放射能環境動態・影響評価

ネットワーク共同研究拠点（ERAN）

FY2023 Final Report

【海外/International　共同研究】

海外共同研究

採択番号	申請者	所属	課題名	共同研究者	受入研究者	受入機関
I-23-01	JOHNSON Edward Thomas	Colorado State University	Collaboration with Tsukuba University on Radiocesium Migration and Nutrient Dynamics		恩田 裕一	CRiES
I-23-02	RALPH Timothy	Macquarie University	Evaluation of soil organic matter dynamics at Fukushima using an integrated radio-caesium and carbon stable isotope approach	HELANDER Carl	恩田 裕一	CRiES
I-23-03	村上 治子	Massachusetts Institute of Technology	福島の流域の長期地下水汚染の予備調査		恩田 裕一	CRiES
I-23-04	COOPER Russell James	University of Liverpool	Forecasting radiocesium migration by overland flow during high intensity rainfall events		恩田 裕一	CRiES
I-23-05	BLAKE Henry William	University of Plymouth	Utility of portable gamma sensors to support agricultural land management decisions for soil and contaminant management	TAYLOR Alex	恩田 裕一	CRiES
I-23-06	COPPIN Frederic	Institut of Radioprotection and Nuclear Safety	The use of 137/133Cs isotopic ratio to determine long term behavior of 137Cs in forest	HURTEVENT Pierre	恩田 裕一 加藤 弘亮 高橋 純子	CRiES CRiES CRiES
I-23-07	MCDOWELL Hunter William	University of New Hampshire	Controls on river water biogeochemistry	WYMORE Adam	恩田 裕一 高橋 純子	CRiES CRiES
I-23-08	Wood Mike	University of Salford	Extending the Fukushima Radioecological Observatory'		恩田 裕一 アンダーソン ドノヴァン	CRiES IREM
I-23-09	GILBERT Franck	French National Center for Scientific Research (CNRS)	Soil biodiversity and functional processes in radio-contaminated forests (Fukushima Prefecture, Japan)	BONZOM Jean-Marc ARMANT Olivier CAPOWIEZ Yvan IRIBAR-PELOZUELO Amaia BENOISTON Anne-Sophie	難波 謙二 ヨシェンコ ヴァシル	IER IER
I-23-10	BONZOM Jean-Marc	Institute for Radioprotection and Nuclear Safety (IRSN)	Effects of environmental radiocontamination in Fukushima Prefecture on tree frog physiology and populations	ARMANT Olivier GILLES André CAR Clément FRELON Sandrine MIURA Ikuo	難波 謙二 石庭 寛子 和田 敏裕	IER IER IER
I-23-11	KOMISSAROV Mikhail	Ufa Institute of Biology UFRC RAS	Distribution peculiarities of sediments and radiocesium on the Abukuma River floodplains and in the Ogaki Dam Reservoir caused by typhoon Hagibis		コノプリョフ アレクセイ 脇山 義史 五十嵐 康記	IER IER IER
I-23-12	LINNIK Grigorievich Vitaly	Vernadsky Institute	Landscape modeling of the fate of radiocesium (r-Cs) in the basins of small pond systems in the vicinity of the Fukushima Daiichi Power Plant (FDNPP)		コノプリョフ アレクセイ 脇山 義史 五十嵐 康記	IER IER IER
I-23-13	ROY Tapashi Ghosh	University of Chittagong	Nickel(II) complexes of carbamoylethyl derivative of octamethyl isomeric macrocyclic chelator: Synthesis, characterization, biological evaluation, and applications in radioactive waste decontamination	BEGUM Zinnat Ara RABI Saswata	ラハマン モハマド モフィズル イスマイル	IER
I-23-14	ANANTHANARAYANAN Chandrasekaran	Sri Sivasubramaniya Nadar College of Engineering (Autonomous)	Assessment of prospective Beach Sand Minerals and their Radioactivity along the Thoothukudi to Kanyakumari coastal area of Tamil Nadu		ラハマン モハマド モフィズル イスマイル	IER
I-23-15	PALIT Debashis	University of Chittagong	Synthesis of dioxo complexes of molybdenum, an important raw material for nuclear medicine	RAKSHIT Sukla BEGUM Zinnat Ara	ラハマン モハマド モフィズル イスマイル	IER
I-23-16	BARUA Suman	University of Chittagong	Assessment of natural radioactivity and function of minerals in soils of the ship-breaking area, Bangladesh, by Gamma Ray spectroscopic and Fourier Transform Infrared techniques	BEGUM Zinnat Ara	ラハマン モハマド モフィズル イスマイル	IER
I-23-17	BISWAS Bushon Foni	Faculty of Science	Synthesis and characterization of Co(III) and Ni(II) complexes of N-pendent derivatives of an isomeric octamethyl tetraazamacrocyclic ligand and applications in radioactive waste decontamination	BEGUM A. Zinnat ROY Ghosh Tapashi	ラハマン モハマド モフィズル イスマイル	IER

採択番号	申請者	所属	課題名	共同研究者	受入研究者	受入機関
I-23-18	BEZHENAR Roman	Institute of Mathematical Machines & Systems Problems of National Academy of Sciences of Ukraine (IMMSP)	Modelling of the transfer of radionuclides and their uptake by marine biota due to hypothetical accidental release of the Fukushima storage water	MADERICH Vladimir	高田 兵衛	IER
I-23-19	BURDO Olena	Institute for Nuclear Research National Academy of Sciences of Ukraine	Establishment of FISH probes for dicentric analysis of wild rodents in Chornobyl	中田 章史	石庭 寛子 三浦 富智 アンダーソン ドノヴァン	IER IREM IREM
I-23-20	GAGNAIRE Beatrice	IRSN (French Institute for Radioprotection and Nuclear Safety)	Assessment of the effects of ionizing radiation in bees - BEERAD	BONZOM Jean-Marc BELZUNCES Luc BRUNET Jean-Luc DUBOURG Nicolas CREVET Margot	難波 謙二 石庭 寛子	IER IER
I-23-21	ARAMRUN Kitkawin	Office of Atoms for Peace	Radiation Mapping Survey Around Radiation Facilities In Thailand For Radiological Emergency Preparedness And Response		床次 眞司	IREM
I-23-22	SUHARIYONO Gatot	National Research and Innovation Agency (ORTN),	Development of Iodine-131 Absorption Efficiency Methods from Charcoal Filters with a Variety of Adsorbent Materials that are cheap for the safety of Thyroid Patients, Nuclear Workers and the Environment		床次 眞司	IREM
I-23-23	Makhsun	National Research and Innovation Agency (BRIN)	Radon monitoring system as an earthquake precursor based on a scintillation detector and real time monitoring		床次 眞司	IREM
I-23-24	KOUNTCHOU NOUBE Michaux	Institute of Geological and Mining Research	Development of a test bench for the electronics of ionizing radiation detectors based on FPGA and microcontrollers.	Saïdou MBARNDOUKA TAAMTÉ Jacob FOLIFACK SIGNING Vitrice Ruben OMGBA ABANDA Zacharie Stève YERIMA ABBA Hamadou	床次 眞司 細田 正洋	IREM IREM
I-23-25	WAHYUDI Wahyudi	The National Research and Innovation Agency of Indonesia	Spatial uranium distribution in Mamuju	NUGRAHA Djatnika Eka PUTRI Jenisa Andeva	床次 眞司 大森 康孝	IREM IREM
I-23-26	NUGRAHA Djatnika Eka	The National Research and Innovation Agency of Indonesia (BRIN)	Development method of Radioparticulates measurement in the Mining area		床次 眞司 大森 康孝 クランロッド チュティマ	IREM IREM IREM
I-23-27	NDJANA NKOULOU II Joseph Emmanuel	Institute of Geological and Mining Research	Radiological characterization of local building materials and environmental monitoring of the iron bearing areas of Mbalam, Kribi and Bipindi, South-Cameroon.	Saïdou TCHUENTE SIAKA Yvette Flore OUMAR BOBBO Modibo	床次 眞司 大森 康孝 クランロッド チュティマ	IREM IREM IREM
I-23-28	RATTANAPONGS Chanis	Kasetsart University	Study of the relationship of radon and airborne particulate matter to lung cancer incidence factors in the high background radiation area in Kanchanaburi	ARAMRUN Kitkawin	床次 眞司 クランロッド チュティマ	IREM IREM
I-23-29	SYAIFUDIN Mukh	National Agency for Research and Innovation (BRIN)	Construction of Fluorescence in situ Hybridization (FISH) based Translocation Dose-Response Calibration Curve for Evaluation of Health Risk of Nuclear Workers		三浦 富智	IREM
I-23-30	KURNIA Iin	National Agency for Research and Innovation (BRIN)	Optimization fixation time for detection gamma H2AX as biomarker of DNA DSB after low dose radiation		三浦 富智	IREM
I-23-31	RAMADHANI Dwi	National Agency for Research and Innovation (BRIN)	Micronucleus-Centromere Assay for Assessing Ionizing Radiation Damage from Unintended and Accidental Radiation Exposures		三浦 富智	IREM
I-23-32	PURNAMI Sofiati	National Agency for Research and Innovation (BRIN)	A cytogenetic dose-response curve for low-dose range gamma-irradiation in human peripheral blood cells using three-color FISH		三浦 富智	IREM
I-23-33	MAKMUR Murdahayu	National Agency for Research and Innovation (BRIN)	Optimization of the tritium analysis method and its application to sea water samples	NUGRAHA Djatnika Eka PUTRA Irawan Permana Deddy	赤田 尚史	IREM
I-23-34	ROSIANNA Ilsa	National Agency for Research and Innovation (BRIN)	Development method of radioactivity measurement in drinking water sample using TXRF	NUGRAHA Djatnika Eka YUSUF Riyaz	赤田 尚史 田副 博文	IREM IREM

