Ontology Development for Searching Soil Knowledge

Tongpool Heeptaisong and Anongnart Srivihok

Department of Computer Science, Faculty of Science, Kasetsart University, Bangkok, Thailand
g5184040@ku.ac.th, fsciang@ku.ac.th

Abstract

Thailand is an agriculture based country which many inhabitants are farmers. Knowledge on soil is scattered in many places, this is difficult to search for soil topics. This paper presents steps to create soil ontology to aid in the soil knowledge search. This soil ontology is also compatible to be used by other information systems. It further helps in searching of knowledge from multiple sources on the Internet and supports knowledge sharing and knowledge reuse which is the important process in knowledge management. As a result, the seed soil ontology contains 84 nodes and 83 relationships. Establishing soil ontology has been reviewed by a soil specialist, it is accurate and can be implemented effectively.

***Keywords**: Soil Science Ontology, Ontology Design, Semantic Web, Knowledge Representation*

1. Introduction

Thailand is an agricultural based country located in Southeast Asia region. Using land for agriculture about 130 million hectares from approximately 320 million hectares [10]. Knowledge of soil is very important for the farmers and it must be managed in a systematic way in both the soil maintenance and management. Due to storing of several patterns of soil knowledge and scattered in various sites, knowledge is explicit or tacit in person. Tremendous of explicit knowledge in an electronic files on the Internet, it is difficult to use keywords to search for soil knowledge and results are always not satisfied the user's requirements. Therefore, it has to cooperate with other technologies to enhance the retrieval of knowledge and provide answers as experts. The technology widely popular today is ontology technology.

Ontology is a type of knowledge that is created by experts for searching semantic information that is more accurate and precise than other methods. For instance when user wants a document on Soil fertility, he may use "fertility" as keyword after that ontology will be used to find related keywords (such as essential nutrient element, nutrient absorption, nitrogen, sulfur, phosphorus, potassium, calcium, magnesium and iron) and use them to help for soil knowledge. Therefore ontology will improve efficiency in knowledge search. Moreover, ontology also supports knowledge sharing and reuse which is a key process in the knowledge management system [9].

As mentioned above, the researchers tried to develop ontology in other domain such as Thai Rice [1], Thai Succession Law [4] and Health & Medical domain [2],[7],[8]. However, no Ontology of Soil Science is developed in Thailand. The objective of this study is to develop Soil Science Ontology based on the knowledge from Thai Experts and explicit knowledge for searching soil knowledge from sources.

This paper is organized as follows: Section 2 describes important ontology and tools which were used to create widely ontology. Section 3, we propose the framework of soil ontology building. Section 4 covers the experimental results and discussion. Finally, the conclusions and future work will be address in section 5.

2. Related Theory

2.1 Soil is an important resource to agriculture in Thailand, because it is used for agriculture especially farming approximately 40 percents. Soil is environment which is naturally occurring, caused by decomposition of rock by using a over long time. Stone decay corrosion is different in size when mixed with fossil, water, air, and became soil texture[5],[6]. Nowadays Soil Science knowledge have stored in different sources so searching is time consuming and always not satisfied the user's requirements.

2.2 Ontology will be used for semantic search and knowledge representation with another information system. Moreover, human and the computer can understand. Ontology will be in the form of terms and relationships between terms for instance fertilizers keyword relates with organic fertilizer, biofertilizer and chemical fertilizer. It may also increase the weight of term to help in knowledge search accurately. Nowadays ontology can develop two methods that are created by experts [1] and by terms of a document extracted automatically [3], [4] but the first method is correct and has been the most popular.

2.3 Hozo is a ontology editor which is developed in Japan and is an open source. It is widely popular for ontology development because it can be used develop ontology structure easily and can support Resource Description Framework (RDF), Ontology Web Language (OWL), Extensive Markup Language (XML) and a standard of W3C [11].

2.4 Related articles,

Thunkijjanukij *et al.* developed Thai Rice ontology by 27 domain experts and use Delphi technique to collect data [1].

Boonchom and Soonthornphisaj proposes an automatic ontology building about Thai Succession Law by using new algorithm Ant Colony. As a result, this ontology has been accepted by experts[4].

