PROCEEDINGS OF INTERNATIONAL SYMPOSIUM ON SOIL MANAGEMENT FOR SUSTAINABLE AGRICULTURE 2017

-PART 1-

INTERNATIONAL SYMPOSIUM ON SOIL MANAGEMENT FOR SUSTAINABLE AGRICULTURE 2017

ORGANIZER:
THE UNITED GRADUATE SCHOOL OF AGRICULTURAL SCIENCE, GIFU UNIVERSITY

-PART 2-

UGSAS-GU & BWEL JOINT POSTER SESSION ON AGRICULTURAL AND BASIN WATER ENVIRONMENTAL SCIENCES

CO-ORGANIZER:
GIFU UNIVERSITY REARING PROGRAM FOR BASIN WATER ENVIRONMENTAL LEADERS

BWEL

AUGUST 28 - 30, 2017
6TH FLOOR, UGSAS BLDG. GIFU UNIVERSITY, JAPAN

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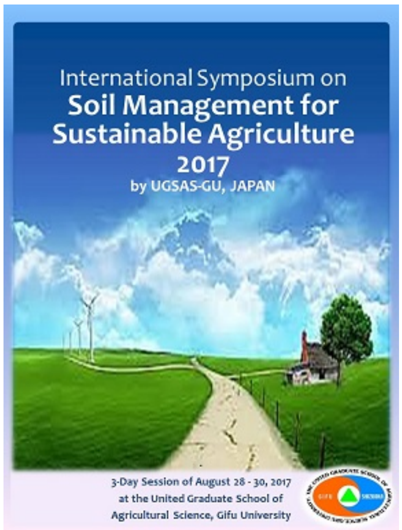
International Symposium on Soil Management for Sustainable Agriculture 2017

PROGRAM
–PART 1-



DAY ONE: Monday, August 28

Time: 9:30-19:30
Venue: Main Seminar Room (6F in UGSAS Building, Gifu University)
Master of Symposium: *Prof. Kohei Nakano (Gifu Univ.)*

Time Table

9:30-10:00 Registration

10:00-10:05 Opening Remarks
Prof. Masateru SENGE (Dean of UGSAS, Gifu Univ.)

10:05-10:10 Welcome Speech
Dr. Fumiaki SUZUKI (Executive Director and Vice President of Gifu Univ.)

10:10-10:50 Keynote Speech 01
Prof. Yasushi MORI (Okayama Univ.): Soil Physical Rehabilitation

10:50-11:30 Keynote Speech 02
Assist. Prof. Yuki KOJIMA (Gifu Univ.): Soil Water and Energy Dynamics

Session 1 —General Issue and Solution— Session Chair: *Prof. Muhajir Utomo (Lampung Univ.)*

11:30-11:55 01. *Prof. Isril BERD (Andalas Univ.)*

11:55-12:20 02. *Dr. Komariah (Sebelas Maret Univ.)*

12:20-12:30 Photo Session

12:30-13:40 Lunch Break (Light meals served)

Session 2 —Soil Science— Session Chair: *Assistant Prof. Keigo NODA (Gifu Univ.)*

13:40-14:05 01. *Prof. Muhajir UTOMO (Lampung Univ.)*

14:05-14:30 02. *Dr. Afandi (Lampung Univ.)*

14:30-14:55 03. *Mr. Didin Wiharso, M.Sc. (Lampung Univ.)*

14:55-15:20 04. *Dr. Nuyen Thi Hang NGA (Thuy Loi Univ.)*

15:20-15:30 Coffee Break

Session 3 —Watershed Management—Session Chair: *Associate Prof. Takeo ONISHI (Gifu Univ.)*

15:30-15:55 01. *Dr. Khandra Fahmy (Andalas Univ.)*

15:55-16:20 02. *Dr. Muhammad MAKKY (Andalas Univ.)*

16:20-16:45 03. *Dr. Eri Gas EKAPUTRA (Andalas Univ.)*

16:45-17:10 04. *Mr. Fadli IRSYAD, M.Sc. (Andalas Univ.)*

17:40-19:30 Dinner Meeting (At Gifu University Restaurant (1))

DAY TWO: Tuesday, August 29

Time: 9:00-17:40
Venue: Main Seminar Room (6F in UGSAS Building, Gifu University)
Master of Symposium: *Prof. Ken HIRAMATSU (Gifu Univ.)*

Time Table

9:00-9:30 Registration

9:30-10:10 Keynote Speech 03
Prof. Akira WATANABE (Nagoya Univ.): Soil Organic Matter Dynamics

10:10-10:50 Keynote Speech 04
Assoc. Prof. Fumitoshi IMAIZUMI (Shizuoka Univ.): Erosion Control Engineering

10:50-11:00 Coffee Break

Session 4 —Soil Biology & Microbiology— Session Chair: *Prof. Isril Berd (Andalas Univ.)*

11:00-11:25 01. *Dr. Retno Rosariastuti (Sebelas Maret Univ.)*

11:25-11:50 02. *Dr. Sudadi (Sebelas Maret Univ.)*

11:50-12:15 03. *Dr. Widyatmani Sih Dewi (Sebelas Maret Univ.)*

12:15-13:20 Lunch Break (Light meals served)

Session 5 —Soil Chemistry— Session Chair: *Dr. Retno Rosariastuti (Sebelas Maret Univ.)*

13:20-13:45 01. *Prof. Fusheng Li (Guangxi Univ.)*

13:45-14:10 02. *Dr. Mujiyo (Sebelas Maret Univ.)*

14:10-14:35 03. *Ms. Dinh Thi Lan Phuong, M.Sc. (Tyui Loi Univ.)*

14:35-15:10 Break & Preparation for Poster Presentation Session

15:10-17:00 -PART 2- *Please refer to the next page for details.
UGSAS-GU & BWEL Joint Poster Session on
Agricultural and Basin Water Environmental Science

DAY THREE: Wednesday, August 30

Time: 10:00-17:00
Study Tour on Soil and Water Management

Visiting TANIGUMI Historic Temple and Local Irrigation System &
TOKUYAMA DAM with Underground Facility for Water Management

UGSAS-GU & BWEL Joint Poster Session on Agricultural and Basin Water Environmental Sciences

PROGRAM
–PART 2-

DAY TWO: Tuesday, August 29

Time: 15:10-17:00
Venue: Main Seminar Room (6F in UGSAS Building, Gifu University)

Time Table

15:10-16:45	Poster Presentation
16:45-16:55	Best Presentation Award ceremony
16:55-17:00	Closing remarks *Prof. Fusheng LI (Head of the Promotion Office of Gifu University Rearing Program for Basin Water Environmental Leaders (BWEL))*