採択番号	申請者	所属	課題名	共同研究者	受入研究者	受入機関
I-23-35	RAHMAN M. Safiur	Bangladesh Atomic Energy Commissio	Capacity building for development of nuclear techniques for analysis of radionuclides and potential toxic elements in environmental samples collected from Ruppur Nuclear Power Plant (RNPP), Bangladesh	SUDOWE Ralf	田副 博文 アンダーソン ドノヴァン	IREM IES
I-23-36	SOLA Phachirarat	Chulalongkorn University	Study of NORM levels using high purity germanium (HPGe) gamma spectrometry and heavy metals analysis using ICP-MS in soil samples collected from Thailand (continuous)	KRANROD Chutima KRITSANANUWAT Rawiwan	田副 博文	IREM
I-23-37	CHAMIZO Calvo Elena	National Center of Accelerators	Anthropogenic radionuclides in the Southern Ocean	Shinonaga Taeko	田副 博文	IREM
I-23-38	SUDOWE Ralf	Colorado State University	Comparative assessment and analysis of radionuclide measurement in fish of Fukushima	JOHNSON Thomas	アンダーソン ドノヴァン 田副 博文 赤田 尚史 山田 椋平	IREM IREM IREM IREM

Collaboration with Tsukuba University on Radiocesium Migration and

Nutrient Dynamics

氏名：JOHNSON Edward Thomas
受入研究者：恩田 裕一

１．成果

Radiocesium Migration and Nutrient Dynamics in Fukushima Prefecture

２．論文

None at this time

福島の流域の長期地下水汚染の予備調査

氏名：村上 治子
受入研究者：恩田 裕一

１．成果

Remarkable progresses have been made in decontamination and recovery after the Fukushima Nuclear Power Plant Accident. The transport of Cs-137 in terrestrial systems has been extensively studied over the past 11 years after the Fukushima Daiichi Nuclear Power Plant accident. So far, the major transport pathway has been associated with particulate and sediment transports. However, there is still a concern about the long-term mobility of Cs-137 in the region, particularly in the forested region. C-137 has been mostly migrating along with soil particles, but it also migrates towards in soil as a dissolved component reaching groundwater and surface water.   In this study, we will perform a preliminary investigation on dissolved Cs-137 transport in subsurface by synthesizing exiting datasets. The US Department of Energy (DOE) Savannah River Site (SRS) F-Area (South Carolina, United States) is a nuclear material production site mainly operated during the Cold War. The SRS F-Area has three unlined seepage basins, which received approximately 7.1 million m3of acidic, low-level radioactive waste solutions between 1955 and 1988. Currently, an acidic contaminant plume extends from the basins to about 600 m downgradient, moving toward the Fourmile Branch creek. The plume contains various radionuclides (e.g., H-3, I-129, U-238) as well as nitric acid. It is estimated that 8.2 TBq of Cs-137 was released into the basins. It provides opportunity to study the long-term transport of Cs-137   We synthesized Cs-137 discharge data and groundwater and surface water concentration data at the SRS F-Area. Our results show that the concentrations in groundwater rapidly attenuate within F-Area from the basin locations to the downgrading near the stream. We also estimated that the inventory of Cs-137 in the stream was smaller than that in Fukushima coastal region's catchment (14-536 TBq), but the concentrations of Cs-137 in sediment within SRS and some catchments are same order of magnitude. The Cs-137 concentrations in surface water (1km downgradient) were ranged ND to 110 pCi/L (4.1 Bq/L) during 1996-2015. Based on these observations, we may conclude that the groundwater pathway can be quite limited.   "

２．論文

Forecasting radiocesium migration by overland flow during high intensity rainfall events

氏名：COOPER Russell James

受入研究者：恩田 裕一

１．成果

The project brought together the expertise of Onda's group in radiocesium migration with the modelling tools of Cooper's group to produce new understanding of the controls of soil erosion by subsurface drainage and overland flows during high intensity rainfall, in order to better forecast the impacts of rainfall events on radiocesium wash-off. Rainfall events were simulated in the Large-scale Rainfall Simulator at NIED in Tsukuba over two soil-plots, one consisting of granitic soil, the soil used in decontaminated areas in Fukushima, and the other consisting of Andisol, the original, parent soil in Fukushima. The results revealed: (1) The granitic soil had fundamentally different hydraulic and sediment characteristics to original soil in Fukushima. Namely the granitic soil had a higher infiltration rate and poorer water storage capacity and experienced enhanced rates of runoff and erosion in comparison to the original soil; and (2) This difference has important consequences for agricultural productivity in decontaminated areas in Fukushima, making the landscape less resilient to erosion and landslides during the typhoon season, as well as having potential implications for the transport of soil-phase radiocesium.

２．論文

The use of 137/133Cs isotopic ratio to determine long term behavior of 137Cs in forest

氏名：COPPIN Frederic
受入研究者：恩田 裕一・加藤 弘亮・高橋 純子
共同研究者：HURTEVENT Pierre

１．成果

Due to FDNPP fallouts, Japanese forests have been contaminated by 137Cs in 2011. This study aimeds at determining if the distribution of 137Cs reached an equilibrium state in forest ecosystems 12 years after the accident. One of the objectives of the AMORAD international research program (2013-2022) was to improve the efficiency of the Cs-137 transfer modelling in forests at different time scales. Specifically, the model developed by IRSN (TREE4) allowed identifying the transition from a transient post-accident situation to an apparent equilibrium state. The TREE4 model is based in particular on the quantitative description of the biogeochemical cycles of 137Cs and its stable chemical analogues (133Cs and K). The temporal evolution of the 137Cs/133Cs isotopic ratio in the different tree organs informs about the achievement of this apparent equilibrium state, which is reached when the 137Cs/133Cs isotopic ratio remains constant over time for a given organ or flux (e.g. canopy weathering flux). The comparison of isotopic ratios in biomass organs with those measured in the soil fractions (bulk, labile, exchangeable) should determine which pool has to be considered as the bioavailable stock in soil.   The analyses were conducted on samples coming from Yamakiya forest sites. To make the analyses and estimate the target equilibrium 137Cs/133Cs isotopic ratio of each site, the total amount of 137Cs (Bq/m²) and 133Cs (mg/m²) were estimated for four sampling campaigns (2014, 2016, 2016, 2018). The total amount of both isotopes was considered for tree and added to (1) the total amount in soil, (2) the water available fraction or the Ammonium acetate exchangeable fraction of isotopes. Finally, three targeted equilibrium 137Cs/133Cs were obtained : total, tree + soil water available and tree + soil exchangeable. The total ratio was almost stable during the 4 sampling years suggesting that input of 133Cs can be neglected.   The results are presented for the three different sampled sites (Mature Cedar plot (MC), Young Cedar plot (YC), and Broadleaves plot (BL)). The 137Cs/133Cs of different tree organs were compared to the equilibrium 137Cs/133Cs ratios. The 137Cs/133Cs ratio depends on which fraction of soil was

considered. As expected, due to the presence of 133Cs included in the mineral soil matrix, the total ratio is the lowest, whereas the tree + soil water available fraction is the highest. Concerning the 137Cs/133Cs ratios of tree organs, different behaviors with time were observed. For the organs directly impacted by the initial deposit (Needles) a decrease in the 137Cs/133Cs ratio was observed. In contrast the organs not directly impacted (Sapwood) an increase then a decrease was observed These two behaviors are those theoretically expected for these organs. For roots the ratio seems stable whereas for heartwood a difference in behavior for the three stands can be observed. Finally, the accuracy of 137Cs/133Cs ratio in tree organs is higher is only water or the exchangeable fraction of these isotopes in soil were considered than the total fraction. Eight years after the accident, evolution of the 137Cs/133Cs ratio suggests that equilibrium is not totally reach at the stand scale almost for cedar plots. For the Broadleaves plot it seems that tree organs present the same 137Cs/133Cs ratio already two years after the accident. Additional tree organs were sampled during this project until 2023, their analyses will permit to complete the actual dataset.

2．論文

Extending the Fukushima Radioecological Observatory'

氏名：Wood Mike

受入研究者：恩田 裕一・Anderson Donovan

１．成果

The Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident in 2011 necessitated the establishment of radioecological observatories to study the long-term effects of radioactive contamination on ecosystems. This report outlines a scoping study conducted to establish an additional Radioecological Observatory in the Fukushima region, aiming to facilitate coordinated, hypothesis-driven research in radioecology. Radioecological Observatories serve as natural laboratories for coordinated research on the effects of radioactive contamination on ecosystems. The European Radioecology ALLIANCE proposed these observatories to focus research efforts and collaborate on studying areas affected by nuclear incidents, including Chernobyl and Fukushima. Several potential sites were initially suggested by the European Radioecology ALLIANCE. However, due to logistical constraints, an "Observatory site" within the Namie area of Fukushima Prefecture was selected. This site is located 23 km northwest of the FDNPP, with an initial deposition of 4,727 kBq/m2 and annual precipitation of 1442 mm. The area comprises Japanese Cedar stands with a tree density of 3,300 trees/ha and brown forest soil. The selected site underwent initial characterization to assess its suitability as a Radioecological Observatory. Plausible locations were identified, and data on environmental parameters were collected and published. Although motion-activated cameras and acoustic recorders were initially considered, logistical challenges prevented their deployment. Instead, game trail cameras were deployed at the site. These cameras offer high-quality images and video recording, durability, and animal detection capabilities. However, they have limitations such as a one-time high cost, lack of sound recording, and the need for periodic SD card changes. The scoping study for the Fukushima Radioecological Observatory lays the groundwork for ongoing research into the long-term effects of radioactive contamination in the region. Despite challenges in acquiring equipment, the deployment of game trail cameras represents a significant step towards establishing a comprehensive monitoring system. By fostering collaboration and sharing resources, the observatory aims to contribute to a deeper understanding of the ecological consequences of nuclear incidents and facilitate informed decision-making for the management of affected environments.

