Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-01 Room:202 Time:May 23 08:30-08:45

Long-term flux observation at Koshin Observatory of Lake Kasumigaura?

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Water vapor, temperature, wind velocity and CO2 concentration have been measured at 10Hz at the Koshin Observatory of Lake Kasumigaura, together with relevant meteorological and hydrological mean variables since June of 2007. By applying the eddy correlation method to these data, fluxes of water, heat and so on have also been estimated. In the presentation, some findings from the analysis that include relation between these point-estimated fluxes with those of Lake kasumigaura as a whole, bulk coefficient relation with wind speed and lake surface current, water balance consideration, will be the focus for the discussion of the future research directions.

Keywords: Lake Kasumigaura, Evaporation, Flux, bulk coefficient

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-02 Room:202 Time:May 23 08:45-09:00

A long term monitoring of water cycle in the Mongolian plateau

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We have been observing continuously soil moisture, vegetation and fundamental hydrological elements at several points in the study area in the Mongolian plateau since 2000. At the same time, AMSR-E has been observing daily soil moisture over Mongolia since 2002. We have been obtaining interesting results of water cycle change analyzing the data of the in situ and satellite observations. We will discuss the observation results, recent results and future activities.

Keywords: soil moisture, vegetation, remote sensing, AMSR-E, AWS, ASSH

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-03 Room:202 Time:May 23 09:00-09:15

Preliminary study on long-term evapotranspiration from a forested watershed in relation to ambient air temperature

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Hydrological studies examining the effects of climate change on water cycling in forests have frequently used projected climate change scenarios and discussed forthcoming hydrological change in the forested areas. Thus, relatively less knowledge is available in discussing the effects of climate change in the past on forest hydrology. This study made preliminary comparison between 70-year annual mean air temperature (Ta) at a forest site and 80-year annual evapotranspiration (ET) from that site. The examined watershed was Shirasaka Watershed (SW), Seto, Aichi, Japan, where long-term data sets of Ta, rainfall, and runoff were available. Annual ET was determined from watershed water balance, assuming both of leakage loss to bed rock of the watershed and change in stored water within the watershed to be negligible. The Ta at SW seems to have no clear rising or declining trends by mid-1980s, but thereafter rose abruptly by c. 1^{o}C, and remained such high Ta level to the present. This long-term Ta trend seemed similar to that being derived from data at remote stations of Japan Meteorological Agency (see http://www.asahi-net.or.jp/˜rk7j-kndu/kenkyu/ke45.html). Annual ET was calculated at c. 830 mm y^{-1} and $>$900 mm y^{-1}, for the 1970-1987 period (before the abrupt Ta change) and the 1988-2009 period (after the abrupt Ta change), respectively. The increased ET in recent years might be caused the high Ta level and suggested enhanced water vapour exchange between SW and the atmosphere due to the recent warming.

Keywords: Forest watershed, Air temperature, Evapotranspiraiton, Long-term data set

Japan Geoscience Union Meeting 2011
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AHW027-04 Room:202 Time:May 23 09:15-09:30

Water flux in forest soil estimated by Buckighum-Darcy Equation

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We applied Buckinghum-Darcy equation with measured soil K-theta relationship to the topsoil(30 cm depth) and subsoil(90 cm depth) in upper- and lower-plot of the forest slope, and calculated the vertical soil water flux throughout a year to validate the annual soil water flux. The annual soil water flux was 530 mm for upper plot, smaller than the annual stream runoff rate of the study catchment(643 mm), and 982 mm for the lower plot, larger than the stream runoff rate. Both soil water fluxes were smaller than the annual precipitationof the study catchment(1282 mm). We considered that these fluxes represented the difference of the slope position between the plots and that they were reasonable as the vertical water flux in unsaturated soil below rooting zone.

Keywords: forest soil, soil water, water flux, Buckingham-Darcy Equation, K-theta relationship

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-05 Room:202 Time:May 23 09:30-09:45

A comparison of flow characteristics of forested watersheds with different climates and catchment sizes

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INTRODUCTION

Transport of water in a mountainous watershed affects water balance and flow regimes as well as movement of sediment, nutrients, and chemicals in head water areas. Watershed experiments including those employing paired catchments have long been utilized to infer effects of forest on water balance and flow regimes in a mountainous watershed. Quite a number of studies reported how water balance and flow varies with changes in forest conditions such as deforestation, afforestation, tree growth, forest fire, diseases, land use conversion. However, extents of effects of forest conditions relative to other factors such as climates and catchment sizes are still in question. As such, this study aimed to infer how variations in climates and catchment sizes can affect flow characteristics of forest watersheds.

STUDY SITES AND METHODS

This study compared flow characteristics of Forest Experimental Watersheds (Jozankei, Kamabuchi, Takaragawa, Tatsunokuchi-yama, Sarukawa; hereafter referred to as JZK, KMB, TKR, TKY, and SRK, respectively) of Forestry and Forest Products Research Institute (FFPRI) of Japan. Notable features of these experimental watersheds are that they covers a wide variety of climatic conditions and that catchment sizes vary widely with the smallest catchment of KMB No.3 (1.5 ha, 172-244 m) up to the largest catchment of TKR Honryu (1906 ha, 816-1945 m). Daily discharge from each catchment during 10 years from 1991 through 2000 (Abe et al., 2010; Goto et al., 2005; Hosoda et al., 1999; Hosoda and Murakami, 2006, 2007; Shimizu et al., 2008) were used. Daily discharge averaged over the first, middle, and last ten-days of each month was calculated together with annual averages.

RESULTS AND DISCUSSION

Because calculation of 10-days mean daily discharge (hereafter, referred to as q10) smoothes out individual storm response, discharge would maximize during snowmelt seasons for watersheds with heavy snow in winter such as JZK, KMB, and TKR. A peak of q10 hydrographs appears during the last 10-days of April in JZK and during the first 10 days of April in KMB. While variations in the timing of the peak amongst catchments within the same watershed were small for JZK and KMB, considerable variations in both timing and rate of the peak of q10 were observed in TRK with more delayed and higher peak for the larger catchment. This indicates that a larger catchment includes higher places receiving more precipitation and its larger relief would disperse the timing of snowmelt due to altitudinal gradient of air temperature. Also, even during the periods of Bai-u and typhoon seasons, q10 is higher for the larger catchment in TKR, suggesting that more rainfall would precipitate in the higher part of the watershed.