Presenters

P01: Tran Duy Quan (UGSAS-GU)
P02: Ning Li (UGSAS-GU)
P03: Dina Istiqomah (UGSAS-GU)
P04: Akash Chandela (UGSAS-GU)
P05: Daimon Syukri (UGSAS-GU)
P06: Witchulada Yungyuen (UGSAS-GU)
P07: Panyapon Pumkaeo (Graduate School of Integrated Science and Technology, Shizuoka University)
P08: Arif Delviawan (Graduate School of Integrated Science and Technology, Shizuoka University)
P09: Siwattra Choodej (UGSAS-GU)
P10: Jobaida Akther (UGSAS-GU)
P11: Annisyia Zarina Putri (Graduate School of Applied Biological Sciences, Gifu University)
P12: Masaya Toyoda (Graduate School of Engineering, Gifu University; BWEL)
P13: Tharangika Ranatunga (UGSAS-GU; BWEL)
P14: Shuailei Li (Graduate School of Natural Science and Technology, Gifu University; BWEL)
P15: Ruoming Cao (Graduate School of Applied Biological Sciences, Gifu University; BWEL)
P16: Fenglan Wang (UGSAS-GU; BWEL)
P17: Diana Hapsari (UGSAS-GU; BWEL)
P18: Ran Song (Graduate School of Engineering, Gifu University; BWEL)
P19: Chen Fang (UGSAS-GU; BWEL)
P20: Guangyu Cui (Graduate School of Engineering, Gifu University; BWEL)
P21: Ali Rahmat (UGSAS-GU; BWEL)
P22: Junfang Zhang (Graduate School of Engineering, Gifu University; BWEL)
P23: Siyu Chen (UGSAS-GU; BWEL)
P24: Wenjiao Li (Graduate School of Engineering, Gifu University; BWEL)
P25: Huijuan Shao (UGSAS-GU; BWEL)

CONTENTS

— PART 1 — KEYNOTE SPEECHES

KEYNOTE SPEECHES

01: Soil Physical Rehabilitation -Artificial Macropore Installation to Restore Organic Matter in Soils-
Yasushi MORI · p. 2

02: Development of Soil Property Sensors Using Heat Transfer
Yuki KOJIMA, Yuta NAKANO · p. 4

03: Stability of Soil Organic Matter in Soil Management for Sustainable Agriculture
Akira WATANABE · p. 6

04: Relationship between vegetation cover and sediment transport activities on mountain hillslopes
Fumitoshi IMAIZUMI · p. 8

GUEST/ALUMNI PRESENTATIONS

SESSION 1 —General Issue and Solution—

01: Analysis study of landslide induced by earthqueke in Tandikat Partamuan, Padang Pariaman District, West Sumatra, Indonesia
Isril BERD, Amrizal SAIDI, Skunda DILIAROSTAP · · · · · · · · · · · · · · · p. 12

02: SOIL RESOURCE ISSUES IN INDONESIA
Komariah and Masateru SENGE · p.19

SESSION 2 —Soil Science—

01: Soil Carbon Stock and Sequestration after 29 Years of No-tillage in Sumatra, Indonesia
Muhajir UTOMO, Jamalam LUMBANRAJA, Tamaluddin SYAM and Fajri Taufik AKBAR
· p.25

02: Soil Properties in Relation with the Incidence of Heart Rot Disease in Pineapple due to Phytophthora sp. in Humid Tropical Climate of Lampung, Indonesia
Afandi, P. Cahyono, G.alang I. Jaya, M.A.S. Syamsul Arif, Ivayani, and Auliana Afandi
· p.30

03: Changes of soil morphology and properties in long-term soil management under humid tropical regions of Lampung, Indonesia
Didin Wiharso, Muhajir Utomo and Afandi · · · · · · · · · · · · · · · · · · p. 33

04: Application of bentonite to soil reclamation in drought areas of Ninh Thuan province, Viet Nam
Nuyen Thi Hang NGA · p. 40

SESSION 3 —Watershed Management—
01: The Evaluation of Watershed Condition of Sumani Based in Solok Regency Based on Land Characteristic
Delvi Yanti, Khandra Fahmy, Isril berd, Fery Arlius • • • • • • • • • • • • • • • • p. 44

02: Wisdom Agriculture Application in Oil Palm Industry for Promoting Healthy Soil and Emission Reduction
Muhammad MAKKY, Delviyanti, Isril BERD • • • • • • • • • • • • • • • • • • • p. 47

03: Soil and Water Conservation with Zero Runoff Model in Oil Palm Plantation
Eri Gas EKAPUTRA, Fadli IRSYAD • p. 58

04: Conservation Analysis of Kuranji Watershed using SWAT Application
Fadli IRSYAD, Eri Gas EKAPUTRA • p. 65

SESSION 4 —Soil Biology & Microbiology—
01: Phytoremediation of Soil Contaminated by Chromium (Cr) of Industrial Waste Using Mendong Plant (Fimbrystilis globulosa) in Its Combination With Agrobacterium Sp.I3 or Organic Matter
Pungky Ferina, Supriyadi, Retno Rosariastuti • • • • • • • • • • • • • • • • • • p. 70

02: Potency of rhizobiota consortium as biofertilizer inoculants to inhibit basal rot and increase yield
Sudadi, Hadiwiyono and Sumarno • p. 76

03: BIOCHAR AND AZOLLA FOR SUSTAINABLE RICE SOIL MANAGEMENT
Widyatmani Sih Dewi and Masateru Senge • • • • • • • • • • • • • • • • • • • p. 80

SESSION 5 —Soil Chemistry—
01: Emissions of CH4 and N2O and the relationships with soil properties under different irrigation methods and nitrogen treatments
Fusheng Li • p.87

02: Methane Emissions in Paddy Field and Its Mitigation Options for Win-Win Solution
Mujiyo, Ken Hiramatsu and Takeo Onishi • • • • • • • • • • • • • • • • • • • p.89

03: Solutions for nutritional zinc management in paddy soils in the Red River Delta of Vietnam (Tien Lu region, Hung Yen province)
Dinh Thi Lan Phuong, Nguyen Thi Hang Nga • • • • • • • • • • • • • • • • • • p. 95

— PART 2 —

UGSAS-GU & BWEL Joint Poster Session on Agricultural and Basin Water Environmental Sciences

P01: **Research on cause of dam failure under view point of hydraulic fracturing – Case study KE 2/20 REC dam failure in Vietnam**
Tran Duy Quan, Shinichi Nishimura, Masateru Senge and Fumitoshi Imaizumi • **p. 100**

P02: **Data mining the efficiency of auction in origin market based on random forest-A case study of ATSUMI AREA, AICHI Prefecture -**
Ning Li and Shigenori Maezawa • **p. 102**

P03: **Study of plant pathogenic genes of a soft rot disease causing bacterium, *Dickeya dadantii***
Dina Istiqomah and Naoto Ogawa • **p. 104**

P04: **Augmentation of nuclease resistance and gene silencing by synthesizing 3'-end nucleoside base modified small interfering RNAs**
Akash Chandela and Yoshihito Ueno • **p. 106**

P05: **Maintenance of oligosaccharides content during soybean sprout cultivation by controlling temperature conditions**
Daimon Syukri, Manasikan Thammawong and Kohei Nakano • • • • • • • • • • • **p. 108**

P06: **Effect of temperature on flavonoid metabolism in citrus juice sacs *in vitro***
Witchulada Yungyuen, Gang Ma, Lancui Zhang, Kazuki Yamawaki, Masaki Yahata, Satoshi Ohta, Terutaka Yoshioka and Masaya Kato • • • • • • • • • • • • • • • • **p. 110**

