AHW07-P01 　　　　会場:3 階ポスター会場 　　　　時間:4 月 29 日 18:15-19:30

関東地方のスギ壮齢林における樹液流速測定法による蒸散量の評価
Evaluation of transpiration in a mature stand of Japanese cedar in Kanto region, Japan

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Forests cover about 70% of land area of Japan, and Japanese cedar (*Cryptomeria japonica*) occupies about 20% of total forested area. To understand the hydrologic cycle in Japan, we need measurements conducted in forested area, especially for the most representative species of Japanese cedar. Recently, the water balance of a stand of Japanese cedar has been made clear quantitatively by using eddy-covariance method and sap flow technique in Kyushu Island, south-western part of Japan (Kumagai et al., 2014; Shimizu et al., submitted). However, although Japanese cedar is most representative species in Japan, very few studies have been carried out in other part of the country. Based on the sap flow technique, we started to evaluate the amount of transpiration of a stand of Japanese cedar located in Kanto region, in the central part of Japan. In this paper, we show the relationship between outermost sap flow (Q_{0-20}) and single-tree transpiration (Q), tree-size parameter affecting Q, and correlation between stand transpiration (TR) and meteorological factors.

We conducted measurements in a mature stand of Japanese cedar, whose age is 61, within Tsukuba Experimental Watershed located in southern part of Mt. Tsukuba, Japan. Tree density is 1115 trees/ha, and annual mean leaf area index measured with LAI-2000 (LI-COR, USA) is 3.6. We set an observation plot in a Japanese cedar stand, and measured sap flux densities for all trees of the plot, 13 trees, with Granier method (Granier, 1985). Based on the wood core sampling with an increment borer, we determined the width of sapwood for 13 trees. Japanese cedar has white zone, in which water movement stops, in the sapwood area. We injected acid fuchsin into stem, and distinguished colored area as sapwood. The length of Granier sensor was 20 mm: in case that the width of sapwood was more than 20 mm, additional sensors were inserted into the sapwood at the depths from 20 to 40 mm and 40 to 60 mm. The sap flow at each depth is calculated as the product between the sapwood area corresponding to the depth and measured sap flux density. Q is finally obtained as total sum of sap flow of all depths. We calculated TR as the sum of Q of 13 trees divided by the area of the plot. On the meteorological tower, air temperature, humidity and net radiation were measured. Analyses are performed in the period from August to November, 2013.

The value of $Q/(Q_{0-20})$ had positive linear relationship with canopy projection area unshaded by other trees (CPA_{TH}). This trend implied that the contribution of Q_{0-20} to Q is small for trees having good light condition. Q had positive linear correlation with diameter at breast height (R^2=0.62), however, the higher correlation (R^2=0.70) was found between Q and CPA_{TH}. In this stand, CPA_{TH} is probably important factor affecting distribution of sap flow within the stem and tree-to-tree difference in Q. On the other hand, through the analysis period, TR had high positive correlation with equilibrium evaporation (R^2=0.83), but had lower correlation (R^2=0.39) with vapor pressure deficit (D). Focused on the summer period from August to September, we found higher correlation between TR and D (R^2=0.74). Thus, in summer, the driving energy of transpiration is mainly D due to the large aerodynamic conductance at the stand. However, the correlation between TR and D became small in the autumn. This stand is located in the north-facing slope, and has very high contrast in meteorological condition between summer and autumn. The different relationship between TR and D probably implies that plant physiological response of Japanese cedar in summer is different from that in autumn.

Cited paper
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Kumagai et al. 2014. J. Hydrol. 508: 66-76.
Shimizu et al. Submitted for publication.

キーワード: スギ, 樹液流, 蒸散, 樹体サイズパラメータ, 飽差
Keywords: Japanese cedar, sap flow, transpiration, tree-size parameter, vapor pressure deficit

AHW07-P02　　　　　　会場:3 階ポスター会場　　　　　　時間:4 月 29 日 18:15-19:30

SURFACE RUNOFF ESTIMATION BASED ON TOTAL RAINFALL-TOTAL LOSS RAINFALL RELATIONSHIP FOR CATCHMENTS IN ISHIKARI RIVER

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One of the main objectives of research in hydrology is to improve the accuracy of surface runoff estimation for enhancing flood prediction. Rain water falling to the ground surface will infiltrate into the soil and the excess rainfall will be surface runoff. The infiltrated water is defined as loss rainfall and loss rainfall is subtracted from total rainfall (actual rainfall intensity) to obtain the surface runoff (excess rainfall intensity). The non-linearity of surface runoff phenomena in the mountainous basins based on universal lumped kinematic wave model has been studied. Current study about total rainfall-total loss rainfall relationship by using tanh fitting curve has been conducted for 65 catchments located in 27 prefectures in Japan. Hourly rainfall and hourly runoff observation data for 10 years during summer time is used as required input data. Runoff parameters in the tanh function represented by *a* and *b* parameters are utilized to estimate effective rainfall based on water holding capacity theory. The purpose of this study is to estimate surface runoff by using effective rainfall for semi-ungauged river basins at the upper catchments area in Ishikari River Basin, Hokkaido Island, Japan. The obtained results are compared to the observation data for validation purpose.