For watersheds without substantial snow such as TKY and SRK, discharge maximized during Bai-u seasons, while the peaks in SRK is much larger by four or five times than those in TKY.

Annual mean of daily discharge is largest for Honryu catchment in TKR, followed by 3 catchments in KMB, 3 catchments in SRK, Shozawa and No.1 catchments in TKR, 2 catchments in JZK, and 2 catchments in TKY. Higher averages in KMB over those in SRK despite of an inverse relationship in annual precipitation suggests that differences in evapotranspiration overwhelmed differences in precipitation. Except for the largest Honryu catchment in TKR, the order of annual mean daily discharge suggests that in terms of water balance inter-watershed variations is larger than intra-watershed variations unless a catchment size varies significantly.

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Keywords: forested watershed, flow characteristics, climatic conditions, catchment sizes

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-06 Room:202 Time:May 23 09:45-10:00

Effects of forest plantation plactices on runoff and downstream environment

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Sixty-five percent of Japanese land is covered by forests. More than 40% of the forest is consists by Japanese cedar and cypress plantation. Because plantation typically concentrate in headwater watershed which are an important reservoir basin to the densely populated region in downstream, water resources in Japan primary depends on water supply from the headwaters covered by forest plantations. Despite the importance of forest management, the area of abandoned forest plantation has been increased because of declining domestic forest industry and market due to low timber prices, high labor cost, and shortage of forest operators. Due to the low light conditions, understory vegetation cover tends to be sparse in the dense, unmanaged plantations, particularly Japanese cypress forests. Under such forest, infiltration excess overland flow and resultant soil surface erosion occurs. Such overland flow and soil erosion affect runoff and water quality at the downstream counterparts. Therefore, unmanaged and devastated plantations hamper the functions of forest for regulating discharge and recharge of water resources. Increasing the frequency of drought and flashy flood due potentially to global climate change also threaten the stable water supply and flood management in watersheds.

Forest thinning is essential for maintaining forest stand conditions and hydrological processes in devastated plantation forest. Recent studies demonstrated that intensive 50-60 % thinning can increase infiltration rate and reducing the opportunities of overland flow and soil surface erosion by recovering understory vegetation. Thinning generally reduces canopy interception and evapotranspiration. Thus, net precipitation reaching ground surface after thinning increases compared to the pre-thinning condition. Such increases in effective rainfall promote greater amount of groundwater recharge after the thinning. However, no quantitative assessment has been conducted for evaluating the effects of intensive thinning (removal of stems $>$ 50%) on runoff and sediment discharge at a watershed scale. This project specifically aims to examine the influence of intensive thinning practice on the variation of low flow (drought period) discharge. I present some results obtained through this project.

Keywords: Water Cycle, Forest Plantation, Runoff

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-07 Room:202 Time:May 23 10:00-10:15

SOx and the relation of witherring of trees

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The cause of withering of trees is brought abut by sulfuric acid which generated in combustion of fossil fuel. If sulfuric acid is added to the mixture of the sodium chloride which comes from the sea, and manganese dioxide which comes from soil, strong toxic chlorine and deliquescent manganese sulfate generate. They destroy the cell of trees.

The sulfuric acid added to soil changes the metal ingredient of soil into soluble metal sulfate. Trees absorb metal sulfate with water and combine with phosphoric acid in the formative layer. Phosphoric acid becomes inactive and it causes withering.

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AHW027-08 Room:202 Time:May 23 10:15-10:30

The influence of heavy metal accumulated in aquatic life in the Hyogo,Ikuno mine outskirts and the Yabu City.

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In this study, water chemistry was studied under the condition of serpentine area with high Mg ion concentration and the metal mine area with high sulfate concentration from mine drain. In particular heavy metal ion concentrations for water and river small insect such as larva of mayfly, dragonfly and crane fly were measured in order to clarify its water chemistry impact for aquatic ecosystem and its heavy metal bioaccumulation. The Sekinomiya serpentine area in the north of Hyogo prefecture and the closed Ikuno mine area in the middle of Hyogo prefecture were selected as the studied areas.

In the Ikuno mine area, high concentrations of Ca2 +, Mg2 +, SO42-, and HCO3- for river water at the center of mine were found and Zn and other heavy metals were over the Japanese effluent standards, 5.0mg / L with the highest Zn concentration, 25.1 mg / L. This high concentration of mine waste water is thought to be derived from muck in the drift and dumping area in the mine, although mine company still treat mine waste water.Then,it is very difficult to treat waste water from an abandoned mine.

Generally, serpentine is high concentration of Mg and then weathering process brings out low concentration of Ca2 + and high concentration of Mg2 + and HCO3- for water and then in the Sekinomiya serpentine area, river water also shows the same water chemistry. However, in the Sekinomiya serpentine area, some high concentrations of dissolved ion such as Ca2+ and sulfate for river water were found near the abandoned Natsume mine and Nakase mine area and a high concentration is thought to be caused by the effects of mine drainage as well as the Ikuno mine. Further high concentration of Cr and Pb in the serpentine area was found and then Ni and Cd concentrations in crane fly reach 2.4 mg/kg and 1.2 mg/kg by dry weight in the Ikuno mine area. Then Ni and Cr concentrations in dobsonfly reach 14.6 mg/kg and 0.4 mg/kg by dry weight in the Sekinomiya serpentine area respectively.

Concentration of heavy metals in aquatic organisms depends on species, life term, and food. As crane fly and dobsonfly are carnivorous larger body and they are located on top of the ecological pyramid for the aquatic insect, they show the highest metal concentration in two areas.

Keywords: Rest abolition mine, Mine waste water, Serpentine geological feature, Heavy metal, Acatic life, Biological magnification

Japan Geoscience Union Meeting 2011
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AHW027-09 Room:202 Time:May 23 10:45-11:00

Seasonal patterns of nitrate concentration in forest streams: Hydrology or biogeochemistry?

