ISBN: 978-602-70580-0-2

INACID

PROSIDING

SEMINAR NASIONAL INACID

Tema:
Strategi Pengelolaan Irigasi
dan Rawa Berkelanjutan
Mendukung Ketahanan Pangan Nasional
Dalam Perspektif Perubahan Iklim Global

Palembang, 16-17 Mei 2014

INACID

PROSIDING

SEMINAR NASIONAL INACID

Tema :
Strategi Pengelolaan Irigasi dan Rawa Berkelanjutan Mendukung Ketahanan Pangan Nasional dalam Perspektif Perubahan Iklim Global

ISBN 978-602-70580-0-2

Balai Besar Wilayah Sungai Sumatera VIII
Palembang – Sumatera Selatan
16 – 17 Mei 2014

PROSIDING

SEMINAR NASIONAL INACID
STRATEGI PENGELOLAAN IRIGASI DAN RAWA BERKELANJUTAN MENDUKUNG KETAHANAN PANGAN NASIONAL DALAM PERSPEKTIF PERUBAHAN IKLIM GLOBAL

DEWAN REDAKSI

Diterbitkan oleh	:	Balai Besar Wilayah Sungai Sumatera VIII
Tim Penyunting	:	Prof. Robiyanto H. Susanto, M.Agr.Sc
	:	Ir. Achmad Syarifuddin, MSc.
	:	Drs. H. Ishak Yunus, ST.MT
	:	Ir. H. Hendri, ST, M.Si
	:	Dr. Momon Sodik I, M.Sc
	:	Drs. Budianto
	:	Ir. Djaya Sukarno, M.Eng.
Redaksi Pelaksana	:	Pupi Sri Punarsih, S.P
	:	Ucu Sutarsa

DAFTAR ISI

Makalah Pararel

SUB TEMA I

Nomor Makalah : 4.5

INTERAKSI CUACA, KELEMBABAN TANAH DAN MUKA AIR TANAH DI LAHAN GAMBUT DENGAN SISTEM ZONASI AIR TERPADU DI SEMENANJUNG KAMPAR

Satyanto K. Saptomo[1], Dian Novarina[2], Aulia L.P. Aruan[2], Susilo Sudarman[2], Budi I. Setiawan[1], Muhajir Utomo[3]

[1] Departemen Teknik Sipil dan Lingkungan, Institut Pertanian Bogor (IPB), saptomo@ipb.ac.id
[2] PT APRIL Management Indonesia
[3] Fakultas Pertanian

ABSTRAK

Sistem zonasi air terpadu (IWZ) dan Pengukuran , Pelaporan dan Verifikasi (MRV) telah menjadi pendekatan yang harus dilakukan dalam pengembangan dan pemanfaatan lahan gambut. IWZ mengatur lahan menjadi zona-zona air berdasarkan elevasi geografis untuk mengendalikan level muka air saluran dan tanah yang umumnya setiap zona memiliki perbedaan elevasi 1 sampai 1,5 m. Pelaksanaan IWZ bertujuan untuk mencegah banjir , mempertahankan kelembaban tanah yang cocok untuk pertumbuhan tanaman dan untuk mencegah kebakaran hutan gambut . IWZ dan MRV telah dilaksanakan di Estate Meranti , Semenanjung Kampar sejak awal perkembangannya . Muka air di Estate Meranti yang dijaga antara 40 cm dan 90 cm di bawah permukaan tanah, untuk tanaman pokok yaitu akasia. Pemantauan parameter lingkungan dilakukan dengan menggunakan sistem monitoring yang dilengkapi data logger yang mengukur curah hujan , radiasi matahari , suhu dan kelembaban udara , suhu tanah, EC tanah, kelembaban tanah, dan potensial tanah. Kedalaman muka air tanah diukur menggunakan sensor dengan metode tekanan hidrostatik. Data yang direkam dari tahun 2011 sampai dengan 2013 menunjukkan variasi dari parameter yang diukur interaksi antar parameter. Penerapan IWZ dalam pengelolaan air menjaga kelembaban tanah dan muka air tanah pada tingkatan yang tidak jauh dari batas yang disyaratkan. Dalam periode kering berkepanjangan IWZ dapat menghindari kelembaban tanah dan muka air dari penurunan drastis. Muka air tanah dapat dijaga dalam kisaran yang menguntungkan pada sebagian besar periode, dan dengan demikian memberikan kelembaban yang cukup untuk tanah dan tanaman .

