Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AGE04-01 Room:101A Time:May 20 09:00-09:15

Development of a tensiometer-TDR coil probe for the measurement of soil-water retention curves on water-repellent soils

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Soil- water repellency accounts for influencing many of the key soil hydrological processes such as reduced infiltration, preferential flow and surface water flow. Water repellency- induced fingered flow can lead to considerable variations in water content in an initially water repellent soil. The precise and continuous measurement of hydraulic properties of water repellent soils is important for understanding soil-water interaction. Moreover, there is a need for small-scale, non destructive measurement techniques to obtain direct, high resolution measurement of soil-water content and water potential. To study the soil-water retention properties for hydrophobized sands and natural volcanic ash soil during repeated wetting and drying processes, a mini tensiometer-time domain reflectometry (T-TDR) coil probe was developed with dimensions of 6-mm diameter and 30-mm length. Seven mini T-TDR coil probes were developed and the performances were tested against Toyoura sand, hydrophobized sands and volcanic ash soil. Due to the poor performance of dielectric mixing models, a simple two-point calibration equation was proposed. The new mini T-TDR coil probe also provided reliable, simultaneous measurements of volumetric water content and soil-water potential (h) measurements when investigating the soil-water retention characteristics of hydrophobized sands and natural volcanic ash soils under repeated wetting and drying cycles.

Keywords: Mini T-TDR coil probe, soil-water retension, water repellency

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Parameter Estimation of Hysteretic Soil Hydraulic Functions of an Andisol using the Multistep Outflow-inflow Experiments

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Japanese volcanic ash soils, Andisols, have unique physical properties. For example, the water retention curve of an Andisol generally has a dual-porosity shape resulting from separate macropore (inter-aggregate) and micropore (intra-aggregate) contributions, and a very high saturated water content (often as high as 0.85 cm^3/cm^3) because of the inherent nature of soil aggregation in these soils. Since capillary retention is dominant in inter-aggregate pores, hysteresis in water retention curves may occur between drying and wetting processes. This study presents inverse estimation of hysteretic soil hydraulic functions of Andisol using the multistep outflow-inflow experiments.

An Andisol from an upland field at the National Institute of Vegetable and Tea Science in Mie, Japan was passed through 2 mm sieve. The soil was packed with a bulk density of 0.75 g/cm3 in .a 5-cm-long, 5-cm-diameter acrylic column having a porous plate at the bottom. The bottom boundary pressure ranging from 0 to -85 cm was controlled for drainage and wetting from the bottom. A tensiometer was installed horizontally at 2.5 cm depth. Cumulative water outflow-inflow was monitored based on the weight of the soil column.

Soil hydraulic functions described with a bimodal van Genuchten (VG) introduced by Durner (1994) were separately estimated for drainage and wetting. We assumed hysteresis only appears in the first part of the VG function. When ?1 values for the first VG are different between drying ($alpha_1{}^d$) and wetting ($alpha_1{}^w$), however, hysteretic unsaturated hydraulic conductivity in terms of water contents appears in lower water contents. Hence we defined an independent $alpha_1{}^k$ for the unified unsaturated conductivity in terms of water contents. Initial values for the bimodal VG were determined based on the observed water retention curve. Parameters alpha1, n1, w2, Ks and l were optimized for the objective functions of pressure readings, cumulative water flux at the bottom, and the average water contents of the soil column using HYDRUS1D. The modified hydraulic conductivity of bimodal VG was found to successfully describe hysteretic soil water retention and unsaturated hydraulic conductivity in term of pressure head, whereas the estimated unsaturated hydraulic conductivity is non-hysteric in terms of water content.

Keywords: Andisol, Hysterisis, Water retention curve, Unsaturated hydraulic conductivity, Inverse analysis

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AGE04-03 Room:101A Time:May 20 09:30-09:45

Occurrence of soil water repellency and implications for the filtering function of soils

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There is increasing global concern about soil water repellency (SWR) as a soil degradation process. SWR is a transient property expressed in patchy wetting-up behaviour of soils once they dry out below a soil-specific critical water content. It might pose a threat to the delivery of soil ecosystem services in particular to the regulating services in relation to water and carbon, and food provisioning. The understanding of the economic, ecological and environmental consequences of SWR is still limited. Moreover, we are unable to predict when and where SWR will occur, or when it might disappear.