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In recent two decades, the seasonal variation of nitrate discharge from forested ecosystems has been increasingly focused by ecologists and hydrologists as a diagnostic indicator of the nutrient status of ecosystems. Major factors controlling the seasonal patterns of stream nitrate concentrations include seasonal variations in (i) nutrient demands of plants and microbes, (ii) solute transport capability of the hydrological condition, and (iii) in-stream nutrient usage and supply. In this study, we attempted to show how case studies have helped to elucidate the dominant controlling factors by comparing data from Japanese catchments with previously compiled data from studies in North America and Europe, and explain the different influences of hydrological and biogeochemical controls exert in rainy summer regions (Japanese catchments under the Asian monsoon climate) and dry summer regions (sites in the northeast United States and Europe). The seasonal variation of hydrological conditions is a predominant controlling factor in Japanese forests, whereas it has been considered that nutrient demand may predominate in the northeast United States and Europe. We, ecologists and hydrologists have to recognize that it is important to compare seasonal patterns among different climate regions to obtain more universal explanations of the seasonal variation in stream nitrate concentration. In addition, multi-scale investigations will be strongly needed to provide insight into the relative contribution of hillslope biogeochemical effects and the influences of in-stream biological activities.

Keywords: forest ecosystem, streamwater, nitrate, seasonal variation

Japan Geoscience Union Meeting 2011
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AHW027-10 Room:202 Time:May 23 11:00-11:15

Meaning of mean residence time for the biogeochemical responses of streamwater in a forested headwater catchment

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Effects of annual variation of climate conditions or residence time distributions of ground- and streamwater on long-term variations of streamwater chemistry are discussed in a forested headwater catchment, Kiryu Experimental Watershed (KEW), Japan, where hydrochemical observations have been continuing in recent two decades. The entire area of KEW is underlain by Cretaceous biotite granite, called the Tanakami granite. Mean annual precipitation was 1639.0 mm from 1990 to 2010.

In KEW, episodic increases in nitrate concentrations in streamwater due to the partial dieback of red pine trees since the end of 1980's were observed. Many of the blighted trees fell down by the typhoon No.26 at September 1994. On the other hand, the stream nitrate concentrations began to increase in 1993, peaked in 1995?97, and are then slowly decreasing. The concentrations at 2010 were about one fourth of those at the peaked values, and have not yet recovered to the pre-disturbance values. Such time lag is caused by the delay of decomposition, nitrogen leaching from dead woods, and transport through groundwater flow to the stream. The mean residence time of the streamwater estimated with oxygen isotope variation is 43 months. Considering the weighting function used in this estimation, the contribution of 1-year-age water is maximal, even though 10 or more older water is also contribute to the streamwater. Therefore, the dynamics of nitrate concentrations in streamwater are successfully explained by the weighting function, or the distribution of residence time.

The long-term variations of chloride concentrations showed the decreasing trend till around 2000, and then constant. The decreasing trend might be achieved by the decrease of chloride input because the dry chloride deposition was not collected by the forest canopy after the disturbance. Although the forest canopy is now almost closed, the groundwater has not fully turned over yet, and the concentrations have not yet recovered.

These results mean that the 'apparent' forest disturbance may relatively soon recover, however, these effects on the streamwater chemistry through the groundwater dynamics will persist for a long time. The mean residence time is one of the essential information to consider such prolonged phenomena, and thus, the long-term observation is of necessity important.

Keywords: Forested headwater catchment, Mean residence time, streamwater, hydrochemistry, Long-term observation

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AHW027-11 Room:202 Time:May 23 11:15-11:30

Spatial and temporal change of average residence time of spring and stream waters and its hydrological interpretation

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Multi-tracer approach using solution, CFCs and stable isotopes was applied to investigate the temporal and spatial variation of residence time of spring and stream waters in a forested headwater catchment underlain by granite, Hakushu, Yamanashi Prefecture, central Japan.

The average residence times of spring, tributary and main stream waters were estimated to be ranging from 7 to 16 years, 7 to 19 years and 7 to 13 years, respectively during high flow season, whereas those in the low flow season were estimated to be ranging from 14 to 20 years, 10 to 17 years and 7 to 19 years, respectively. Thus, the residence time of the water during the high flow season was higher than that during the low flow season, and that of the main stream water with a larger catchment area was lower than that of spring water with a smaller capture area.

The hydro-chemical data suggests that the high groundwater table and hydraulic gradient in the mountain causes a dominant role of shallow groundwater with a short residence time in the spring/stream water during the high flow season, whereas the deep groundwater contributes dominantly in the spring/stream water during the low flow season. Additionally, the water with a short residence time recharged by the precipitation fallen at the higher elevation seems to cause the shorter residence time of the main stream water.

Keywords: Headwater, Residence time, Spring, Stream

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AHW027-12 Room:202 Time:May 23 11:30-11:45

Residence time of permafrost groundwater at Yakutsk region, Eastern Siberia

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Water environments and hydrologic changes in permafrost regions are very crucial issues in current climate change. Better understanding of groundwater dynamics in permafrost regions is necessary for vulnerability assessment to the changing climate. Recent researches focusing on Eurasian Arctic Rivers reported that discharge from those rivers should be sensitive to climate warming primarily as a result of the melting of ground ice, because positive streamflow trends might exceed precipitation trends in magnitude around the Russian Arctic region. It was demonstrated that permafrost most likely plays a key role in long-term streamflow variability. It was also speculated that reduced intensity of seasonal ground freezing, together with precipitation increases, might drive increases in river discharge to the Arctic Ocean. However those age or residence time are not much known. In this research, in order to determine residence time of permafrost groundwater, hydrologic tracers such as chlorofluorocarbons (CFCs) and sulfur hexafluoride have been applied to the supra-permafrost and intra-permafrost groundwater in Yakutsk region of Eastern Siberia. The results showed that bulk groundwater age ranged from 5 to 50 years old after the recharge. It is necessary to separate the groundwater age estimation between supra-permafrost and intra-permafrost groundwater.

