Extended abstract No. 335

SPATIAL GROUNDWATER LEVEL PERFORMANCE IN THE TROPICAL PEAT OF THE BLOCK C AREA, MEGA RICE PROJECT, CENTRAL KALIMANTAN, INDONESIA

Koichi Yamamoto [**], Yoshiyuki Ishii[**], Hiroshi Fukami[***], Ken Koizumi[****], Kitso Kusin[*****], Gatot Eko Susilo,[*,******], Adi Jaya[*****], Suwido H. Limin[*****] and Hidenori Takahashi[**]

* Graduate school of Science and Engineering, Yamaguchi University, 2-16-1, Tokiwadai, Ube, Yamaguchi, Japan, +81-863-85-9320, k_yama@yamaguchi-u.ac.jp,
** Hokkiado University
*** Hokkaido Reserarch Organization
**** Raax Co. Ltd.
*****Civil Engineering Department, University of Lampung , Bandar Lampung, Lampung, Indonesia
******Palangkaraya University

SUMMARY

Carbon emission from the abandoned field of the Mega Rice Project is one of the global environmental problems in Indonesia. To cope with the problem, JICA-JST SATREPS program "Wild Fire and Carbon Management in Peat-forest in Indonesia" will adopt numerical model of groundwater flow for restoring the area. To adopt model, the ground water levels and canal water levels have been measured continuously in Block C of Mega Rice Project, Central Kalimantan to investigate the groundwater movement of in the tropical peat. More than 40 observation wells were installed to measure the fluctuations of the groundwater in an area of 20 km^2. GPS has been used to ensure the accuracy of the position and elevation of each measurement pipe in observation wells. The study showed, in the Block C area, ground water levels of the main canals (Kalampangan Canal and Taruna Canal) were always much lower than the groundwater levels of the surrounding areas. It means that the groundwater levels in the surrounding area of canals changed independently and has negative correlation with the canal water levels. The fluctuation of the water in the canal is also affected by the amount of rainfall and evapotranspiration.

KEYWORDS: Groundwater, peat swamp forest, wetland, Indonesia

INTRODUCTION

It is estimated that between 0.81 and 2.57 Gt carbon were released to the atmosphere in 1997 as a result of burning peat and vegetation in Indonesia (Susan *et al.*, 2002). Peatland fire and forest degradation are great source of CO_2 emission. In the late 1990s, massive drainage canal excavation has been performed during the Mega Rice Project in tropical peat swamp forest in Central Kalimantan, Indonesia (Jaenicke *et al.*, 2011). This massive drainage canal excavation has caused significant groundwater level decrease and soil drying within the surface peat layer. Many severe wildfires occurred in the extremely dry El Niño year (Langner and Siegert, 2009), leading to peatland degradation, which causes irreversible peat subsidence (Wösten *et al.*, 1997). To protect the peatland from wildfires, it is necessary to maintain a high groundwater level in the peat layer, one of the most important restoration measures of tropical peatlands is blocking of drainage canals with dams and thus raising the groundwater level of the surrounding peatland (Suryadiputra *et al*., 2005),(CKPP, 2008), (Jauhiainen *et al*., 2008) and (Jaenicke *et al*., 2010). Rewetting effect by damming were evaluated using remote sensing (Jaenicke *et al*., 2011). However, actual drainage effect and rewetting effect on the spatial distributions of the regional groundwater in the Mega Rice Project area is very limited. The main objective of this study is to evaluate the drainage effects of ditches and canals on the spatial groundwater level by the actual measured groundwater distributions.

METHODS

Study site

The study was conducted in Central Kalimantan Province, Indonesia. The area is lying between the Kahayan River and the Sebangau River and called ‘Block C’ of the Mega Rice Project area. Our study site is located 15 km southeast of Palangkaraya City, in the northern of Block-C area. There are two main canals, the Kalampangan Canal, which crosses the area from the Kahayan River to the Sebangau River, and the Taruna Canal, which starts at the junction of the Kalampangan Canal in the southeast direction.