Katakunci: Pengelolaan air, lahan gambut, hutan tanaman, MRV, produktivitas

INTRODUCTION

The presence of pulp and papers producers industries has benefited hundred of consulting and contracting companies and gives many job opportunities for local, regional as well as foreign workers in Indonesia. The industry relied on wood supplies from forest plantation most of which in form of logs of Acacia trees. Acacia is known as one of fast growing trees that is easily adaptive in much type of soils, and can be harvested in 5 years.

It is important to do comprehensive approach in pursuing a sustainable forest plantation since many forest plantations have been in operation with less consideration to this matter in the first time. Since water is a focal point in wetland ecosystem then proper water management plays important key on the success of seeking sustainable forest plantation in low lying peatland, Setiawan et. al. (2009) introduced an integrated water zoning system (IWZ) with the main objective to maintain water table suitable for plant growth, supporting water transportation and preventing soil degradation. The development of IWZ required knowledge and information including the analysis of climates and water balance.

Ministry of Forestry is the first governmental institution that have started an exercise to arrange and implement MRV system for **acacia plantation** operating in peat lands by appointing a team of independent verificators. The main task of the team is to monitor and evaluate MRV carried out voluntarily (Voluntarily MRV) in peat lands in Kampar Peninsula, Riau Province with the concession area about 30 thousand hectares. After 2 years of exercise, a newly permitted forest plantation has to carry out MRV (Compulsory MRV) that will be monitored and evaluated intensively by an independent team appointed by the Ministry. In the other words MRV had become obligatory for new forest plantation, especially in peatland area.

IWZ and MRV implementation can hopefully promote the sustainable biomass production in peatland. As part of the MRV implementation in Kampar Peninsula, a monitoring station for MRV had been set up in Estate Meranti which is also become the observation site for joint research cooperation between APRIL and Bogor Agricultural University. This paper aims to presents the result of weather and environment monitoring during 2 years of MRV exercise in the MRV Monitoring station in Estate Meranti.

IWZ AND MRV IN ESTATE MERANTI

Integrated Water Zoning System

IWZ, also known as Ecohydro Management, is the designation of water zones based on geographical elevation to control water table and water level. This is made possible by creating artificial hydraulic boundary between zones, such as canals. As an example, one water zone can be designated within 1m difference of surface elevation and the difference of water elevation between zones is also 1 m. All canals can function as this hydraulic boundary, but smaller canals will be required for smaller zoning. depends on the field condition.

Setiawan et. al (2001) shows the irreversible deformations of peatsoil, including changes in its physical and hydraulic properties which all can be avoided by preserving the water table. In other occasion, peat land water control system was proposed by Setiawan et al (2002) by introducing electronic control system to wetland developed into farmland. This trial was successful, but required special water management infrastructure that enables water to be easily regulated. In forest plantation industry that operate thousands of hectares of wetland, which commonly has very narrow elevation difference, IWZ seems to be the answers for the water management

The implementation of IWZ integrates the objectives to prevent flooding, preserve suitable soil moisture for plant growth and to prevent peat and forest fire as also guided in Selaras Principles for

sustainable forest plantation (Setiawan 2009). The continuous study of IWZ implementation is one of effort to improve the IWZ system and also the sustainable forest plantation.

Monitoring Station

The MRV's monitoring station is situated in Estate Meranti, Kampar Peninsula, Riau Province, Indonesia which concession belongs to APRIL Group (Fig 1.). This is one of effort of the company to comply the MRV of the concession. The monitoring of the parameters is done using automatic data loggers to records quarter-hourly weather and soil water variables.

EM50 data logger is used to measures and records rainfall, solar radiation, air temperature and humidity, soil temperature, soil EC, soil temperature and soil potential. Water table at the station is measured using hydrostatic pressure type of water level sensor and logged with data logger. Software based on worksheet and Macro programming was developed during the activity for data management and analysis.

During the project, the company staffs were involved in installation, maintenance and data management. At first they were trained gradually about how to install the instruments, how to measure and how to manage the data. Then, the trainees were also taught to process and to analyze the data and to present the data. In the following years, the company staffs are expected to be able to do the similar task to support the MRV. The data presented in this paper was prepared for the MRV of the plantation and with help of the company staff.

