Study on the mechanism of soil and groundwater contamination by 1,4-Dioxane

*Makoto Nakashima[1], Ray Uwe Hidaka[1]

1.Kokusai Kogyo Co., Ltd.

It is planned to implemented the Environmental Quality Standard (EQS) for soil pollution of 1,4-Dioxane (DXA) in Japan soon. DXA ($C_2H_8O_2$) has a density similar to that of water at room temperature and is a colorless and transparent liquid. It has a relatively low boiling point at 101℃, dissolves well in both water and oil, and belongs to the group of volatile organic compounds (VOC). Due to these characteristics DXA is a widely used solvent and was used in large amounts as stabilizer for 1,1,1-Trichloroethane (MC). It is assumed that DXA has a low affinity to adsorb on organic substances within the soil matrix, has a lower volatilization rate and is hence highly mobile. Therefore, it is likely that its soil and groundwater contamination mechanism is different compared to other VOC.

In this study, in order to understand the behavior characteristics of DXA in soil and groundwater, as well as soil and groundwater contamination mechanism, distribution experiments regarding DXA between solid-liquid phase and liquid-gas phase as well as three kinds of soil column experiments were conducted. Toyoura sand and organic soil were used for all experiments respectively. The results of these experiments about the behavior of DXA were compared to that of MC which often occurs together with DXA.

DXA was almost only present in pore water in the distribution experiments, and only a small amount adsorbed on soil particles or vaporizes into the gas phase. In case that MC was present as NAPL in water, the presence of MC phase did not affect the distribution of DXA.

Soil column experiments in order to understand the volatilization in unsaturated soil showed that DXA which vaporized from contaminated soil dissolves in soil water while spreading upwards through the soil gas, in case that DXA is present in the unsaturated soil. Therefore, the probability of DXA to spread until close to the soil surface through soil gas is low, and it was further shown the possibility that soil leachate values exceed the EQS for soil pollution in intermediate depths.

Further soil column experiments, in order to understand the infiltration properties during precipitation into the unsaturated soil, showed that DXA in the unsaturated zone will dissolve in infiltrating rain water and percolate with it; however, in case that rain water does not infiltrate into the unsaturated soil, the concentration of DXA remains high within the soil matrix. Hence it is likely that at places where rain water infiltration does not occur, such as under buildings, the concentration of DXA in the unsaturated soil remains high within the soil matrix and that DXA can be mobilized after demolition of buildings through infiltrating rain water until it reaches the aquifer where it may cause groundwater contamination.

In this research, DXA specific soil and groundwater contamination characteristics were examined by understanding the behavior characteristics of DXA in the unsaturated zone.

The content of this presentation was partly funded by the Environmental Research and Technology Development Fund (5-1503) of the Ministry of the Environment, Japan.

Keywords: 1,4-Dioxane, soil and groundwater contamination, contamination mechanism, unsaturated soil, soil column experiment

Hydrochemical and isotopic composition of groundwater in Douala, Cameroon: Effect of recharge and waste water on water contamination

*Mengnjo Jude Wirmvem[1], Takeshi Ohba[1], Brice Tchakam Kamtchueng[2], Wilson Yetoh Fantong[2], Muga Yaguchi[1], Mumbfu Ernestime Mimba[1,2], Tasin Godlove Bafon[3], Gloria Eneke Takem[2], Ako Andrew Ako[2]

1.Sch. of Sci, Tokai Univ., 2.IRGM, Cameroon, 3.Compagnie Minière Du Cameroun SA

High water demand for domestic use in the Douala urban city with over 3 million inhabitants is met mainly by shallow groundwater through shallow wells, boreholes and springs in Pleistocene alluvium and Pliocene sand deposits. Chemical controls and recharge process of the groundwater have not been thoroughly investigated. Accordingly, this study examines the main controls on groundwater composition and spatial view of its contamination, timing of recharge and link between the recharge process and quality of the water. Conventional field measurements in January 2015 were followed by analysis of major ions and stable hydrogen and oxygen isotopes in 52 water samples. A significant range of EC values from 15 to 6890 µS/cm in both surface water and the groundwater suggests various controls on the chemical composition of the water. Low pH values in the groundwater from 3.61 to 6.92 with an average value of 5.04 indicate an acidic aquifer. The water types were Na-Cl, Ca-Mg-SO_4-Cl, Ca-Mg-HCO_3 and Na-HCO_3 with the Na-Cl water type being the most dominant in shallow open wells, boreholes and springs. Despite the nearness to the sea, only the River Wouri and few groundwater samples were strongly affected by salinization. Nitrate, which exceeded the WHO guide value of 50 mg/l in 22 % of the groundwater, poses a health problem, particularly infant methaemoglobinaemia. Mass ratios of Cl/Br in the groundwater ranged from 54 up to 3249 (with an average value of 652). The ratios scattered mostly along the mixing lines between dilute waters, septic-tank effluent and domestic sewage. The majority of samples especially the high NO_3^- shallow open wells clustered around the septic-tank effluent end member. This cluster indicates that shallow groundwater in the urban city of Douala is highly contaminated by seepage from the numerous and widely distributed pit latrines. The stable isotopes in the groundwater indicated its meteoric origin and rapid infiltration after rainfall. Most groundwater samples plotted between precipitation in the months of April and August along the Douala meteoric line showing no isotopic signatures of the most depleted and heaviest September to October monsoon rains. The narrow plot suggests a timing of the main recharge between the April and August rains and no considerable variation in recharge conditions during the hydrological year. The $\delta^{18}O$ values showed narrow ranges and overlaps in rivers (-3.10 to -2.13 ‰), springs (-3.09 to -2.90 ‰), shallow wells (-3.79 to -2.47 ‰), and boreholes (-3.53 to -2.88 ‰) with an even spatial distribution. These observations depict hydraulic connectivity, good water mixing and a homogeneous aquifer system mainly receiving local diffuse/direct uniform areal recharge from rainfall. The rapid and diffuse recharge through the permeable alluviums and sands favour the leaching of effluent from the pit latrines into the aquifer system; hence, the high NO_3^- and Cl^- in shallow wells. Based on ionic relations, the groundwater chemistry is mainly controlled by silicate weathering, ion exchange and leaching of waste from pit toilets. Drilling of deep boreholes is highly recommended.

