Advanced Science and Technology Letters
Vol.85 (Information Technology and Computer Science 2015), pp.29-32
http://dx.doi.org/10.14257/astl.2015.85.07

A Trend of Long-term Ecological Research Platform Technology

Sunil Ahn[1], Jihoon Jang[1]

[1] KISTI, Yuseong-gu, Daejeon, Korea
{siahn, jangoq}@kisti.re.kr

Abstract. Environmental factors play an important role in functions and distribution of organisms. Basic objective of the long-term ecological research is to monitor environmental changes due to climate change and track the consequences, to cope with the environmental issues that may arise now and in the future. For long-term ecological researches, a system (Cyber Infrastructure) is essential, which can continuously harvest and manage the data about ecosystem changes. Countries around the world have been building a platform that can harvest and manage the data about ecosystem changes for long-term ecological researches. This paper examines the trend of the long-term ecological research platform technology in order to meet various requirements of the long-term ecological research.

Keywords: LTER, Platform, Trend

1 Introduction

Environmental factors play an important role in the biological function and distribution. Organisms on Earth are distributed according to climate characteristics, and climate has a lasting impact on the growth of plants and animals. Impacts of the global warming on biodiversity have been reported in many parts of the world. Changes in one species result in consecutive changes in other organism related to it, affecting the entire ecosystem.

Basic objective of the long-term ecological research is to monitor environmental changes due to climate change and track the consequences, to cope with the environmental issues that may arise now and in the future. It is difficult to explain the causal relationship between climate change and ecosystem changes through the harvest of data over a short period of time should be compared to short-term analysis of the data harvested for a short period of time but it is necessary to harvest and compare data for a long period of time. For long-term ecological researches, a system (Cyber Infrastructure) is essential, which can continuously harvest and manage the data about ecosystem changes.

Countries around the world have been building a system that can continuously harvest and manage the monitoring data about the ecosystem changes for the long-term ecological researches. Representative examples are PASTA [1] and MetaCat [2] of USA, EU DEIMS [3], Australia TERN [4] of Australia, AEKOS [5], CERN [6] of

ISSN: 2287-1233 ASTL

China, and the like. This paper examines the trend of the long-term ecological research platform technology in order to solve various issues related to the long-term ecological researches.

2 LTER Platform Technology

2.1 PASTA

Provenance Aware Synthesis Tracking Architecture (PASTA), which started its official services in January 2013, is a synthesis data storage of the US Long Term Ecological Research (LTER) network. The existing LTER network stored data for each site, and shared and managed only the metadata for data through MetaCat software. This resulted in a problem of data fragmentation and made inter-site data integration difficult. In order to solve this problem, PASTA stores data after synthesizing the data managed by each site into a standard format. Data stored in each site are harvested to the PASTA system through "EML Parser/Loader". Afterwards, they are synthesized into a standardized format through the automated process. Metadata for the reprocessed data is registered through MetaCat and published for user service.

The PASTA can manage the metadata in an EML-based standard format, using MetaCat and provides RESTful interface, to enable easy interface with various data processing and analysis tools such as R language, Kepler, Matlab and the like. It also manages provenance data for all processes of creating reprocessing data, to provide a method that can be referred to in the process of reprocessing new data in the future. In addition, it supports a standardized vocabulary and search using "LTER Controlled Vocabulary" and provides a service to create DOI for reference to each dataset.

2.2 DEIMS

Drupal Ecological Information Management System (DEIMS) is a metadata management system of Europe-LTER network. Data in the Europe-LTER network is managed site by site, and metadata for the data is integrated and managed through the DEIMS. The DEIMS supports various search methods based on the connectivity such as user profiles, sites, projects and journals by providing methods to express the connection between concepts. Developed on the basis of Drupal contents management system for the relation information based search using taxonomy and keywords, the DEIMS supports the standardized vocabulary and searches, using "EnvThes Controlled Vocabulary."

The DEIMS converts metadata stored in it into EML format and publishes them through MetaCat, for global data sharing. In addition, it provides a web-based metadata editor, a module for creating data compatible with EML, BDP and ISP, and information curation process through workbench. However, it is still difficult for the DEIMS to integrate data among sites due to such problems as heterogeneity and

fragmentation of data in each site. Therefore, studies have been going on about ontology-based ecological data management methods through separate SORONTO project.

2.3 TERN/AEKOS

Terrestrial Ecosystem Research Network (TERN), started in 2009, is an ecological research support network of Australia and consists of eight (8) subnetworks. In the TERN, data is managed for each subnetwork and the TERN manages metadata only. For automated extraction of metadata from each subnetwork, the TERN uses OAI-PMH protocol and RIF-CS format. Though some subnetworks support EML format, the TERN does not officially support the EML and thus there is a potential problem for global data integration.

Australian Ecological and Knowledge Observation System (AEKOS) is one of subnetworks of the TERN. It was started to resolve such problems as fragmentation of ecological data, absence of data context, data diversity, and lost data. It serves as a storage for various ecological data such as Multi Scale Plot Network (MSPN), Australian government data and general research data, and also supports various searches and data integration through taxonomy and ontology. Data of each site is automatically harvested by "Data Ingester", and ends up being stored in the AEKOS site through conversion process. Data can be requested through e-mail, and delivered in csv format or SQL format. The AEKOS has developed and utilized its own "Controlled Vocabulary", and provides a service to create DOIs for reference to each dataset.

3 Conclusion

This paper examines the trends of long-term ecological research platform technology to resolve various issues related to the ecological researches. The biggest issue of the long-term ecological research platform is to solve the problem of data fragmentation, and to provide a method to flexibly integrate the data harvested through each site. The PASTA of the USA, AEKOS of Australia and CERN of China try to solve the problem of data fragmentation by supporting controlled vocabulary and data synthesis. In order to solve this problem, the DEIMS uses standardized vocabulary and some ontology. However, the problem has not been completely solved and remains as an ongoing homework for the long-term ecological research platforms. It is expected that efforts to solve the problem of data fragmentation using ontology will continue.

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