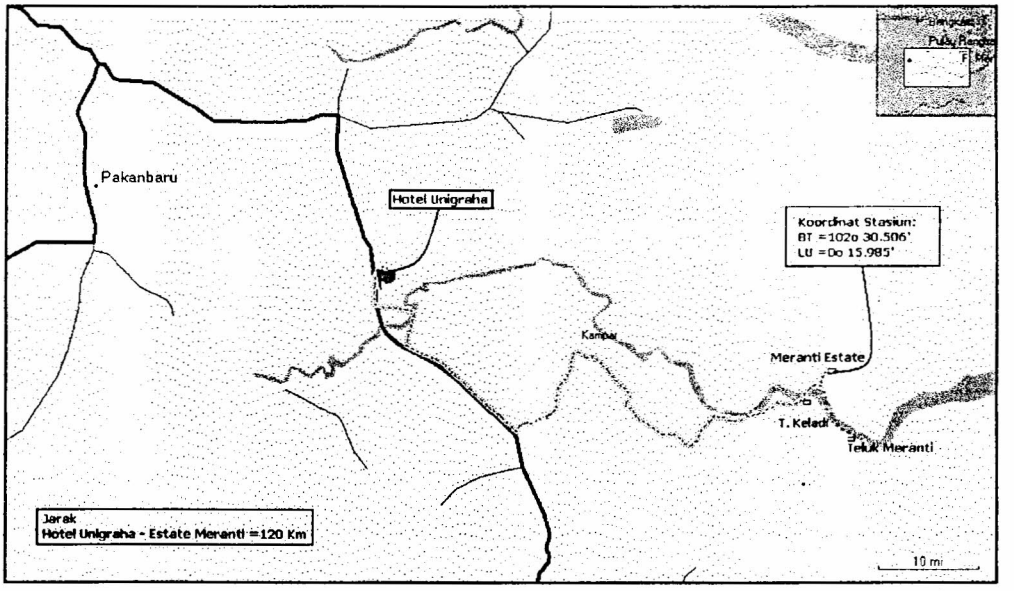

Figure 5 Estate Meranti MRV's Monitoring Station

RESULTS AND DISCUSSION

Data Management

The quarter-hourly data recorded by data loggers needs to be properly processed and analysis in order to obtain hourly, daily or monthly information depends for reports inquiry. Since the amount of data tends to be huge, special worksheet were developed using Macro Enabled Worksheet. In our case, we use daily data as shown in Table 1. Some data can be simply averaged through the day such as temperature, humidity, moisture, soil potential and water table. Other can be summed to get its total, e.g. rainfall and evapotranspiration. The daily total solar radiation in the other hand needs numerical integration method to obtain its daily total. This can be done by using summation of rectangular area or trapezoidal area formed by the measurement curve.

Table 16 Daily data processed from quarter-hourly recorded data.

No	Parameter	Daily value (unit)
1	Solar radiation	Total (MJ)
2	Air Temperature, Relative Humidity	Averaged (°C, %)
3	Rainfall	Total (mm)
4	Soil temperature, EC, Moisture	Averaged (°C, mS/cm, cm^3/cm^3)
5	Soil Potential	Averaged (kPa or pF)
6	Water table	Averaged (cm)
7	Eto (Radiation method)	Total (mm)

Soil Physical and Hydraulic Properties

Soil physical and hydraulic properties were important to understand the soil or medium behavior. How the soil behaves in permitting water to be flown or stored in the soil are examples that can help to determine what happen to the water and also the soil when water related event occurs such as rainfall, drought or manmade event like drainage. The amount of moisture in soil that is uptake able by the plants root also depends on these properties.