Keywords: groundwater chemistry, Cl/Br ratio, waste water contamination, environmental isotopes, diffuse groundwater recharge, Douala-Cameroon

Ammonium and nitrate contamination source and dynamics in groundwater of Kathmandu Valley, Nepal

*Takashi Nakamura[1], Kei Nishida[1], Suresh Das Shrestha[3], Yuki Yamamoto[1], Kazuki Akahane[2], Yasuhiro Takimoto[2]

1.International Research Center for River Basin Environment, University of YAMANASHI, 2.Faculty of Life and Environmental Sciences, University of Yamanashi, 3.CDG, Tribhuvan University

Groundwater quality is a critical problem in the Kathmandu Valley, Nepal. The population of the city increased by 6 times in the last six decades and more than half of water demand depends on groundwater source. Microbial and nitrogen contamination causes loss of water resources, nevertheless, understanding of ammonia and nitrate source and contamination process in groundwater system. Objective of this study is to identify the source and contamination processes of the ammonium and nitrate in the groundwater.
Groundwater samples were collected from 32 shallow dug wells, 7 tube wells and 5 deep tube wells in September 2014 and August 2015. About 87% and 60% of groundwater exceeded WHO guideline values for ammonium and nitrate concentrations respectively. Nitrogen isotope values of ammonium suggest that natural soil production from lake sediments layer in the valley is main contamination sources for deep and shallow tube wells. In case of dug wells are contaminated by soil production with sewage nitrogen. And nitrogen and oxygen isotopes in nitrate suggest the sewage is main contamination sources of shallow dug wells and denitrification occurrence in shallow groundwater.
Ammonium nitrogen isotope values are shows less than 10‰. On the other hand nitrate isotope values are above 10‰, these differences of ammonium and nitrate-nitrogen isotope values are suggests the nitrate contamination sources are only sewage with out nitrification by ammonium originated from natural soil. The ammonium stored in groundwater body with out nitrification and denitrifications.
Acknowledgement
This study are supported by the Science and Technology Research Partnership for Sustainable Development Program (SATREPS, Project Manager: Prof. Narendra Man Shakya and Prof. Futaba Kazama) of Japan Cooperation Agency (JICA)/Japan Science and Technology Agency (JST).

Keywords: Kathmandu Valley, Groundwater, Nitrogen isotope in ammonia, Nitrogen and oxygen isotope in nitrate

Temporal variation of contamination in perched water and groundwater at an open dumpsite in Sri Lanka

*Udayagee PubuduPriya Kumarasinghe[1], Yudzuru Inoue[1], Takeshi Saito[1], Masanao Nagamori[2], Mowjood Mohamad [3], Ken Kawamoto[1,4]

1.Gaduate school of science and engineering, Saitama University, Japan, 2.Center for Environmental Science in Saitama, Japan, 3.University of Peradeniya, Peradeniya, Sri Lanka, 4.International Institute for Resilient Society, Saitama University. Japan

In Sri Lanka, solid waste management is mainly focused on waste collection and dump into open dumpsites. The leachate produced from these dumpsites often pollutes surface water and groundwater. Identification of temporal variation for leachate and groundwater quality is an important factor when installing leachate treatment systems, since water quality depends on many factors. In this study, an open dumpsite was selected from wet zone, Sri Lanka, and its perched water inside waste layer and groundwater quality were monitored for two years (March 2013 to March 2015). Perched water and groundwater samples were collected with one month interval and samples were analyzed for 14 parameters. Leachate pollution index (LPI) and piper diagrams were used to analyze the temporal variation of water quality. Overall and sub-indices of LPI were calculated to identify temporal variation of risk for groundwater contamination. Groundwater samples showed constant and low LPI values except for the initial stage of the monitoring and those constant values were similar to those for the control, a well located at out of the dumpsite. LPI indices calculated for perched water is higher than that of groundwater, but it gradually decreased with the time. There is no considerable different observed in perched water and groundwater with respect to the presence of heavy metals. Reduction of LPI exhibited the high dissolution of the pollutants over the time. No correlation was observed between LPI and amount of rainfall received over the time.