キーワード: Surface Runoff, Flood Prediction, Total Rainfall-Total Loss Rainfall, Water Holding Capacity Theory
Keywords: Surface Runoff, Flood Prediction, Total Rainfall-Total Loss Rainfall, Water Holding Capacity Theory

Integrate simulated annealing algorithm and WASH123D to develop an automatic identification system for Chuoshui River in
Integrate simulated annealing algorithm and WASH123D to develop an automatic identification system for Chuoshui River in

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Taiwan is located in the subtropical areas and often suffers from typhoons and heavy rains. In order to reduce the threat caused by typhoon, it is necessary to accurately estimate the water level of a river for flood disaster prevention and mitigation. Hydraulic analysis of a river is important in river management planning and engineering design. The identification of hydraulic parameter has huge impact on the water level estimation of a river during the hydraulic analysis. Manning＇s roughness coefficient is usually used to describe a river＇s surface roughness and sinuosity in hydraulic modeling. This coefficient is usually determined empirically in the past, which is tedious and time-consuming. Therefore, the optimization algorithms become an effective tool for engineers to select the Manning＇s roughness coefficient.

The concept of simulated annealing algorithm (SA) is based on an analogy to crystallization process of the physical annealing from a high temperature state. Since SA has the Metropolis mechanism to escape local optimum trap, it has been applied to various types of optimization problems. In addition, the hydraulic model plays a crucial role for flood simulation and the WASH123D, an integrated multi-media, multi-processes and physics-based computational model suitable for various spatial-temporal scale, is selected in this study to simulate the water level. The purpose of this study is to integrate SA and WASH123D to develop a system for automatically identifying the optimal Manning＇s roughness coefficients of the reach according to the given upstream and downstream boundary conditions of the river. Firstly, the cross sections and related hydrological data of the river are collected for flood hydrograph simulation in WASH123D and make sure the model can be executed for the reasonable range of the Manning＇s roughness coefficient. Then, the system incorporates SA with WASH123D to identify the optimal Manning＇s roughness coefficient according to the objective function for minimizing the difference between observed and simulated water level. The system is applied to the Chuoshui River in Taiwan. Flood in two typhoon events is simulated and the flood hydrograph is analyzed in this study to find the optimal Manning＇s roughness coefficient. Results demonstrate that the system proposed in this study has feasibility to automatically identify the Manning＇s coefficient.

キーワード: Simulated annealing algorithm, WASH123D, Manning's roughness coefficient, Automatic identification system
Keywords: Simulated annealing algorithm, WASH123D, Manning's roughness coefficient, Automatic identification system

Groundwater levels and qualities in megacities of Korea
Groundwater levels and qualities in megacities of Korea

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This study was conducted to evaluate the groundwater levels and groundwater qualities in six metropolitan cities (Seoul, Busan, Daegu, Incheon, Daejeon and Ulsan) of Korea. For this purpose, we collected the groundwater level data of 2001-2011 from the Korean National Groundwater Monitoring Stations in the cities and semi-annual groundwater quality data analyzed by the Korean Ministry of Environment for the same period. Using these collected data, we analyzed the change in the water levels in and outskirt of the cities and in groundwater qualities in the cities. The groundwater levels in the outskirt were generally higher (0.84-15.66 m bgs), compared with those in the central part of the city (3.89-75.16 m bgs), and well responded with the seasonal rainfall (higher in the summer but lower in the winter). However, the groundwater levels in the central part of the city were largely affected by pavement, deep underground building such as subway, and artificial pumping, not by the seasonal effect. The six metropolitan cities showed ranges of 0-507 mg/L and 0-22,000 mg/L for NO_3-N and coliform, respectively. In addition, groundwater contamination with TCE (0.00-4.50 mg/L), PCE (0.00-0.48 mg/L) and 1.1.1 TCA (0.00-0.11 mg/L) was also found. The groundwater contamination with these contaminants was relatively severe especially in Seoul and Busan, which may be attributed to their high densities of populations and industrial facilities. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2011-0007232).