P07: **Bioconversion of AHX to AOH by Buttiauxella gaviniae A111**
Panyapon Pumkaeo, Ayaka Kikuchi and Shinji Tokuyama • • • • • • • • • • • • • **p. 112**

P08: **The characteristics of screened particle with different pulverization process and drying condition**
Arif Delviawan, Shigehiko Suzuki, Yoichi Kojima and Hikaru Kobor • • • • • • • • **p. 114**

P09: **Isolation, semi-synthesis of Costunolide from Saussurea lappa and their TNF-α inhibition**
Siwattra Choodej, Khanitha Pudhom and Tohru Mitsunaga • • • • • • • • • • • **p. 116**

P10: **Protein-based functional analysis of renin and (pro) renin receptor genes in hypertensive and diabetic Bangladeshi population: Pursuing the environment-induced molecular traits**
Jobaida Akther, A. H. M. Nurun Nabi, Tsutomu Nakagawa, Fumiaki Suzuki and Akio Ebihara • **p. 118**

P11: **The budding yeast Saccharomyces cerevisiae requires Vitamin B1 (Thiamine) for acetaldehyde tolerance**
Annisyia Zarina Putri, Madoka Kubota, Haruka Matsuyama, Tetsushi Takagi, Mizuho Inagaki, Masaya Shimada, Takashi Hayakawa and Tomoyuki Nakagawa • • • • • **p. 120**

P12: **Comparison of typhoon HAIYAN (2013) and typhoon MELOR (0918) using pseudo-global warming experiments**
Masaya Toyoda, Jun Yoshino and Tomonao Kobayashi・・・・・・・・・・・・・p. 122

P13: **Controlling the process of denitrification in flooded rice soils by using microbial fuel cell applications**
Tharangika Ranatunga, Ken Hiramatsu and Takeo Onishi・・・・・・・・・・・p. 124

P14: **Effect of aeration time on total coliform and E. coli concentrations in excess activated sludge**
Shuailei Li, Guangyu Cui and Fusheng Li・・・・・・・・・・・・・・・・・・・・p. 126

P15: **The nitrogen cycling in a deciduous broad-leaved forest, central Japan**
Ruoming Cao, Siyu Chen, Shinpei Yoshitake, Chiyuki Asai1 and Toshiyuki Ohtsuka
・・・・・・・・・・・・・・・・・・・・・・・p. 128

P16: **Small hydraulic generation using irrigation facilities: Case study of Meiji Yousui district**
Fenglan Wang, Keigo Noda, Kengo Ito and Masateru Senge・・・・・・・・・・p. 130

P17: **Seasonal difference role on sediment rating curve at small broadleaves and coniferous forest catchments in Kuraiyama, Japan**
Diana Hapsari, Takeo Onishi, Masateru Senge, Fumitoshi Imaizumi and Ali Rahmat
・・・・・・・・・・・・・・・・・・・・・・・p. 132

P18: **Effects on organic matters released from wastewater sludge under thermal treatment**
Ran Song, Guangyu Cui, Huijuan Shao, Shuailei Li and Fusheng Li
・・・・・・・・・・・・・・・・・・・・・・・p. 134

P19: **Seismic risk evaluation of irrigation tanks -Case study of two irrigation tanks in Ibigawa-cho, Gifu Prefecture, Japan-**
Chen Fang, Hideyoshi Shimizu, Shin-Ichi Nishimura, Ken Hiramatsu, Takeo Onishi and Tatsuro Nishiyama・・・・・・・・・・・・・・・・・・・・・・・・・・p. 136

P20: **Malodor emission of activated sludge from municipal wastewater treatment process after inoculation with sludge from a slaughtering house wastewater treatment facility**
Guangyu Cui, Manami Mori, Yasushi Ishiguro and Fusheng Li
・・・・・・・・・・・・・・・・・・・・・・・p. 138

P21: **Hydrological characteristics under different vegetation types in small watershed, Central Japan**
Ali Rahmat, Keigo Noda, Kengo Ito and Masateru Senge・・・・・・・・・・・・p. 140

P22: **Analysis of solar irradiance fluctuations for photovoltaic (PV) module outdoor performance testing**
Junfang Zhang, Kota Watanabe, Tomonao Kobayashi and Jun Yoshino
・・・・・・・・・・・・・・・・・・・・・・・p. 142

P23: **Structural change and biomass increment of a subtropical/warm-temperate *Lucidophyllous* (evergreen broad-leaved) forest over a 28-year period, central Japan**
Siyu Chen, Ruoming Cao, Shogo Kato, Shinpei Yoshitake, Akira Komiyama and Toshiyuki Ohtsuka • p. 144

P24: **Leaching behaviors of arsenic during temporary storage of tunnel spoil: evaluation based on column test**
Wenjiao Li, Tsutomu Sakakibara, Atsushi Umeda, Taro Tsuge and Fusheng Li
• p. 146

P25: **Sorption and distribution of cesium on different additives applied to contaminated soils**
Huijuan Shao and Yongfen Wei • p. 148

Conservation Analysis of Kuranji Watershed using SWAT Application

○Fadli IRSYAD, Eri Gas EKAPUTRA
(Faculty of Agricultural Technology, Andalas University)

SUMMARY

Land degradation is a major cause of high runoff compared to other factors. Changes in land use occurring in an area cause a change in the catchment area conditions and may cause changes in runoff. If runoff occurs during minor rain and infiltration of water into large soil, then water is first stored in soil that will increase ground water availability. The Kuanji watershed is one of the watersheds in Padang City with an area of 202.7 km^2 and consists of 5 sub-catchments. This research was conducted on Kuranji watershed which geographically located at 100°20'31.20 "- 100°33'50.40" E and 00°55'59.88 "- 00°47'24" S. This research was conducted in March - June 2013. This study has used ArcSWAT 12 application. Initial stages in this research are data collection, SWOT analysis in Kuranji watershed, and determination of conservation area of Kuranji watershed. Results of research using ArcSWAT for Kuranji watershed were more than 3000 HRUs. The largest runoff was 84 mm with an area of 75.195 ha, and spread in four sub-districts (Pauh, Padang Utara, Nanggalo, and Koto tengah). The recommended conservation areas are Limau Manih (81.56 ha), Lambung Bukit (42.27 ha), Gunung Sarik (86.32 ha), Kuranji (60.20 ha), and Lubuk Minturun (64.45 ha)

Introduction

Land use changes that occur in a region has impacts on condition of the catchment area directly or indirectly (Poyatos et al., 2003; Turkelboom et al., 2008). Furthermore, these condition cause changing in surface flow, this influence to the condition of the river (outlet) on the watershed (Baker et al., 2013; Ghaffari et al., 2010; Niehoff et al., 2002). Land use change is the main cause of high runoff compared to other factors. If the forests within a watershed were converted into a settlement, the peak river flow will increase from 6 to 20 times. The number depends on the type of forest and the type of settlement (Kodoatie et al., 2008). The land slope factor, soil type and vegetation above contribute in determining the amount of runoff and water that can be stored into the soil through infiltration process (Turkelboom et al., 2008).