Keywords: permafrost, thermokarst, supra-permafrost groundwater, intra-permafrost groundwater, lake-talik-groundwater system

Japan Geoscience Union Meeting 2011
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AHW027-13 Room:202 Time:May 23 11:45-12:00

Long-term observation of stable isotopes in precipitation over Indonesia

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Daily rainfall and rain water stable isotopes (Oxygen-18 and Deuterium) were observed from 2001 at six stations over maritime continent. There are Kotatabang, Jambi, Denpasar, Makasar, and Manado in Indonesia, and Peleliu Island in Palau. The daily rainfall amount and stable isotopes shows temporal characteristics with larges differences. Rainy season is almost occurred in December to February while dry season is July to August in each station except over Palau with occurred during May to June. The range of isotopic content is about -15 permil to 7 permil for daily Oxygen-18 over these local stations. The correlation coefficient between daily rainfall amount and isotopic content is not significant. However, there are three stations where have significant correlations in monthly rainfall and stable isotopic content (Kotatabang, Denpasar, and Makasar). Furthermore, we found clearly negative trend in relationships between monthly precipitation amount and isotopic content. It is suggested that seasonality rainfall is more related than individual rainfall. Seasonal variation of stable isotopes in precipitation as a response to Australian monsoon also is considered. The significant correlation between monthly stable isotopic content and Australian monsoon index is found on Denpasar, Makasar, and Palau, where Denpasar and Makasar have negative correlation and Palau positive correlation. It is suggested that these three stations have a relation with easterly and westerly wind over Australian monsoon region.

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AHW027-14 Room:202 Time:May 23 12:00-12:15

Long-term variations of rainfall and rainfall characteristics in Asian monsoon region

Jun Matsumoto[1*], Nobuhiko Endo[2], Jun-Ichi Hamada[2], Hisayuki Kubota[2], Ikumi Akasaka[2], Hideyuki Kamimera[2], Kooiti Masuda[2], Manabu D. Yamanaka[2], Shuichi Mori[2], Taiichi Hayashi[3], Toru Terao[4], Fumie Murata[5], Masashi Kiguchi[6], Yusuke Yamane[7], Masumi Zaiki[8], Junpei Hirano[1]

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As for the long-term Asian monsoon variations, monsoon rainfall variations by utilizing All Indian Monsoon Rainfall for over 130 years have been analyzed. On the other hand, the rainfall data during and prior to the World War-II have been very limited and they have not been well analyzed in other Asian monsoon countries. Under the International Asian monsoon project, MAHASRI (Monsoon Asian Hydro-Atmosphere Scientific Research and prediction Initiative) in GEWEX/WCRP, we have tried to reveal the long-term changes in precipitation, rainfall characteristics, and water cycle over land areas in Asian monsoon region by installing own observation network, and/or by rainfall data collection including data rescue for the old document data. In this presentation long-term variations of rainfall and rainfall characteristics in Asian monsoon region supported by the Data Integration and Analysis System (DIAS), funded JAMSTEC by the National Key Technology, the Ministry of Education, Culture, Sports, Science and Technology, Japan, by the Global Environment Research Fund (B-061 and B-092) of the Ministry of the Environment, Japan funded Tokyo Metropolitan University, and by the various Grant-in-Aid for Scientific Research, Japan Society for the Promotion of Science for the authors will be introduced.

Keywords: Asian monsoon, Precipitation, Rainfall characteristics, Long-term variations

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-15 Room:202 Time:May 23 12:15-12:30

Where does the evaporated water of canopy interception go? A possibility of dictating continental-scale precipitation

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1. Introduction

In the early 20th century forest hydrologists presumed that forest could feed rain that implies stream flow from the forested areas is higher than that from the other land uses. However, in the late 20th century this assumption has been proved to be incorrect based on the results of the catchment experiments. Nowadays, few forest hydrologists study on the effect of rain increase by forest, and rainfall (R) is regarded as an independent variable to explain the partitioning of rainwater. Nevertheless, the idea of rain increase by forest has not yet been denied. Canopy interception (CI) occupies some 20% of R, but you do not know where it goes after evaporation. CI can be a major source of rain above forest and can affect rainfall distribution on a continental-scale. It is expected that the hypotheses described in the next section would be a breakthrough of this issue. This study presents one of the hydrological approaches to prove this new concept.

2. Hypotheses and scenario of an R-CI interaction

First and foremost, the reason why an enormous quantity of water evaporates by CI has not yet been clarified. For instance, Hashino et al. (2005; Proceedings of Annual Conference Japan Society of Hydrology and Water Resources; In Japanese) observed evaporation rate of 13 mm hour^{-1} for rainfall intensity of 59 mm hour^{-1} with the total rainfall of 420.5 mm brought by a typhoon. Splash droplet evaporation (SDE) can explain a huge amount of evaporation during rainfall (Murakami, 2006; J. Hyrol.) but, the SDE hypothesis gives no information on how water vapor is removed, where it goes and the source of the latent heat. One of the promising solutions for this is evaporative force (EF) proposed by Makarieva and Gorshkov (MG 2007; HESS). This theory states buoyancy works for water vapor in the air since the molar weight of water is lighter than that of air. The more humid the air gets, the stronger buoyancy becomes. Accordingly, EF explains effective evaporation during a rain event under high relative humidity.

MG has proposed another important theory, the Biotic Pump Theory. They advocate that in a forested area water vapor is sucked into the inland from the coastal area due to EF under the condition of high evaporation by forest, and this keeps R constant through the coast to the inland a couple of thousands km away from the ocean.

Murakami (2009; Forest Canopies, NOVA Pub.) integrated the idea of SDE and the theory of EF to hypothecate that water vapor generated by CI is transported back up to cloud due to EF and at the same time the latent heat released in the cloud gets back down to forest canopy that makes up for latent heat of vaporization. This hypothesis can make both ends meet in terms of the water vapor and the latent heat during rainfall.