Keywords: Open solids waste dumps, perched water, groundwater, contamination, leachate pollution index (LPI)

V&V approach for the groundwater analysis

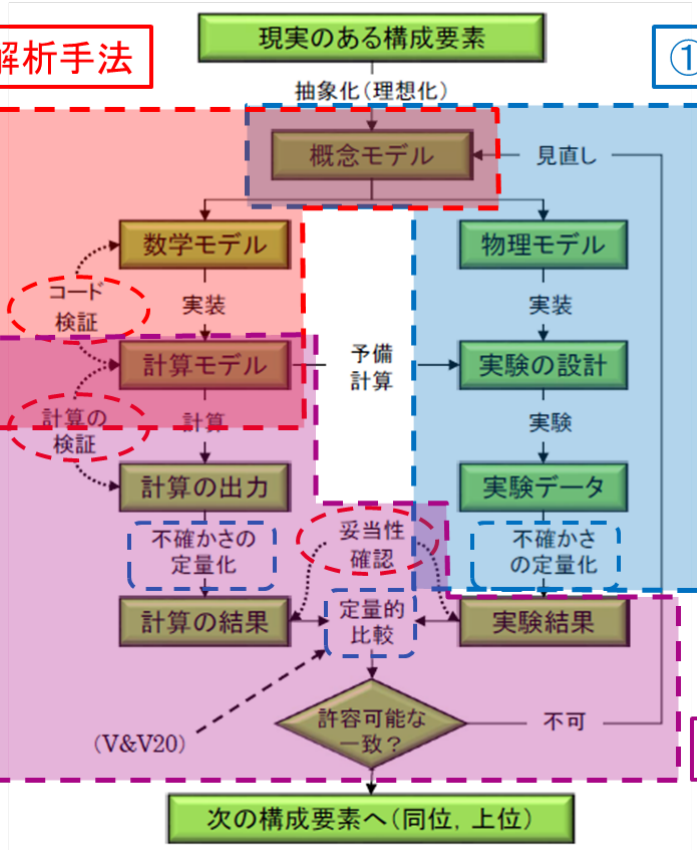
Hiroyuki Tosaka[2], *Tomonari Shiraishi[1]

1.SHIMIZU CORPORATION, 2.The Univ. of Tokyo

In recent years, V&V (Verification and Validation) which supports the quality guarantee of numerical simulation is remarkably examined in a wide range of simulation fields, in addition to the quality guarantee in the ISO9001 series. There was not so much attention paid to V&V in view of groundwater flow analysis in the past. In the field of safety evaluation which is necessary for radioactive waste disposal, however, JSCE (Japan Society of Civil Engineers) has showed a series of procedures from creating numerical models to V&V for the purpose of groundwater flow analysis. In the related researches, there is a challenge which is using one of chemical characteristics for the prediction V&V of the age of groundwater, as well as traditional data like water level, pressure, and flow rate. There are also several researches about the evaluation method of heterogeneity and uncertainty.On the other hand, the basic law on the water cycle was enacted in 2014. It is estimated in the future that the necessity of groundwater flow analyses with V&V would rise up for the design and safety evaluation of underground facilities.In JAGH (Japanese Association of Groundwater Hydrology), a research group named as "the problem finding of V&V approach for groundwater analysis" started from 2015 in the investigation and research committee. The group is discussing which problems should be tackled for meeting social needs; collecting actual examples and experimental data for V&V of groundwater analysis code. In 2016, the group is planning to publish a book collecting code-verification samples and to give seminars concerning V&V.

Keywords: Grouondwater flow analysis, Verification, Validation

ASME V&V10のフロー図と課題抽出にあたっての区分け



②地下水解析手法

地下水解析
目的
手法
精度
コード検証
理論解比較

計算の検証
精度の検証

不確かさの定量化

妥当性の確認
定量的比較

①地下水調査方法

地下水調査
目的
手法
精度

不確かさの定量化

③妥当性確認方法

Precise measurement of river cross-section using photogrammetry for discharge observation

*Yu Tabayashi[1]

1.University of Tsukuba

River discharge data can be calculated by multiplying river cross-section area and flow rate. As gaining precise river cross-section area is difficult, river discharge data often include some errors. Photogrammetry is a method to gain a precise shape of objects but it was hard for non-expert to master. Thank to the improved technology of digital photo, computer and computer software, we non-expert nowadays have chance to apply this technology to multiple fields. In this study, I used photogrammetry technology to acquire river cross-section data at Kosakuragawa River, foot of Mt. Tsukuba. The data matched with the data I gained with tape measure. By using photogrammetry, it is expected that we could gain much precise river cross-section data as we could gain continuous data of riverbed. When the light condition and water clarity is fine, we could apply this method and improve accuracy of discharge data.

Keywords: Photogrammetry, River cross-section, Discharge

