in project proposals success (Fourcaudot et al. 2011). In addition to this, the JRC is using the information retrieved through the WEIRS system for analyzing the correlation between WEIRS data and the indicators gathered within the AquaKnow Geodata Library (see Figure 5 for one example). The aim of these analyses is to support DEVCO in improving the design of future calls and assessing the relevance of the current funded projects.

The Energy Facility database is integrated within the EUEI portal. The platform is also a collaborative project portal in which users can contribute with news, documents, events or capacity building activities on the energy sector. Similarly to the AquaKnow platform, the EUEI includes different working groups such as the Energy Facility group in charge of evaluating energy proposals.

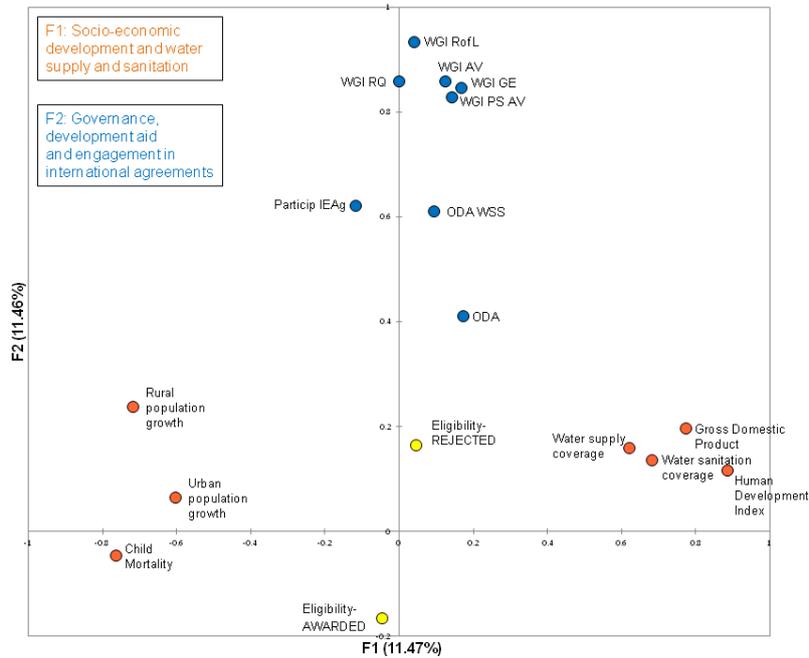


Figure 5. Results of a principal components analysis with data retrieved from the WEIRS system. Colors (orange/blue) inform about the component (F1 or F2) they are mostly correlated to. Yellow variables locate the success or failure of proposals relative to each component. See Dondeynaz et al. (2012) for a description of indicators associated to the second component (F2).

3.1 The technology

From the point of view of the system architecture, two aspects should be emphasized: the content management system (software to publish different types of data on the web), and the implementation of the web GIS tool. The system has been developed using the web content management system Drupal¹ and MySQL as a relational database management system. Drupal is an open source software that allows publishing contents on the web in an efficient manner. It provides functionality for accessing data with different roles guarantying WEIRS data confidentiality and integrity. Additionally, the modularity and extensibility of this software allowed us to develop a number of tools specific to this project such as the web GIS tool. The latter was implemented based on GeoExt and OpenLayers, two different Java Scripts APIs that are used for developing web GIS applications. Mapserver, an open source platform for publishing spatial data on the web, was used as an internal engine to generate and publish maps and graphs on the fly based on users' demand. This information is disseminated via Web Map Services (WMS) following the standard from the Open Geospatial Consortium (OGC)². This protocol is commonly used for serving georeferenced map images over the Internet. Thanks to the OGC standard, maps can be invoked using the AquaKnow platform and any other GIS software in the form of URLs, facilitating data sharing among registered users.

The Energy portal is based on the same technology and principles used for developing the AquaKnow platform. There are only some minor differences in the development in order to meet the specific needs of both projects. For instance, the AquaKnow Geodata Library was not foreseen when developing the Energy portal.

¹ <http://drupal.org>

² <http://www.opengeospatial.org/>

Therefore the EUEI platform does not display complementary geographical information but only information related to the energy project proposals.

4 CONCLUSIONS AND RECOMMENDATIONS

WEIRS is currently a valuable analysis prototype tool for the European Commission services, international donors, development partners and policy makers for defining and improving the effectiveness of policies as well as identifying priority needs for development in the field of water and energy in the ACP region. Specifically, the WEIRS system has proven their usefulness during and after the proposals selection procedure: they were used to storage, summarize and query data, visualize it together with socio-economic context information, and export data for additional analysis information from the last water facilities call for proposals. It has also improved the communication between the institution in charge of the project (DEVCO) and the team developing the infrastructure and data analysis at the JRC.

Since the information is accessible all over the world, it could also help facilitating the selection procedure for cases where the selection depends on teams with different locations, for instance different delegations of the European Commission.

The system is different from other standard web portals and databases in that it allows integrating information from several formats and data sources and performing spatial analysis via web, which can be shared through URL services with any person using a GIS program, without having to use the online platform itself. It also displays several types of summaries of the information to facilitate data analysis by the user.

The cost in terms of human resources for developing the system was reasonable. Thanks to the flexibility and modularity of the software, the system could also be adapted for different applications in the future. Additionally, the use of open source software ensures access to the technology in the context of developing countries. All these issues ensure that the system can be easily replicated, reused and further developed.

Complementary, other AquaKnow features such as the possibility to share spatial datasets, images, working documents, videos, etc. could potentially be used by organizations implementing the projects and DEVCO to monitor projects performance and impact.

Future developments in the WEIRS system will include the incorporation of more datasets into the AquaKnow Geodata Library, the development of tools to import data in other formats and perform spatial analysis; and the possibility to download data as a Web Feature Services.

One of the main lessons learnt from the system development process is the importance of data quality, essential for assuring that the results of the analysis are reliable. Data cleaning previous to inclusion in the database was extremely time consuming and often not satisfactory since applicants and proposals were sometimes difficult to track in order to replace or validate some obviously erroneous data. The development of an online interface for proposals submission might solve this problem. It might additionally accelerate the proposals management by DEVCO.

Finally, even though statistical data analysis is currently carried out offline, the functionalities required for this analysis could be also integrated into the WEIRS system by extending its architecture.

5 NOTATION AND UNITS

ACP	African Caribbean and Pacific
CIESIN	Centre for International Earth Science Information Network
DEVCO	Development and Cooperation-EuropeAid
EDF	European Development Fund
EU	European Union
EUEI	European Union Energy Initiative
EUWI	European Water Initiative
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical Information System
JRC	Joint Research Centre
MDGs	Millennium Development Goals
OGC	Open Geospatial Consortium
UNDP	United Nations Development Programme
URL	Universal Resource Locator
WEIRS	Water and Energy Facilities Information System
WMS	Web Map Service

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