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# HEALS

**Health and Environment-wide Associations  
based on Large population Surveys**

*FP7-ENV-2013- 603946*

<http://www.heals-eu.eu/>

## **Deliverable 8.2: Environmental data management system (EDMS)**

**WP 8: Environmental Data Mining**

**Version number 2**

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FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
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## TABLE OF CONTENTS

1. Introduction.....	4
2. System requirements and implementation .....	6
2.1 Compatibility .....	7
2.2 Design, implementation and data population .....	8
2.2.1 Implementation steps .....	8
2.2.2 Web framework / application architecture.....	8
2.2.3 Data base specifications .....	10
2.2.4 Data Population via (Common) Data Template(s) .....	12
2.2.4.1 Data Collection Entry – Template Form .....	13
2.2.5 Data directly retrieved from other databases.....	18
3. Data search and presentation .....	19

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	3/21

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<b>EU Project Officer</b>	Tuomo Karjalainen,- <a href="mailto:Tuomo.KARJALAINEN@ec.europa.eu">Tuomo.KARJALAINEN@ec.europa.eu</a>		

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<b>Author (Partners)</b>	P.Karagiannis, E.Tolis, J.G. Bartzis (UOWM)			
<b>Responsible Author</b>	J.G. Bartzis		<b>Email</b>	bartzis@ipta.demokritos.gr
	<b>Partner</b>	UOWM	<b>Phone</b>	+30 210 6503426

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Sarigiannis	26/10/2015	Corrected version 1	Some amendments have been done on the first version.
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FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	4/21

## 1. Introduction

The design and implementation of the Environmental Data Management System or EDMS, is one of the three specific tasks in WP 8 and it is in close relation with the other two tasks, namely Data Collection and Data Quality and Assessment. In short, the EDMS has to be a solid and robust application in order to host the data processed or pre-processed by the aforementioned tasks.

Pre-processing involves the identification of suitable environmental data sources for environment-wide application studies in specific areas. This task will be carried out through detailed review of past and ongoing research and survey projects.

Moreover, this data have to be gathered as well and possibly stored in its existing format before they are stored in the EDMS. This means that primary data, when available, will come in a wide variety of forms as long as its structure and file format is concerned.

Ultimately, since the collected data will serve other WPs, the dataset, after having been evaluated in terms of quality and applicability, will have to be transformed in a standard format, compliant with the INSPIRE Directive.

The environmental data management system has been created through the WP8 of the HEALS project in order to gather, collect and mine the environmental data from other information sources and data that will be produced through the project. The first approach on creating the EDMS had three alternatives:

- Link to existing databases
- Incorporate data directly retrieved from other databases into the environmental management system
- Extract datasets and import them to the environmental management system

The last is characterized as the best alternative; however the storage capacity of the system will increase in huge number. Also the design of the database includes the storage of the

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	5/21

collected data in a coherent environmental data management system (EDMS) for further use within the project. Therefore, the EDMS has been built under the logic of a common data template which can be used to insert data sets into the EDMS database. Thus, data under all the aforementioned categories can be inserted without the need of large storage. The system provides methods for linking to existing databases as well as extracting datasets and importing them into the EDMS. Thus, incorporating other databases into the EDMS is now redundant as it is covered by the importing methods in use.

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	6/21

## 2. System requirements and implementation

On top of the already referred cross – task issues the EDMS must be designed and implemented following certain procedures and standards. Critical issues that must be taken into account here is that the HEALS database should be able to retrieve data from existing Databases. Additionally,

- a) All data must be geo-referenced using the same geographic projection system, by specifying the geographic coordinates of each single observation, both for point and for polygonal spatial information and
- b) All data will be univocally coupled to a time reference (instant, hour, day, month, year, etc.) and as such they must be ready to be investigated, by using time series based statistics. Also, they must be easily aggregated on the basis of different time scales. There also must exist queries for automatic updating, importing data, exporting data, selecting specific subsets and grouping records.

Furthermore the EDMS has to be in compliance with the INSPIRE Directive. The Directive 2007/2/EC of the European Parliament aims to create a European Union (EU) spatial data infrastructure. It addresses 34 spatial data themes which are based on the following common principles:

1. Data should be collected only once
2. Combine seamless spatial information
3. Should be possible for information collected to be shared
4. Geographic information readily available
5. Geographic information easy to find
6. Implementing Rules (IR).