Buranarach and coworkers used ontology cooperated with Healthcare systems to predict Chronic Disease patient as expert [7].

3. The Framework of Soil Ontology Building (SOB)

The steps of soil ontology development are shown in Figure 1. They include 5 steps as follows.

3.1 Data preparation step is a term extraction process. This data set is collected manually from soil resources such as dictionaries of Soil Science [5], Introduction to Soil Science text book [6] and various sources that is popular and reliable. As a result from this process, there are 1,097 keywords of Soil Science, examples are shown in Table 1.

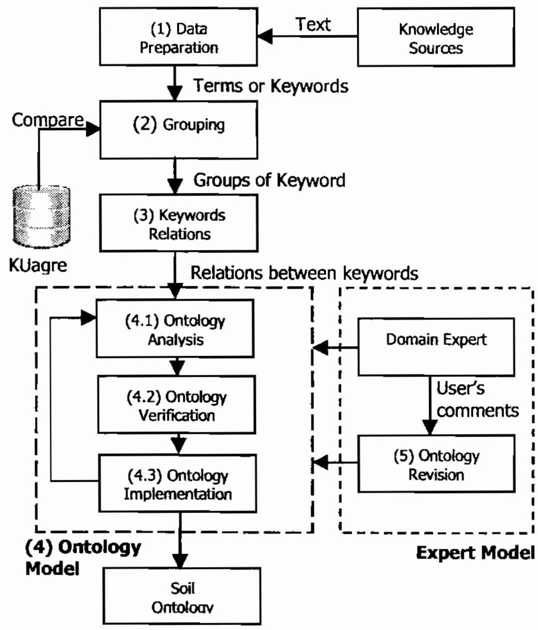

Fig. 1. The framework of soil ontology development

Table 1. The soil keywords collected from sources

No.	Thai Keyword	English Keyword
1.	การจำแนกดิน	soil classification
2.	การดูดซับ	adsorption
3.	สารละลายดิน	soil solution
4.	สารสกัดจากดิน	soil extract
5.	วัสดุอนินทรีย์	mineral soil material
6.	วัสดุดินอินทรีย์	organic soil material
7.	ปุ๋ย	fertilizers
8.	ธาตุอาหารพืช	Essential nutrient element
9.	ดินเค็ม	Salinity
10.	เชื้อรา	Fungi
11.	วัสดุปรับสภาพดิน	soil conditioner
12.	สภาพกรด	acidity
13.	สัณฐานดิน	soil morphology
14.	ปุ๋ยพืชสด	green manure

3.2 Data Grouping. After Step 3.1, we have to classify these keywords. This step, keywords were checked with the famous agriculture knowledge base of Thailand named KUagre [12]. The results were a group of 13 main categories and 71 subcategories. Then, groups are brought into the process of creating relationships between terms to be ready to develop ontology as shown in Table 2 and Table 3.

Table 2. The list of main categories of Soil Science

No.	Thai group	English group
1.	แหล่งกำเนิดดิน/ต้นกำเนิดดิน	Soil genesis
2.	สมบัติดิน	Physical properties of soil
3.	เคมีดิน	Soil chemistry
4.	จุลชีววิทยาดิน	Soil microbiology
5.	วัสดุอินทรีย์ดิน	Soil organic matter
6.	ความอุดมสมบูรณ์ดิน	Soil fertility
7.	การว่านปุ๋ย/ปุ๋ย	Fertilizers
8.	สัณฐานดิน/สัณฐานวิทยาดิน	Soil morphology
9.	การสำรวจดิน	Soil survey
10.	การจำแนกดิน	Soil classification
11.	การกร่อนดิน	Soil erosion
12.	การอนุรักษ์ดิน	Soil conservation
13.	การจัดการดิน	Soil management