２．論文

Soil biodiversity and functional processes in radio-contaminated forests

(Fukushima Prefecture, Japan)

氏名：GILBERT Franck
受入研究者：難波 謙二・Vasyl Yoschenko
共同研究者：BONZOM Jean-Marc・ARMANT Olivier・
CAPOWIEZ Yvan・IRIBAR-PELOZUELO Amaia・
BENOISTON Anne-Sophie

１．成果

1- Soil biodiversity and functional processes in radio-contaminated forests (Fukushima Prefecture, Japan)　Keywords: Fukushima Prefecture, ionizing radiation, forest, soil communities, functional processes The objectives of the collaborative French-Japanese RINSHŌ project are to study the in situ effects of radio-contamination on both soil biodiversity (microorganisms and eukaryotes) and two associated functional processes: leaf litter decomposition and soil bioturbation, in forests of the Fukushima Prefecture (representing approximately 70% of the total radio-contaminated land area). Indeed, those two integrative processes are specifically　investigated because they are related to the transfer and the transformation of organic matter and are carried out by interacting organisms belonging to various soil biological compartments and ecological niches (from bacteria to macrofauna, epifauna and endofauna). Our hypotheses are: (i) radio-contamination has an impact on soil biodiversity, (ii) radio-contamination has an impact on the activity of soil organisms and the processes they drive, (iii) the impact of radio-contamination is dose-dependent. In the November-December 2023 period, six Cryptomeria japonica forest sites of the Fukushima Prefecture along positioned along a radio-contamination gradient were equipped with experimental units (five units per site). These units were composed of, among other devices: - fine and large mesh C. japonica litter bags to quantity both microbial and all-decomposers litter decomposition); - deposition zones of fluorescent tracers (luminophores) to quantify soil bioturbation; - TMS-4 TMOS dataloggers to register surface and deep temperature and humidity patterns during the experimentation time; - dosimeter columns to measure the radioactivity profiles within soils. Samplings for both eDNA (bacteria and eukaryotes

compartments), physical-chemical and radioactivity analyses of soils and litter were also realized. Collection of experimental devices and complementary samplings will be carried out after six (June 2024) and 12 months (nov-dec. 2024) of experimentation. 2- No paper on our still on-going project has been yet published, but the project has been presented as a poster: 10th Annual Symposium of the IER, Fukushima University "Forest and marine Environments in Fukushima now" - 28-29 February 2024 - Fukushima (Japan). Poster: Soil biodiversity and functional processes in radio-contaminated forests (Fukushima Prefecture, Japan) (Lambert Q., Armant O., Benoiston A-S., Capowiez Y., Hättenschwiler S., Iribar-Pelozuel A., Kaneko N., Lamothe S., Nanba K., Yoschenko V., Wada T., Bonzom J-M. & Gilbert F.)

２．論文

Effects of environmental radiocontamination in Fukushima Prefecture

on tree frog physiology and populations

氏名：BONZOM Jean-Marc

受入研究者：難波 謙二・石庭 寛子・和田 敏裕

共同研究者：ARMANT Olivier・GILLES André・

CAR Clément・FRELON Sandrine・MIURA Ikuo

１．成果

　　Objective/Context - The objective of this research project is to better understand and quantify the biological effects of environmental radiocontamination in the Fukushima Prefecture on wildlife. For this purpose, we have chosen a model species, the tree frog (Dryophytes japonicus). In June 2022, we captured 214 tree frogs in Fukushima Prefecture at 11 different sites (i.e., corresponding to 11 populations) along a contamination gradient (ambient dose rate range: 0.08 - 6.9 μSv/h). We collected about 20 male tree frogs per population. In this call for ERAN 2023 projects, our primary objective was to analyze all the biological samples (transcriptomic, genetic analyses) and to calculate the dose rates of each individual. Dosimetry - For each of the 11 tree frog populations (named S1, S2, etc.), the average (± SD) total dose rates (as well as the range) that we calculated are in $\mu Gy.h-1$: S6 = 0.001; S7 = 0.002; S8 = 0.003; S5 = 0.005; S2 = 0.006; S4 = 0.03 ± 0.006 (0.02-0.04); S10 = 0.03 ± 0.008 (0.02-0.05); S1 = 0.06 ± 0.04 (0.04-0.21); S11 = 0.18 ± 0.06 (0.13-0.32); S3 = 0.21 ± 0.14 (0.10-0.71); S9 = 0.80 ± 0.25 (0.62-1.74). For sites 2, 5, 6, 7, and 8, the total dose rate is the same for all individuals within the same site. Indeed, since the internal activity is below the detection limit, the total dose rate corresponds only to the external dose rate. Transcriptomics - A reference transcriptome of Dryophytes japonicus was produced de novo from organs (testis, eye, brain, heart, testis and liver) dissected from 3 individuals captured in non-contaminated site in the Fukushima prefecture. The testis and tibia muscle of 200 tree frogs exposed along the radio-contamination gradient are currently processed in order to generate mRNAseq transcriptomics data that will allow us to characterize the potential physiological state on tree frogs.　Energy metabolism - To investigate effects of exposure to radionuclide contamination on energetic metabolism of

tree frogs, the activities of three enzymes, citrate synthase, cytochrome c oxidase, both linked to aerobic metabolism, and lactate dehydrogenase, relative to anaerobic metabolism, were measured in the thoracic muscles (involved in calling mate) and in the liver (detoxication and energy storage organ). In the thoracic muscle, a dose-related increase of citrate synthase and lactate dehydrogenase activities was observed. No dose-related impact was shown on cytochrome c oxidase meaning that the number of mitochondria does not appear to be affected by radiocontamination. On the contrary in the liver, dose-related decrease in citrate synthase and cytochrome c oxidase activities suggest aerobic metabolism decreases (not significant trend for COX) whereas anaerobic metabolism seems to be boosted to compensate considering the dose-related increase in lactate dehydrogenase activity. Genetics analyses - A first test of dRADseq was performed on eight individuals (two sampled in 2012, two in 2013 and four in 2022). 1,704 loci were compared between these individuals which show strong differentiation between at least three different lineages. These lineages are not congruent with previously identified mitochondrial haplogroups and probably reflect admixture processes. The dRADseq of other individuals is underway and will enable analysis of mito-nuclear discordance, admixture processes and other evolutionary processes inferred from the variation in nuclear genetic diversity.

2．論文
Publications in progress

Distribution peculiarities of sediments and radiocesium on the Abukuma River floodplains and in the Ogaki Dam Reservoir caused by typhoon Hagibis

氏名：KOMISSAROV Mikhail
受入研究者：Alexei Konoplev・脇山 義史・五十嵐 康記

１．成果

A huge amount (about 6.4 PBq) of radiocesium (r-Cs) was deposited in north-west of Japan after Fukushima Daiichi Nuclear Power Plant accident. The environment in Fukushima Prefecture was seriously subjected to ecological stress, for example the Abukuma River – the longest (length 234 km) river, and Ogaki dam at Ukedo River – one of the biggest dam in Fukushima Prefecture. The initial contamination levels of both objects were considered as high. The abovementioned water bodies represent an essential water resource for the local inhabitants and paddy field irrigation; therefore, the r-Cs concentration has important implications for the "health" of humans and biota. During some erosional natural events (intensive rainfall/snowmelt) the turbidity and r-Cs concentration in water bodies could increase, especially due to typhoons. Hagibis was (6–13 October 2019) the strongest typhoon in the last several decades in Japan and caused widespread destruction and high-floods. The rainfall in Fukushima Prefecture was nearly 600 mm in 24 h (mean annual precipitation is 1200 mm). In such conditions the large amount of contaminated sediments is delivered to the water bodies. The siltation rates, features of transport and redistribution of sediments, their texture and concentration of r-Cs (as well in water) is required a detail study. This is a continuing study of a previously supported by ERAN research proposal (I-22-08). In 2022 the investigations were conducted for different parts (from source to mouth and elevation: floodplain, 1 and 2 terrace above the floodplain) of Abukuma River. All field and laboratory works were completed. In 2023 we analyzed the obtained results and prepared articles for publication; some data related to Ogaki dam was also used. To improve the reliability of findings, the additional sampling of sediment cores and water in Ogaki dam is planned in 2024. Analysis of obtained previously and compiled results suggest, that the max 137Cs inventory Abukuma River valley bottom in 2018 was ~ 950 kBq/m2 (~ 600 in 2019), it is indicated a high washout of r-Cs from up- and mid-stream to mouth and

ocean. The thickness of "fresh" sediment deposited on the floodplain in the case of the ordinary flood is in the range 1–5 cm, while it increased up to 40–50 cm after the extreme flood associated with typhoon. The high r-Cs concentrations were found in sediments both of Abukuma River and Ogaki dam with domination of fine fractions. The sediments of Ogaki dam contain in average 5×10^4 Bq/kg of 137Cs and ~70% of silt (0.05–0.002 mm) fraction, whereas in Abukuma River – 2×10^3 Bq/kg of 137Cs and 50% of silt.