The Kuanji watershed is one of the watersheds in Padang City with an area of 202.7 km^2 and consists of 5 sub-catchments. According to Arsyad (2006), the slope of the land is closely related to the erosion. The higher the slope, the infiltration of rainwater into the soil becomes smaller, so the surface runoff and erosion becomes larger. In this study, a conservation simulation of watershed discharge was conducted using SWAT Application (Arnold et al., 1994). Geographic information system (GIS) data are analyzed using the Arc-GIS application Arc Interfaces software for Soil and Water Assessment Tool (Arc-SWAT 12). The application can calculate the influence of climate parameters on the amount of discharge from a stream, sedimentation, chemical transport of agricultural land and other uses in the management of a watershed over a period of time. This study aims to analyze the critical areas of Kuranji watershed for reference by government and related agencies in conducting conservation activities. Soil and water conservation activities in the Kuranji watershed can minimize runoff and erosion occurring in the watershed

Material and Method

The SWAT (Soil and Water Assessment Tool) application is a model to analyze a river or basin condition, developed by Dr. Jeff Arnold for USDA, Agricultural Research Service (ARS). SWAT was developed to predict the impacts of land management practices on water, sediment and chemical yields in watersheds with different types of soil, land use and management over long periods of time (Neitsch et al., 2004).

SWAT Simulation on Kuranji Watershed

SWAT model allows performing a partial watershed analysis. SWAT model describes the interaction of each smallest element of the watershed that is in the form of HRU (Hydrological Response Unit). The HRU describes the hydrological response occurring in one unit area. The division of HRU is based on overlay of soil characteristics, land use, and land slope. The SWAT model analyzes the overall HRU in the watershed, to describe the watershed condition thoroughly but can analyze the watershed conditions from the smallest element of HRU. The stages in SWAT analysis are as follows:

1. Watershed delineation

   The Kuranji River Basin was made by Automatic Watershed Delineation method in SWAT application. The DEM map of the Kuranji watershed area with a resolution of 30 m x 30 m was used as input to present the elevation difference from each point to see the direction of surface water flow. The flow of the formed river will form a watershed.

2. Hydrological Response Unit (HRU)

   The hydrological region was formed by the manufacture of Hydrological Response Unit (HRU) in SWAT applications. Input data in the form are land use maps, soil map and the slope of the land. The slope used in determining the HRU is divided into several divisions according to Arsyad (2006) ie < 3; 3-8; 8-15; 5-30; 30-45; > 45. The threshold of the percentage of total area used for land use (10%), soil type (5%), and Slope (5%) has a percentage of area smaller than the threshold specified to be ignored.

3. SWAT simulation

   At this stage the input data used is the simulation period of 2010-2015. The data files include climate station data (.txt), daily rainfall data files (*.pcp), daily temperature (*.tmp) and weather generator files (*.wgn) files.

4. Visualization of simulation results.

   At the stage of visualization the desired output parameters can be displayed in ArcSWAT, in the form of color gradations.

SWAT model on Kuranji watershed can be used as a guideline for conservation. Because the simulation results will illustrate the condition of HRU from Kuranji watershed related to runoff, erosion, evapotranspiration and ground water recharge that happened. Thus can be determined area / HRU that need to be done to minimize the conservation of runoff, erosion and destructive power of water. The simulation result also aims to determine the location / area of the watershed that needs to be conserved.

Kuranji River Conservation Area Analysis

The land slope, soil type and vegetation factor in an HRU are instrumental in determining the amount of runoff that occurs and the amount of water that can be stored into the soil through infiltration process. If runoff occurs during minor rain and infiltration of water into large soil, then water is first stored in the soil that will increase groundwater availability. If the infiltration rate is small then surface flow will increase, this may result in increased erosion, increase rapid river discharge, and rising energy damaged of water. So the focus of the conservation effort in the Kuranji watershed is the increase of water storage into the soil.

In this activity there were several alternatives to increase water storage ability, but not to eliminate the hydrological function. The effort is an appropriate targeted reforestation. Tree planting should be targeted in order to affect the condition of Kuranji watershed. The location of HRUs that has a large influence on runoff and high water damage has been used as a working area in land conservation scenarios in terms of landuse, slope, soil, channel, and others.

Result and Discussions

1. Geographical Condition of Kuranji Watershed

Kuranji is geographically located at 100°20'31.20 "- 100°33'50.40" East Longitude and 00°55'59.88 "- 00°47'24" South Latitude. Kuranji watershed has an area 202 km2 with a main river length of 32.41 km and a river density of 1.36 / km. This watershed has several sub-basins, among others: (1) Kuranji Sub-basin (An area of 19.86 km2, the main river length of 14.66 km); (2) Belimbing sub-basin (An area of 62.64 km2 with the main river length 17.08 km) ; (3) Air Sungkai sub-basin (An area of 6 km2 with length of main river 3.63 km); (4) Padang Janiah Sub-Basin (An area of 82.26 km^2 with a main river length of 18.86 km); And (5) Limau Manih sub-basin (an area of 31,93 km2 with length of main river 16,42 km).

2. Climate Condition

Climatic conditions in the Kuranji watershed is an area with tropical climatic conditions where rainfall is high enough between 3500-4000 mm/year of climatic conditions in the Kuranji watershed can be seen in Table 1.

3. Soil Condition

Soil characteristics for Kuranji watershed are grouped into 4 types of soils based on FAO 1974 (in Neitsch, 2005) (Table 2).

4. Land Use

Land use in Kuranji watershed has changed significantly. Based on the data of land use obtained from Rupa Bumi Indonesia in 2014, the land use condition as in Table 3 is obtained.

5. SWAT Simulation

Watershed delineation

The depiction of the watershed requires DEM data in its processing. In this study the DEM data used had a resolution of 30 x 30 m.

Table 1 Climate Condition in Kuranji Watershed

Month	Temp (°C)	RH (%)	Rainfall (mm/m)	ET (mm/m)	Wind (m/s)	Radiation (Mj/m^2)
Jan	26,5	83,5	31,04	110,0	2,1	14,6
Feb	26,3	84,7	30,42	101,2	2,1	14,2
Mar	26,6	83,5	34,40	123,0	2,1	16,3
Apr	26,9	83,1	29,62	119,0	1,8	16,1
May	27,0	82,8	25,88	121,3	1,5	16,0
June	26,6	81,6	29,27	109,8	1,6	15,1
July	26,3	79,9	34,58	122,8	1,7	16,2
August	26,3	78,7	26,35	132,0	1,7	17,5
Sep	26,7	78,0	27,00	136,3	1,7	18,6
Oct	26,9	79,0	19,98	136,3	1,8	18,0
Nov	26,8	80,8	20,57	120,4	1,9	16,4
Dec	26,6	82,2	29,87	113,0	2,1	15,4

Table 2. Soil characteristics of kuranji watershed

Soil Type	Area (ha)	Perscentage (%)
Vertisol	12146,756	54,09
Phaeozem	6778,852	30,19
Andosol	1708,922	7,61
Ferralsols	1822,707	8,12
Total	22065,269	100

Table 3 Land use condition

Land use	Area (ha)
airport	118,78
Primary Dryland Forest	12128,61
Water Body	63,34
Secondary Dryland Forests	124,08
Field	0,1
Mixed Forest	1542,07
Settlement	1542,72
Rice fields	5318,57
Shrubs	1162,11
Total	22000.38