Table 3. The list of subcategories of Soil Science

No.	Main No.	Thai subgroup	English subgroup
100	1	วัสดุดิน	Soil forming material
101	1	กระบวนการผุกร่อน	Weathering process
102	1	การเปลี่ยนแปลงดิน	Soil formation
103	2	เนื้อดิน	Soil texture
104	2	ความหนาแน่นดิน	Soil density
105	2	ความพรุน	Soil porosity
106	2	โครงสร้างดิน	Soil structure
107	2	สีของดิน	Soil color
108	2	ความชื้นดิน	Soil water/moisture
109	2	อุณหภูมิดิน	Soil temperature
110	2	การถ่ายเทอากาศดิน	Soil aeration
111	3	คอลลอยด์ดิน	Soil colloid
112	3	การแลกเปลี่ยนแคดออน	Cation exchange
113	3	สภาพเป็นกรดเป็นด่าง	Acidity-alkalinity
114	3	ดินเค็ม	Salinity
115	3	ดินโซดิก	Sodicity
116	4	แบคทีเรีย	Bacteria
117	4	แอคทิโนไมซีท	Actinomycets
118	4	เชื้อรา	Fungi
119	4	สาหร่าย	Algae

3.3 Keyword Relation. The aim of creating relation is to help finding association between keywords and groups. This step must be conducted accurately. The relationships are based on the standard of ontology as shown in Table 4.

Table 4. The list of relation name

No	Relation Name	Meaning
1	Is-a	The keyword has similar or equal meaning with group.
2	Part-of	The keyword is part of group.
3	Attribute-of	The keyword is attribute of group.

3.4 Ontology development model includes (1) ontology analysis (2) ontology verification and (3) ontology implementation. Each process was checked by Soil Science specialist accurately. Then, Soil ontology is developed by Hozo editor As shown in Figure 2.

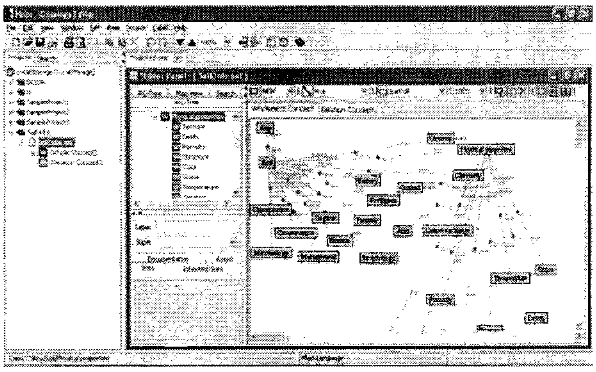

Fig. 2. Hozo-ontology editor

3.5 Ontology revision step is the final process when brought soil ontology to use in knowledge search. After that we will assess the performance of soil ontology from the user's comments. To maintain this ontology the schedule for revision step may be different depending on domain of knowledge.

4. Result

After soil ontology development, we have found that the ontology includes all 84 nodes and 83 relationships as shown in Figure 4. For relation building we will use both the "Is-a" and "Part-of". The soil ontology must be stored in the OWL document file as shown in Figure 3. This file can be used in the knowledge search collaborating with engine in database of information system.

```
<owl:Class rdf:ID="Soil__ดิน_">
  <rdfs:label>Soil__ดิน_</rdfs:label>
  <rdfs:subClassOf rdf:resouree="#Any" />
</owl:Class>
<owl:Class rdf:ID="Genesis__แหล่งกำเนิด_">
  <rdfs:label>Genesis__แหล่งกำเนิด_</rdfs:label>
  <rdfs:subClassOf rdf:resource="#Soil__ดิน_" />
</owl:Class>
<owl:Class rdf:ID="Propcrty__สมบัติดิน_">
  <rdfs:label>Property__สมบัติดิน_</rdfs:labcl>
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</owl:Class>
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</owl:Class>
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</owl:Class>
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</owl:Class>
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</owl:Class>
<owl:Class rdf:ID="Morphology__สัณฐานวิทยา_">
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</owl:Class>
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</owl:Class>
<owl:Class rdf:ID="Classification__จำแนก_">
  <rdfs:label>Classification__จำแนก_</rdfs:label>
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  <rdfs:subClassOf rdf:resource="#Soil__ดิน_" />
</owl:Class>
<owl:Class rdf:ID="Management__การจัดการ_">
  <rdfs:label>Management__การจัดการ_</rdfs:labcl>
  <rdfs:subClassOf rdf:resource="#Soil__ดิน_" />
</owl:Class>
```

Fig. 3. OWL document file of soil ontology

5. Conclusions

The aim of this paper is soil ontology development for supporting the soil knowledge search, therefore it is also compatible to be used by other information systems. It further helps in searching of knowledge from multiple sources such as HTML, documents or databases on the Internet and supports knowledge sharing and knowledge reuse which is the important process in knowledge management. Establishing soil ontology has been reviewed by a soil specialist, it is accurate and can be implemented effectively. In the future work we will use this ontology with other information systems and add weight of term in ontology from user's comment to improve accuracy its.