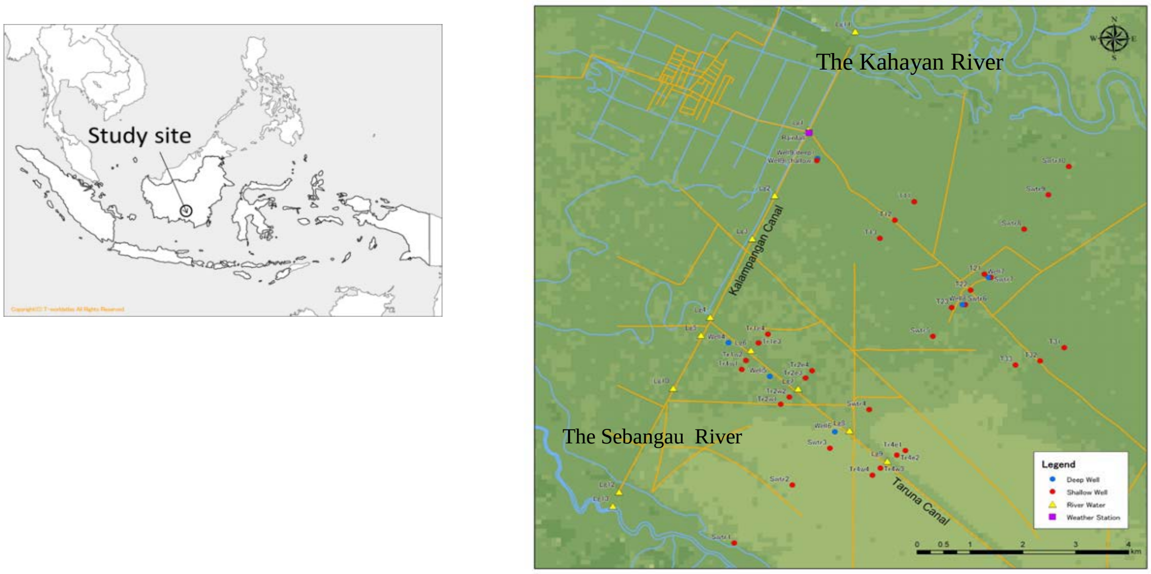

Figure 1. Study site and distribution of the observation wells and water level loggers (Blue: deep well, Red: Shallow well, Yellow: canal)

GPS survey for groundwater wells

Groundwater observation wells were installed in the Block C on July 2010 (Figure 1). Iron pipe of 20 mm in diameter was used as benchmark in each well. The length of the benchmark pipes is more than 3 meters. Our pipes completely penetrated peat layer and reached the subsurface layer. These benchmarks were measured by the static GPS observations. Observation period for one measurement of GPS was 30 minutes in 15 seconds interval. The vertical accuracy of the GPS is 5 mm plus 1.0 ppm of base line length. We determined the reference point as “BM3”, which is the benchmark of Palangkaraya airport because national coordinate reference is not available in Central Kalimantan. All the data was calculated by Trimble Total Control and we used the geoid model, EGM 2008 to calculate coordinates.

Water level observation

Water level meters and barometers (OYO S&DL mini) were installed in the wells and started to measure water levels automatically. Water level meters take data for every 1 hour. Total of 31 shallow wells of 5 meter deep including existing wells were set to observe shallow groundwater in the surface peat. Deep groundwater wells are developed to observe groundwater levels of the sand layer around 20 m deep. All these wells have automatic water level meters. Also, water level gauges and loggers were installed in the Kalampangan Canal (7 points) and the Taruna Canal (4 points). The period of water level measurement was from February 2 to August 15, 2011.

RESULTS AND DISCUSSION

Spatial water level of the groundwater and canal

Spatial water level of the shallow groundwater and canal is shown in Figure 2. It is obvious that water levels in canal are much lower than the other areas. Especially, shallow groundwater tends to be gradually low beside the road. Along this road, there are ditches to drain groundwater from the ground surface to engage agriculture. Because groundwater level gradient is steep beside the ditch of the road, the road side ditches seems to be very effective for draining shallow groundwater as well as canals. From the survey, shallow groundwater is entered to the canal by surface runoff from the spring along the canals. On the other hand, shallow ground water is always high for the wells which are far from the canals and road. Therefore, shallow groundwater is hydraulically disconnected to the canal water and shallow groundwater is perched groundwater. To drain this shallow groundwater, shallow ditches beside the road, for example, is very effective as well as big canals like the Kalampangan and Taruna.