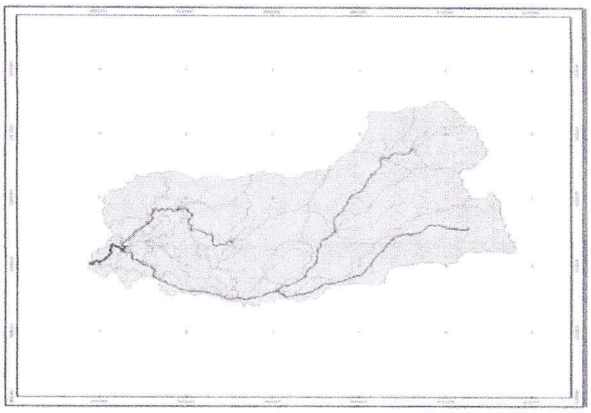


Fig. 1 Kuranji Watershed

This is intended for SWAT processing in a more detailed kuranji watershed and closer to real conditions in the field. The delineation of watershed was done by Automatic Watershed Delineation method. The results of Kuranji River Basin depiction can be seen in Figure 1. Based on the delineation result, the total watershed area is 21795.364 ha with five sub-catchments.

Hydrological Response Unit (HRU)

The hydrological region is formed by the manufacture of Hydrological Response Unit (HRU) in SWAT applications. The threshold of the percentage of total area used for land use (10%), soil type (5%), and Slope (5%) has a percentage of area smaller than the threshold specified to be ignored. The results of this process for Kuranji watershed were 2034 HRU.

SWAT Analysis Results

At this stage the input data used was the simulation period of 2015. The data files include climate station data (.txt), daily rainfall data files (.pcp), daily temperature (.tmp) and weather generator files (.wgn) files.

6. Analysis of Kuranji Watershed Conservation Using SWAT Applications

SWAT model on Kuranji watershed can be used as a guideline for conservation. This is because the simulation results will illustrate the condition of HRU from Kuranji watershed related to runoff, erosion, evapotranspiration and ground water recharge that happened. Thus can be determined area / HRU that need to be done to minimize the conservation of runoff, erosion and destructive power of water. The simulation result also aims to determine the location / area of the watershed that needs to be done conservation, so that conservation is done on target (Irsyad, 2011).

Based on the simulation results in Kuranji watershed, the location with high runoff distribution, this can be seen in Figure 2.

The result of simulation for erosion in Kuranji watershed is obtained by several locations with a relatively large erosion level with the distribution can be seen in Figure 3.

Reforestation / tree planting should be targeted so that conservation is done correctly affect the condition of Kuranji watershed.

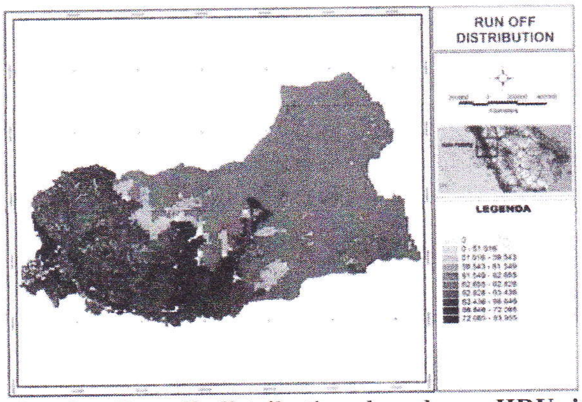


Fig. 2 Runoff distribution based on HRU in Kuranji Watershed

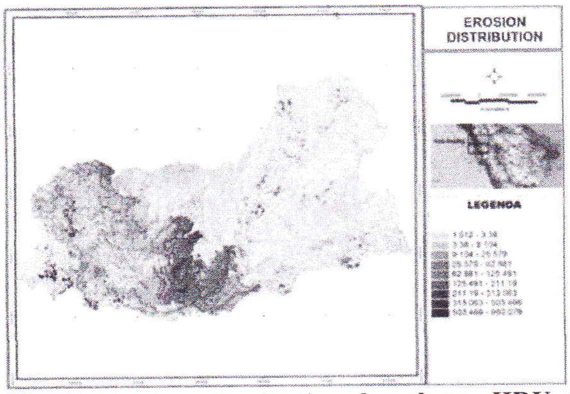


Fig. 3 Erosion distribution based on HRU in Kuranji Watershed

Fig. 4 Conservation site in Kuranji watershed

Table 4 Conservation site in Kuranji Watershed

Sub-District	Area (ha)
Limau Manih	81,56
Lambung Bukit	42,27
Gunung Sarik	86,32
Kuranji	60,20
Lubuk Minturun	64,45
Total	**334,80**

The location of HRUs that has a large influence on runoff and high water damage has been used as a working area in land conservation scenarios in terms of land use, slope, soil, channel, and others. The result of location determination based on slope and landuse that need to be done reforestation obtained some location in middle part of DAS. The location of reforestation can be seen in Figure 4.

The location of conservation activities is located in several sub-districts in Kuranji watershed. This can be seen in Table 4. The location has a slope of> 45 and has open land cover, grass and shrubs, the location is also very risky due to landslides resulting from runoff and carrying capacity Land to low surface slides.

Conclusion

The Kuranji watershed has a total basin area of 21795,364 ha with five sub-catchments. SWAT analysis result for Kuranji watershed was obtained by DAS HRU as much as 2,034 HRU. The largest runoff is 84 mm with an area of 75.195 ha, and spread in four sub-districts (Pauh, Padang Utara, Nanggalo, and Kototengah). The recommended conservation areas are Limau Manih (81.56 ha), Lambung Bukit (42.27 ha), Gunung Sarik (86.32 ha), Kuranji (60.20 ha), and Lubuk Minturun (64.45 ha).

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Soil and Water Conservation with Zero Runoff Model in Oil Palm Plantation

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SUMMARY
Soil and water conservation by infiltration through infiltration wells are very important. Because considering the land use changes in the earth's surface as a consequence of the growth in population and economy, society. Infiltration wells will decrease runoff and erosion rate. If the surface flow decreased, soils eroded and drift would be reduced. The impacts are runoff and erosion will be small. This research was conducted in June to August 2016 in West Pasaman PTPN VI. This study aims to determine the number of recharge wells, dimensions, distribution of recharge wells and reduce the volume of runoff that occurs. This research was conducted through the following steps: (1) Analysis of Intensity Rain, (2) Determination of the coefficient of runoff, (3) Analysis of Spatial Hydrology, (4) Calculation of Volume runoff, (5) Calculation of recharge wells needs, and (6) Distribution recharge wells. The secondary data used in this research were the rainfall data, map of PTPN VI, and the SRTM data were used to analyze the volume of runoff. The results of the analysis are obtained on Afdeling 1, where are 21 water catchment areas with runoff volume, and the number of wells required catchment different. So from 21 the catchment area takes 5200 recharge wells that can hold the runoff volume of 23,400 m^3 with areal extents section , 948.985 Ha, infiltration wells have dimension 1.5m ×1.5m and height 2m

Introduction

Global climatic changing of the earth due to greenhouse effect has impacts on weather conditions in every region of Indonesia. Among the impacts are the increase of rainfall intensity, flash flooding (rob), local storm / tornado, temperature, droughts and landslides. Indonesia region which lies on the equator gets sunlight throughout the year and it has only two seasons, rainy and dry seasons. The dominance of the two seasons greatly affects the availability of water. In dry season shortage of water occurs and in rainy season there is an increase of runoff.

