Hellenic Natural Resources with Ontologies

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Abstract

The natural resources in Greece are affected from global warming and human exploitation. This has motivated an increasing number of people to begin a systematic effort to avert further damage. This work proposes an ontology for the description of natural resources and climate change in order to assist this effort. The proposed model is based on OWL. The Web Ontology Language (OWL) is a family of knowledge representation languages for authoring ontologies. As a case study the natural resources of the region of Pella are described. The proposed representation allows the software agents in the semantic web to apply their queries in order to extract useful environmental information. Finally, an interaction among a number of different ontologies for the purpose of modeling the impact of the climate change in the sustainability of the natural resources is sketched.
Keywords: natural resources, ontologies, ecoinformatics

1. Introduction and Related Work

In the past few years, the field of the ontologies has gained a lot of interest because of its potential. The term *ontology* in computer science is about the formal representation of knowledge as a set of concepts and entities and the relationships between them. In the framework of the semantic web, known as *WEB 3.0*, many researchers have proposed ontologies about several entities, such as gene ontologies, food ontologies and so on.

Another field that is very prominent not only in research but, also, in our daily life and even our economy is the ecology and the natural environment. In this paper, we try to join these two sectors under an ontology for natural resources, specifically about the region of *Pella* in the northern of Greece. It will be shown in the rest of this work that the linking between the natural resources and the climatic parameters is direct and intuitive.

Past work has focused on the area of ecoinformatics, using ontologies as a tool for representing ecological terms. More precisely, a lot of research has been conducted in biology and ecology (see [Madin et al.] and references). The ecological concepts [Williams et al. (2006)] are in great interest between those efforts using the OWL model as a descriptive method. Furthermore, class hierarchy in landscapes and ecosystems [Lepczyk et al. (2008)] provides a new opportunity for the representation of environmental aspects in order to be accessible from software agents. The tools that Semantic Web provides give another point of view in organizing, storing and distributing data that describe animals, plants and so on [Hollander et al. (2006)]. DBpedia is a characteristic example of this main stream exploiting the existing information in Wikipedia[DBpedia] [Ontology Classes] and categorizing it for further usage. An enormous source of information about special protection areas and therefore natural resources can be found within the network of Natura 2000 [Natura 2000]. Natura 2000 is an international network about protected natural areas in Europe, including Greece. Finally, it's worth mentioning the serious effort in describing the wild flora and fauna and their relationship [Wildlife Ontology]. This effort is motivated by the above works and tries to customize those concepts relevant to the hellenic natural resources and climate.

2. Proposed ontology model

In this section an ontology for natural resources in the area of Pella is introduced. Pella was selected because of the wealth and the variety of the natural resources (rivers, lakes, animals etc). The ontology is shown in Figure 1.

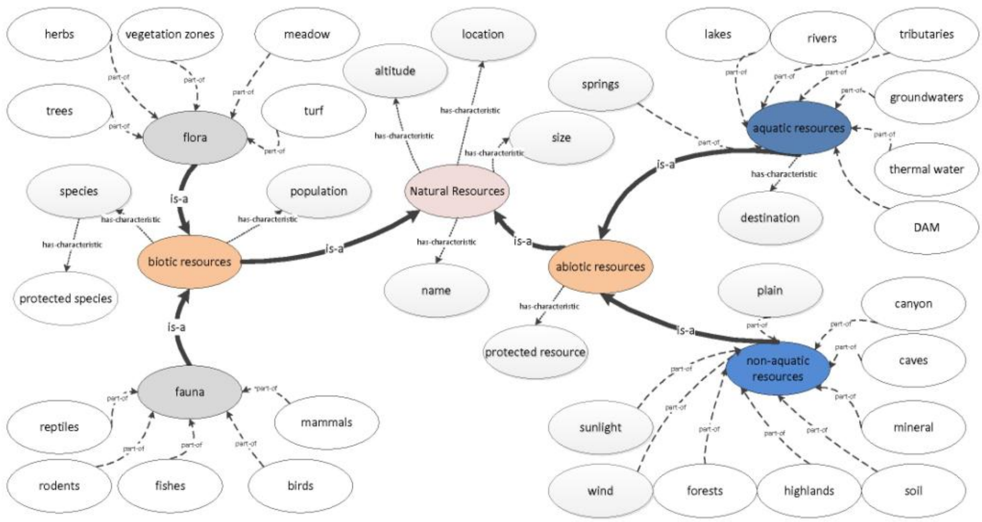

Figure 1. *An ontology representing Natural Resources concepts.*

The OWL code, which corresponds to these concepts is given in *http://195.251.111.53/~skours/Eureka11/index.html* in detail. Some queries that can be answered are:

- Information about a specific kind of natural resources that fulfill a criterion, e.g. rivers, mountains
- What kind of fruits or vegetables can be grown on the Pella's soil
- Agrotourism's conditions
- Transmission of groundwater contamination
- Renewable energy sources' outlook
- New jobs related to environment science

3. River Resources

We show below some indicative data about local natural resources of Pella, specifically rivers.

Table 1. *Data about rivers in the region of Pella.*

name	**oth.name**	**Size**	**source**	**destination**
Loudias	Mavroneri	38 km	Paiko	Thermaikos
Edessaios	Vodas	29 km	Vorras	Moglenitsas
...	...	...	...	...