3. Direction of the studies

To estimate CI using meteorological data hydrologists utilize a conventional boundary-layer theory. However, obviously, it underestimates CI and do not elucidate high evaporation rate, e.g. $>$10 mm hour^{-1} (Murakami, 2007; J. Hyrol.) and you need to clarify the observational facts, i.e. an enormous amount of evaporation, whether the scenario in the previous section is correct or not. A simple experiment can reveal a part of the essences of this phenomenon. Some studies showed that agricultural crops have an equivalent amount of CI with forests, and it is needed to clarify the minimum height of the vegetation that CI begins to decrease with diminishing height. Other studies reported that LAI is insensitive to CI, but there exists the minimum LAI from which CI decrease. These approaches enable the parameterization of CI with respect to vegetation structures. Feeding back these hydrological approaches, though it is a plot scale, to the atmospheric sciences considering the hypotheses in the previous section, we might scale them up to the continental, and could prove the effect of rain increase by forest.

Keywords: canopy interception, evaporative force, Biotic Pump, rain increase

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AHW027-16 Room:202 Time:May 23 12:30-12:45

Future perspectives in hydrological and biogeochemical researches in terrestrial ecosystems

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Influence to the society due to climate change and human interaction to the natural resources often takes place through changes of hydrologic and biogeochemical cycles in terrestrial ecosystems. As such it is essential to understand the role of ecosystem in the environment homeostasis. This can be accomplished by mutli-scale observations of hydrologic and biogeochemical cycles in terrestrial ecosystems. This session aims at promotion of such studies by reviewing knowledge we have accumulated so far and by discussing directions, methodology and organization of such investigations in the coming decades.

Keywords: terrestrial ecosystems, hydrological cycle, biogeochemical cycle, long-term monitering

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-17 Room:202 Time:May 23 14:15-14:30

Role of ground observation networks for long-term and continental scale carbon budget estimations in East Asia

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Recent studies using flux measurement networks in Asia have shown that the year-to-year changes in annual net ecosystem CO2 exchanges are controlled by different key factors in different biomes. In humid temperate forests, the key factors are the temperature and solar radiation during the growing season, which vary year-to-year in response to the timing of the early summer rainy seasons. In tropical forests in Southeast Asia, the keys are the length and strength of the dry season, and the El Nino/Southern Oscillation (ENSO)-related dry weather and smoke from fires.

In order to improve future climate change predictions, more synthetic knowledge of how ecosystem functions on carbon and water cycles respond to large-scale meteorological phenomena, such as year-to-year changes in Asian monsoon circulations would be desirable. This is because ongoing global warming has the potential to increase the frequency and magnitude of many extreme climatic events, including floods, droughts, storms, and anomalous temperatures in the global scale as well as in the Asian monsoon region. Another reason is that any of the recent climate prediction models needs to incorporate the biological feedback of terrestrial ecosystems that may play important roles in the global carbon and water cycles. However, we still do not understand the magnitude of the feedback, and the models have enormous uncertainties in the estimation of that feedback.

Since there is a potential that the frequency of anomalous weather conditions increases in the future affecting productivity in the Asian forests, further studies are necessary to gain a more accurate understanding of the response of Asian ecosystems to the meteorological patterns. As a case study, responses of East Asian forest productivity to large-scale meteorological anomalous pattern will be presented and the role of ground observational network for detecting long-term and continental scale terrestrial ecosystem responses will be discussed. The results lead to an understanding of the spatial distribution of ecosystem responses to large-scale meteorological phenomena and serve as a verification dataset for the development of forest carbon monitoring, accounting and reporting system.

Keywords: carbon cycle, terrestrial ecosystem, ground observation, AsiaFlux

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-18 Room:202 Time:May 23 14:30-14:45

A long-term monitoring of the carbon uptake by Japanese forests via micrometeorological observation network

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1. Introduction

To curb global warming, the profound knowledge of carbon uptake and the carbon cycle processes in the terrestrial ecosystem are the most important and urgent issues. Therefore, it requires the extensive observation in the field and the improvement of the database about the carbon budget and its functions in forests from various types in different regions.

The global long-term monitoring network of the terrestrial ecosystems (FLUXNET) and its regional network among Asian nations (AsiaFlux), which was established in 2000 and has been organized mainly by the Japanese researchers, focus on the carbon budget to address this issue. This study reports results from forest carbon exchange under the forest tower flux observation network in Japan, FFPRI FluxNet.

2. Methods

Six observation towers, FFPRI FluxNet, are located at SAP (Deciduous forest in Sapporo, Hokkaido), API (Deciduous forest in Appi, Iwate), KWG (Deciduous forest in Kawagoe, Saitama), FJY (Coniferous forest in Fujiyoshida, Yamanashi), YMS (Mixed broadleaved forest in Yamashiro, Kyoto), and KHW (Coniferous forest in Kahoku, Kumamoto).

Flux and the micrometeorological elements such as wind velocity, air temperature, and carbon dioxide concentration above the canopy have been observed. The closed-type gas analyzer has been used for the eddy covariance technique. The data quality has been controlled among sites. The elements such as net ecosystem productivity (NEP), ecosystem respiration (RE), gross primary productivity (GPP), and the other related micrometeorological elements were compiled into the database which is available on our web site.

3. Results

The seasonal changes in NEP at SAP and API, which have cool and snow covered winter, showed constant CO_2 release in winter and large CO_2 uptake from May to August as the forest canopy closure. Meanwhile, the NEP in coniferous sites in FJY and KHW showed CO_2 absorption throughout the year, and drop from June to August as the high air temperature and the reduction of the solar radiation due to the rainy season.

The following two examples are the change in NEP associated with the natural forest disturbances. In 2004, SAP forest had hard hit by a typhoon. After this wind disturbance, the summer NEP dropped by 50%, while the winter NEP unchanged. In the annual bases, the estimated RE increased conspicuously, however the GPP decreased slightly despite of approximately 50% of trees around the tower were uprooted or stem-collapsed, eventually changed the forest completely as the carbon source. In August in 2007, API experienced severe insect damage by *Syntypistis punctatella* and the forest canopy lost their entire leaves. The NEP changed drastically from positive to negative after the damage, and the annual NEP decreased to 1/3 from the previous year, which attributed to reduction of GPP and steady RE. However, the decrease in NEP had recovered in the next year.