Rainfall that falls to the ground at first will wet the land, buildings, plants and rocks. When rain falls on the area of porous it will seep into the ground as infiltration, the longer the water will seep deeper until it enters the area of the aquifer and eventually into the groundwater (Robertus, 1999). Run off occurs when the land cannot longer infiltrate surface water because the land is already in a state of saturation. Run off the main cause of erosion in some areas in Indonesia.

Absorption of surface runoff water into the ground can be carried out by an eco-drainage system (Krebs et al., 1997). This system can also reduce the erosion that occurs, fill the soil aquifer, and prevent damage, and rain harvest during the dry season (Contreras et al. 2013; Papafotiou et al., 2015; Kumar et al., 2013; Afolayan et al., 2012; and Otti et al., 2013)

Application design of infiltration wells will be applied to reduce the rate of runoff and ensuring the availability of groundwater in PTPN VI West Pasaman. This method is one of the zero runoff model (Setiawan 2010). The design of infiltration wells is necessary need to consider climatic factors, soil conditions and land use. Climatic factors to consider is the amount of rainfall, the greater the rainfall in an area means greater absorption wells required. Increased groundwater through the production of absorption wells needs to be done on a large scale, because of the ground really need the supply of water through infiltration wells (Ihsan et al., 2016). Based on the above, the authors conducted a study entitled "Oil and Water Conservation with Zero Runoff Model in Oil Palm Plantation".

Material and Method

This research was conducted in June to August 2016 in Oil Palm Plantation PT.PN VI Pasaman Barat and Laboratory of Land and Water Resources Engineering.

The tools were used in the implementation of this study, namely: a set of computers; GPS, and stationery; a digital camera for documentation retrieval. The materials used in this study were (1) Software ArcGIS 10.3, Global Mapper, and Google Sketh Up 8; (2) Data precipitation last 10 years from 2006 to 2015; (3) Map the location of PTPN VI Pasaman Barat; (4) Data SRTM 1 Arc-Second.

The first procedure performed in this study was to conduct a field survey to determine the condition of the field such as topography, land cover, and soil types. This research was conducted through the following steps: (1) Analysis of Intensity Rain, (2) Determination of the coefficient of runoff, (3) Analysis of Spatial Hydrology,

(4) Calculation of Volume runoff, (5) Calculation of recharge wells needs, and (6) Distribution recharge wells.

Rainfall were estimated with a specific return period (Bhim et al. 2012), were calculated by four methods of frequency distribution (Suripin 2014). namely:

1. Normal distribution
2. Log Normal Distribution
3. Log Pearson III distribution
4. Gumbel distribution

The frequency distribution is used to determine the relationship of the magnitude of extreme hydrological events such as floods with a number of events that have occurred so the chances of extreme events predicted time (Bhim, 2012). Data analysis was performed on all four of these methods include the average, standard deviation, coefficient of variation, coefficient of skewness (heeling / skewness) and kurtosis coefficients.

Rainfall intensity is expressed in high rainfall (mm/hr) per unit time, which occurs at a time duration, when rain is concentrated. One common formula for calculating the intensity of the rain is the formula Mononobe.

$$I = \frac{R24}{24}\left(\frac{24}{Tc}\right)^{2/3}$$

Runoff coefficient is the ratio between runoff and precipitation (Rajil, 2011). The runoff coefficient values based on land use factor is presented in Table 1 below.

Table 1 Runoff coefficient (C) for a rational method

Land use	Runoff coefficient (C)
Secondary dry forest	0.03
Thicket	0.07
Primary Forest	0.02
Industrial Plantation Forest	0.05
Secondary swamp forest	0.15
plantation	0.4
Dryland Agriculture	0.1
Dryland Agriculture mixed shrub	0.1
Settlement	0.6
Paddy field	0.15
Tambak	0.05
Open land	0.2
Bodies water	0.05

Analysis of Spatial Hydrology to draw the direction of runoff. It determined by topography. Topographic maps can be created from SRTM data so that the resulting contours of the land and the water flow visible research location on the map with the help of ArcGIS 10.3 software by using the tools Flow Direction. The results of the flow direction has been obtained and then used as a reference for determining the amount of the water catchment area (CA) using Extension Basin Hydrology, then each catchment area is calculated areas processed using ArcGIS 10.3 software.

According USSCS (1973), one of the methods commonly used to estimate the peak flow rate (discharge planning), the Rational method. Rational method was developed based on the assumption that the rainfall has uniform intensity and evenly throughout the drainage area for at least equal to the time of concentration (tc), the mathematical equations Rational Method is as following:

$$Q = 0.278.\ C.\ I.\ A$$

Placement location of Infiltration/recharge wells were analyzed using a contour map PTPN VI West Pasaman, from SRTM data will be processed on the Global Mapper software to obtain contour in each catchment area. The contour map is converted to raster data in ArcGIS 10.3 software using Topo extension to raster, raster then will be cut in accordance with the administrative boundaries PTPN VI West Pasaman and each catchment area in section 1 by using extension extract by mask. Infiltration wells will be placed at points bevy of water that can be seen by a map of the movement direction of flow of PTPN VI West Pasaman then recharge wells will spread all amounts have been calculated and analyzed.

Result and Discussions

PTPN VI has the areal extents 3549.16 hectares, and consists of four department. PTPN VI Ophir Business Unit located in the border area between the province of West Sumatra and North Sumatra Province.

1. Rainfall plan (R24)

Determination of rainfall estimation to use the study site's average precipitation last 10 years (2006-2015) were obtained from climatological station PTPN VI Business Unit Ophir, Pasaman Barat. Rainfall data were obtained and analyzed in order to extract statistical parameters to select the appropriate method of distribution of the rainfall, the results obtained from the Log Pearson III method that meets the requirements for analyzing the rain draft of the study sites. The value of the parameter and design rainfall were obtained in Table 2 and Table 3 below:

Table 2 Parameter Analysis Test statistic Distribution Log Pearson III

Parameters	value
The average CH	26.5
Average - Average Log	1.410
The standard deviation	Sx = 0.077
The coefficient of variation	Cv = 0.0029
The coefficient of skewness	Cs = 0.876
Kurtosis coefficient	Ck = 4.14

Based on the analysis of statistical parameters of rainfall data of the past 10 years found the average value of precipitation 26.051, then the average value of logs obtained 1,410, the value of a standard deviation of 0.876 this shows the data more inclined to right because it is positive, then obtained standard deviation or standard deviation of 0.077, this value indicates the size of the statistical distribution of data or an average distance of deviations of data points measured from the average value of the data. The value of rainfall each specific return period can be seen on Table 3.

Table 3 Maximum daily rainfall by return period.

Return Period (years)	Plan Rainfall (mm)
1	23
2	25
5	29
10	32
25	37
50	40
100	43

Based on the above data on the 1-year period, the value of 23 mm rainfall. This means that the rain is expected to be equaled or exceeded in any one year. Plan Rainfall is estimate that the rain if exceeded k times in a long period of years will have a value M k / M is approximately equal to 1 / T.