### 6.1. Metadata

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	7/21

6.2. Data Specifications

6.3. Network Services

6.4. Data and Service Sharing

7. The Implementing Rules are adopted as Commission Decisions or Regulations and are binding in their entirety.

Building the EDMS is perceived as a 4 step process. First, we must define the web framework and application architecture which will be used. The application, in general will consist of a web component, various application programming interfaces for interacting with databases and the database itself. Then, we have to choose an appropriate Database Management System and design of the relational model or models. Secondly, we need to populate the EDMS via a commonly accepted template for entering data sets. The third step is to establish links to existing databases or more appropriately to their web interfaces in order to provide a head start for the steps to come. At the same time we can work on the matter of connecting to other databases through queries for automatic updating, importing data, exporting data, making specific selections or grouping records. The last step involves data which come in formats that require further processing.

## 2.1 Compatibility

Additional tasks to fulfill while implementing the database include:

1. Automatic updating,
2. Importing from other platform (such as IPCHeM and ToxHub) potentially in other formats
3. Exporting into other data formats,
4. Selecting specific subsets of data,
5. Grouping records by means of aggregation functions.

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	8/21

The structure of the EDMS must be compatible with the **IPChEM** database of the JRC and the **ToxHub** platform of the HEROIC project, so that a bidirectional link for data exchange and interoperability can be easily implemented during the project execution and in the future, contributing thus to environmental data integration across Europe.

## 2.2 Design, implementation and data population

### 2.2.1 Implementation steps

1. STEP 1
  - 1.1. Web framework / application architecture
  - 1.2. Database Architecture
2. STEP 2
  - 2.1. Data Population via (Common) Data Template(s)
3. STEP 3
  - 3.1. Data directly retrieved from other databases
4. STEP 4
  - 4.1. Other data transfer

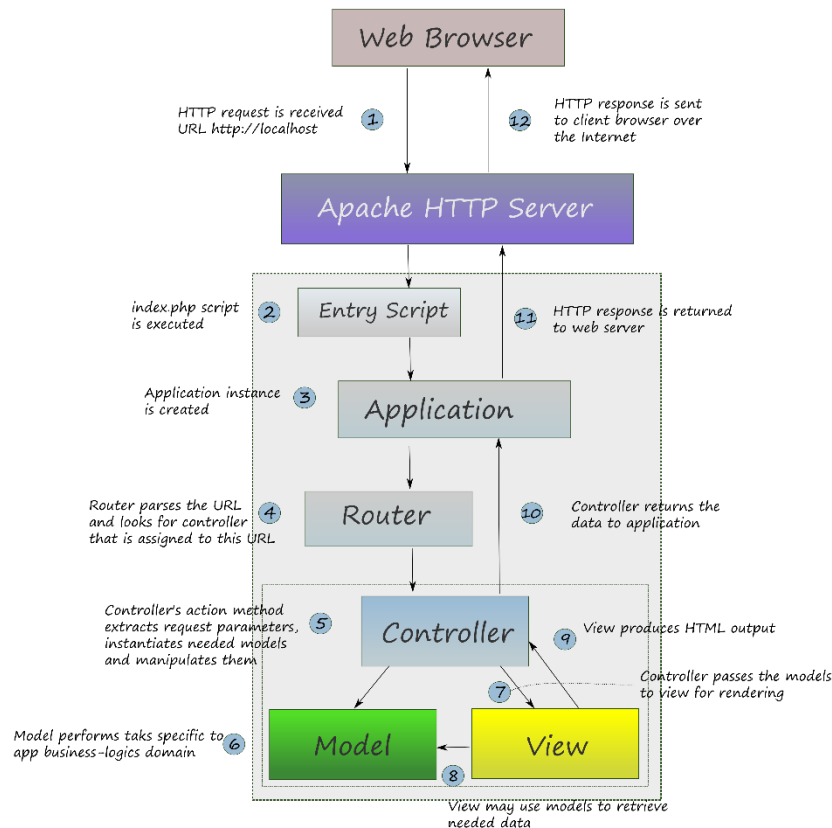
### 2.2.2 Web framework / application architecture

The web framework is the software which we can use to implement the web application and the APIs to it and its underlying databases. Some of the most prominent programming languages which support web frameworks are PHP, Python, Java and Ruby. For the EDMS we opted for PHP as it is backed by widely tested frameworks that assist our effort. Such



FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	9/21

frameworks would also impose the Model–View–Controller or MVC software pattern a general application architecture.