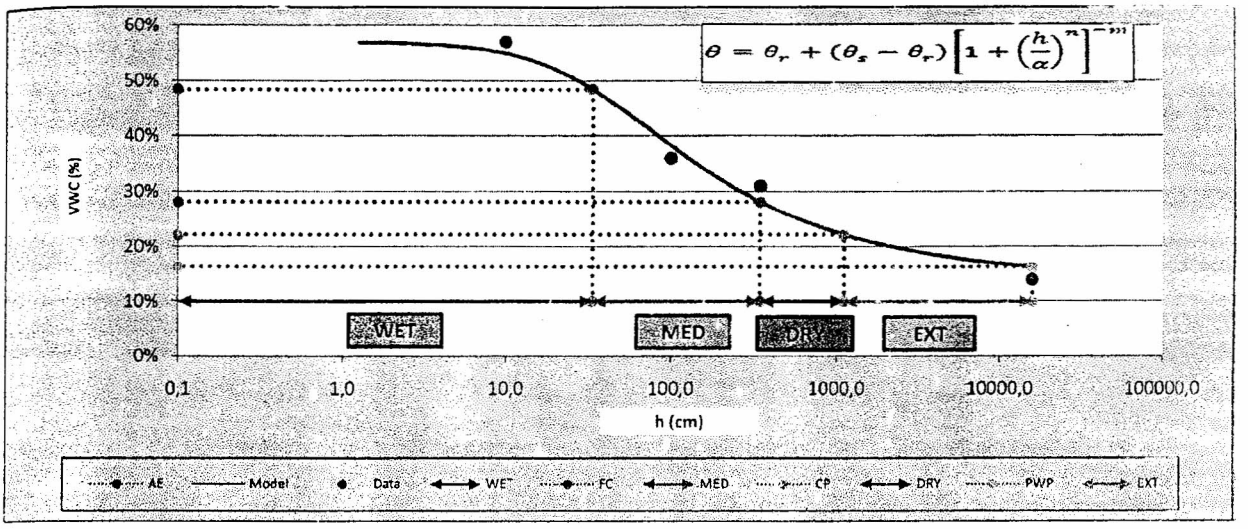

Figure 6 Estate Meranti Soil Water Retention Curve

Soil moisture and soil water potential are two terms that express the wetness of the soil from different angle. Volumetric water content (vwc) is the ratio of volume of water in the soil and the total volume of the bulk soil itself. In the other hand vwc is volume based soil moisture measure. Water retents in the soil pores in a certain amount. The wetter the soil is, the easier water to be extracted from the pores even only by gravitational force. The retention is also known as soil water potential, is expressed by negative pressure and also depth of water column (cm H2O), which log value is known as pF. Soil water potential determines how easy is water can be uptaken by root. Most of vegetation can get water from the soil that has pF below 4.2. Soil with pF lower than 2.54 will release water through gravitational flow or percolation. Here, between these pF values the water is available in the soil and not percolating, and these values can be used as minimum and maximum threshold of soil moisture condition.

Water retention curve (WRC) relates the pF and vwc values following equation proposed by van Genuchten (1980). The model should be parameterized by using vwc and pF data measured in the laboratory for respected soil samples. The water retention curve for Estate Meranti's MRV station is shown in Fig. 2. Here, the wetness of the soil is separated into WET, MEDIUM, DRY and EXTREME DRY with their respective pF and vwc value.

Weather, Soil Moisture and Water Table

The dynamics of rainfall, watertable and soil moisture are presented in Fig. 3 through Fig. 8. These are recorded during the periods of 2 years trial of MRV implementation in Kampar Peninsula. As the station is situated in a water zone, it is assumed that water table is regulated by the surrounding canal which water is kept at the designated level. This is done by blocking the water flow in the canal with *peat*

dam and only let the overflow through smaller bypass canal that can easily open and close. The water level is regularly measured and monitor.

In 2011, water table at the monitoring station never decreased less than the maximum permitted depth. During heavy rain event, water table increased and became shallower than the minimum permitted depth for a few days as shown somewhere in June, October and December (Fig. 3) before decreased again. As the water hydraulic head in the soil is higher (water table is shallower) than the water level in the canal, soil water will gradually flow out to the canal through sub-surface flow and the water table got deeper.

In the other hand, during July to August when rainfall was less, water table decreased but did not exceed the maximum permitted depth. Similar to the condition of heavy rainfall event but oppositely, during deficit of water the hydraulic head of water in the soil tends to be lower than canals water level. Water seeped from the canal through soil pores and increased the water table.