２．論文

a）Konoplev, A., Wakiyama, Y., Igarashi, Y., Nanba, K., 2023. Fate and transport of Fukushima-derived radiocesium in the environment: Key findings and challenges for the future. International Journal of Plant, Animal and Environmental Sciences 13 (4), 75–90. https://doi.org/10.26502/ijpaes.4490154. b) Konoplev, A.V., 2023. Physicochemical mechanisms of dissolved 137Cs seasonal variations in freshwaters: Fukushima and Chernobyl. Radiochemistry 65 (6), 708–714. https://doi.org/10.1134/S1066362223060127.

Landscape modeling of the fate of radiocesium (r-Cs) in the basins of small pond systems

in the vicinity of the Fukushima Daiichi Power Plant (FDNPP)

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１．成果

1. Report. Closed and semi-closed ponds in the contaminated zone of the Fukushima Dai-ichi nuclear power plant (FDNPP) accident in March 2011 are the most suitable objects for radioecological monitoring of the secondary redistribution of 137Cs as a result of erosion processes in different landscapes. Radioactive contamination of reservoirs was formed in March 2011 because of the deposition of 137Cs on the pond water surface, which led to water pollution. In subsequent years, changes in radioactive contamination of ponds occur as a result of input/output 137Cs processes, which are typical for Funasawa and Suzuuchi ponds. Unlike these two ponds, Inkyozaka is closed filled fire extinguishing pond, i.e. radioactivity in this pond can only be added by surface runoff from its catchment. The cartometrically obtained data on the water surface area of reservoirs, as well as the catchment area, clarify similar data presented in [1, 2] and will later be used for appropriate calculations of the intake of r-Cs into reservoirs as a result of wash-off. The area of Inkyozaka water surface is 0.74 ha, whereas the basin area is 2.53 ha, the ratio basin/pond area equal 3.41. Whereas for Suzuuchi (irrigation pond), and Funasawa (recreational urban pond), these ratios are 8.4 and 16, respectively, which indicates that the potential secondary pollution for these two ponds may be significantly higher than for Inkyozaka. However, the data of 2017 survey on 137Cs inventories in catchment soils and bottom sediments for Inkyozaka, Suzuuchi and Funasawa revealed a more complex picture of 137Cs distribution, which cannot be explained by a simple basin/pond ratio to assess secondary redistribution processes as a result of erosion processes. The actual ratio of the average 137Cs inventories in bottom sediments and catchment soils for Inkyozaka, Suzuuchi and Funasawa in 2017 was 0.7, 1.63 and 1.52, respectively. The actual erosion and the corresponding wash-off of 137Cs-137 into ponds depends on many different landscape factors, including geomorphological, land use, vegetation. Based on the results of the analysis of digital elevation model (DEM)

derivatives（slope, curvatures, LS- factor）and modeling of hydrological factors from DEM using GIS SAGA and GRASS（Flow accumulation, Effective flow length, Sediment balance）, an evaluation of radiocesium wash-off by soil erosion as a potential 137Cs-137 input into ponds was performed.

２．論文

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Konoplev, A., 2023. Physico-chemical mechanisms of dissolved 137Cs seasonal variations in freshwaters: Fukushima and Chernobyl. Radiochemistry, 65（6）, 708-714 （in English）. https://doi.org/10.1134/S1066362223060127

I-23-13

Nickel(II) complexes of carbamoylethyl derivative of octamethyl isomeric macrocyclic chelator: Synthesis, characterization, biological evaluation, and applications in radioactive waste decontamination

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共同研究者：BEGUM Zinnat Ara・RABI Saswata

１．成果

・Research objective・ Radioisotopes of nickel（r-Ni: Ni-59, Ni-63）are produced in the structural steels of nuclear reactor vessels and internal components from neutron activation of corresponding naturally occurring stable isotopes. The shape-persistent macrocycles can selectively isolate r-Ni from the waste matrix. The current study was undertaken to achieve the following objectives: a）Preparation and characterization of a carbamoylethyl derivative of octamethyl isomeric macrocyclic chelator; b）Preparation and characterization of its Ni(II) complexes; c）Carrying out a study on their biological activities; d）Using the new macrocycle as an absorbent of radioisotopes of Ni. ・Experimental・ The macrocyclic chelator was mixed with the Ni(II) salt in a suitable solvent medium to prepare the metal complexes. The chelator and corresponding metal complexes have been characterized by some physical methods（color, melting point, solubility, etc.）, microanalysis（C, H, N, and S）, spectroscopic techniques（IR, UV-VIS, NMR, and Mass）, and X-ray crystallography. The antimicrobial activities of the chelator and corresponding metal complexes have been studied against some bacteria. The antioxidant activities of the prepared compounds are also investigated. ・Summary of findings・ Current work has the following conclusions: a）A new carbamoylethyl derivative macrocyclic chelator and its Ni(II) complexes have been synthesized and characterized; b）Remarkable biological activities of the prepared compounds were observed; c）The new macrocycle is found to act as an excellent absorbent of Ni(II) during complex formation.

２．論文

Assessment of prospective Beach Sand Minerals and their Radioactivity along the Thoothukudi to Kanyakumari coastal area of Tamil Nadu

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１．成果

・Research objective・ Coastal sediments contain a variety of radioactive mineral deposits generated by the weathering and erosion of mineral rocks. The activity concentrations of U-238, Th-232, and K-40 in the Earth's crust are determined by the dispersion of minerals such as monazite and zircon in soil, sediments, sand, and construction materials. Natural radionuclides, specifically U-238, Th-232, and K-40, de-excite to their ground states, producing natural gamma radiation. This radiation is a primary extrinsic irradiation source for animals, plants, and humans worldwide. Continuous exposure to gamma radiation has the potential to injure tissues by modifying cell structure and destroying DNA, which can lead to significant health problems such as cancer. Therefore, this study aims to (i) assess the activity concentration of U-238, Th-232, and K-40 in sediment samples from the southern coastal area of Tamil Nadu through gamma-ray spectrometry, (ii) evaluate the heightened level of radiation hazards by examining radiological parameters, (iii) compare the obtained results with globally recommended limits and similar studies conducted worldwide to comprehend the distribution pattern of radionuclides in the coastal region, and (iv) identify the primary radionuclide contributing to background radiation in the study area using multivariate statistical techniques. ・Experimental・ From January to December, samples were systematically collected from Thoothukudi and Kanyakumari (21 locations), with Kanyakumari located in India's southernmost region. A gamma-ray spectroscopy system comprises a NaITl scintillation detector with 98% counting efficacy, and a 1024-channel computerized multi-channel analyzer (MCA) was utilized to measure the activity concentration of radionuclides. Efficiency calibration was conducted using IAEA-approved reference-grade materials, including RG-U, RG-Th, and RG-K. Energy calibration was achieved by inserting known-energy gamma sources, Cs-137 (662 keV) and Co-60 (1173–1332 keV), into the detector. The activity concentrations of U-238 and

Th-232 and their decay products were determined using their progeny's photopeaks, which were 1764 keV for Bi-214 and 2614 keV for Tl-208. The concentration of K-40 was determined using a gamma-ray transition at 1460 keV. ・Observations・ The activity concentrations of naturally occurring radionuclides, namely U-238, Th-232, and K-40, were measured in the southern coastal area of Tamil Nadu, India, using the Gamma-ray spectroscopic technique. The findings indicate that elevated thorium levels and the corresponding dose rates are attributed to monazite-deposited beach sediments in the study area. The strong positive correlation between thorium and all radiological parameters suggests that the radioactivity is primarily due to the Th-232. On the other hand, U-238 and K-40 do not significantly contribute to the overall radioactivity despite their elevated levels in the coastal area of Tamil Nadu.

2．論文

Synthesis of dioxo complexes of molybdenum, an important raw material

for nuclear medicine

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共同研究者：RAKSHIT Sukla・BEGUM Zinnat Ara

１．成果

・Research objective・　The isotope Mo-99 is an element used in producing technetium-99m (Tc-99m). Tc-99m is used in research into a multitude of ailments. Roughly 85% of medical imaging in nuclear medicine uses this isotope. Mo-99 is produced by the fission reaction of low-enriched uranium, which results in high-specific activity Mo-99. The universal means by which Tc-99m is made available for clinical applications is from the elution of generators containing high-specific activity fission-based Mo-99. However, the fission products are a mixture of different radionuclides. So, it is essential to separate them, and it is done by various means. The complexation of Mo by ligands can separate Mo-99 from the fission product mixture. So, we have planned to prepare some Mo-complexes with some new ligands and characterize them. ・Experimental・　Five ligands were prepared by the condensation of S-methyldithiocarbazate with cyclopentanone, furan-2-aldehyde, thiophene-2-aldehyde, pyrrole-2-aldehyde, and acetophenone. The ligands were then allowed to form a complex compound of Mo by taking Mo acetyl acetonate as a precursor. ・Findings・　The ligands were characterized by IR, NMR, UV spectroscopy, and different physical parameters. It has been seen that all the Mo complexes are black-colored and diamagnetic. The IR, NMR, and UV analyses reveal that the ligand coordinates to the Mo dioxo moiety by azomethine nitrogen and thiol sulfur atom. IR and NMR spectroscopic data also proved the presence of Mo dioxo moiety. The presence of the OH group in the Mo complex was also confirmed by the IR spectrophotometric method. Hence, a bridging structure of the Mo complex is suggested.