Among the different forest type and its climatic condition, the NEP observed in each sites ranged from 3 to 4.5 t[C]$ha^{-1}y^{-1}$ except YMS, which was located in the oligotrophic soil condition. Our results showed that the forest released 74 to 88% of the totally absorbed carbon (GPP) as RE and the remaining 12 to 26% of GPP was NEP.

Keywords: tower flux observation, NEP, Ecosystem respiration, GPP

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-19 Room:202 Time:May 23 14:45-15:00

A decade of studies at Mase paddy flux site: how long is long enough?

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It is the thirteenth year since the tower-flux measurement started at a rice paddy field in Mase, Tsukuba, Japan (Mase paddy flux site) in July 1999, and it is the tenth year since the organized system of long-term measurement got ready to work in 2002 after repeated trial and error at the beginning stage. Since lifetime of monitoring sites in agricultural fields in Asia is generally short as summarized by AsiaFlux (Mizoguchi et al., 2009), the decadal observation at the Mase site is probably longer than average. What is the significance of the long-term measurement in a rice paddy, where, unlike forest or grassland site, transplanting and harvesting are regularly repeated every year? This is the question always casted on us and also we ourselves are wondering to us. Sometimes the question has another form: how many years of observation is enough? The answer may depend on what we need, but I cannot find a good answer now. Here, I show some results on inter-annual variations of observed fluxes to discuss the issue.

At the Mase site, we are conducting the measurement placing the various instruments in a rice paddy, which was managed by the field owner who is a sideline farmer. We basically leave field management to the field owner. He cultivates Koshihikari, the most popular rice variety in Japan, and gets average crop yield in the prefecture. The coefficient of variation (CV) of crop yield in nine years from 2002 to 2010 was 7%, whereas the CV of the total solar radiation in the growing season was 9% and standard deviation of air temperature averaged over the growing season was 0.9 degree Centigrade. The CVs of the total net ecosystem CO2 exchange (NEE) and evapotranspiration were both 10%. The CV of gross primary production (GPP) estimated from observed NEE was 5%, but it was reduced to only 2% if we exclude GPP in the 2004 growing season, which had extraordinarily large GPP under conditions of high temperature and plenty of solar radiation. The small inter-seasonal variation in GPP reflects stable Japanese rice production, which is supported by excellent cultivation practices and moderate climate conditions. Since we cannot find long-term trends in the fluxes above, a period of ten years seems to be sufficient for understanding the current state of the fluxes. However, some fluxes showed obvious changes in last 10 years. For instance, methane emission decreased from the 2006 growing season. This is presumably caused by the change of rice straw management: until 2004, rice straw was plowed into soil after harvest, but in and after 2005, rice straw was partially burnt in the field before plowing. A probable scenario is that the burning of rice straw reduced soil organic matters which were used for methanogenesis in early stage of the next growing season. So we are now analyzing how the change in rice straw management affected CO2 efflux in the fallow season. Agricultural fields are strongly affected by human impacts through field management. Changes in field management as well as increase in temperature and CO2 concentration will affect CO2 flux and evapotranspiration. A 10-year period is not sufficient to detect those influences by field observation, but we may have another approach. We have recently decided to spend time to think about it by minimizing observation at the Mase site.

Keywords: flux, rice paddy, carbon dioxide, methane, evapotranspiration, AsiaFlux

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-20 Room:202 Time:May 23 15:00-15:15

Long-term measurements of atmospheric CO2 concentration and its isotopes at a cool-temperate deciduous forest in Japan

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For a better understanding of the global carbon cycle, worldwide systematic measurements of CO_2 concentration are being made. Its carbon and oxygen isotopic measurements that give us useful information about the relative contributions of the terrestrial biosphere and the ocean in the carbon cycle and those of the photosynthetic and respiratory CO_2 components in the biospheric flux, have also been made at some stations. However, systematic measurements at sites influenced strongly by terrestrial biospheric activities are still insufficient, especially in the monsoon Asian region. Therefore, we have been measuring atmospheric $CO_2$and its isotopic ratios at the Takayama site in a cool-temperate deciduous forest in central Japan since 1993 and 1994, respectively, together with the oxygen isotopic ratio in precipitation since 2002. In this paper, we will present secular trends and year-to-year variations of the concentration and the isotopic ratios obtained from the long-term measurements at the site, and discuss factors governing these variations.

Keywords: long-term measurement, CO2, stable isotope, forest ecosystem, carbon cycle

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-21 Room:202 Time:May 23 15:15-15:30

Water/Energy/CO2 exchanges on the twe larch forests in easten Siberia

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Evapotranspiration, energy flux and meteorological conditions has been measured in a larch forest near Yakutsk (YLF) at eastern Siberia from 1998 to understand the water-balance characteristics and its long term variation. Recently, environmental change such as increasing soil water and its influence on forest canopy was observed, and construction of a new insight to forest response is under way. On the other hand, observation at the other larch forest located at Elgeeii (ELF), in which some environment such as precipitation is different from YLF, was started to develop understanding in response of larch forest to environmental variability.

1. Water balance over 9 years

Annual evapotranspiration including interception loss was relatively steady at 169-220mm compared with the wide range in annual precipitation (111-347 mm) in YLF. This fact contradicts to world-wide (but not including permafrost region) observation result, in which the response of annual evapotranspiration to annual precipitation was remarkable at annual precipitation below 500 mm (Zhang et al. 2001).

A very large increase in the temperature and moisture content of the surface soil was observed since 2004, while there was no clear trend in meteorological condition such as air temperature and radiation. At the same time, the thawing depth of the permafrost has been rapidly deepening. The rapidly increase of soil water storage in 0-100cm depth, which cannot be explained only by precipitation, indicates input of melting water from the deeper layer.

2. Controlling factor on annual evapotranspiration

During the same period, the yearly evapotranspiration coefficient (the ratio of evapotranspiration to potential evaporation) ranged from 0.30 to 0.45, and this fact indicates that the interannual variation of evapotranspiration is controlled by regulation of the land surface rather than by atmospheric demand. Soil water content was the most important variable among the factors determining evapotranspiration coefficient at this time scale. Interannual variability of soil water content is found to be related to the summertime precipitation at previous year, which indicates that rain water precipitated during summer was stored in frozen soil till melting at the next summer.