Soil moisture (vwc) fluctuation as shown in Fig. 4 for year 2011 was also kept within the favorable condition, which is also partially due to water table contribution. As water table was kept in the designated minimum and maximum limits, the soil was kept from long saturation or ponding and also kept from being over dried. This condition is favorable for trees. As healty growing trees will not be easily smoldered, thus forest fire can be avoided.

During year 2012, water table was deeper than the maximum permitted depth most of the time from early of the year until October. There is not yet report of canal water level regarding this event, but there was information that there was peat dam construction. Due to this, the monitoring station was accidentally situated at downstream of the constructed dam that is in lower water level zone. This is believed as the cause of the deeper water table during dry season, until the peat dam was "restored" in October. In the rest of the year 2012, water table was kept within the designated depth for most of the time.

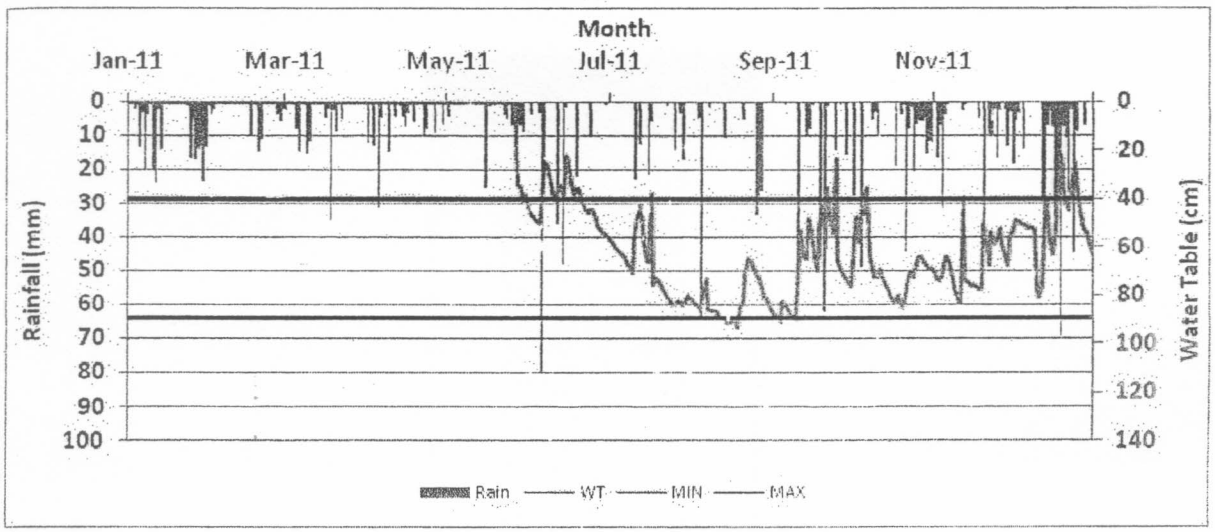

Figure 7 Rainfall and Water Table in year 2011

