Internet GIS for ASIA Flux Database

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1 Introduction

"S-1 project: Integrated Study for Terrestrial Carbon Management of Asia in the 21st Century Based on Scientific Advancements", which is to estimate CO_2 Flux in Asia is curried out since 2002 until 2007 under the Global Environment Research Fund, Ministry of the Environment, Japan. Comparison of point based meteorological observation data, satellite data with model simulation (SIMCycle, BIOM BGC, TsuBimo, etc) and assimilation of meteorological data, satellite data with models to evaluate the trend of CO_2 Flux in Asia are the final goal of this project. As a field observation datasets, eddy covariant method based monitoring for CO_2 Flux and other related parameters have been observed under the project. Many environmental researchers use those data through the FLUXNET or ASIAFLUX data distribution network. Also satellite data, which would suite for assimilation, are selected and collected i.e. NOAA AVHRR 10days composite data produced by SIDAB, University of Tokyo, SPOT Vegetation dataset from VITO and MODIS products from NASA. Those dataset contains advantages and disadvantages applying for the assimilation for CO_2 flux estimation.
It would be a key issue to manage these data more efficiently, to retrieve these data more easily and to utilize these data in simulation model more directly. In order to meet such demands, a database system, which has the following characteristics, is proposed. [1]
1. Internet based database system, which enables easy access to users and data providers to access the database with a user-friendly format
2. All data should be managed based on positioning information. This can be done using GIS (Geographic Information System) techniques.
3. Minimum maintenance and easy management (Utilizing open source)
4. Standardization of the data format to integrate and utilize various kinds of data more easily.
5. Renewal/Updating the data using the most recently available data across the internet, such as satellite data or meteorological data
6. Integration with a Flux simulation model
For Design of the system, which meets these requirements, Web-based GIS using GRASS (Open source GIS) is introduced.

Satellite data, which would suite for assimilation, are selected and collected under this system i.e. NOAA AVHRR 10days composite data produced by SIDAB [2], SPOT Vegetation dataset [3] and MODIS data from IIS, University of Tokyo [4].

2 Sites and measurements

Studying the environmental controls on gross primary production (GPP) and net ecosystem exchange (NEE) of the ecosystem is a primary method for understanding the carbon cycle of terrestrial ecosystem in Asia. The purpose of this meteorological monitoring is to measure the year to year changes in the NEE with the use of a long-term flux measurement and to describe the carbon budget of the ecosystem. There are more than twenty sites measuring CO2 flux in Asia.
We have been developing multi-scale GIS: CO_2 flux GIS database in Asia and site GIS which covers more site specific information.
Some of the sites are listed following sites
http://www-cger2.nies.go.jp/asiaflux/index.html
Among which, Takayama flux site, established in 1993, is located about 15km east of Takayama City, in the central part of Japan (36 08N 137 25E H1420m) is selected as a test site for site GIS. The site consists of broadleaf deciduous secondary forest aged more than 40 years. The site is mountainous and a tower 27m in height is located on a ridge that is oriented in an east-west direction.
Flux of sensible heat, water vapour, and CO_2 have been measured continuously since July 1998 by the eddy covariance method on the tower using a three-dimensional ultrasonic anemometer and a closed-path infrared gas analyzer. Fluxes were calculated every half-hour taking into account the CO_2 storage in the canopy.
http://www.aist.go.jp/RIODB/PXECO/e_intro_page.php

Items	Heights(m)	Instruments
Short wave radiation	25.5↑↓	Pyranometer Albedo meter
Photosynthetic active radiation	19.5↑↓, 2↓	Quantum sensor
Long wave radiation	24.5↑↓	Infrared radiometer
Canopy surface temperature	24.0	Infrared radiative thermometer
Atmospheric pressure	1.5	Barometer
Wind direction and mean wind speed	26.0, 10.0	Combined wind vane and fan anemometer
Mean air temperature and humidity	25.5, 19.0, 9.0	Platinum resistance thermometer and Humicap hygrometer
Mean CO2 concentration	27.0, 18.0, 8.8, 5.8	Non dispersive infrared gas analyzer
Fluctuations of wind speed and air temperature	25.0	Ultrasonic anemometer thermometer
Fluctuations of CO2 and H2O density	25.0	Closed-path CO2/H2O analyzer
Soil temperature	-0.01,-0.05,-0.1,-0.2,-0.5	Platinum resistance thermometer
Soil heat flux	-0.02	Soil heat flux plate
Soil water content	-0.15, -0.4	TDR soil water content sensor
Leaf area index		Plant canopy analyzer, Quantum sensor

Table 1List of the measurements at Takayama Site
※Precipitation, snowfall, soil respiration, diameter of trees, and litter fall are measured by Gifu University.

Further information on methodology and measurements at this site is referred to
http://unit.aist.go.jp/emtech-ri/24ae-sg/Atmos-e/AtmosTop/Atmos.html
In addition to such kind of meteorological measurements, to acquire phonological information, video system equipped with fish-eye lens is installed since 1998.
http://staff.aist.go.jp/old-gamo/2002-2/top/2-2-1introduction.html

Figure 1: A Flux tower at Takayama site.