3. Plant response to increasing soil water ? concept of elastic and plastic stress

Some forest around YLF has experienced withered dead of larch trees during 2007 and 2008. Following increase of the soil water since 2004 as mentioned above, evapotranspiration rates increased till 2006. They turned to drop in the summers of 2007 and 2008, although we found no significant change in atmospheric demand for evaporation and soil water content had maintained high values since 2005. During this period, no decrease of understorey evapotranspiration was observed. These tendencies imply that only the overstorey vegetation suffered severe damage due to the extremely high soil water content because, unlike the understorey, the overstorey cannot rapidly adapt to wet conditions. Based on these results, we will propose a conceptual model of ”elastic” and ”plastic” stresses for evaluating the tolerance and/or tipping point of vegetation to unexpected ambient conditions.

4. Regional characteristics in water and carbon cycle

A new flux station was constructed at Elgeeii (ELF) located at 300 km of southeast from Yakutsk in 2009. Although it was found no clear difference in meteorological condition and evapotranspiration at these two sites during the growing season (May to September), net absorption of carbon dioxide (net ecosystem exchange, NEE) was 1.8 times larger at ELF compared to YLF. Under high light condition, following increase of vapor pressure deficit, NEE at ELF increased while that at YLF was restrained. This result indicates possibility that dryness of the atmosphere does not necessarily restrain exchange process as reported in the several works of Siberian forest.

Keywords: water balance, energy balance, CO2 balance, plastic stress, elastic stress

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-22 Room:202 Time:May 23 15:30-15:45

Challenges for the long-term observation of land-atmosphere interactions

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The presentation introduce challenges of hydro-meteorological observations in Nepal/Himalayas and Tsukuba city to evaluate the land-atmosphere interactions within a sub-grid scale area with multiple components.

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Keywords: Mountain meteorology, local circulation, land-atmophsere interaction, precipitation system, energy budget, long-term observation

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-P01 Room:Convention Hall Time:May 23 16:15-18:45

The estimation for temporal and spatial fluctuations of litter moisture in three forested areas, Japan

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Mapped estimates of the risk of forest fire would benefit forest management, and could be used to decide restrictions on the public use of forest areas.

In this study, the litter moisture contents were predicted with the tank model and the degrees of hazards of forest fire hazard were estimated at each 8-9 forest stands in three forested areas, Tatsunokuchi-yama Okayama, Tatsuta-yama Kumamoto, and Tsukuba-san Ibaraki, in Japan. Model was adapted to 8-9 forest stands in each area.

Fuel moisture decreased with each speed for each forest stand among simulated days depending the solar radiation on the each forest floor. Litter moisture was less than 0.2g g-1 and fire risk is judged to be highest in almost forest stands on the day after long drought period. On the other hand, spatial variation of litter moisture was widest to be 0.19 - 0.80g g-1 on the day during the drying process. This means that litter drying speed and fire risk is different between forest stands. Thus, it is significant to construct the system to warn forest fires for each forest stand to manage the people’s activities in this public forested area for preventions of the forest fire.

The data of precipitation and net radiation in Tsukuba-san is provided by Dr. Shin’ichi Iida. We appreciate his work for this study.

Keywords: Tank model, Solar radiation on the forest floor

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-P02 Room:Convention Hall Time:May 23 16:15-18:45

Homeostasis of evapotranspiration measured during the succession from Japanese red pine to evergreen oak

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Introduction

The succession from Japanese red pine (*Pinus densiflora*) to evergreen broadleaved forest comprising mainly evergreen oak (*Quercus myrsinaefolia*) are widely observed (Yamashita and Hayashi, 1987). During the succession causing the change in forest structure, the change in evapotranspiration process would occur. Delzon and Loustau (2005) measured the transpiration and the evapotranspiration for several stands which have different ages, and reported that the transpiration decreased with the increase in age, but the evapotranspiration was not changed, "homeostasis of evapotranspiration". Similar homeostasis might occur during the succession. We measured the evapotranspiration at the beginning and the end of a 17-year period from 1985 to 2002 during which the forest changed from the pure red pine forest to the multi-layered forest of red pine and evergreen oak.

Method

We measured the evapotranspiration with energy-balance and eddy-covariance method in a secondary forest of Japanese red pine in the Terrestrial Environment Research Center, University of Tsukuba. The interception loss was calculated as the difference between the gross rainfall (P) and the sum of throughfall (TF) and stemflow (SF). Based on the sap flux density measurements, the transpiration from red pines (TR_P) and the transpiration from lower-layered evergreen trees (TR_L) were estimated in 2002. To estimate the depth of water uptake by root system, we measured soil water potentials by the tensionmeter nests around trees in 2004. We described the details of the forest structure in Iida et al. (2001 and 2003) and of the hydrological measurements in Iida et al. (2005, 2006 and 2008).

Results and Discussion

We show the annual values, for example ET, I, TR_P, TR_L and so on, as the proportion to P (%). Decline in the stand density of red pine caused decreases in TR_P from 28% in 1985 to 10% in 2002 and in I from 17% to 9%, while ET was 53 and 52% in 1985 and 2002, respectively: ET did not change and the homeostasis was found. The decreases in TR_P and I were counterbalanced by TR_L.

The throughfall (TF) did not change: the decrease in I was resulted from the significant increase in SF. More vertical branches and smoother bark of the lower canopy trees enhanced SF. Concentrated input of SF infiltrates around the tree base. Smaller SF of red pines suggested smaller available water for the uptake by the root system. We found that the lower soil water around the red pine after the rainfall events, and that the red pines uptake water from deeper soil in summer. These results corresponded with the report by Yamanaka et al. (2006).

These results indicated that lower-layered evergreen trees concentrated larger amount of water to their root systems to use for larger transpiration compared with red pines, and could imply that the evergreen trees had the advantage for the competition of soil water. However, the lower canopy trees had worse radiation condition which could adjust TRL and resulted in the counter-balancing effect on ET. The conditions of soil water and radiation will change with proceed of the succession: predicting the homeostatic control of ET by the ecosystem is very difficult. If the evergreen trees would have the closed canopy, the competition of water and radiation among the evergreen trees would be very severe and ET may not continue increasing. The future measurements must be need to predict that the ecosystem keep the homeostasis of ET in the climax or not.