To improve our knowledge on the extent of SWR in the North Island of New Zealand, we conducted a survey on the occurrence of SWR under pastoral land use. We sampled the top 4 cm of soils across 50 sites from ten soil orders and five drought-proneness classes in the summer 2009/10. We found that 98% of the sites will become hydrophobic when they dry out, and that 70% of the sites were hydrophobic at the time of sampling. The survey revealed that the phenomenon of SWR is prevalent throughout all regions and it is independent of climate but it is influenced by soil order. The degree of SWR and its persistence for air-dried samples were positively correlated with the soils carbon and nitrogen contents, and negatively with bulk density. The persistence of SWR for field-fresh samples was additionally negatively correlated with the soil water content.

To improve our understanding of the environmental consequences of SWR, we conducted field and laboratory experiments with water-repellent soils from New Zealand. We focused on the local scale runoff, infiltration and leaching processes. Theoretically, in a hydrophilic dry soil, water infiltrates across the entire cross section of the soil surface. While in soils suffering from SWR, water infiltrates only across a fraction of the soil surface in the form of fingers, or it runs off. Measuring water and ethanol infiltration with tension disc-infiltrometers in the field, we found that SWR indeed reduced water infiltration by up to a factor of 20. Solute transport experiments through intact soil columns in the laboratory revealed that the soils buffering and filtering services were compromised by soil-water repellency. Enhanced preferential flow was found in the hydrophobic soils with elevated levels of soil organic matter. To quantify directly the impact of SWR on runoff, we developed a laboratory-scale runoff measurement apparatus. We compared the runoff resulting from the run-on of water with that resulting from an ethanol solution. The experiments with the ethanol solution can be taken as a proxy measure of the wetting-up behaviour of hydrophilic soils. No runoff occurred in the experiments with ethanol from any of the soils. We observed that runoff of water did not occur evenly across the entire soil slab, but was concentrated in channels, and covered only a fraction of the soil surface. Consequently, even a soil with an extremely high persistence of SWR resulting in almost the entire run-on water running off the soil slab, lost only a relatively small fraction of the solutes applied evenly to the soil surface, in runoff. We hypothesize that the channel-like pattern of runoff is typical for hydrophobic soils, and that the potential for nutrient loss in runoff from hydrophobic soils is limited.

Our research demonstrated that the filtering and buffering functions of water-repellent soils were compromised at the local scale. Integrating these local phenomena up to a larger scale of a catchment is not straightforward. We are unable to predict the larger-scale impact of water-repellent soils on catchment hydrology, and nor could we predict the impact on the regulating and provisioning ecosystem services that soils provide. More research is needed to understand better the causes and occurrence of SWR, and the larger-scale environmental, ecological and economic impacts of SWR.

Keywords: soil water repellency, infiltration, preferential flow, runoff, pesticide transport, soil organic carbon

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AGE04-04 Room:101A Time:May 20 09:45-10:00

Mass and Heat Transport Characteristics in Differently-Decomposed Peaty Soils at Variably-Saturated Conditions

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Peaty soils in wetlands are known as one of the major sources and sinks of global C and it is escaped as greenhouse gases to the atmosphere (e.g., Alm et al., 1999; Pilegaard et al., 2003). Knowledge of mass and heat transport characteristics in differently-decomposed and variably textured peaty soils at different moisture contents is important for simulating the emissions of the greenhouse gases, especially methane, from the wetlands (e.g., Alm et al., 1999; Pilegaard et al., 2003). Unique physical Characteristics of peaty soils such as high organic matter content, high total porosity and volume shrinkage may influence various transport properties of peaty soils. In this study, the analogies and differences between the soil transport parameters were investigated for differently-textured and variably-saturated soils and unified models were developed based on modified Archie s laws.

The study site was Bibai marsh, Hokkaido in Japan. Undisturbed peat samples were taken from three different sites in Bibai marsh at different depths using 100cm3 cylindrical cores. Peat 1 samples were sampled inside the marsh area, while Peat 2 samples were sampled from the area nearby a drainage ditch surrounding the marsh. Peat 3 samples were obtained from forested area located outside the wetland. Fiber contents showed that Peat 3 samples were the most decomposed followed by Peat 2 and Peat 1 samples. The peat samples were initially saturated and subsequently drained using two different methods corresponding to the matric suction ranges. The thermal conductivity (TC), gas diffusivity (Dp), air permeability (Ka) and unsaturated hydraulic conductivity (Kunsat) were measured at different soil moisture suction levels.