3 Satellite data

Satellite data, which would suite for assimilation, are selected and collected under this system i.e. NOAA AVHRR 10days composite data produced by SIDAB [2], SPOT Vegetation dataset [3] and MODIS data from IIS, University of Tokyo [4] as a low to moderate resolution satellite data. NASA provides various types of MODIS processed data. Some of which are provided as ISIN projection with HDF formats.
All data are collected and converted into GIS data. Further we have developed ASTER database system covering these sites. Some other high-resolution data such as IKONOS, QuickBird and DEM data are also collected.

3 Proposed system

To manage these various types of data (raster, site data plus vector) more efficiently, to retrieve these data more easily and to utilize these data in simulation model more directly, a database system, which has the following characteristics, is proposed.
1. All data should be managed on GIS system.

GRASS GIS system is proposed.

2. Internet based database system, which enables easy access to users and data providers to access the database with a user-friendly format

Combination of GRASS with Mapserver is proposed.

3. Minimum maintenance and easy management

By utilizing Free and Open Source Software, maintenance cost for the GIS can be minimized.

4. Standardization of the data format to integrate and utilize various kinds of data more easily.

By compiling collected data into GRASS GIS, it would be easier to meet the needs for standardization, i.e. G-XML.

5. Renewal/Updating the data using the most recently available data across the Internet, such as satellite data or meteorological data

Some of the satellite data or GIS data are updated continuously and can be download freely. One of the key in GIS database is data update. To meet this, automatic data collection and update system is proposed.

6. Integration with a Flux simulation model
Not only satellite data corrected automatically from various web-sites, but also the observation data from each flux sites, transferred automatically via the Internet are compiled with GIS database and converted/assimilated into model to estimate CO_2 flux. As a final output of this system, automatically updated CO2 flux estimates can be acquired.
Scheme of the system is depicted as Figure 2.

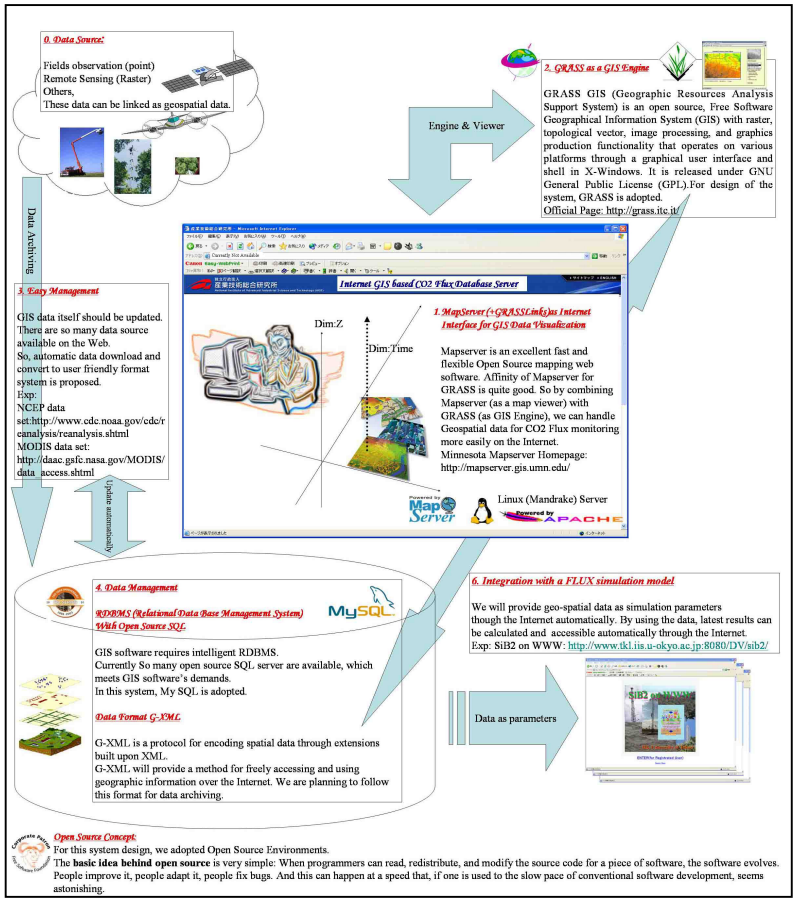

Fig 2 Scheme of the system

References

[1] Koki Iwao, *et.al*, Internet GIS based CO2 Flux Database Design, Proceedings of Synthesis Workshop on the Carbon Budget in Asian Monitoring Network, pp 97, October 2003
[2] SPOT-Vegetation: http://free.vgt.vito.be/
[3] SIDAB: http://rms1.agsearch.agropedia.affrc.go.jp/menu_en.html
[4] Satellite data archive system at IIS, University of Tokyo: http://yasulab.iis.u-tokyo.ac.jp/index_e.htm