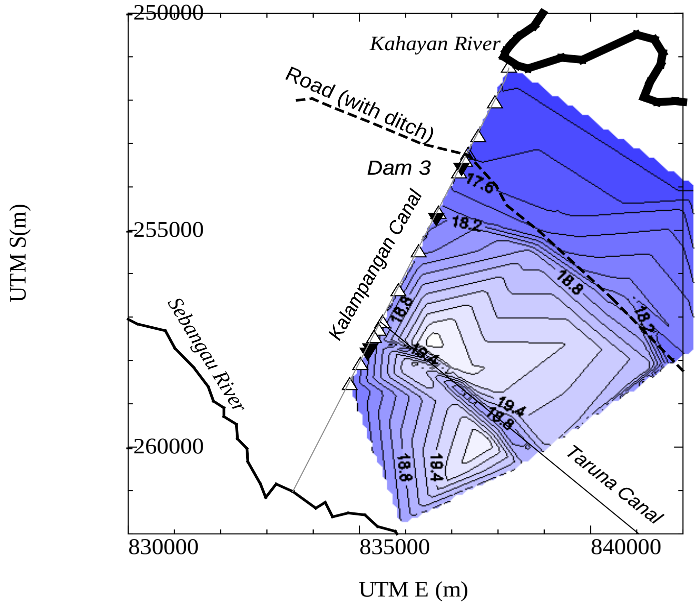

Figure 2. Shallow groundwater level distributions in the north Block-C area in Central Kalimantan, Indonesia on March 1, 2011 (wet season) .

Canal water table change along Kalampangan Canal

Longitudinal water level change of the Kalampangan Canal is shown in Figure 3. All the water levels are measured on 13:00-15:40, 26 Sep. 2010. The Kalampangan Canal was classified in four sections; 1) Kahayan backwater section, 2) dammed section, 3) peat dome section and 4) Sebangau backwater section. In the dammed section, water level was maintained in high regardless of both side of the canal water table were low. At the junction of the Kalampangan and the Taruna Canal, which is situated at 4 km from the Sebangau River, water level was higher than around point.

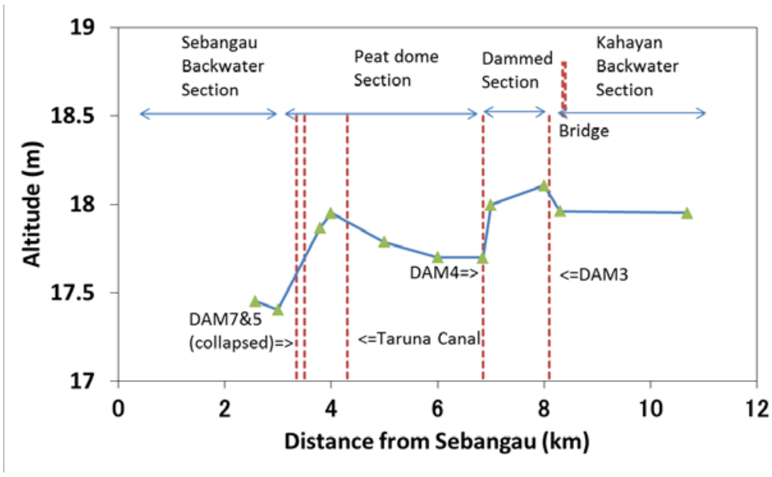

Figure 3. Longitudinal water table change along the Kalampangan canal, 26, Sep. 2010.

Water table change characteristics of the groundwater

To analyze groundwater level change, principal component analysis was applied to the water level of deep wells, shallow wells and canals. The contribution rates of the first principal component and second principal component were 82.28% and 7.03%, respectively. The first principal component means that the change of water level is strongly affected by the precipitation and evaporation. The second principal component means that the groundwater discharge because of the negative correlations of the canal water levels in “peat dome section” and the groundwater table of the shallow well. The fluctuation of water level in the Rivers are weakly affected by the local rainfall, but it seems to be also affected by large scale discharge of groundwater because they show positive second principal components.