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Keywords: succession, evapotranspiration, homeostasis, transpiration, water uptake by root system

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-P03 Room:Convention Hall Time:May 23 16:15-18:45

Runoff change in a catchment of decisuous forest without any treatment for sixty years

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In many hilly moutains in Japan (satoyama) that people collected firewood and muck for hundreds of years, vegetation has been grown up naturally without uses and treatments after the energy revolution around 1960. Its effects on rainfall-runoff responses is widely interested from a view-point of flood control and water resources management. Long-term observations in small catchments with such a vegetation process since early 20th Century can be analyzed for evaluating these effects.

This sdudy tried to assess a data set obtianed from a 60-year observation in Tatsunokuchi-yama Kitatani catchment(17.3 ha, Paleozoic formation) near Okayama City. The annual precipitation and air tempearture were 1236 mm and 13.5 degC.

The annual water balance showed an obvious change in the annual-unit water storage, and the annual evapotranspiration (ET) was controlled by annual air temperature. An intereting finding for ET was an additional increase to this tempearture effect in recent years after 1990.

Using monthly ET estimated from Hamon's Equation (Tani and Abe, Bul. FFPRI 1987) and the annual ET obtained above, a simulation of rainfall-runoff response for the 60 years in this catchment was attempted by a runoff model (HYCYMODEL)(Tani et al., Hydrological Processes in press). Although an additional analysis by a high-resolution data set is needed, our simulation using the daily-data set found no drastic change in the buffering effect of runoff. Revegetation work operated for a bare land in granite mountains can convert ground-surface flow into subsurface flow, providing an obvious buffering effect. However, we can suppose that the period of 60 years was too short for a development of soil producing an increase of the buffering effect.

Our previous study on storm runoff responses in this catchment (Tani., J. Hydrology 1997) demonstrated that the storm runoff volume approached the rainfall volume after the wettest condition for a large storm event of the total rainfall over 300 mm. A HYCYMODEL simulation using the hourly data for one of these large storm evants suggested that runoff buffering potential (Tani, J. Hydrology 2008) still remained valid for this condition.

We can summarize that forest cutting may be desirable for the water use under a dry condition compared to humid climate in Japan because the minimum annual precipitaion of 622 mm was recorded in 1939 and ET has increased in recent yeras after 1990. Nonetheless, a large-scale clear cutting should be avoided from a view point of soil conservation because of the runoff buffering potential mainteined during large storm events.

Keywords: Runoff response, Evapotranspiration, Deciduous forest, Long-term change, Water resource, Satoyama

Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AHW027-P04 Room:Convention Hall Time:May 23 16:15-18:45

Variation of basin retention and changes of vegetation - transit in Tatsunokuchi-yama

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Forest has effect to decreases total rainfall amount by canopy interception, and also has effect to delay water discharge by high infiltration rate of forest soil. By these effects, forest is regarded that reduces flood runoff. In a recent tendency to increase local heavy rainfall, it is thought that the forest's flood reducing function is getting more important. However, the function, it must be depending on forest condition, has not been clearly revealed. Accordingly, inter-annual changes of retention curves in Kita-tani (TK) and Minami-tani (TM) in the Tatsunokuchi-yama forested experimental watershed where runoff has been observed since 1937 were analyzed, and were compared with changes of forest conditions.

Retention curve is expressed as relationship between rainfall (P) and loss (L) which is difference between P and direct runoff in unit hydrograph. Approximation of P-L relationship in this study is; $L=S\{1-\exp(-KP)\}$. Since L=S when P is infinity, S is called maximum basin storage (Fujieda, 2007). But, since L is consisted of part of baseflow, basin storage change, and evapotranspiration, L is not necessarily stored in basin. Hence, S is called maximum retention amount in this study. Changing rate of L depending on P is represented by K; greater K gives more rapid increasing of L depending on increasing of P for same S.

For each flood event with peak daily runoff was greater equal 1 mm from 1937 through 2009, direct runoff was calculated by graphical method. L was obtained by subtraction of the direct runoff from P in the direct runoff period. To average fluctuation of inter-annual rainfall conditions, retention curves were regressed using P and L in every 5-year with yearly step. Correlation coefficients were greater than 0.8 except 2005-2009 in TK (0.7). Obtained regression constants S and K were recognized as 5-year moving average of retention curve. Furthermore, 5-year running median of S and K were calculated to clarify the inter-annual trends.

S ranged about from 50 to 400 mm. The time series patterns of S were different from the pattern of P, and TK has different variation pattern of S from TM. S became greater when forest was growing thickly. In contrast, S became smaller when pine wilt disease or forest fire occurred, and clearcut was conducted. Therefore increasing of S must be mainly derived from increasing of evapotranspiration. When S in TK and TM are compared, S in TM varied greater than S in TK. This difference might be not only derived from runoff characteristics based on individual topography and geology, but vegetation background; TK was covered with naturally regrown secondary forest since 1948, whereas coniferous trees were planted in TM.

K ranged about from 0.002 to 0.018, and showed antiphase of S. S-K relationships were not different between TK and TM, and were approximated to an exponential function. K rapidly decreases with increasing of S, and becomes almost constant when S is greater than 200 mm. Although K is small when forest is thickly growing, greater S gives greater increasing of L following increasing of P compared with condition which is greater K and smaller S.

Overall, it was recognized that S increased along with growing of forest. Thus, it is clear that thickly growing of forest controls flood runoff. However, S especially became greater when pine trees grew all over the watershed. In comparison, effects of regrown secondary forest and partly planting of conifer were gently appeared on variation of S. It is concluded that effect of forest growing on S is different by forest type. While change to mixed forest is promoting from a view point of biological diversity, when conservation of urban area is considered in a recent tendency to increase local heavy rainfall, it is suggested that appropriate arrangement of conifer in suburb forest can be one of effective flood measures.

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Keywords: retention curve, forest condition, long-term variation, Tatsunokuchi-yama forested experimental watershed, flood mitigation