A percolation threshold was introduced for each heat and mass transport parameter and the normalized TC, Dp, Ka and Kunsat as a function of normalized fluid content suggested a strong analogy between these parameters. This analogy was well represented by an excluded volume expansion of Archie s second law. It showed a clear two-region behavior suggesting the applicability of the new two-region model concept for bimodal porous materials. However, each parameter showed its own characteristic behavior with different fluid contents. Model curves for the each transport parameter by using Archie s law with reference point (EXAR) were fitted well to the measured data for all transport parameters for both pore regions. And the consistent parameter values of the Archie saturation exponents (n) in two regions were obtained for three peaty soils. Thus, the EXAR models seem useful for describing the two-region behaviors of heat and mass transport parameters for peaty soils. In perspective further studies will be conducted to obtain all four parameters across same soil moisture conditions.

Keywords: Mass and heat transport, Peaty soil, Differently decomposed, Differently saturated

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AGE04-05 Room:101A Time:May 20 10:00-10:15

Modeling of fate and transport of rice pesticide in river basin a case study for the Chikugo River basin

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Pesticide runoff from paddy field is one of the major causes on non-point source pollution in aquatic environment. It may induce the adverse effects on the aquatic life via pesticide exposure. Various monitoring studies have reported that rice pesticides were detected at public water area during rice cultivation season so far. Meanwhile, verification of monitoring results using a mathematical model based on the field data have hardly conducted. Therefore, this study aims to develop a mathematical model to assess the pesticide exposure in paddy watershed.

An integrated model, named the PCPW model, was developed in this study. The model consists of three sections; river section, paddy block section, and non-paddy section. In the river section, while solving Saint-Venant equations were solved numerically with the Preissmann implicit scheme for unsteady flow simulation, one-dimensional advection dispersion equation was solved with the modified finite element method to predict pesticide concentrations. In the paddy block section, a compartment model, named PCPF-B model, was used to simulate water balance and pesticide fate and transport in multiple paddy plots simultaneously. As for the non-paddy section, rainfall-runoff processes for city, upland and forest were estimated using a modified tank model. Numerical solutions of the PCPW model were coded with Visual Basic for Applications in Microsoft ExcelR.

The PCPW model was verified by comparing simulated results with rice herbicides concentrations collected in Kose river basin located Fukuoka Prefecture, Japan. Hydrologic and soil data in Kose River basin were imported from Geographical Information System (GIS). The target basin was divided into sub-basin. The extracted numerical data such as elevation, area of individual land uses and physicochemical properties of paddy soil were assigned as the input parameters of each sub-basin. The observed data of discharge at reservoir and estimated values from the tank model for forest were imposed as the upstream boundary condition for unsteady flow simulation. Information regarding applied herbicide, such as application date and usage ratio, physicochemical properties, and recommended water management were prepared from literatures. The two rice herbicides, pretalachlor and mefenacet were selected as the target compounds. Simulation was conducted from June to July in 2009. Simulated herbicide concentrations at up-, mid- and downstream of Kose River were evaluated with observed concentrations.

Results showed that river flow rates were predicted satisfactory. The simulated herbicide breakthrough curves show two distinct shapes; broad and sharp ones. Judging from rainfall data and applied water management scenario, it was considered that the former was due to water management and the latter was due to intensive rainfall events. Aforementioned results indicated that the PCPW model was potentially applicable for advanced assessment tool of pesticide exposure in river basin.

Keywords: rice herbicide, simulation model, river basin, GIS

Japan Geoscience Union Meeting 2012
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AGE04-06 Room:101A Time:May 20 10:45-11:00

Behaviors of carbon dioxide in soils as affected by tillage systems

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Agricultural practices have the potential to store or emit greenhouse gas which is a crucial part of sustainable development. Therefore the study of carbon sequestration especially the behaviors of carbon dioxide in soils under different agricultural practices are so significant. Considered about tillage is one of the most important agricultural managements and some contradictions also existed in recent literatures, this research aimed at the effects of tillage management on carbon dioxide behaviors (CO_2 flux, concentration) and carbon store in soil. We sampled the undisturbed soil columns from the field and incubated in greenhouse that the temperature and water content were controlled. The results indicated that: The cumulated CO_2 flux of tillage soil was 377.8g m^{-2} that was greater than no tillage soil (332.3 g m^{-2}) during the whole incubation period. But the significant higher CO_2 concentrations in no tillage soil profile were measured compared with the tillage soil especially in the 7.5cm, 12.5cm, 20cm and 30cm depth. The result did not coincide with the general situation that high concentration may reflect the high production of CO_2. Also soil environment such as temperature, water content and structure were different under two tillage systems. In general CO_2 behaviors and carbon cycling in soil were affected by tillage systems and the mechanism of the impacts on CO_2 production and transfer will be detailed analyzed in the presentation.