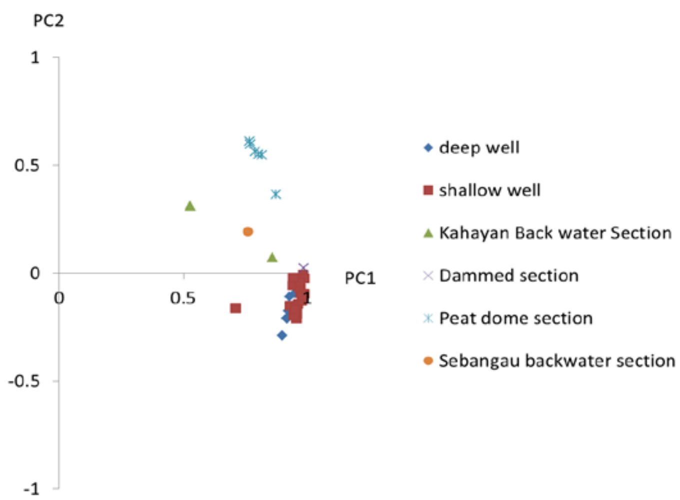

Figure 4. Distribution of the PCA scores of the PCA analysis for the water levels of shallow well, deep well and canal. Kahayan Back water section, Dammed section, Peat dome section and Sebangau backwater section is canal water and these are noted in Figure 3. PC1: First principal component, PC2: Second principal component.

CONCLUSIONS

To evaluate the dam and canal effects on the changes of groundwater table in the Block C area of the ex-Mega Rice Project, we measured groundwater table and got the first order analysis results. From the principal component analysis, it was revealed that groundwater level changes are mainly based on precipitation and evaporation. However, the ground water discharge from the peat dome also affected to the canal water level. Spatial groundwater table distribution revealed that the shallow (top) groundwater in the developed tropical peat swamp is possibly perched groundwater resulted from the poorly permeable peat soil. These perched groundwater discharges to the canals by surface run off as well as seepage. Shallow ditches beside the road are very effective to drain this shallow groundwater as well as big canals. Therefore, to stop constructing shallow canals or to stop drainages from the small canals are very important to do in order maintain ground water high.

REFERENCES

CKPP (2008), Provisional Report of the Central Kalimantan Peatland Project, *CKPP Consortium, Palangka Raya, Indonesia.*

J. Jaenicke, J.H.M. Wösten, A. Budiman, F. Siegert (2010), Planning hydrological restoration of peatlands in Indonesia to mitigate carbon dioxide emissions, *Mitig. Adapt. Strateg. Glob. Change*, pp. 223-239.

J. Jaenicke, S. Englhart, F. Siegert (2011), Monitoring the effect of restoration measures in Indonesian peatlands by radar satellite imagery, *Journal of Environmental Management*, Vol. 92, Issue 3, pp. 630-638.

J. Jauhiainen, S.H. Limin, H. Silvennoinen, H. Vasander (2008), Carbon dioxide and methane fluxes in drained tropical peat before and after hydrological restoration, *Ecology*, 89 (12) , pp. 3503–3514.

A. Langner, F. Siegert (2009), Spatiotemporal fire occurrence in Borneo over a period of 10 years, *Glob. Change Biol*., 15, pp. 48–62.

I.N.N. Suryadiputra, A. Dohong, R.S.B. Waspodo, L. Muslihat, I.R. Lubis, F. Hasudungan, Susan E. Page, Florian Siegert, John O. Rieley, Hans-Dieter V. Boehm, Adi Jaya and Suwido Limin (2002), The amount of carbon released from peat and forest fires in Indonesia during 1997, *Nature* 420, pp. 61-65.

I.T.C. Wibisono (2005) A Guide to Blocking of Canals and Ditches in Conjunction with the Community, *Wetlands International – Indonesia Programme, Bogor.*

J.H.M. Wösten, A.B. Ismail, A.L.M. Van Wijk (1997), Peat subsidence and its practical implications: a case study in Malaysia, *Geoderma*, 78, pp. 25–36.