**Figure 1. The MVC model as part of a http (user) interaction.**

In MVC, the model represents the data. The model or data is independent of the model and view components. The view displays the model data, and sends user actions (e.g. button clicks) to the controller. That is, after it has been formed and presented to the user, the user can use it to invoke the controller which will possibly retrieve data or manipulate the data and alter the view.

The controller as already said, provides model data to the view and interprets user actions. It can also send commands to its associated view to change the view's presentation of the model. The controller generally depends on the view and the model.

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	10/21

The MVC model is quite straightforward and it can be used to model the EDMS reliably. In the EDMS data have to be stored independently. This represents the model. An interface must be present to retrieve or alter the data (import / edit data set). This is done by the controller modules which receive input through web interfaces, available to users with elevated privileges and manipulate the model. Finally the data must be presented to the end user. This can be perceived as the view.

### 2.2.3 Data base specifications

The design of the Database structure which besides accommodating **HEALS** own datasets should be able to retrieve data from **existing Databases** identified in Task 8.1 through suitable query scripts. The Database in the EDMS, will be implemented in a standard database package or using a standard database management system, for interoperability in data storage, management and exchange with the HEALS geodatabase platform developed in WP12.

Interoperability involves both the database for the stored datasets and any other databases necessary for building the web interface of the stored data as well as the Application Programming Interfaces (API's) for data exchange. Relational database management systems such as MySQL or PostgreSQL seem the straightforward choice for this part of the application, being open source and widely tested, supported and of course deployed in numerous applications, not to mention their ease of use in web applications. PostgreSQL has the additional attribute of being object – oriented, bringing the advantages of concepts such as objects, classes and inheritance in data base schemas and is probably the best alternative in cases MySQL cannot cope with the datasets that are to be stored and queried. The implication here is that it is not necessary to use only one Database Management System. Should the application dictates a different approach additional systems should be used without losing compatibility with the existing ones.

It is obvious that one of the first tasks to address must be the design of the relational models and table schemas which will clearly depict how the datasets will be stored and how the integrity constraints, which are set to provide and maintain the accuracy and consistency of

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	11/21

data over its entire life-cycle, will be defined and then expressed in the relational model. Having in mind the diversity of available datasets this will be a very complex task and it entails numerous issues that have to be addresses individually which will most likely arise during the implementation process.

The Database structure which will accommodate HEALS datasets will also store data from existing Databases. These databases will have already been identified and suitable query scripts, depending on each situation, will be implemented in order to fulfill the task of retrieving and converting the desirable data. The following steps are envisaged:

1. Data base architecture design steps
2. Define DB structure (tables and relations).
3. Review existing databases' schemata
  - 3.1. Define queries to import data from other databases
  - 3.2. Define update queries
  - 3.3. Define selection queries
4. EDMS will be populated by insert queries with data that will be collected using the specified template. Therefore:
  - 4.1. Develop scripts to collect and store data
  - 4.2. Convert to our own db format (schema)
  - 4.3. Define queries to import data
  - 4.4. Define update queries
  - 4.5. Define selection queries

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	12/21

## 2.2.4 Data Population via (Common) Data Template(s)

There are two categories of potential data for the purpose of the HEALS project:

- The Existing Data
- HEALS Own Data

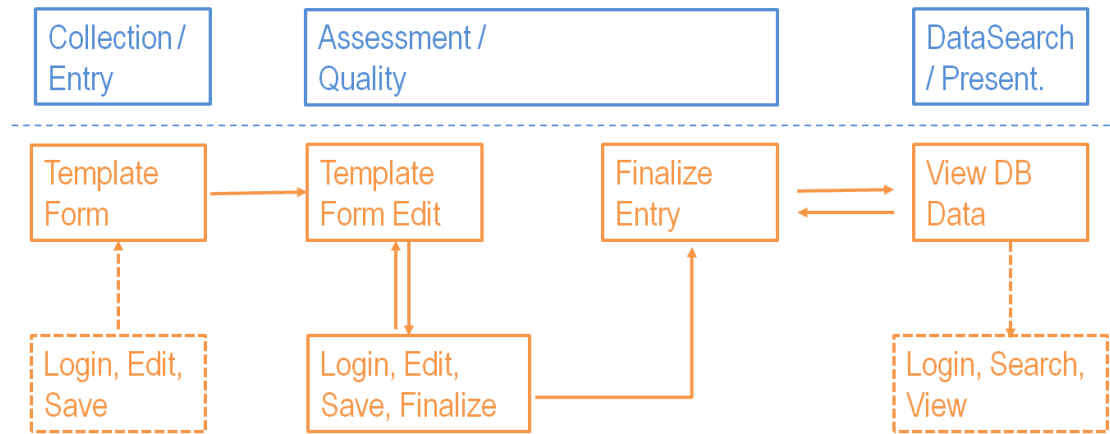
The methodology followed for creating the HEALS EDMS was first to Transfer/Fill data into a common template in xls/xml format and then to feed these data into the database. As decided an xml template was created in order to fulfill the above methodology and covered the potential data.

The EDMS features three user categories. Although the EDMS is in close relation with the WP12, its design and implementation was carried out before the specifications of WP12 had been drafted. Therefore, after WP12 has a solid implementation of its users and their privileges we may opt to add user categories in order to be coherent with WP12.

1. There is the simple user type which logs into the system and can perform queries on the stored data.
2. The partners can also contribute by submitting data sets that could be potentially stored in the data base
3. The editors, which apart from contributing data sets, review and approve what partners have contributed.

Figure 2 depicts the EDMSs structure and core functionality as a flowchart. Under the Collection / Entry label we have the actions the partners can perform (login, edit, save).

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	13/21



**Figure 2. EDMS – STEP 2 – Insert Data via (Common) Data Template(s)**

The partners can fill a Template Form and submit it for consideration. Under the Assessment / Quality label we can see the actions an editor can perform. The editor, asynchronously, can review and potentially approve (finalize) entries submitted from any partner. Only then these data are available and can be retrieved by queries simple users make. The latter is described under the Data Search label where there is the interaction a simple users can perform with the EDMS (login, search and view).

#### 2.2.4.1 Data Collection Entry – Template Form

The following sections are covered by the template form that every project partner need to fill in to provide an environmental data set that will be stored in the EDMS:

1. Data Class
2. Environmental Stressors
3. Location
4. Medium/Medium Characteristics
5. Data Information

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	14/21

6. Data Source / Web link / upload single file
7. Measurement methodology
8. QA/QC Procedure
9. Submitting Partner

In Annex I, is presented the manual provided to the submitting partners in order to fill in correctly and to clarify issues of the template form.

The EDMS of HEALS project contains data on the following environmental categories of interest (**Data class**) as it is mentioned previously:

- Land use/Land cover
- Meteorological Data
- Comfort data indoors (temperature-relative humidity)
- Air emission data
- Air emission data – consumer products
- Pollutant concentration data – indoor air
- Pollutant concentration data – outdoor air
- Pollutant concentration data – in vehicle air
- Pollutant concentration data – soil
- Pollutant concentration data – dust
- Pollutant concentration data – water
- Pollutant concentration data – drinking water
- Food concentration data
- Population data (age/gender/etc)

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	15/21

- Noise data
- Building characteristic data
- Heat Stress Data
- Pharmaceutical Data
- EMF Data

Under the ***environmental stressor*** the EDMS includes the priority pollutants of the HEALS project. The list includes at least:

- PM10, PM2.5 NO<sub>2</sub>
- O<sub>3</sub>
- Volatile Organic Compounds (VOCs)
- Phthalates
- Toxic metals
- Organic compounds
- Organoalogenes
- Dust mites
- Pesticides
- Endocrine disruptors
- Persistent Organic Compounds (POPs)
- Mold
- Pollen

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	16/21

- Noise

The above stressors' catalogue will be rearranged or transformed including PM1, Ultra fine particles and Nano particles. Also, the Endocrine disruptors will fused into the appropriate existing categories (e.g. Pthalates, POPs).

Also data providers to the system can enter another environmental stressor that is interest to the project and cannot listed in the above list due to space limit.

The **location** part of the data insert template form provides information about the spatial distribution of the corresponding data such as country of origin of the data, geographical region, longitude, latitude etc., while the **medium characteristics** provides the specific medium (air, soil, water, food etc.) that the data refer.