2. Calculation of Rainfall intensity

The calculation of rainfall intensity within the return period T years of daily rainfall data can be calculated by using the Mononobe formula. According to the statement Loebis (1992) that the rainfall intensity (mm/hour) can be derived from daily rainfall data using equations Mononobe.

Table 4 Analysis The rainfall intensity (mm / hour)

CA	Periode Ulang (Tahun)						
	1	2	5	10	25	50	100
CA 1	27	29	35	38	43	47	51
CA 2	28	30	35	39	44	48	52
CA 3	25	26	31	34	38	42	45
CA 4	19	21	24	27	30	33	35
CA 5	23	25	29	32	36	39	43
CA 6	35	37	43	48	54	59	64
CA 7	24	26	30	33	37	41	44
CA 8	21	22	26	29	33	36	39
CA 9	31	33	39	43	48	52	57
CA 10	27	28	33	37	0	45	49
CA 11	22	23	27	30	34	37	40
CA 12	29	31	36	40	45	49	53
CA 13	32	34	40	45	50	55	59
CA 14	21	22	26	29	33	36	39
CA 15	16	17	20	22	25	27	29
CA 16	20	21	25	0	0	34	0
CA 17	14	15	18	20	22	24	26
CA 18	12	13	16	17	20	21	23
CA 19	12	13	15	17	19	21	23
CA 20	15	16	19	20	23	25	27
CA 21	11	12	14	16	18	19	21

In the table above can be seen the calculation results obtained for the intensity of the rain that took place in each catchment area (CA), each CA has a rainfall intensity is different, because it is influenced by the length of the flow that occurs in each catchment area (CA), in Diversion rain into streams there are several properties of rain is important to note, among others, is the intensity of rainfall, rainfall depth and concentration time (Soemarto, 1987).

Time of concentration (tc), is used to determine the length of the rain water flows from upstream to downstream flow. Time of concentration (tc) is calculated using the formula Kirpich (1940).

The length and slope flow CTA obtained by using Geographic Information System (GIS), based on the results obtained SRTM data processing flow that occurs in each CA, so the length of the flow can be measured using a map. The length of the flow in the CA is the length of the maximum flow from the upstream point to a downstream point (Triadmojo, 2008).

Based on the results in Table 4 are the smallest rainfall intensity on CA 21, this is due to the length of the flow that occurred in the CA, causing streaming, a long time from a point upstream to downstream, and rainfall intensity obtained small. In the CA 21 long stream measured on a map that is 2,343 km, the tilt of 1.7%, and the length of time streaming, 0.6 hours or 36 minutes, and the largest rainfall intensity contained in CA 6, with a length of 0.417 km flow, with a slope of 4, 3%, so time streaming, fast, ie 0.114 hours or 6.84 minutes.

3. Directions and Watershed Runoff (CA)

Determining the direction of water runoff that occurs at the site of the research results from processing of data SRTM 1 arc-second which has a spatial resolution of 30 meters, the data is then carried out the process of the clip (cutting) by using software ArcGIS 10.3, after it and then made a topographic map by using software Global Mapper, so that the resulting map topography in research location.

Topographic maps that have been made visible topographical conditions in some parts of the corrugated region Afdeling 1, topographic high located towards the north or towards the mountain Pasaman. Topographic map is then used for processing with ArcGIS 10.3 software for the resulting map directions runoff, contour lines are used to determine the direction of the runoff.

Table 5 The Cathment Area (CA)

Catchment Area (CA)	Luas (ha)
Catchment area 1	12,261
Catchment area 2	14,695
Catchment area 3	15,974
Catchment area 4	18,128
Catchment area 5	18,319
Catchment area 6	18,426
Catchment area 7	19,234
Catchment area 8	19,816
Catchment area 9	21,757
Catchment area 10	22,699
Catchment area 11	22,880
Catchment area 12	32,367
Catchment area 13	41,152
Catchment area 14	41,272
Catchment area 15	42,716
Catchment area 16	46,454
Catchment area 17	85,011
Catchment area 18	93,740
Catchment area 19	98,524
Catchment area 20	105,329
Catchment area 21	158,231

Runoff comes from the highest points and move toward the lower points in a direction perpendicular to the contour lines.

Map directions runoff that has been obtained can be seen toward the more dominant runoff moved south-west or seaward. Map directions runoff is then processed again by the software ArcGIS 10.3 for later obtained the distribution of water catchments in Afdeling 1.

Based on the results of processing map directions runoff generated 21 DTA in Afdeling1. The DTA is obtained with an area of 158.231 hectares ie DTA 21 for the smallest DTA DTA 1 with an area of 12.261 ha. Surface flow at Watershed occur in several forms: 1) the flow of runoff on the soil surface, 2) flow through through the ditch / sewer, 3) flow through streams, and 4) the flow through the main river. The flow of the land surface runoff occurred during or after rain in the form of runoff on the soil surface. The flow went into the ditch / sewer which then flows into the streams further into the flow in the main river. Hydrological characteristics of the catchment area is influenced by the length of the river / stream, shape, area, relief / topography, and drainage patterns of the catchment (Triatmodjo, 2008).

4. Coefficient and Runoff debit

Rational method runoff coefficients for the location of research can be seen from land use, namely plantation. Runoff coefficient value is 0.4 for plantation areas, can be seen in Table 1.

Runoff discharge that occurs in the location study was calculated using a rational method for estimating the peak discharge caused by heavy rains in the catchment (DAS) is small. A small catchment area is considered uniform when the distribution of rainfall in space and time, and duration of rainfall normally exceeds the concentration time. Some experts view that the catchment area of less than 2.5 km^2 can be considered a small watershed (Ponce, 1989). After calculation, it can be seen in Table 6 runoff discharge that occurs in the respective DTA with a specific return period.

Based on the calculation results table above can be seen runoff discharge, discharge runoff obtained is affected by 1) catchment area, 2) runoff coefficient, and 3) Intensity of Rain. Catchment area are the main parameters that influence the outcome of the discharge, the discharge of runoff largest found in DTA 21, it can be seen the influence of the area of comprehensive DTA 21 compared with the DTA other, the DTA 21 is the area's

Table 6 Discharge of Runoff (m^3 / sec)

CA	Periode Ulang (Tahun)						
	1	2	5	10	25	50	100
CA 1	0.4	0.4	0.5	0.5	0.6	0.6	0.7
CA 2	0.5	0.5	0.6	0.6	0.7	0.8	0.8
CA 3	0.4	0.5	0.5	0.6	0.7	0.7	0.8
CA 4	0.4	0.4	0.5	0.5	0.6	0.7	0.7
CA 5	0.5	0.5	0.6	0.7	0.7	0.8	0.9
CA 6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
CA 7	0.5	0.5	0.6	0.7	0.8	0.9	0.9
CA 8	0.5	0.5	0.6	0.6	0.7	0.8	0.9
CA 9	0.7	0.8	0.9	1.0	1.2	1.3	1.4
CA 10	0.7	0.7	0.8	0.9	1.0	1.1	1.2
CA 11	0.6	0.6	0.7	0.8	0.9	0.9	1.0
CA 12	1.0	1.1	1.3	1.4	1.6	1.8	1.9
CA 13	1.5	1.6	1.8	2.0	2.3	2.5	2.7
CA 14	1.0	1.0	1.2	1.3	1.5	1.6	1.8
CA 15	0.7	0.8	0.9	1.0	1.2	1.3	1.4
CA 16	1.0	1.1	1.3	1.4	1.6	1.7	1.9
CA 17	1.3	1.4	1.7	1.9	2.1	2.3	2.5
CA 18	1.3	1.4	1.6	1.8	2.0	2.2	2.4
CA 19	1.3	1.4	1.7	1.9	2.1	2.3	2.5
CA 20	1.7	1.8	2.2	2.4	2.7	2.9	3.2
CA 21	2.0	2.1	2.5	2.8	3.1	3.4	3.6