6. Acknowledge

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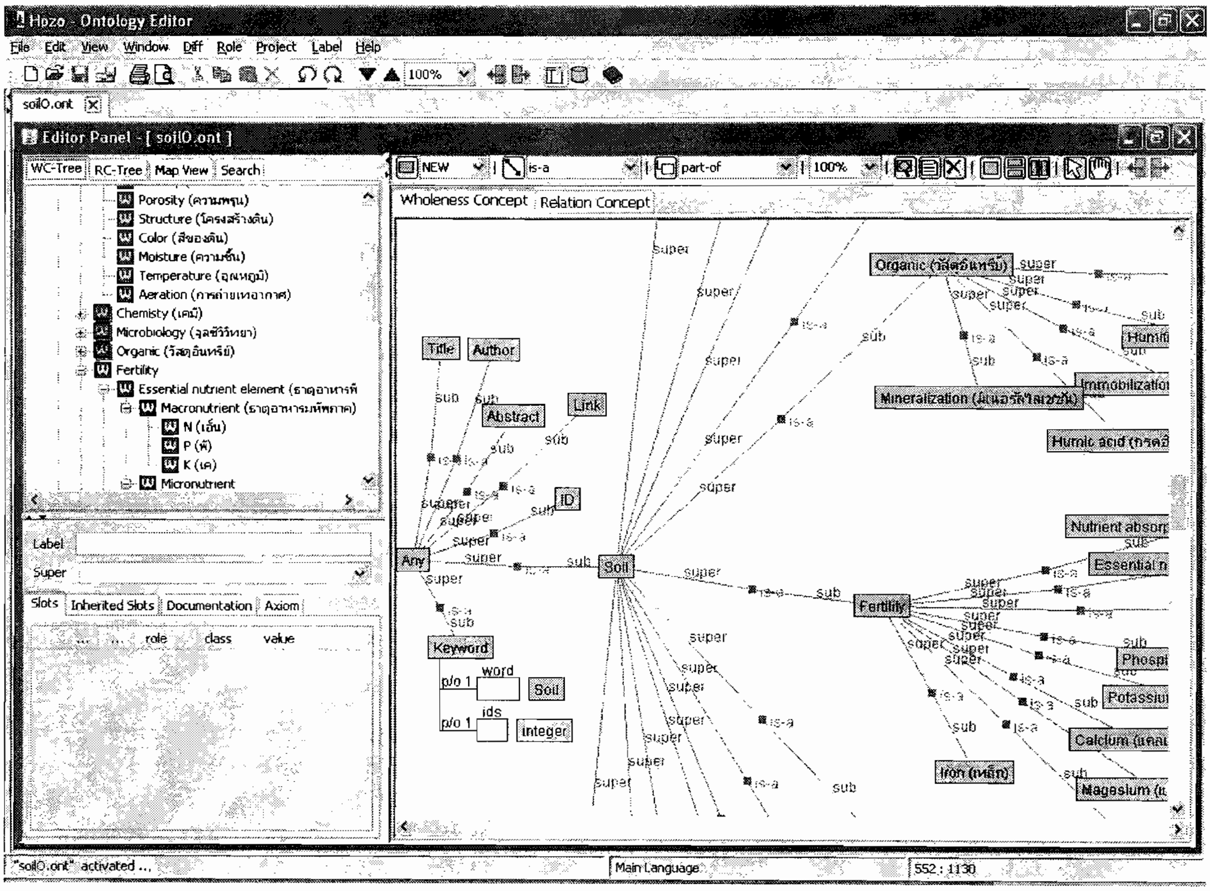

Fig. 4. An soil ontology