In the **Data information** part of the template is listed the temporal dimension, the time resolution, the measurement units of the corresponding data along with any useful information on the provided data for better understanding the way of the data presented in the EDMS.

The **Data Source / Web link** section contains the active web link for the data that is treated and accessed outside the HEALS EDMS as well as the umbrella web link that the data came from. Also in this section there is the option of upload to the HEALS database a single file containing data of interest that can be provided to the HEALS project.



FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	17/21

Choose from the options below.

**A. Data Class**

SELECT AN OPTION ▼

**B. Environmental Stressors**

- |                                         |                                            |                                                 |                                     |                                          |
|-----------------------------------------|--------------------------------------------|-------------------------------------------------|-------------------------------------|------------------------------------------|
| <input type="checkbox"/> N/A            | <input type="checkbox"/> PM <sub>10</sub>  | <input type="checkbox"/> PM <sub>2.5</sub>      | <input type="checkbox"/> VOCs       | <input type="checkbox"/> Phthalates      |
| <input type="checkbox"/> Toxic Metals   | <input type="checkbox"/> Organic compounds | <input type="checkbox"/> Organoalogenes         | <input type="checkbox"/> Dust mites | <input type="checkbox"/> Mold            |
| <input type="checkbox"/> Pollen         | <input type="checkbox"/> Pesticides        | <input type="checkbox"/> Endocrine disruptors   | <input type="checkbox"/> POPs       | <input type="checkbox"/> NO <sub>2</sub> |
| <input type="checkbox"/> O <sub>3</sub> | <input type="checkbox"/> Noise             | <input type="checkbox"/> Other (please specify) |                                     |                                          |

**C. Location**

Country

SELECT AN OPTION ▼

Region(s)

Municipality(ties)

Location Characteristics

Ambient Environment Type

Click and select one or more values

Microenvironment Class

- ☐ Outdoors
- ☐ Indoors
- ☐ In vehicle
- ☐ Unspecified
- ☐ Other (please specify)

Longitude

Latitude

Altitude

Above Ground Level

Spatial resolution

SELECT AN OPTION ▼

**Figure 3 Data Template form through the website of EDMS.**

In the **measurement methodology** part it is reported the method used to obtain the data as well as the information on the whole procedure for obtaining the specific data such as technical equipment used, sampling techniques etc., while in the section of QA/QC the data that are imported or accessed through external web links are accompanied with all the quality control and quality assurance procedures that are available.

Finally in the **submitting partner** section is listed the identity of the data provider. In figure 3 is showed the xml form of the data template for the EDMS HEALS database.

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	18/21

### 2.2.5 Data directly retrieved from other databases

The underlying methodology encompasses the following steps:

1. Review existing database schemas
2. Define DB structure (tables and relations)
3. Develop scripts to collect and store data
4. Convert to our own db format (schema)
5. Define queries to import data
6. Define update queries
7. Define selection queries

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	19/21

### 3. Data search and presentation

After the above steps are complete for each entry that represents data from other databases, data retrieval involves selection queries based on three categories (Figure 4). Further query functionalities (filters pertained to time or geographic regions) will be added, if needed, as the work continues and communication with the WP12 is established:

1. Data Class
2. Country
3. Pollutant / Stressor

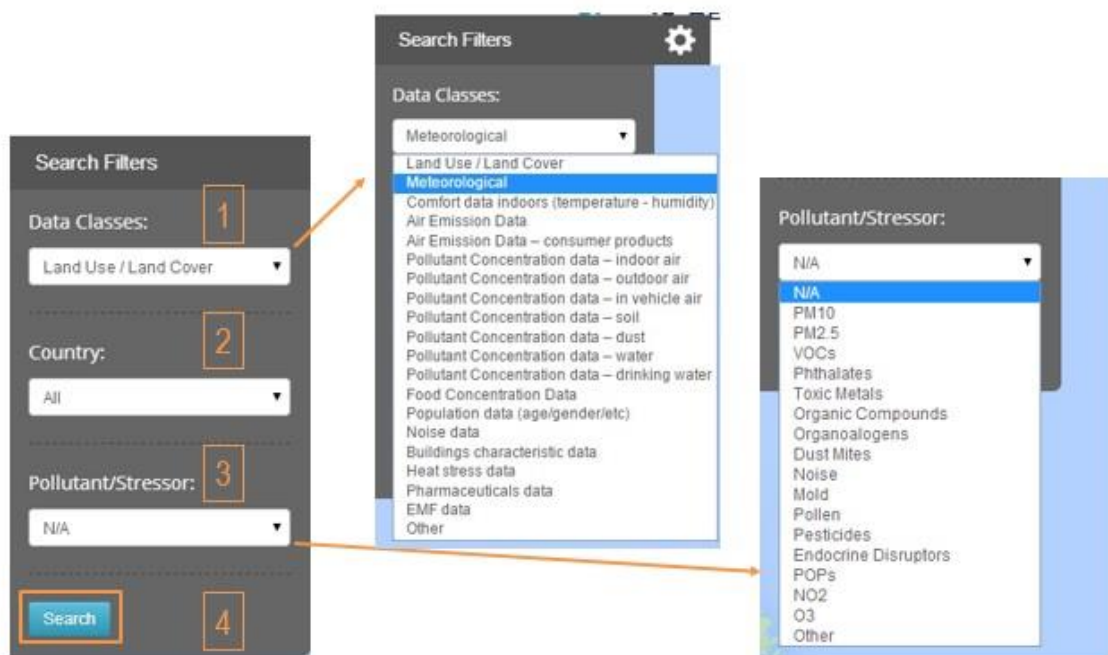


Figure 4. Data search options

The search produces the available data sets (Figure 5).

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	20/21

#### Selected criteria:

Data Class:Pollutant concentration data – outdoor air, Country: Greece, Pollutant/Stressor: PM<sub>10</sub>.

#### Available Data Sets:

Data Set No.	Data Set Description Summary
<b>DataSet 1</b>	Data are quantified stressor concentration in air. Units are µg/m <sup>3</sup> except for: CO: mg/m <sup>3</sup> Cadmium, nickel, arsenic: ng/m <sup>3</sup> <i>Relative URL(s)</i> : <a href="http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8">http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8</a> <i>Relative file(s)</i> not defined. <a href="#">More...</a>
<b>DataSet 2</b>	Data are quantified stressor concentration in air. Units are µg/m <sup>3</sup> <i>Relative URL(s)</i> : <a href="http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8">http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-8</a> <i>Relative file(s)</i> : GR0008A0000500100day.1-1-2001 OK.xlsx <a href="#">More...</a>
<b>DataSet 3</b>	Concentration of PM <sub>10</sub> in air measured in µg/m <sup>3</sup> <i>Relative URL(s)</i> not defined. <i>Relative file(s)</i> : JULY_OCT 2012.rar <a href="#">More...</a>

**Figure 5. Available data sets after search.**

Each set, upon selection is presented providing the categories used to collect the data in tabbed format.(Figure 6)

Location/Medium
Data Information
Data Source/Weblinks
Measurement Methodology
QA/QC

**Region(s):**  
No data stored.

**Municipality(ies):**  
Thessaloniki, Aliartos, Athens, Agia Paraskevi, Elefsina, Galatsi, Heracleion, Ioannina, Kalamaria, Eleftherio-Kordelio, Koropi, Larissa, Ano Liosia, Likovrisi, Amarousio, Megalopoli, Nea Smyrni, Kalithea, Oinofyta, Panorama, Patra, Peristeri, Pireas, Sindos, Ptolemaida, Thracomakedones, Zografos, Volos

**Longitude:** From: 20.85 To: 25.08011    **Latitude:** From: 35.3325 To: 40.739842    **Altitude:** From: 4 To: 750    **AGL:** From: No data stored. To: No data stored.

**Spatial Resolution:**  
Point

**Medium:**

**Ambient Environment Type:**  
1.Urban 2.Suburban 3.Rural 4.Industrial

**Microenvironment Class:**  
1.Near canyon street (L/H less than 1.5) 2.Near wide street/road

**Figure 6. Data presentation**

FP7-ENV-2013-603946	D8.2 – Environmental Data Management System (EDMS)		
	<b>WP8:</b> Environmental Data Mining	<b>Security:</b>	
	<b>Author(s):</b> P.Karagiannis, E.Tolis, J.G. Bartzis	<b>Version:</b> 1	21/21