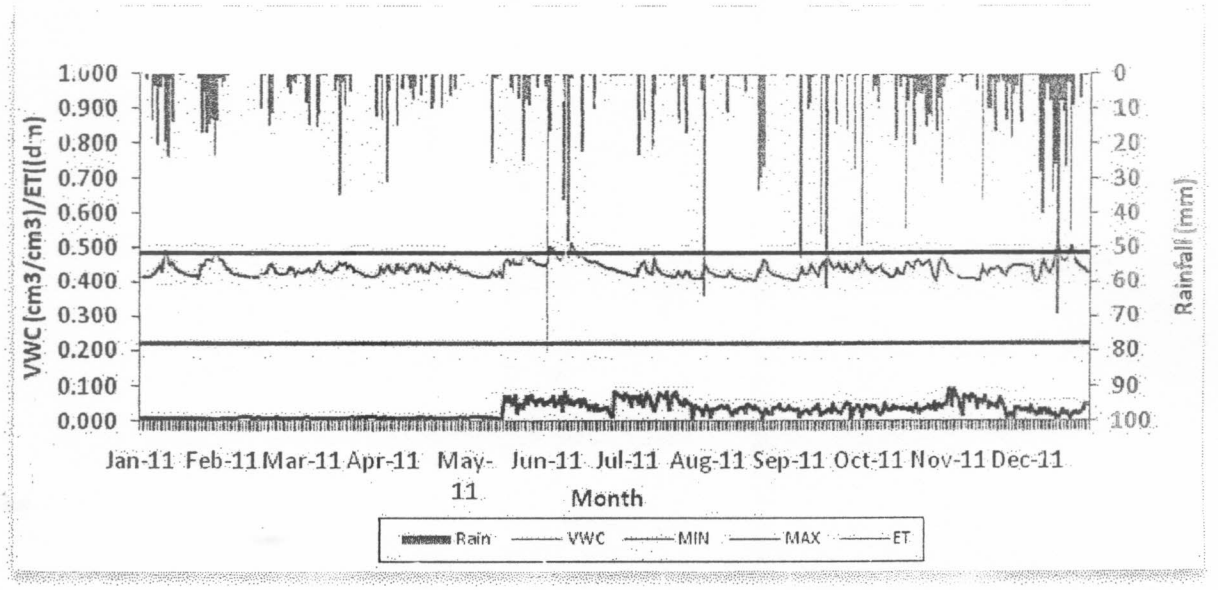

Figure 8 Rainfall, Soil Moisture (VWC) and Evapotranspiration (ET) in year 2011

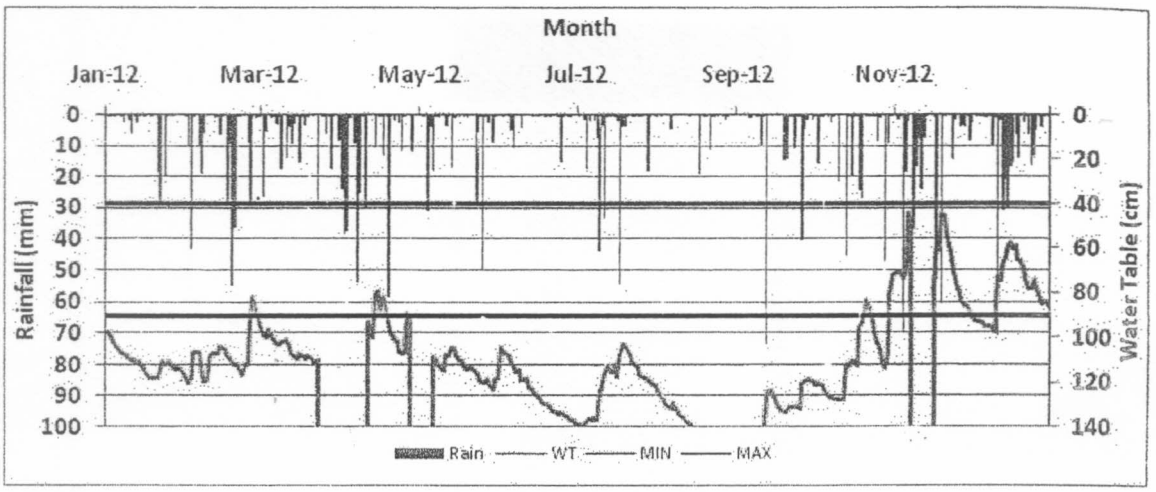

Figure 9 Rainfall and Water Table in year 2012

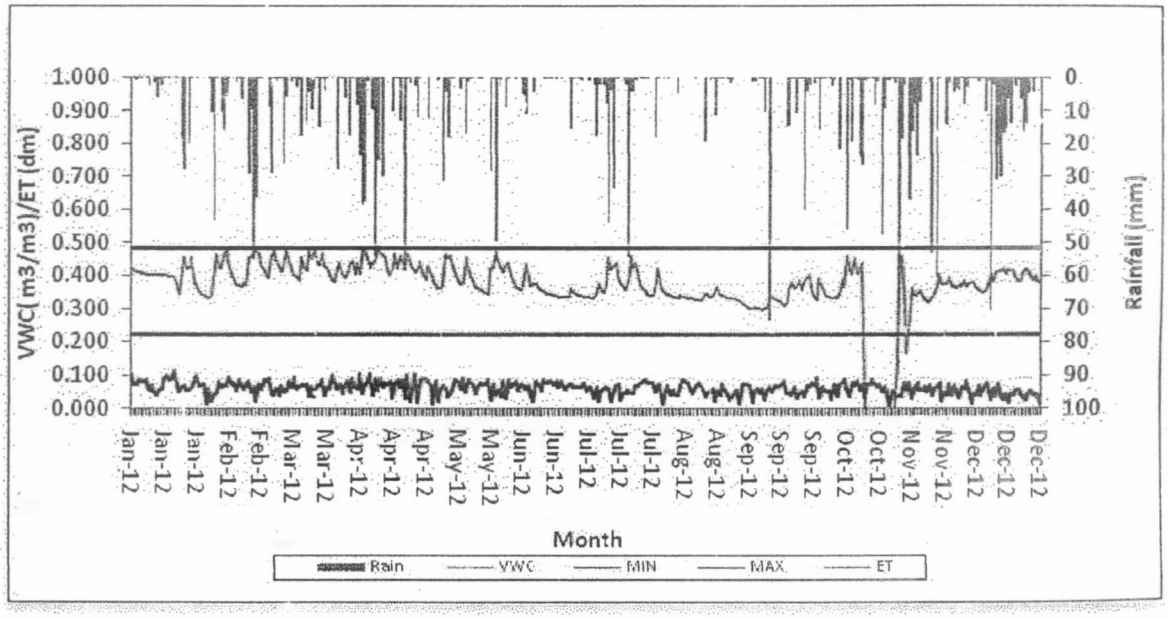

Figure 10 Rainfall, Soil Moisture (VWC) and Evapotranspiration (ET) in year 2012

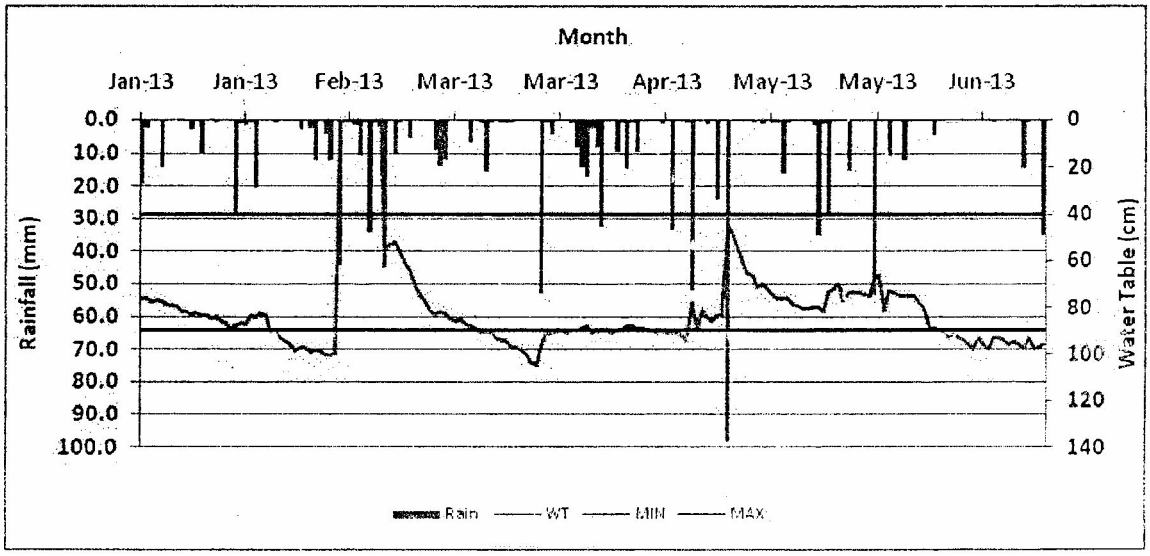

Figure 11 Rainfall and Water Table in year 2013

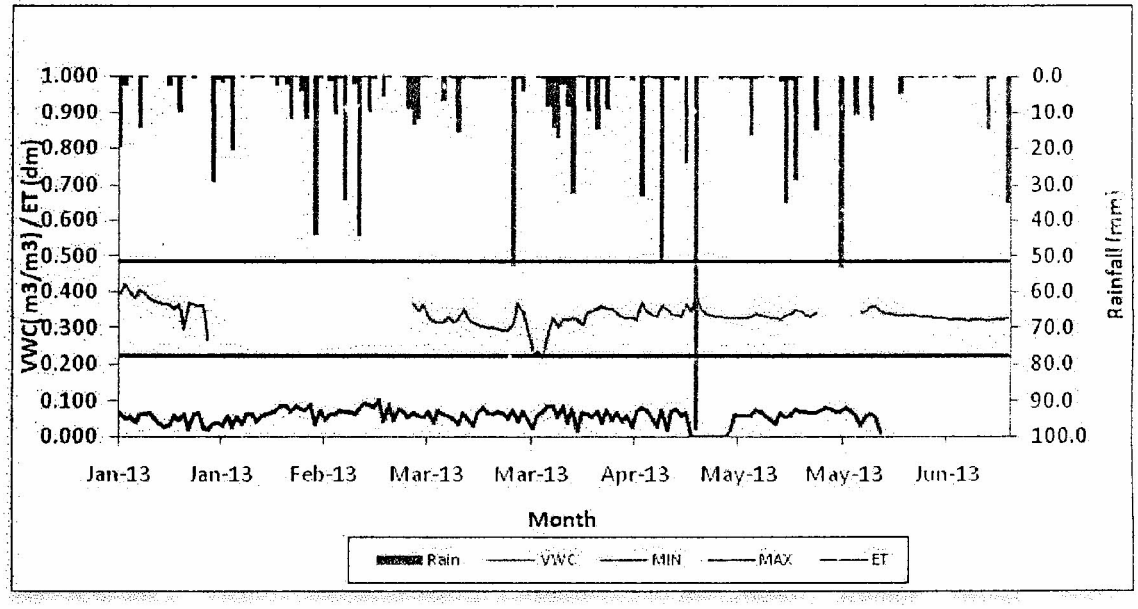

Figure 12 Rainfall, Soil Moisture (VWC) and Evapotranspiration (ET) in year 2013

Water table performance in 2013 was not as good as in 2011 although it was within the designated depths in most of the time. This could be due to few causes such as the extended effect of the peat dam construction that altered the water zone of the measurement site, less rain in 2013 or other reason that is must be discovered.

The soil moisture records during 2 years of experience shows sufficient moisture in the soil, in the meaning that the water is enough for plant and thus support the productivity and helps avoid forest fire.