Table 7 The Volume of Runoff (m^3)

CA	Periode Ulang (Tahun)						
	1	2	5	10	25	50	100
1	216	231	272	300	338	368	398
2	256	274	322	356	401	436	473
3	298	319	375	414	466	507	549
4	382	409	481	531	598	651	705
5	351	376	442	488	550	598	648
6	290	311	365	403	454	494	535
7	364	390	458	506	570	620	672
8	400	428	503	556	626	680	737
9	364	389	457	506	569	619	671
10	407	436	512	566	638	693	751
11	454	486	571	631	710	773	837
12	555	594	698	771	869	945	1,024
13	671	719	845	933	1,051	1,143	1,239
14	835	894	1,051	1,162	1,308	1,422	1,541
15	996	1,067	1,254	1,386	1,560	1,697	1,838
16	965	1,033	1,214	1,342	1,511	1,643	1,780
17	2,081	2,227	2,618	2,893	3,258	3,543	3,838
18	2,454	2,627	3,087	3,412	3,842	4,178	4,526
19	2,594	2,777	3,264	3,607	4,062	4,417	4,785
20	2,534	2,713	3,188	3,523	3,968	4,314	4,674
21	4,358	4,665	5,483	6,059	6,823	7,420	8,038

largest, while to discharge runoff smallest one is on DTA 1, which is the catchment area with the smallest area.

5. Volume of Runoff

The volume of runoff is the number of accommodated runoff catchment area that occurred during the drainage time (tc), then from the discharge runoff we can calculate the volume of runoff in the respective catchment areas, where each of the catchment area has a drainage time (tc) dif- different. Here are the results of calculations each catchment runoff volume at a certain return period.

Based on the above calculation can be seen the volume of runoff largest located in the region DTA 21, it can be seen from the large catchment areas in the region, causing the volume of runoff, if seen from the intensity of rain DTA 21, the rain intensity smallest, is caused by the length of time streaming but for the volume of runoff can be seen are the main factors influencing the magnitude of the extent of the catchment area and the length of time jetting, for the smallest runoff volume obtained in the area DTA 1, this results in accordance with an area DTA 1, which is the smallest catchment area of the region.

6. Dimensional Recharge wells

Design dimensional infiltration wells using the volume of runoff with a return period of 2 years, seeing an opportunity rains that occurred 50% and a prediction of rain events are not too short and too long, if using a return period of 1 year, the time is too short, if the return period of 5 years, the odds of a small 20% and the predicted long time. In this study dimensional diffusion well defined with a size of 1.5 meters x 1.5 meters high on its side and infiltration wells 2 meters, so that the storage volume that is generated for the recharge wells is 4.5 m^3. In the table below the results can be seen in the number and volume of each pitcher infiltration wells of water catchment areas.

In table 8 above can be seen, the number and volume of catchment runoff each DTA vary, the DTA 1, the volume of runoff that occurs 231.143 m^3, so it takes 52 pieces of recharge wells to accommodate runoff that occurs, and the volume catchment runoff by recharge wells are 234

Table 8 Number and volume of runoff catchment

CA	Runoff Volume (m^3)	Number of wells	Recharge Volume(m^3)	Number of wells/ha
1	231	52	234	4
2	274	61	275	4
3	319	71	320	4
4	409	91	410	5
5	376	84	378	5
6	311	70	315	4
7	390	87	392	5
8	428	96	432	5
9	389	87	392	4
10	436	97	437	4
11	486	108	486	5
12	594	132	594	4
13	719	160	720	4
14	894	199	896	5
15	1,067	238	1071	6
16	1,033	230	1035	5
17	2,227	495	2228	6
18	2,627	584	2628	6
19	2,777	618	2781	6
20	2,713	603	2714	6
21	4,665	1037	4667	7
	23,363	5200	23400	104

m3, as well as other DTA, such as DTA 21, which is thelargest runoff volume needed recharge wells on the acreage in 1037 with an area of 158.231 hectares to accommodate the runoff volume of 4664.795m^3 (appendix 14), when seen needs infiltration wells in an area of 1 Ha also varies every DTA no need 4, 5 and 6 of absorption wells in 1 Ha, even on DTA 21 extents are most in need of 7 infiltration wells in 1 Ha, on the volume of runoff that is in great need of recharge wells that are so much in keeping with the area large catchment area.

Infiltration wells are designed with the type of square-shaped with dimensions that have been set, the square shape selected because it is easily made in the field and volume of reservoirs produced greater than a cylindrical shape, making it more suitable for the applied field, construction design recharge wells consisting of wall infiltration wells and around recharge wells on the surface of the ground made a small ditch filled with empty oil palm bunches, it serves as a filter so that water seeped into clean and can accommodate sediments due to sediment runoff so that it does not fit into the wells to reduce the volume of catchment it.

7. Distribution Infiltration Wells in location research

Based on the number and map directions runoff, can be determined placement of recharge wells, recharge wells would be made at the meeting point of water and in areas of ramps / flat (not steep), so that water flowing from the high point to the sloping area and can get into recharge wells optimally , Infiltration wells will be deployed on the DTA by considering the density of the contour lines in accordance with their respective amounts so as to absorb runoff that occurs every DTA.

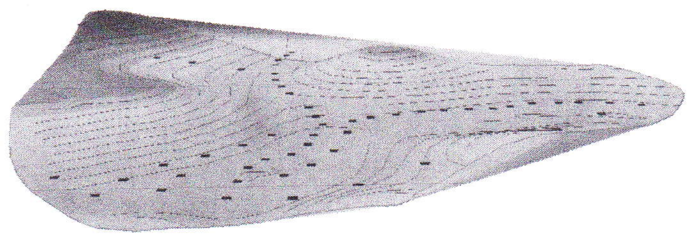

Fig.1 3D Cathment area 1 and Distribution Recharge wells

Conclusion

1. On Afdeling 1 PTPN VI West Pasaman based on the direction of flow generated 21 Watershed each catchment area runoff discharge occurs different when it rains.
2. In section 1 PTPN VI Pasaman Barat with areal extents 948,985 Ha be required 5200 recharge wells or 5 recharge wells per Ha to accommodate the volume of runoff that occurs at 23.363,437 m^3 based on the 2 year period used in the design.
3. Based on the concept of zero run off pitcher volume resulting from 5200 recharge wells as 23.400 m^3 so it can accommodate the volume of runoff that occurs in section 1 PTPN VI.

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