キーワード: groundwater levels, qualities, metropolitan cities, contaminants, Korea
Keywords: groundwater levels, qualities, metropolitan cities, contaminants, Korea

Variation in groundwater-stream water interaction with season: focus on water level, temperature and chemistry
Variation in groundwater-stream water interaction with season: focus on water level, temperature and chemistry

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This study was conducted to reveal seasonal variations of the groundwater and stream water interaction in Gangwon province of Korea using analyses of measured water levels, water temperature and water chemistry from August to November of 2013. For measuring the water levels in the hyporheic zone, four piezometers (IYGW-1~4) were installed at depths of 0.830~1.565 m below stream bed, perpendicular to stream flow direction and the stream level was also measured at IYSW-1. The water level and water temperature were measured every hour using an automatic logger (DIVER). In addition, nearby groundwater, hyporheic water and stream water were collected for ion and stable isotope analyses in the wet (September) and dry seasons (November) along with field measurements of pH, EC, DO and ORP. The water levels of the piezometers generally increased with rainfall, and they were lower than the stream water level in September, indicating a losing stream, but the former was higher than the latter in November, indicating a gaining stream. The reversal of the heads occurred at October 10. The stream water temperature (IYSW-1), directly affected by the surrounding air, was between 0.9~22.9 ℃ with a large fluctuation. However, the hyporheic water (IYGW-4; 1.565 m depth) showed a small range of 13.2~17.8 ℃. The water temperature at IYGW-4 was lower than those of the other piezometers but the reversal of the water temperatures also occurred at October, like the water levels. The groundwater, hyporheic water and stream waters were all classified as Ca-HCO$_3$ type by Piper diagram, which is indicative of effect of ambient air. The EC of IYGW-4 was the highest (136.7 μS/cm), indicating relatively higher influence of the groundwater. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2011-0007232).

キーワード: hyporheic zone, interaction, groundwater, piezometer, Korea
Keywords: hyporheic zone, interaction, groundwater, piezometer, Korea

Change of groundwater condition by operation of geothermal heat pump
Change of groundwater condition by operation of geothermal heat pump

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This study was conducted to evaluate the influence of open loop geothermal cooling and heating system (OLGCHS) and closed loop geothermal cooling and heating system (CLGCHS) on temperature and water level of local groundwater. For this study, groundwater temperature and level were measured daily using level logger at two sites where OLGCHS and CLGCHS are installed for approximately 30 months. In OLGCHS, fluctuation of groundwater temperature was similar to seasonal variation of ambient air temperature. However, this is not attributed to influence of air temperature. The groundwater temperature was fluctuated according the load of OLGCHS. The groundwater temperature was largely changed by operation of OLGCHS in summer compared to those in winter. These results represent that load of OLGCHS in summer is larger than that in winter. The groundwater levels were mainly controlled by precipitation and were slightly influenced by operation of OLGCHS. In CLGCHS, the groundwater temperature and level did not affected by operation of CLGCHS. The groundwater temperature was changed with 3^oC. The groundwater level was mainly influenced by precipitation because groundwater is not used directly in CLGCHS. In addition, response of groundwater level for precipitation was slower than those at OLGCHS because of difference of hydraulic conductivity. These results show that groundwater temperature and level did not significantly changed by OLGCHS and CLGCHS. However, it is necessary that long-term monitoring of groundwater temperature and level at sites, where OLGCHS and CLGCHS are installed, because OLGCHS and CLGCHS can affect the hydrological properties of aquifer with scale and type of use of geothermal energy. This work is supported by the Energy Efficiency and Resources of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy (No.20123040110010) and by the Korean Ministry of Environment under "The GAIA project (No. 171-101-011)".

キーワード: open loop geothermal cooling and heating system, closed loop geothermal cooling and heating system, time series analysis, groundwater level, groundwater temperature, Korea
Keywords: open loop geothermal cooling and heating system, closed loop geothermal cooling and heating system, time series analysis, groundwater level, groundwater temperature, Korea

Impact of ground source heat pumps operation on groundwater condition

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This study was conducted to summarize status of installation of open loop geothermal cooling and heating system (OLGCHS) and to evaluate impact caused by its operation on groundwater condition. In this study, six facilities where OLGCHS is installed were considered. Groundwater is directly used in OLGCHS. The facilities considered in this study have been operated over two years. Groundwater temperature ranged from 6.0 to 24.2oC. Water temperature of natural groundwater and groundwater used to operating of OLGCHS showed difference of 5 to 9oC. pH and EC ranged from 7.5 to 9.1 and from 138 to 465 uS/cm, respectively. pH and EC of natural groundwater and groundwater used to operating of OLGCHS did not show significant difference. All groundwater meet Korean standard of water quality for domestic purpose In addition, saturation indexes of most major dissolved components except H_4SiO_4 showed lower than 1. These results represent undersaturated condition and that there are no minerals which can be precipitated from groundwater used in OLGCHS. Consequently, impact of ground source heat pumps operation on groundwater condition do not observed. However, these monitoring have been conducted continuously because contamination by ground source heat pumps operation can occur in any time. This work is supported by the Energy Efficiency and Resources of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy (No.20123040110010).