Keywords: Tillage systems, CO_2 flux, CO_2 concentrations, Soil carbon, Incubation experiment

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AGE04-07 Room:101A Time:May 20 11:00-11:15

Characterization of Solid waste material from industrial landfill in Japan

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Abstract

Knowledge of geotechnical properties of solid waste properties and their dependencies on the age (i.e., degradation of organic matter) and composition of solid waste material is important for optimizing design of engineering landfill and assessing its long-term performance. In this study, geotechnical properties of solid material with different size fractions taken from an industrial waste landfill in Japan were measured. Laboratory tests were performed to determine the index properties of water content, grain size distribution and composition, total organic content, C/N ratio, specific gravity, Atterberg limits, pH and EC values, and geotechnical properties of compaction, compressibility and shear strength parameters. Field moisture content of solid waste was around 48% and liquid limit and plastic limits were 65% and 42%, respectively. The specific gravities of solid waste material were 2.72 and 2.62 for the finer fraction (grain size less than 2mm) and coarser fraction (grain size lesser than 10mm) respectively. The C/N ratio of waste was around 56 for finer fractions. In addition, ignition losses were about 18.2% and 17.2% for finer fraction and coarser fraction, respectively. Higher C/N ratio and ignition loss value might suggest that the solid waste at finer fraction contains higher amount of less-decomposable organic matters. The pH value of landfill material is about 8.8 and EC value is about 2.8mS/cm, then both values prove that waste material is alkaline. Based on the measurement of the geotechnical properties for solid waste material with different size fraction, the relation between index and geotechnical properties will be investigated.

KEYWORDS: solid waste, landfill, index properties, geotechnical properties, degradation

Japan Geoscience Union Meeting 2012
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AGE04-08 Room:101A Time:May 20 11:15-11:30

Kinetics of Biological Methane Oxidation for Some Selected Composts and Landfill Cover Soil

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The microbial oxidation of methane in landfill cover soil highly contributes to reduced methane emissions from landfill sites. In previous studies, composts are used to promote methane oxidation since methane degradation rates in the landfill cover soils and composts can be expressed by biological kinetic parameters (Km: Vmax). In this study using two different compost materials and soil-compost mixtures at different moisture conditions, the biological kinetic parameters were measured. Compost samples with different water content were incubated under around 8% of CH4 as initial concentration at 30oC. The results from all incubation experiments showed that for every material there was an optimum moisture content at which microbial oxidation of methane is highest. Three kinetics parameters were calculated to fully describe methane oxidation kinetic and also assess the effect of oxygen concentration on methane oxidation rate.

Keywords: Composts, Landfill Cover Soil, Biological Kinetic Parameters

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AGE04-09 Room:101A Time:May 20 11:30-11:45

Composition change from fluvial to estuarine environment: Mahaweli River, Sri Lanka

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The sediments from the Mahaweli River is brought and deposited at the Trincomalee bay a natural deep submarine canyon. In the river most elemental concentrations increase with a decrease in particle size. Regional differences reflect the mass transfer process from terrestrial areas to coastal seas and the influence of the local marine geology. The mean chemical compositions of coastal sea sediments are not similar to those of stream sediments in adjacent terrestrial areas. This observation supports the fact that coastal sea sediments have certainly originated from a mixture of terrestrial and marine materials. The low concentrations of all elements except Sr and Ca in the bay area attribute to the dilution effect due to quartz. However, the spatial distributions of elemental concentrations are not always continuous between the land and coastal seas. The estuary circulation causes the heavy minerals to deposit in the west side of the Trincomalee bay and Th/Sc-Zr/Sc shows that the sediments are of andesite to rhyolite in composition.

Keywords: Mahaweli River, Trincomalee bay, heavy minerals, terrestrial, marine

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AGE04-10 Room:101A Time:May 20 11:45-12:00