Some queries that can be answered, using SPARQL[1] are:

Query 1:

```
PREFIX ex:<http://example.com/NaturalResourceOntology> .
SELECT ?name ?size
WHERE { ?x ex:destination ?destination.
FILTER (?destination, \Thermaikos") }
```

Query 1 Result:

Table 2. *Results obtained from the first query.*

name	**size**
Loudias	38km

[1] SPARQL Protocol and RDF Query Language

4. Mountain Resources

Similarly, some of the main mountains of Pella are given in the following table:

Table 3. *Data about mountains in the region of Pella.*

name	**altitude**	**oth. Name**
Vorras mountain	2.524 m	Kaimaktsalan
Paiko mountain	1.986 m	Megala Livadia
Vermio mountain	2.052 m	Doxa
...	...	...

Query 2:

PREFIX ex:<http://example.com/NaturalResourceOntology> .

SELECT ?name ?oth. name

WHERE { ?x ex:name ?name

?x ex:oth.name ?oth.name

?x ex:altitude ?altitude

FILTER (?altitude > 2.000) }

Query 2 Results:

Table 4. *Data Results obtained from the second query.*

name	**oth. name**
Vorras mountain	Kaimaktsalan

Vermio mountain	Doxa

5. Conclusions and Future Work

The climate change is more than obvious in our everyday life, regardless of where and how we live. This has a direct negative impact to the sustainability of the natural resources, as it tends to damage or even eliminate them most of the times. Because of this fact, an introduction of the *Climate* and *Weather* ontology, as well as their connection, is considered necessary in order to describe the changes in *Natural Resources*. The correlation of the previous ontologies is shown in Figure 2. Figure 2 also depicts an initial representation for the *Human Activities* ontology.

It is evident that mankind and especially the most developed societies live using the environment as an endless repository of resources. Activities such as energy consumption, waste production, fossil fuel exploitation and air pollution have a negative effect on the climate and natural resources of the planet. This common observation is the basis for the correlation of the aforementioned ontologies, as shown in Figure 3. There is no doubt that there is a relationship among them and each one has direct or indirect impact on the others, due to their coexistence in the same domain. This idea could be transferred in the informational level where an appropriate reasoner, existing in the semantic web frame, would infer knowledge or even predictions in response to a user demand. A user in that case would not be limited to a person but more to a task, e.g., machine learning programs processing enormous amount of data. These data would not be just useful for discovering new knowledge for the users, but, in addition, the consistency of their ontological representation would provide a dynamic flexibility that could be more useful in controlling the artificial systems. An example of this potential could be the information for the lifetime of a specific water resource, e.g., lake, which could be extracted as an answer in a complex query. That query could include weather models, registered climate history, as well as information about the behavior[2] of adjacent ecosystems in the wide area.

A connection between the network of Natura 2000 and a related ontology could be easily established using the large tank of information provided by the site of Natura 2000, exactly like the way DBpedia uses the Wikipedia as data source. Our proposed model above could be found helpful as a first step in that direction. Thus, a use case of the proposed ontology could involve information from the site of Natura 2000 related to natural resources, either of the Greek territory or not.

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[2] Complex nested queries.

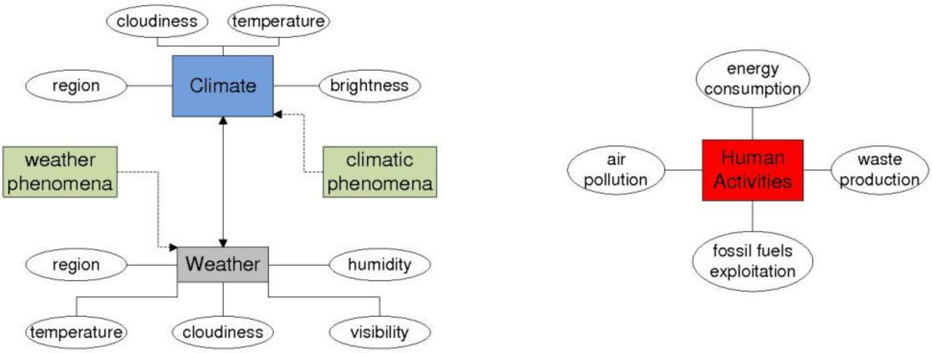
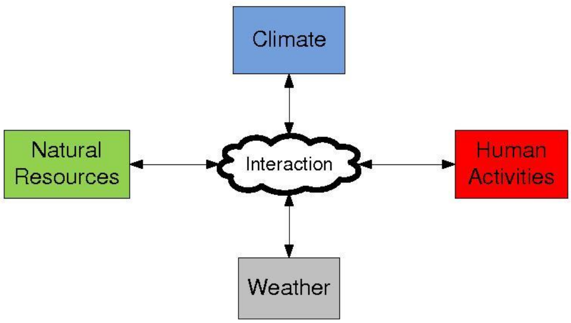


Figure 2. *Connection between Climate and Weather ontologies. Also is presented the Human Activities ontology.*



. ***Figure 3.*** *Interaction between ontologies: Natural Resources, Climate, Weather and Human Activities.*

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DBpedia *http://wiki.dbpedia.org*

Natura 2000 *http://natura2000.eea.europa.eu/*

Ontology Classes *http://mappings.dbpedia.org/server/ontology/classes*

SPARQL Query Language for RDF *http://www.w3.org/TR/rdf-sparql-query/*

Wildlife Ontology *http://www.bbc.co.uk/ontologies/wildlife/2010-11-04.shtml*