２．論文

Assessment of natural radioactivity and function of minerals in soils of the ship-breaking area, Bangladesh, by Gamma Ray spectroscopic and Fourier Transform Infrared techniques

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１．成果

・Research objective・ Commercial vessels typically enter their end-of-life（EoL）phase after an average economic lifespan of 20 to 30 years and commonly undergo dismantling. Annually, approximately 2% of the global inventory, comprising about 45,000 ocean-going ships, is processed within the ship-breaking and recycling industry（SBRI）. In the last two decades, South Asian countries, including Bangladesh, India, and Pakistan, have become favored destinations for end-of-life vessels. The issue of coastal contamination arising from ship-breaking activities at open beaches has been a subject of active debate. Providing an objective opinion on this matter necessitates a health risk assessment of ship-breaking activities. The current study aims to evaluate the impact of natural radioactivity resulting from naturally occurring radioactive materials（NORMs: U-238, Th-232, and K-40）and mineralogical characterization in the soils of the Shipbreaking and Recycling Industries zone in Bangladesh. ・Experimental・ From January to December, samples were systematically collected from five Shipbreaking and Recycling Industries（SBRIs）and one designated control location. Each shipbreaking yard was divided into three distinct segments based on the conducted activities: beaching, cutting, and storage. Notably, the cutting and storage segments are particularly exposed to higher activity levels during ship-breaking operations. Samples extracted from the cutting and storage segments were amalgamated to create composite samples, which were subsequently air-dried and preserved. Following established protocols, these preserved samples were analyzed using Gamma Ray and Fourier Transform Infrared spectroscopic techniques. ・Observations・ The concentrations of naturally occurring radioactive materials, namely U-238, Th-232, and K-40, were measured in Bq/kg using the Gamma

Ray spectroscopic approach. These measurements exhibited variations across the pre-monsoon, monsoon, and post-monsoon seasons. Additionally, Fourier Transform Infrared spectroscopy was employed for the identification and characterization of minerals present, including quartz, microcline feldspar, orthoclase feldspar, kaolinite, montmorillonite, illite, and organic carbon.

２．論文

Synthesis and characterization of Co(III) and Ni(II) complexes of N-pendent derivatives

of an isomeric octamethyl tetraazamacrocyclic ligand and applications in radioactive

waste decontamination

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１．成果

Cobalt (Co) and nickel (Ni) are essential micronutrients necessary for a well-functioning for human body. However, several compounds of Co and Ni are also considered to have chemical and/or radiological toxicity for the environment or individuals. Co-60 (half-life= 5.3 years) and Ni-63 (half-life = 96 years)) are radioisotopes, which produce high-energy gamma rays with a high chance of penetration into the human body to cause internal irradiation in the human cells and may cause cancer. Radioactive isotopes of Co and Ni may be released to the environment because of nuclear power plant operations; an accident occurs in nuclear power plants; radioactive waste dumping in the sea, or from radioactive waste landfills. Therefore, effectively removing these radioisotopes from the existing contaminants is critically important. For the future development of effective chelator-modified sorbents, it is essential to investigate the complexation behavior of Co(III) and Ni(II) with different chelators. The current study aims achieve the following objectives: 1. Synthesis and characterization of methyl substituted ligand salt, 2,9-C-meso-Me8[14]diene·2HClO4 (L·2HClO4) and reduction of the diene to Me8[14]ane. 2. Synthesis of N-bis-carbamoylethyl ligand LBM from isomeric Me8[14]ane (LB) and its characterization. 3. Synthesis and characterization of Co(III) and Ni(II) complexes of the ligand, LBM. ・Experimental・ Condensation of 1,2-diamino propane with acetone in the presence of perchloric acid furnished a 14-membered octamethyl tetraazamacrocycle, Me8[14]diene.2HClO4, which further produced a mixture of isomeric ligands, Me8[14]anes (LA, LB, and LC), on reduction with NaBH4 and subsequent extraction with CHCl3 (pH > 12). The isomers were separated by fractional crystallization from xylene. Interaction of LB with excess acrylamide afforded an N-

pendant derivative, LBM, in which two carbamoylethyl groups were attached to less crowded nitrogen atoms. The complexes of Co(III) and Ni(II) with LBM were synthesized by a non-template method. The complexes were characterized using FTIR, NMR, UV-Vis., and X-ray analyses. ・Observations・ Upon the interaction of LBM with Co(III) acetate in presence of concentrated HCl produced six-coordinated octahedra complex, [Co(LBM)Cl2](ClO4). The reaction between LBM and Ni(III) perchlorate produced six-coordinated octahedra complex, [Ni(LBM)(ClO4)2]. The study suggest that amino-functionalized macrocyclic ligands could be efficient for removing radioactive Co(III) and Ni(II) from wastes.

2．論文

Modelling of the transfer of radionuclides and their uptake by marine biota due to hypothetical accidental release of the Fukushima storage water

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共同研究者：MADERICH Vladimir

１．成果

The open-source Lagrangian model Parcels was applied for the analysis of trajectories of radioactively contaminated water released from Fukushima storage tanks to marine environment. For this aim, virtual particles were released in the coastal zone near the Fukushima Daiichi Nuclear Power Plant (FDNPP). The Parcels model simulates the movement of each particle using 3 components of velocity in the particle location at actual moment of time. The model uses different interpolation schemes, as well as integration schemes for simulating the particles movement due to advection, vertical diffusion, horizontal diffusion etc. Results of simulations can show trajectories, along which the contaminated water will move. The modelling area covers the whole North Pacific. 3D fields for three components of water velocities (U, V, W) were taken from the KIOST-MOM model. They are monthly averaged; so, we used 12 sets of (U, V, W), which were repeated every year. Particles were released from one point near the coast in front of FDNPP at the depth 10 m. One particle was released every 20 minutes during one year, 26,280 particles in total. Simulation was continued for 40 years. Results of simulations were processed to obtain trajectories of particles, which reached selected locations in different parts of Northern Pacific. 11 locations were selected to analyse minimal time needed the contaminated water to reach each location. According to model results, particles will reach Alaska fastest than other locations, only 1.4 years is needed for this. The box model POSEIDON-R was applied for the dose assessment in the area 10 x 10 km around release point. The release scenario was selected as normal release of Fukushima treated water during 30 years. In the POSEIDON-R model, the dynamic processes for water-sediments interaction and for the uptake and retention of radionuclides in marine organisms, which form pelagic and benthic food chains, were employed. The POSEIDON-R calculations were carried out for 50 years (30 years of

release period and 20 years of post-release period) to emulate the real-time scales of the treated water release. It was realistically assumed that only treated water was routinely released. It was conservatively assumed that the discharge of treated water is governed by the maximal allowable annual release of 3H equal to 22 TBq. Since the concentration of radionuclides including tritium in storage tanks varies, the water discharge rate will be different for each tank depending on the concentration of the tritium to achieve the annual release of 22 TBq. Then treated water from tanks with lower concentrations of tritium could be discharged more intensively leading to a higher release rate for radionuclides other than tritium. Obtained in the model individual doses to humans were well below the 1 mSv per year limit for the general public. They were also below the dose constraint value of 50 ・Sv that was set by NRA for domestic nuclear power plants, and even below the annual dose of 10 ・Sv, which is considered by the IAEA as a dose below which there is no negative health effect to be expected.

2．論文

Establishment of FISH probes for dicentric analysis of wild rodents in Chornobyl

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１．成果

Dicentric chromosomes, which are radiation induced chromosome aberrations, are difficult to analyze in rodents because majority of the chromosomes are acrocentric and the short arms are not visible. The purpose of this study is to establish fluorescence in situ hybridization (FISH) method for the bank vole, Myodes glareolus (2n = 56), which is a common rodent species in Chornobyl, in order to simplify and shorten the dicentric assessment by visualizing the centromere of chromosomes. However, conducting research in Ukraine has become difficult and unsafe due to the on-going war. To progress our research, we decided to establish FISH probes for a closely related rodent species in Japan. Using extracted DNA from liver of bank vole (previous study: I-21-11) as a template, the candidate centromere-specific tandem repeat region, Msat-160, was amplified by PCR (referenced by Jernfors et al., 2021) and mounted fluorescent dye to create a probe. Then, chromosome spreads of cultured bone marrow cells were prepared for three related species, grey red-backed vole (M. rufocanus), Northern red-backed vole (M. rutilus) collected in Hokkaido, Japan and bank vole collected in Chornobyl, Ukraine. After labelling each centromere, all of chromosomes with the exception of the Y chromosome were successfully stained for both Japanese vole species. However, for bank vole, some chromosomes were not stained (previous study: I-22-13). To establish new probes, Msat-160 motifs were extracted from whole genome sequence data of bank vole and primers were re-designed. Amplified ladder band by PCR using three species of DNA as template were fluorescently labeled and centromeres of bank vole were labeled by FISH method. Some chromosomes were labeled but some were not, like previous results. As for the next step, we will check sequences of probes and identify the chromosomes that each probe labels and consider using mixture of probes.