Computational Physics of Flow Through Porous Media: Permeability Scaling

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The advent of high-performance computers and advanced fluid dynamics simulation codes allows the Navier-Stokes equations to be solved in realistic three-dimensional pore spaces. As a result it is possible to perform computational experiments on virtual and real porous media that are equivalent in accuracy to physical experiments while yielding unprecedented levels of detail about the resulting flow fields. We will discuss a set of simulations that are aimed at understanding the dynamical basis behind empirical estimates of permeability like the Kozeny equation and related power law models. The Kozeny equation states that the permeability of a porous medium is proportional to the product of porosity with the square of mean hydraulic radius. A Kozeny-type equation is a more general function of porosity and/or hydraulic radius that estimates permeability, in this case a power law. Since its introduction in 1927, the Kozeny equation has been widely applied, but with mixed results. We present computational evidence that the Kozeny equation is most accurate when applied to samples of porous media that fall in a range of porosities between 0.3 - 0.7. In general, the Kozeny equation does not apply to low or high porosity media, and it is less accurate than power law alternatives at all levels of porosity including 0.3 - 0.7. Specifically, we compare estimates of permeabilities based on the Kozeny equation to estimates obtained from three Kozeny-type power laws. Since we produce the entire velocity field within explicit an pore space, we also are able to observe individual streamlines and calculate their tortuosities. We compute statistics of streamline lengths and corresponding breakthrough curves. Based on these microscopic statistics we observe that streamlines fall into two classes: (1) normal streamlines of particles that remain near their neighbors throughout the flow field, i.e., streamlines with low Lyapunov exponents, and (2) streamlines with high Lyapunov exponents that exhibit chaotic behavior by swiftly moving away from their initial neighbors.

Keywords: Porous Media, Permeability Scaling, Kozeny equation, Streamlin

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AGE04-11 Room:101A Time:May 20 13:45-14:00

Numerical analysis of fate and transport of leaked heat exchanger fluids in borehole

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The ground source heat pump (GSHP) systems need to be evaluated in terms of potential risk on groundwater contamination due to the leakage of heat exchanger fluids. The antifreeze fluid is widely used as heat exchanger fluid for the closed GSHP system with ethylene glycol and propylene glycol. Although the toxicity of these fluids is low, the fluid leakage from the tube can deteriorate groundwater quality. As increasing in the installation of GSHP, the risk of ground and groundwater contamination becomes higher. The objective of this study was therefore to predict the fate and transport of leaked heat exchanger fluid around the borehole.

HYDRUS software was used in this study to simulate the fluids transport, which was based on the numerical solution of Richards equation for variably saturated water flow in porous media and advection-dispersion equations for solute transport in the liquid phase. The analysis domain was 10 m $*$ 10 m $*$ 50 m with 10 geological layers to mimic the GSHP system installed at the study site in Tokyo University of Agriculture and Technology. Hydrological and thermal properties obtained from borehole core samples were assigned to each layer. Several different leaking scenarios were simulated in this study. This study demonstrated that fate and transport of leaked heat exchanger fluids can be simulated by HYDRUS. This allows the users of GSHP to assess the potential risk of contaminating surrounding ground and groundwater.

Keywords: ground source heat pump, solute transport, potential risk of contaminating

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AGE04-12 Room:101A Time:May 20 14:00-14:15

The groundwater quality and pore water composition of alluvial deposit in Arakawa Lowland, Japan

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The ground source heat pump (GSHP) has been recognized as one of the most energy conserving systems. However, there is a possibility that the thermal disturbance by using the system might affect the subsurface environment including groundwater quality. In this study, the geochemical properties of the groundwater and pore water were discussed to assess the impact of GSHP on subsurface environments.

Three boreholes of 50 m depth were excavated in the campus of Saitama University and groundwater monitoring wells were installed with two strainers for the upper (GL-16.25 m to 17.80 m) and the lower (GL-38.70 m to 40.15 m) aquifers for each well. The groundwater was sampled from both aquifers for several times from October to November, 2011. Also the pore water was extracted by dilution method (dry sample: water = 1: 10) from twenty-one core samples obtained from one of three boreholes. The water quality such as pH, EC, DO, ORP, inorganic dissolved ions, heavy metals and dissolved gases were measured for the groundwater. Only inorganic dissolved ions and heavy metals were measured for the pore water.

In the lower aquifer, the groundwater showed Ca-HCO3 type, while in the upper aquifer, it was Na, Mg-HCO3 type and also contained higher concentrations of the dissolved components (EC), Li, B and Sr as compared to the lower aquifer. This might be because the upper aquifer consists of marine sediment. For both aquifers, DO and ORP showed low values and only NH4+ was detected as inorganic nitrogen. The dissolved gases such as H2S and CH4 were detected but almost no SO42- in the groundwater. These facts suggested that the groundwater in both aquifers is under the methanogenesis environment.

High concentrations of heavy metals such as As, Cr, Al and Fe were detected in the pore water of the layer below GL-40 m compared to upper layers. The pore water also contained higher concentrations of heavy metals with comparison to the groundwater. These results imply that heavy metals might dissolve to the groundwater with increase of the subsurface temperature.