Nevertheless, The Estate seems to be successful in applying Integrated Water Zoning System or Ecohydro Management. As one main indicator is the water table depth that was controllable throughout the operation of the company in the concession area.

CONCLUSION

Continuous monitoring in Kampar Peninsula to measure and record weather and environment variables had been set up and supplied monitoring data to support MRV of Kampar Peninsula. The monitoring station provides important data regarding the performance of water management which are rainfall, soil moisture and watertable. Water table and soil moisture are manageable in the concession area by implementing IWZ. The interaction between rainfall, watertable and soil moisture shown in the daily data suggests that IWZ is successful in preserving water in favorable condition. The alteration of the water zoning infrastructure can quickly affect the water table of the area as shown by recorded data in year 2012. The results presented in this paper demonstrate one success example in implementation of IWZ and MRV for sustainable forest plantation. However, this effort should be continued to see how it performs so that further improvement can be advised.

REFERENCES

Genuchten, M.Th. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Sci. Soc. Am. J.* 44: 892-898

Setiawan, B.I., S.K. Saptomo and Y. Sato. 2001. Irreversible Deformation of Tropical Peat Soils. Proceedings of the 1st Seminar, Toward Harmonization between Development and Environmental Conservation in Biological Production. Tokyo, February 21-23, 2001. Pages: 223~227

Setiawan, B.I, Y. Sato, S.K. Saptomo and E. Saleh. 2002. Development of water control for tropical wetland agriculture. Advances in GeoEcology No. 35, Pages 259-266, Catena Verl., Reikirchen, Germany.

Setiawan, B.I., Ch.Arif, A.Harisman, S.Arfianto, E.Susandi, J.Ginting, Soewarso. 2009. Integrated Water Zoning For Sustainable Forest Plantation In Tropical Peatlands. Bogor Symposium and Workshop on Tropical Peatland Management: Characterization and Wise use of Tropical Peatland. Bogor, July 15-16, 2009.

Setiawan, B.I. 2011. Selaras Principle for Sustainable Biomass Productions in Indonesia. International Conference on Science and Technology for Sustainability 2011, - Building up Regional to Global Sustainability: Asia vision-". Japan Science Council. Kyoto, 14-16 September 2011.