２．論文

Assessment of the effects of ionizing radiation in bees - BEERAD

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１．成果

The risk assessment linked to the radiocontamination of the environment after a nuclear accident is a major ecological issue but is still surrounded by controversial results and conclusions on the real impact of such events on flora and fauna inhabiting the targeted zones. Moreover, the potential underlying mechanisms of the action of ionizing radiation are poorly known. Therefore, it is important to acquire data on the potential effects of ionizing radiation on ecosystems both in experimental and realistic conditions. The objective of this project is, using a pluri-disciplinary approach, to increase the knowledge of effects and mechanisms of action of IR on physiology and populations of honeybees in the context of chronic exposure (i.e., exposure of a significant period of time relative to the lifespan of exposed organisms) and at low dose rates (sublethal ecotoxicity) in realistic conditions, i.e., on the field and in the laboratory. However, very few data exist on this subject, and it seems important to conduct studies which will serve as a basis to better evaluate the impacts of IR on animal health using honeybees.   Main results: In 2023, six sites were finally selected for hive installation: 2 in Okuma town (High dose), 1 in Namie town and 1 in Futaba town (Low dose) and 2 in Minamisoma town (controls). Our IER colleagues took care of the identification of land owners and the obtention of written authorizations for deploying the hives on the six sites selected. Hives were installed in April 2023 and were sampled in April and in July for Cs measurement and biomarker analyses. Honey was collected in June for measurement of radioCs and pesticide content. In October, the sampling could not have been done due to hornets, who devastated the hives. New hives will be installed in 2024 from April to July. Concerning the laboratory experiments, one irradiation experiment of small hives was performed in April 2023. The irradiation experiment lasted 21 days. Bees were sampled every week for biomarker analyses (still in progress). Analyses were supposed to be done on newborn bees, but the queens stopped spawning while they were inside the irradiation facility. New irradiation experiments will be held in 2024 on queens and larvae.

２．論文

RADIATION MAPPING SURVEY AROUND RADIATION FACILITIES IN

THAILAND FOR RADIOLOGICAL EMERGENCY PREPAREDNESS

AND RESPONSE

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１．成果

In March 2023, There were two radiological incidents in Prachinburi province, Thailand which were interested to public as well as both national and international medias. The first emergency situation was a missing radioactive source of caesium-137（Cs-137）contained in a metal cylindrical shielding from a radiation facility, and the second was the detection of metal ash contaminated caesium-137 at a metal foundry. It has not been confirmed whether those two emergency situations are linked to each other. However, people are concerned about radiation health effects and the release of caesium-137 into the environment, which need to be considered in radiation measurements around the affected areas. The car-borne radiation mapping survey is a technique that can be used to assess and investigate radiation levels in areas of public concern. Therefore, the study aims to develop an effective method using various types of active detectors for measuring radiation dose rates around two areas: the radiation facility that the caesium sources missed and the metal foundry that metal ash contaminated caesium-137 found.

Three types of active detectors with global positioning system（GPS）receivers (i.e., two sets of 2-in× 2-in NaI(Tl) scintillation spectrometers (Rad XP, SI Detection, South Korea), a 2-in×4-in NaI(Tl) scintillation spectrometers (SPIR-Pack, Mirion Technologies, USA), and a 63-mm x 63 mm NaI(TI) scintillation spectrometers (AT6101C, ATOMTEX, Belarus)) are used to measure radiation dose rates together with latitude and longitude positions of each dose rate record. The radiation measurements are conducted within 10 km around two target areas that emergencies occurred by using those three detectors placed in a car with the car speed not more than 40 km/h. Soil samples are also collected to estimate the activity concentration of radionuclides in those soil samples using gamma spectrometers in order to consider the relationship between

dose rates and activity concentrations of radiation measured around the target areas.

The result of this study is the radiation levels around the radiation facility that the ceasiem sources missed and the metal foundry that metal ash contaminated ceasiem-137 found that can be used for assessment and communication with the public about the radiation health effects of the people living within 10 km of the areas and also radiation effects in the environment.

２．論文

Development of Iodine-131 Absorption Efficiency Methods from Charcoal Filters with a Variety of Adsorbent Materials that are cheap for the safety of Thyroid Patients, Nuclear Workers and the Environment

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1．成果

1. The Results Introduction This research aims to develop a charcoal filter efficiency method (activated charcoal) for the absorption of Iodine-131 in hospitals and nuclear installations, to obtain a charcoal filter efficiency result close to the efficiency of a charcoal filter added with TEDA (Tri Ethylene Di Amin). A charcoal filter with KI or NaOH as an adsorbent is cheaper than charcoal filters with TEDA adsorbents. The efficiency is close to 99%, so it can help the burden of hospital thyroid patients from an economic and safety perspective of radiation workers in hospitals, nuclear installations, and the surrounding environment, as well as utilizing local products considering that Indonesia is a large producer of activated coconut shell charcoal. Methods This research consists of making activated charcoal filters mixed with Iodine-131 adsorbent material and testing the efficiency of the filter making results. Making variations in the concentration of each activated charcoal filter (charcoal) is weighed as much as 30 grams and placed in a beaker glass. Potassium iodide (KI), and NaOH were weighed respectively and varied in concentration (0%, 5%, 7,5% and 10%). The methanol solution is mixed with distilled water, then put into a bottle. The weighed KI, and NaOH were put into each bottle for each concentration. The solution is put in a heating furnace at 40 oC. The activated charcoal that has been dried and cooled is put in an activated charcoal filter container. Each activated charcoal filter container is labeled for each concentration made. Active charcoal filter efficiency testing was carried out using an Iodine-131 generator. The iodine generator is opened, dimethyl sulfate $((CH_3)_2SO_4)$ and I-131 are put into the iodine generator. Measurement of the adsorption efficiency of

I-131 at an energy of 364.48 keV on a charcoal filter using a gamma spectrometer system with a NaI(Tl) detector. The Results The quality of impregnated activated carbon decreases if the percentage of impregnated material exceeds 5% by weight. Charcoal with mesh 8-20 (A) is better than mesh 12-30 (B) because the efficiency of charcoal in A is higher than in B. Charcoal with KI compounds has a higher absorption efficiency of I-131 than charcoal with NaOH compounds. Charcoal efficiency with KI and NaOH compounds at a concentration of 5% wt. was better than concentrations of 7.5% and 10% by weight. 2. The Paper I don't have a publication yet, but I hope that I will make a paper this year.

２．論文
not yet

Development of a test bench for the electronics of ionizing radiation detectors based on FPGA and microcontrollers.

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Vitrice Ruben・OMGBA ABANDA　Zacharie Stève・YERIMA ABBA Hamadou

１．成果

Development of a test bench for the electronics of ionizing radiation detectors based on FPGA and microcontrollers Kountchou Noube Michaux, Saïdou, Mbarndouka Taamté Jacob, Folifack Signing Vitrice Ruben, Omgba Abanda Zacharie Stève, Hamadou Yerima Abba, Shinji Tokonami, Hosoda Masahiro　The primary objective of this project is to develop an efficient and low-cost local test bench for verifying the correctness of electronic circuits in ionizing radiation equipment. Additionally, the aim is to reduce maintenance costs, minimize breakdowns, refurbish existing equipment, improve staff performance, and enhance laboratory capabilities. The test bench will also facilitate the adjustment of pole-zero cancellation and study the pile-up effect. Within the framework of this project, our team has been dedicated to the development of a cutting-edge test bench tailored for the electronics of ionizing radiation detectors. Our primary goal has been to create a solution that not only ensures the accuracy of electronic circuits but also addresses the overarching objectives of reducing maintenance costs, minimizing breakdowns, and enhancing the capabilities of CRSTN and IREM laboratories. The project began with an in-depth analysis of requirements, involving extensive discussions with stakeholders to understand their needs and expectations fully. Based on these insights, we meticulously selected appropriate hardware components, including FPGA and microcontrollers, ensuring they met the stringent criteria of performance, flexibility, and cost-effectiveness. Additionally, careful consideration was given to selecting analog components such as ADCs, DACs, and op-amps, essential for signal conditioning and data acquisition. With a clear understanding of the requirements and the chosen hardware, we proceeded to design the system architecture. This involved outlining the

interconnections between FPGA and microcontrollers, defining communication protocols, and allocating responsibilities between different components. For the continuation of this project, which is still in progress and will continue in 2024 (FY2024 ERAN), our team will embark on the development of firmware for the FPGA, implementing sophisticated signal processing algorithms and digital control logic, while concurrently developing user-friendly software interfaces for microcontrollers to facilitate seamless control and data acquisition. The integration of hardware and software components will mark a significant milestone, culminating in an exhaustive testing phase. Rigorous testing protocols were employed to validate the functionality, accuracy, and reliability of the test bench. Calibration procedures will be meticulously executed to ensure precise measurements, laying the foundation for robust performance in real-world scenarios. Upon completion of testing, we'll focus on validation and comparison. We will carry out comprehensive comparative tests, benchmarking our test bench against reference equipment such as the Bladewerx microPulser in Cameroon. The results will validate the effectiveness and will contribute to significantly enhance laboratory capabilities. Documentation and training will be a priority to ensure seamless adoption and utilization of the test bench by laboratory personnel. Detailed documentation will be compiled, covering design specifications, implementation details, and testing procedures. Training sessions will be conducted to equip maintenance staff and laboratory personnel with the necessary skills to leverage the test bench effectively in their daily operations. Looking ahead, our focus will be also on further validation tests, gathering feedback for continuous improvement, exploring collaboration opportunities with other research institutions, and closely monitoring the performance of the test bench in real-world scenarios. We are convinced that the test bench to be developed will serve as a cornerstone in advancing the field of ionizing radiation detection,