Keywords: alluvial deposit, groundwater, pore water, heavy metals

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AGE04-13 Room:101A Time:May 20 14:15-14:30

Temperature effects on hydro-mechanical characteristics of Kaolinite

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The concern of thermal effect on geo-mechanical behaviors of soils is growing especially due to the applications of ground source heat pumps (GSHP) as well as nuclear waste disposal facilities in geo-environment. The effects of temperature variation on hydro-mechanical characteristics of clay (Kaolinite) were investigated by using a modified oedometer test. The standard oedometer apparatus was modified by installing heat coils, bender elements, and water tanks, which enable the sequential measurements of consolidation characteristics, shear modulus, and hydraulic conductivity for the sample under different consolidation pressure and temperature conditions. In this study, pre-consolidated Kaolinite (ASP 100 clay) samples (6cm diameter with 10cm height) were used to perform consolidation tests at three temperatures (5^oC, 15^oC, 40^oC). Under each consolidation pressure, the greater saturated hydraulic conductivity (K_s) was observed at higher temperature whereas the void ratios were almost similar at the same consolidation pressure. Further measurements of shear modulus, pore size distribution, and surface areas analysis will be performed for the samples during consolidation tests at different temperature conditions. The hydro-mechanical characteristics of kaolinite induced by temperature such as volume change behaviors and hydraulic property will be discussed with information on the micro-scale pore structure of the samples.

Keywords: temperature, hydro-mechanical characteristics, Kaolinite, modified oedometer

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Fusion of Active and Passive Hydrologic and Geophysical Tomographic Surveys: The Future of Subsurface Characterization

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This presentation explains the need for high-resolution imaging techniques to characterize the subsurface, and then discusses difficulties of traditional characterization approaches, followed by a presentation of recent advances in hydrologic/geophysical characterization of the subsurface: information fusion based on active tomographic survey concepts for field scale problems. It finally concludes with examples and propositions regarding how to collect and analyze data intelligently by exploiting natural recurrent events as energy sources for basin-scale passive tomographic surveys. The development of information fusion technologies that integrate traditional point measurements and active/passive hydrogeophysical tomographic surveys, as well as advances in sensor, computing, and information technologies may ultimately advance our capability of characterizing groundwater basins to achieve resolution far beyond the feat of current science and technology.

Keywords: tomographic survey, information fusion, hydrogeophysical, geophysical

Japan Geoscience Union Meeting 2012
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SPATIO-TEMPORAL RELATIONSHIPS OF CATIONS-ANIONS, F, Fe, & Pb WITH As CONTAMINATED WATER OF KAUDIKASA, CHATTISGARH, INDIA

SHUKLA, Dericks[1*], Chandra Shekhar Dubey[1], Elvis Anup Shukla[2], Naoto Matsue[2], Bhupendra Kumar Mishra[1]

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Water chemistry presents a widely research area where interactions at rock-water interfaces play a major role in governing the water quality. Elements that are not available in the rock minerals in contact with the water cannot be expected to be present in the final solution. All water contains inorganic contaminants but presence of arsenic has posed a great threat to human health. In recent years lots of work has been done on arsenic in groundwater of India, but its origin is not well established till now. The water sampling carried out in three consecutive years (2006, 2007, and 2008) from Kaudikasa area show high As contamination (max. 4.05 ppm or mg/L) along with high Fe (max. 22.23 mg/L), F (max. 1.85 mg/L) and Pb (max. 0.15 mg/L) well exceeding the WHO limit. Various plots (Piper, Durov, Schoeller) indicate that water belongs to fresh type of shallow zone which has not travelled a long distance according to Chebotarev sequence. There exists a good inverse relationship of cations-anions (except K) with As, Fe and Pb while a direct positive relationship occurs with F. The spatial variation plots show bimodal characteristics for nearly all elements, indicating the presence of a NW-SE boundary. Arsenic, having its source in felsic rocks, gets emplaced in N-S trending quartz reefs; it is leached out to groundwater at this NW-SE boundary. This arsenic is localized in this area, as shown by depth vs. distance and arsenic profile. Hence as one goes away from this hotspot, the arsenic concentration decreases. Thus the interactions of geochemical relationships play a major role in arsenic dispersion in this area.

