Real-time Soil Information Monitoring by Field Server at a Rain-fed Field in Northeast Thailand

Masaru Mizoguchi[1], Shoichi Mitsuishi[1], Tetsu Ito[1],
Seishi Ninomiya[2], Masayuki Hirafuji[2], Tokihiro Fukatsu[2], Takuji Kiura[2], Kei Tanaka[2], Hitoshi Toritani[3] and Kiyoshi Honda[4]
[1] University of Tokyo (UT), Tokyo, Japan, [2] National Agriculture and Food Research Organization (NARO), Tsukuba, Japan,
[3] National Institute for Agro-Environmental Sciences (NIAES), Tsukuba, Japan, [4] Asian Institute of Technology (AIT), Thailand
Email: amizo@mail.ecc.u-tokyo.ac.jp

1. Introduction

Spatial and continuous soil monitoring is required for assessing impacts of land use and management on soil quality over large area. In order to validate soil moisture data obtained by satellite remote-sensing and direct soil moisture sensor, we are testing real-time monitoring of soil information at a rain-fed field in Northeast Thailand by using Field Server with soil moisture sensors. In this study, we outline this new monitoring system and discuss the problems that we must solve.

2. Experimental methods

Field Server (FS) is a multi-functional sensor node, which consists of CPU (Web server), Network camera and various sensors including soil moisture sensor.[1] The FS enables us monitor soil information in a remote crop field in real time through internet.

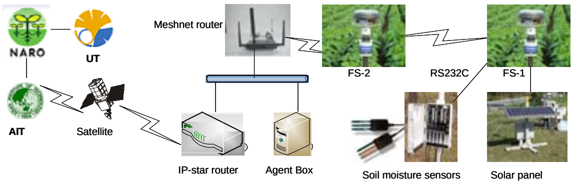

Fig.1 Diagram of real-time soil information monitoring system

We installed three FSs at a rain-fed field in KhonKaen, Northeast Thailand (16°27.657 N, 102°32.443 E) in December 25, 2006 to get meteorological data (air temperature, humidity, radiation, wind velocity, precipitation) and soil information (soil moisture content, ground temperature, electrical conductivity) with image data of the site.

Fig.2 Location of experiment site

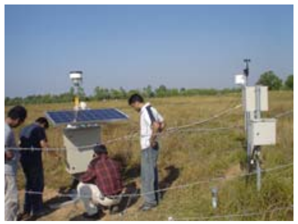

Fig.3 Setup of Field server by Asian team

We inserted soil sensors (ECH_2O-TE, Decagon Device, Inc.) at the depth of 4, 8, 16, 32 cm for monitoring soil information. (Fig.4) These data are automatically stored through internet into a data-server at National Agriculture and Food Research Organization (NARO), Tsukuba, Japan. (Fig.1)

3. Results and Discussion

Fig.5 shows real-time monitoring data sent from KhonKaen FS. Once data are stored in a data server at NARO, we can download these data by using a software [2] developed at NARO. An example of meteorological data and images data are shown in Fig.6 and 7. In reality, the system is still unstable because there are some problems about internet connection in KhonKaen site. We need to solve this problem.

Fig.8 shows soil moisture, soil temperature and precipitation from January to September in 2007. Soil moisture increased abruptly and decreased gradually by rains in March and April. On the other hand, the soil moisture kept high after a heavy rain at the end of April. The variation of soil temperature became small after May, indicating that the heat capacity of soil increased because the soil contained water. In fact, the image on May 21 tells us the water logging in the rain-fed field.

The present problem is the calibration for fluctuating soil moisture data after water logging. We are now studying about the calibration method [3] to compare these soil moisture data to an ALOS (Advanced Land Observing Satellite) data.

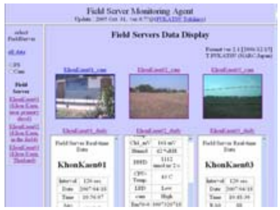

Fig.5 Real-time monitoring data sent automatically from a rain-fed field in Northeast Thailand.

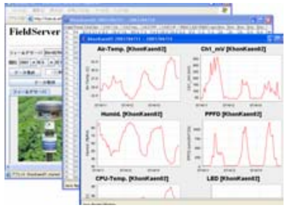

Fig.6 Meteorological data are obtained as a xml-table and graphs.

Fig.4 Installation of soil moisture sensors.

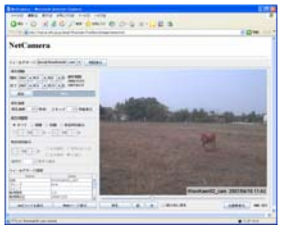

Fig.7 Continuous image data teach us sometimes animal behavior as well as plant growth.

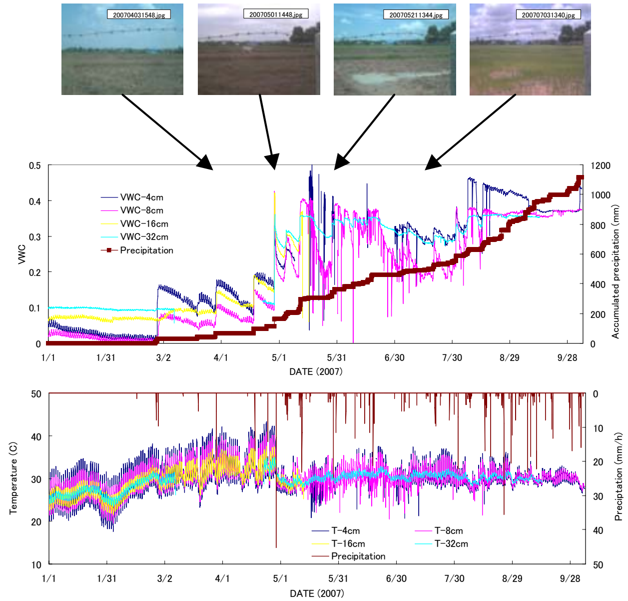

Fig.8 Change of landscape (Upper), soil moisture and accumulated precipitation (Middle), soil temperature and hourly precipitation (Lower) during 2007 dry-rainy seasons in a rain-fed field. The number in the picture denotes date&time that the image was stored.

4. Conclusions

The Field Server with soil sensors is a quite promising tool for field science in Asia because it detects both real-time images and meteorological data including soil moisture. In most unexplored territories in Asia, however, it is difficult to get electric power and internet infrastructure. We need further studies to get stable data from all over the world.

Aknowledgement

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References

1) http://model.job.affrc.go.jp/FieldServer/default.htm

2) Field Server Monitoring Agent, Available at http://fsds.dc.affrc.go.jp/data2/KhonKaen/

3) Shoichi Mitsuishi et.al: Effects of Dry Bulk Density and Soil Type on Soil Moisture Measurement using ECH2O-TE Probe, Poster 90-17 in this room, Monday, November 5, 2007