２．論文

Jacob Taamté Mbarndouka, Vitrice Ruben Folifack Signing, Modibo Oumar Bobbo, Michaux Kountchou Noubé, and Yerima Abba Hamadou. "Air Quality Assessment Based on a Smart Locally CO_2 Monitoring System with Validation by a Reference Instrument." Sustainable Chemical Engineering (2024): 259-278, https://doi.org/10.37256/sce.5120

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Spatial uranium distribution in Mamuju

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共同研究者：NUGRAHA Djatnika Eka・PUTRI Jenisa Andeva

１．成果

Spatial Uranium, Thorium and Potassium Distribution at High Natural Background Radiation Area, Mamuju, Indonesia Wahyudi1, Radhia Pradana1,4,, Ilsa Rosianna2, Agus Nur Rachman1, Andeva Jenisa Putri3, Eka Djatnika Nugraha1* Chutima Kranrod4, Yasutaka Omori4, Shinji Tokonami4 1 Research Center for Safety, Metrology, and Nuclear Quality Technology, The National Research and Innovation Agency of Indonesia 2 Research Center and Technology of Nuclear Fuel Cycle and Radioactive Waste, The National Research and Innovation Agency of Indonesia 3Department of Chemistry, Faculty of Sciences, Sumatera Institute of Technology, Bandar Lampung, Indonesia 4Institute of Radiation Emergency Medicine, Hirosaki University – Japan * Corresponding author: ekad001@brin.go.id   Mamuju is an area that has a high content of uranium. Uranium is geogenic and has three isotopes, i.e., Uranium-238 (238U), 235U, and 234U. Of these, the most abundant is 238U, which makes up about 99.27% of natural uranium. The adverse effects of uranium on human health are due to its radiological and chemical properties. Radioactive elements with a heavy metal nature can deliver a trace quantity of radiation dose to the population. For the present work, surface soil samples from the mineralized area in the high natural background radiation area (HNBRA) Mamuju are collected at 3 locations with different soil depths. This study aims to understand and evaluate the possible interactions of various naturally occurring radionuclides in the Mamuju area. Moreover, the samples are measured using gamma spectrometry with a HPGe detector for determinations of 238U, 232Th, and 40K. Then, make the statistical analysis. The activity concentration of 238U, 232Th, and 40K ranges from 984 to 14507 Bq kg-1, 858 to 4503 Bq kg-1, and 177 to 285 Bq kg-1, respectively. The U/Th concentration ratio in the surface soil was from 0.34 to 11.56 and for the bottom soil 0.58 to 12.90.   The research was conducted at Tande-Tande, Botteng, and Palada Villages, Mamuju – West Sulawesi. This tropical region has dry and rainy seasons, and the shape geological contour is hilly land. A study of the spatial distribution

of 238U, 232Th, and 40K radionuclides in the area was carried out taking the soil sampling with variations of depth, and this study assumed that the radionuclides of U-238 and Ra-226 are equilibrium in the soil. The samples were analysed at the Laboratory with ISO 17025:2017 Accredited. To calculate the activity concentration of 238U in samples, we used the full energy absorbed peak of 214Pb (Eγ = 351 keV) and 214Bi (Eγ = 609 keV). For 232Th, we used the full energy absorbed peak of 212Pb (Eγ = 238 keV), 208Tl (Eγ = 581 keV), and 228Ac (Eγ = 911 keV), while for 40K, we directly used its single peak of 1460 keV. 238U concentrations in Tande-Tande, Botteng, and Palada are relatively homogeneous at various soil depths as well as 232Th, and 40K. Ratio of U/Th at Tande-Tande and Palada has almost the same trend, showing that the two locations have almost the same conditions. This condition differs from Botteng, where the U/Th is quite large so Botteng may have uranium deposits.

2．論文
Car-borne survey and dose assessment from external radiation exposure in Bangka Island

Development method of Radioparticulates measurement in the Mining area

氏名：NUGRAHA Djatnika Eka
受入研究者：床次 眞司・大森 康孝・Kranrod Chutima

１．成果

Inhalation of Radon（222Rn）and Thoron（222Rn） progenies in the domestic environment contributes the greatest fraction of the natural radiation exposure to the public and workers. A large proportion of the inhaled radon progeny deposits in the respiratory tract of the lung, while almost all of the gas and fine particles that are inhaled are subsequently exhaled. Nearly the entire lung dose arises from the inhalation of the radon progeny aerosol and not from the gas itself. This research activity aims to measure radioparticulate in mining areas contributed to inhalation dose due to Naturally Occurring Radioactive Material（NORM）and develop a simple method to measure radioparticulate Particulate matter（PM）10, PM 2.5 and PM 1. The first step is to develop a simple method of radioparticulate, including radon-thoron and their progeny. This method will use an integrated measurement between radioparticulate and EERC/EETC using the improvement of the impactor and measure with Total Reflection X-Ray Fluorescence（TXRF）for direct speciation of elements. Moreover, radioparticulates will be measured in the mining area, especially at the refinery processing in the tin mining industry. After that, estimating the aerosol size distribution were calculating. The result of he Aerosol size distribution as shown in table 1. Table 1. Aerosol size distribusion

２．論文

Pradana, R., Nugraha, E. D., Wahyudi, W., Untara, U., Wiyono, M., Devriany, A., ... & Tokonami, S. Car-borne survey and dose assessment from external radiation exposure in Bangka Island.

Study of the relationship of radon and airborne particulate matter to lung cancer

incidence factors in the high background radiation area in Kanchanaburi

氏名：RATTANAPONGS Chanis

受入研究者：床次　眞司・クランロッド　チュティマ

共同研究者：ARAMRUN Kitkawin

１．成果

The Provincial Health Office, Tha Maka district has the highest number of lung cancer cases in Kanchanaburi. In addition, Kanchanaburi is one of the provinces with high levels of PM 2.5 dust and is in a health hazard category. Therefore, in order to determine the factors that may contribute to these symptoms, the study focuses on radon-thoron measurements in 52 volunteer homes to correlate them with the data and select an area for measuring the concentration of their progeny for each dust size. The passive integrated radon–thoron discriminative monitor (RADUET: Radosys Ltd., Hungary) with a solid state alpha track detector (CR39) was installed for measuring indoor radon-thoron concentrations in the volunteer houses along with the estimation of gamma dose rates indoors and outdoors for choosing the five highest gamma dose rates in each sub-district. Indoor radon-thoron concentrations were again measured using an AlphaGuard detector on five volunteer houses based on the gamma radiation dose rate received at the beginning. Meanwhile, radiation aerosol samples were collected with a Cascade Impactor to separate aerosol particle size using CR-39 and separate the energy of the nuclide based on the Mylar aluminum film thickness. From the results, the measured gamma dose rate values were in the range of 0.11 - 0.25 μSv h-1, with the highest value in the Tha Mai sub-district for indoor and in the Ulok Si Muen sub-district for outdoor, which the values were similar to those in other areas of Thailand. The average values of radon and thoron from RADUET were found to be in the range of 13 - 81Bq m-3 for radon, with the highest concentration at Phra Thaen, while thoron concentrations were found in the range of 2 – 52 Bq m-3 with a maximum value in Phra Thaen. The average equilibrium equivalent radon and thoron within research area buildings as measured by a cascade impactor for separating aerosol particle sizes were 1.9×10-5 Bq/m3 and 3.63×10-6 Bq/m3. Considering all the data obtained, it was found that the radon thoron levels did not exceed

the limits recommended by the World Health Organization. Therefore, it is possible that the radiation concentration in the area may not have influenced the factors that cause lung cancer. However, additional data or annual data collection is needed to compare all values over the long term.

２．論文

Construction of Fluorescence in situ Hybridization (FISH) based Translocation Dose-Response Calibration Curve for Evaluation of Health Risk of Nuclear Workers

氏名：SYAIFUDIN Mukh

受入研究者：三浦　富智

１．成果

Accidental or occupational exposure to ionizing radiation poses a serious risk to public health and safety (Ahmad et al. 2019; Zielinski et al., 2009). According to Barnes et al. (2018), this radiation is a well-known carcinogen and clastogen that damages chromosomes. For the purpose of biodosimetry, a few useful biomarkers can be utilized to show and evaluate the development of radiation-induced alterations in the biological system. In order to triage exposed individuals and implement prompt medical countermeasures, this tool is necessary for quick dose and risk assessment (Herate and Sabatier, 2021). In biological dosimetry, the measurement of chromosomal aberrations in blood samples, mainly dicentric and reciprocal translocation, from exposed personnel is regarded as the "gold standard" and a highly sensitive biomarker (IAEA, 2011). It has been demonstrated that chromosome painting using fluorescence in situ hybridization (FISH) is a reliable and quick way to measure structural chromosome rearrangements, such as chromosome translocation, in human lymphocytes (Shakoori, 2017). The FISH technique, despite its high cost, is thought to be a potent tool for identifying particular chromosomal abnormalities because of its high sensitivity and the speed at which the assays can be completed.　　　Methods The peripheral blood samples were taken by venipuncture from 3 healthy donors (BD vacutainer). All volunteers were male and non-smokers, with an age range of 40 to 58 years old (average of 51 ± 9.64). In brief, whole blood was exposed at RT to X-rays (dose rate of 1.0 Gy/min) at doses ranging from 0.0, 0.1, 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, and 4.0 Gy. Samples were cultured at 37°C for 48 h, in the presence of 180 μg/ml phytomemagglutinin After 48 h, the cultures were fixed, and the chromosome preparations were labeled with a FISH probe according to Abe et al. (2016). At least 800 metaphase cells for every dose of irradiation were scored. Metaphases were captured using the Metafer Image Analysis System (Metasystems). Metaphase spreads were scored blindly for types of damage, which included only a

specific type of stable aberration such as translocations. Fitting the dose–response to the linear–quadratic model was carried out by the method of iteratively reweighted least squares. Results In this experiment, chromosomes translocations were observed among 36,654 metaphase cells painted with chromosome 1, 2, and 4 for all doses of X-rays under a fluorescence microscope. We found that the frequency of cell-containing translocation -positive metaphases is increasing with the radiation dose increment, where these frequencies became much higher due to exposure to the highest doses (2-4 Gy). There is a similar tendency to increase the frequency of cells containing translocation among the three subjects. It can be seen that subject C is less responsive compared to other subjects (Figure 1). There is a quite large individual differences in the frequency of translocation, especially in higher dose than 1 Gy and in subject C who is youngest respondence, it seem affected by confounding factors such as age which is also depend on life-style like smoking.   Figure 1. Relationship between the frequency of cells containing-translocation with dose of X-ray radiation among three subjects (left) and example of multiple aberrants (right). References Abe, Y., Miura, T., Yoshida, M.A., Ujiie, R., Kurosu, Y., Kato, N. et al