Keywords: Arsenic, Lead, Spatio-Temporal Relationship, Groundwater Pollution, Kaudikasa, Chattisgarh

Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AGE04-16 Room:101A Time:May 20 15:30-15:45

Linking local soil transport processes to catchment hydrology and policy options

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A dualism between measurement-modelling is needed to link knowledge of water and nutrient losses at the local scale in order to understand hydrology at the catchment scale. New measurement technologies and networks of remote devices, aided by a suite of rapidly improving modelling techniques, are leading to the development of knowledge to link land management of the catchments inventory of natural capital stocks to the diverse ecosystem services that flow from them (Clothier et al., 2011).

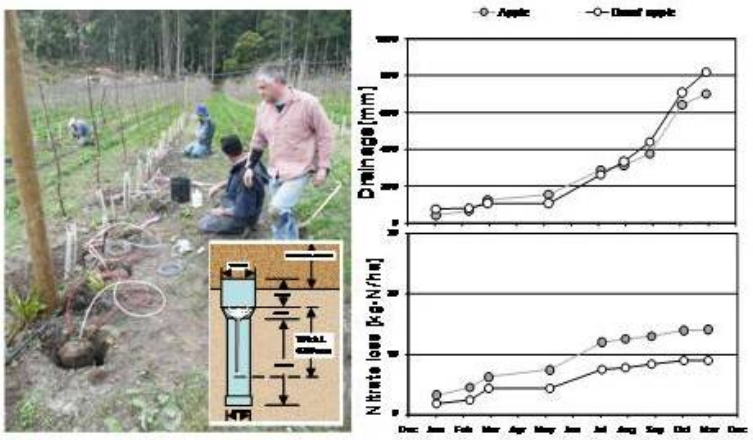
Tension fluxmeters, which mimic local hydraulic conditions in the field, are reasonably priced devices that can be installed in networks across catchments and connected wirelessly to record drainage in real-time. This enables timely manual sampling of their reservoirs to determine nutrient leaching. The results from our network of over 400 fluxmeters in New Zealand, Australia, Korea, and the Pacific Islands are providing detailed information to parameterise our mechanistic transport models. As we show, these biophysical models of transport in soil can then provide detailed understanding from which we can develop meta-models of leaching at the farm scale. From this meta-modelling, nutrient leaching from the patchwork of farm enterprises can linked to the measured quality of receiving water bodies. A challenge is to understand and model the attenuation of nutrients through the diverse transport-pathways to the receiving water bodies. Our initial attempts, just based on empirical inference, are described.

Policy to improve catchment-wide outcomes can take various forms: be it by direct regulation of nutrient inputs, or by grand-parenting through benchmarking and then mandating for a reduction in nutrient losses. Alternatively, this can be done by assessing the value of the provisioning ecosystem services flowing from the landscapes natural capital stocks. We discuss the merits and disadvantages of the various approaches that have been used in different jurisdictions in New Zealand to address the critical issue of water quality in catchments.

Reference: Clothier, B.E., A.J. Hall, M. Deurer, S.R. Green and A.D. Mackay 2011. Soil Ecosystem Services: Sustaining Returns on Investment into Natural Capital. In: Sustaining Soil Productivity & Climate Change: Science, Policy and Ethics, Wiley-Blackwell, Chapter 9, pp 115-137.

Figure. Left: Installing tension fluxmeters in an apple orchard in Australia. Right: Measurements of cumulative drainage and cumulative leaching of nitrogen from two different New Zealand apple orchards.

Keywords: soil water transport, nutrient leaching, tension fluxmeters, modelling, water quality, policy



Japan Geoscience Union Meeting 2012
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AGE04-17 Room:101A Time:May 20 15:45-16:00

Enhancing water infiltration and water-holding in soils by macropore system

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Artificial macropore was introduced into degraded soil profile to enhance infiltration and water holding capacity. Degraded soils sometimes suffer from heavy rain and the impact of rain drops causes soil crust at the surface. This impermeable layer shows poor infiltration, resulting surface flow and erosion of fertile surface soils. Agriculture practice usually employs tillage, however, this traditional technique would break soil aggregates and cause another particle losses. Therefore, the key issue is enhancing infiltration without tillage. The objective of this research was that enhancing water infiltration into soils and control water distribution in soil profiles using artificial macropores.

Masa soils, one of the degraded soils in western Japan, were packed into columns (diameter:16cm, height:60cm) to 55cm with a bulk density of 1.45gcm-3. Rainfall was applied with a shower device once every three days to greenhouse experiment and continuously applied to growth chamber experiment. The amount of rainfall was maintained 400mm which is typical in semi-arid regions. The rainfall intensities were 2 and 20mmh-1, respectively. Water content was monitored at 10,30 and 50cm by soil water sensors. Moreover, overflow surface water was collected by plastic bottles.