キーワード: Heat pump, groundwater, ground source
Keywords: Heat pump, groundwater, ground source

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源流域における降雨イベント規模に応じた河川流出機構の変化
Change of the stream discharge process affected by the rainstorm magnitude in the small headwater catchment

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　地球温暖化に起因して降水量や降雨強度などの降雨イベント特性が増加しているため、世界中の地域で洪水や地滑りなどの災害が多く発生している。この変化は、水資源の在りかたを変えるかもしれない。本研究では地下水流出の割合と降雨規模の関係を理解するために、熊本県阿蘇山西麓台地に隣接する森林流域と牧草流域において 2012 年 7 月から 2013 年 11 月までのあいだの降雨イベントを対象に EC を用いてハイドログラフの二成分分離を実施した。河川水の EC は、EC ロガーを用いて各パーシャルフリュームにおいて 10 分間隔で記録した。これらの観測データと先行研究 (Onda et al.,2006; 一柳・加藤,1998; Ichiyanagi et al.,1994; Iwagami et al.,2010; 大類ほか,1992; 勝山ほか,2000; Katsuyama et al.,2001) から、河川流出量・地下水流出の割合・降雨規模の関係についてまとめて検討を試みた。
　総降水量が 9 mm から 727 mm で、ピーク雨量が 5 mm/h から 94 mm/h までの様々な規模の 18 回の降雨イベントを観測した結果、従来の観測研究において報告されている範囲の降雨規模では、地下水流出割合が降雨規模の増加に伴う減少傾向が認められ、従来の結果と一致していた。この場合、降雨の増加に伴う河川流出量は降雨起源の”新しい水”の増加によるものと考えられる。一方本研究では、従来の研究では観測されていない大降雨時の観測値が加わっており、総降水量が 200 mm でピーク時の雨量が 20 mm/h 以上の場合、地下水流出割合の増加してくる傾向が観測された。この規模の大降雨の場合、河川流出量の増大は地下水起源の”古い水”が押し出されて増加しているもの考えられた。本研究の観測結果から、降雨の規模が河川流出機構の形成に影響を与えていると考えられ、降雨規模に応じた二段階の分類を試みた。第一段階では、降雨開始前の河川流出の大部分は”古い水”によって形成されているが、降雨規模の増大に伴い河川水を占める”古い水”成分が徐々に減少し、総降水量が 200 mm 付近のイベントになると、河川水の大部分は降水成分を主体とする”新しい水”によって支配される。その後、総降水量が 200 mm を超えるような大降雨の場合には、これまでの傾向と逆に河川流出量の増加に伴い河川水中に占める地下水を主体とした”古い水”成分が増加する (第二段階)。

キーワード: 2 成分分離, 河川流出機構, 降雨規模, 地下水流出
Keywords: Two component hydrograph separation, Stream discharge process, Rainstorm magnitude, Groundwater discharge

AHW07-P09　　　　　会場:3 階ポスター会場　　　　　時間:4 月 29 日 18:15-19:30

水文学における変化・発達の視点に関する総合討論
General discussion on insight into change and evolution in hydrology

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　洪水・渇水、水質変動などの水・物質循環の変動は、より時間的に長いスケール流域条件や気候変動の変化・発達の影響を受けている。そのため、これらの変動を地形・土壌・植生などに関する「現在」の条件だけから予測することには限界があり、「変化・発達」を考えることが水文学の今後の展開において重要である。こうした概念は、IAHS では PUB(Predictions in 　ungauged basins) に引き続く次の 10 年計画である Panta Rhei（万物は流転する）でも指摘され、広範な討議が要請されている。
　　また、われわれは、2011-15 年度の科研費を得て、植生成長、土壌層発達、地形発達の時間入れ子構造の流出影響について、独自に研究を行ってきている。
　　そこで、本セッションでは、これらの自然変化に、人為攪乱・管理などの人間影響をも加え、各変化とその相互作用が水・物質循環に及ぼす影響に関する発表をもとに、今後の研究方向を討議したい。

キーワード: 総合討論
Keywords: general discussion