As results at greenhouse experiments, columns with artificial macropores reduced surface water while control columns showed high surface water at 20mmh-1 rainfall. Artificial macropore columns induced rainfall water much deeper than control columns did. Rainfall intensity affected surface soil condition, making surface crust at 20mmh-1 intensity rainfall. At growth chamber experiments, temperature was controlled at 25 oC to observe water holding ability of artificial macropore columns. Because induced rainfall was kept in deeper profile in the columns, more water was held in artificial macropore columns than controlled columns. In all, artificial macropore systems enables control of infiltration water distribution and hold rainfall water much effectively than natural soil profile. It would make possible for degraded soil to keep water and nutrients in soil profiles.

Keywords: soil environment, macropore, infiltration, carbon storage

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AGE04-18 Room:101A Time:May 20 16:00-16:15

Contaminant Transport Modeling in a Soil with Variable Charge Properties under Different pH Conditions using HP1

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The fate and transport of contaminants in soils is a function of not only the fluid flow rate, but also of a range of possible geochemical reactions, including changes in pH. A good example is the transport of solutes in volcanic-ash soils. These soils typically possess a high buffering capacity (i.e., an ability to resist changes in the pH of the soil solution). In particular pH ranges, this capacity is reflected by an increase in negatively charged sites during infiltration of relatively alkaline solutions, and an increase in positively charge sites in case of acid solutions. Hence, values of the cation exchange capacity (CEC) and anion exchange capacity (AEC) can also change, which in turn leads to different sorption behavior. In this study, the soil buffering capacity and adsorption properties were evaluated using a variable charge model describing the pH-dependent charges. Simulations were carried out of two transport scenarios involving cation and anion exchange following the infiltration of alkaline and acid solutions into an initially pH neutral environment. Cation and anion concentrations and changes in the soil solution pH were evaluated using the HP1 simulator. Although the transport scenarios were mostly hypothetical, results showed correct modeling representations of the adsorption dynamics under different pH conditions. The applied approach provides considerable potential for simulating chemical transport in variable-charge soils.

Keywords: pH dependent charge, solute trasport, buffering capacity, HP1, Andisol

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Translocation of Fukushima driven 137Cs and 134Cs in forest organic soil layer

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After the Fukushima power plant accident (11 March 2011) a huge amount of radionuclide materials were released. Its distribution and deposition pattern varies depending on the distance from the power plant, weather condition following the accident, topographic features, land cover types and the like. Forest land cover plays a great role on the distribution and deposition pattern of the radionuclide materials mainly by trapping and holding in canopy. Litter, wet and dry fall forms are the major transfer pathways that canopy trapped-radionuclide to reach forest floor. Studies have been carried out on the migration and related behavior of 134Cs and 137Cs in forest soil layers following the Chernobyl accident. However, a litter-fed continuum was not included in the process while it is known as major provider of radionuclide to forest floor. Therefore for better understanding of the movement of these radionuclides at least a part from the entire journey, litter-fed continuum has to be enclosed as radioactive recharger to forest organic soil layer. Hence, soil and litter samples are being sampled in Karassawa forest mountain chain, located ca.160 km away from the crippled power plant in Tochigi prefecture. The O-horizon is divided in to three major sub-layers (Ol, Of and Oh) according to their status of decomposition. Radionuclide activities in both soil and litter samples were quantified by using gamma ray spectrometry. All the values of the radionuclides were corrected for decay back to 20 May 2011 to analyze only the dynamic of time-dependent down ward velocities at different soil organic layers. Results revealed that the ratio of 134Cs to 137Cs in litter was 1.00 and in the absence of soil erosion scenario, litter has contributed 71% of 137Cs and 97.8% of 134Cs to their respective total soil inventories. This makes litter the main conveyor of atmospheric radionulides to forest soil. Since 137Cs has Chernobyl remnant in the soil, it has been detected up to 30 cm soil depth and has shown relatively faster downward velocity as determined based on its relaxation depth. Whereas 134Cs is totally originated from Fukushima accident and its depth is limited to upper10 cm soil layer with 1.6 cm y-1 downward velocity. A continuum translocation of the radionuclides in different parts of O-horizons that includes litter as year-round sources of radioactivity is under investigation.

Keywords: Cs-137, Cs-134, radionuclide, litter-fed, organic soil horizon