2．論文

Optimization fixation time for detection gamma H2AX as biomarker of DNA DSB

after low dose radiation

氏名：KURNIA Iin

受入研究者：三浦 富智

１．成果

Effect of Different Blood Anticoagulant to γ-H2AX Expression for Biodosimetry and Genome Damage Biomarker Application Iin Kurnia Hasan Basri1*, Dwi Ramadhani1, Mukh Syaifudin1, Sofiati Purnami1, Tomisato Miura2** 1Research Center for Radiosotope, Radiopharmaceutical and Biodosimetry Technology Research Organization for Nuclear Energy National Agency for Research and Innovation (BRIN) Kawasan PUSPIPTEK Serpong Gedung 11, Setu, Tangerang Selatan｜15314 Banten｜Indonesia 2Department of Risk Analysis and Biodosimetry Institute of Radiation Emergency Medicine, Hirosaki University Japan *email: iink001@brin.go.id **host research supervisor   ABSTRACT   Background Biological indicators are used for assessing DNA damage and repair in cells exposed to ionising radiation. DNA double-strand breaks (DSBs) have been known as one of the most significant lesion-producing lethal and mutagenic effects in irradiated cells. This biological marker for DSBs is the presence of γ-H2AX foci in the cell nucleus after exposure to ionising radiation. γ-H2AX formation was analysed in human lymphocytes with the problem being finding the best incubation time, temperature, and anticoagulant type for collecting blood from remote areas before being brought to the laboratory for γ-H2AX analysis.   Method The blood was obtained from three male donors and irradiated by X-ray with a dose of 0.5 Gy and held in heparin and EDTA anticoagulant for 1 and 24 hours of incubation time at temperatures of 4oC, 20oC, and 32oC.   Cells were fixed with paraformaldehyde and spread on a microscope slide using a Cytospin. The slides were immunostained after an incubation period. The number of foci per cell was scored automatically in about 100 cells per dose using Metavision with foci counting.   Result The mean number of foci/cells before irradiation for donor A = 0.02 and 0.05, donor B = 0.03 and 0.04, and donor C = 0.03 and 0.04 in EDTA and heparin anticoagulant, respectively. One hour after 0.5 Gy irradiation, the mean number of foci/cells was A = 0.82, B = 1.21, C = 0.98

in EDTA, and A = 1.13, B = 1.37, C = 1.64 in heparin anticoagulant. After 4 oC incubation time, these were A = 0.43, B = 0.34, C = 0.13 in EDTA, and A = 1.58, B = 1.67, C = 1.39, in 20 oC A = 0.97, B = 0.84, C = 0.53 in EDTA, and A = 1.05, B = 0.87, C = 0.82 in heparin anticoagulant, in 32 oC A = 0.19, B = 0.14, C = 0.09 in EDTA, and A = 0.71, B = 0.42, C = 0.16 in heparin anticoagulant. No statistically significant number of γ-H2AX foci from the A, B and C donor before irradiated in both EDTA and heparin anticoagulants. One hour after 0.5 Gy irradiation there were statistically significant increasing of γ-H2AX foci for all donors both in EDTA and heparin anticoagulant. Twenty hours after incubation in 4 oC, in donor C there was no statistical increasing of number γ-H2AX foci before irradiation but in donors A and B increasing when the blood collected by EDTA anticoagulant, but in heparin anticoagulant the number of γ-H2AX foci from donors A, B and C showed statistical increase. After incubation at 20 oC for 24 hours, for both EDTA and heparin anticoagulant, there were significant increase of number of γ-H2AX foci from donors A, B, and C. After incubation for 320 C for 24 hours except in donor C, number of γ-H2AX foci in heparin anticoagulant showed significantly higher than incubation with EDTA. Conclusion After low dose irradiation, the number of γ-H2AX foci in heparin anticoagulant is higher than that of EDTA anticoagulant and it recommended that anticoagulant factor should be considered before the analysis of γ-H2AX foci for application in biodosimetry and genome damage biomarkers. Keywords: anticoagulant, γ-H2AX foci, ionising radiation, human lymphocytes, biological indicators.

２．論文

A cytogenetic dose-response curve for low-dose range gamma-irradiation in human peripheral blood cells using three-color FISH

氏名：PURNAMI Sofiati

受入研究者：三浦 富智

１．成果

Introduction Biodosimetry is a fundamental approach for determining the dose of ionizing radiation absorbed by an individual. The FISH technique using three colored chromosome-specific painting probes (chromosomes 1, 2, and 4) have been used to evaluate the biological effects of low-dose range ionizing radiation on human peripheral blood cells. In this study, we aim to obtain the reference dose response curve for evaluating cytogenetic effects of low-dose range irradiations on human lymphocytes using three color FISH　Methodology Human blood from three healthy donors have collected in Heparin-containing vacutainer tubes. Blood samples were irradiated with five X rays doses (0.1; 0.25; 0.5; 0.75 and 1 Gy) then cultured for 48 hours continue with harvesting and painting process. The number of chromosome aberrations have analyzed by chromosome painting (chromosome pairs 1, 2 and 4) for translocation analysis. Result The frequency of translocation was increased with the increment of radiation dose, by following a linear-quadratic curve, based on the observation in three subjects exposed to X-rays. When the data from all subjects were pooled, a similar trend was observed. The equation obtained using the pooled data was: $Y = 0.01283X + 0.0039$ ($R2 = 0.9664$); which Y: Translocation per cells vs X: Dose (Gy). The increased of translocation with the radiation dose was found, thus our study support the applicability of the FISH technique for biodosimetry.

２．論文

Dwi Ramadhani, Devita Teriana, Sofiati Purnami, Viria Agesti Suvifan, Iin Kurnia Hasan Basri, Teja Kisnanto, Tiara Andalya Oktariyani, Dira Syafira, Muhamad Yasin Yunus, Tomisato Miura, Mukh Syaifudin and Retno Widowati, γ -H2AX and phosphor-ATM enzyme-linked immunosorbent assays as biodosimetry methods for radiation exposure assessment: a pilot study, Radiation Protection Dosimetry, 2023, 1-8, https://doi.org/10.1093/rpd/ncad253

Optimization of the tritium analysis method and its application to sea water samples

氏名：MAKMUR Murdahayu
受入研究者：赤田　尚史
共同研究者：NUGRAHA Djatnika Eka・PUTRA Irawan Permana Deddy

１．成果

I-23-33 OPTIMIZATION OF THE TRITIUM ANALYSIS METHOD AND ITS APPLICATION TO SEAWATER SAMPLES: ANTICIPATION OF TRITIUM DISPOSAL FROM THE FUKUSHIMA DAIICHI NUCLEAR REACTOR, JAPAN MAKMUR Murdahayu, NUGRAHA Eka Djatnika, PUTRA Deddy Irawan Permana & AKATA Naofumi   Introduction Japan has announced plans to discharge more than 1.2 million tons of radioactive water from the waste treatment reactor of Japan's Fukushima Daiichi Nuclear Power Plant (FDNPP) into the Pacific Ocean by March 2023. Disposal of tritium waste is carried out on the East coast off the coast of Fukushima, tritium radionuclide will be carried throughout the Pacific Ocean by global ocean currents, and dispersed into the surrounding marginal seas. Tritium-contaminated water will enter the waters of the Indonesian Sea through the Makassar Strait which is the main route for the Indonesian Throughflow. This will have an impact on increasing the concentration of natural tritium in Indonesian waters. Tritium-contaminated water can pose a radiation threat to marine ecosystems and human health, including in the waters of the Indonesian Sea. Thus, the optimization of the tritium analysis method from seawater was carried out in this study and the selected method will be applied to samples from Indonesian marine waters, so that tritium baseline data is obtained before the disposal of tritium waste from Fukushima, Japan.   Methodology There are many marketed scintillation cocktails available for tritium counting, but only several retain a considerable amount of water, and even fewer have adequate specifications for low-level counting. We compared the efficiency of the Ultima gold LLT and OptiPhase HiSafe cocktails, which are now available in our laboratory. Samples were collected samples from Halmahera Sea and Sunda Strait were collected monthly from January to November 2023. Seawater samples were collected using a plastic bottle. After collecting 700 ml of water, samples were distilled to remove any impurities, to reduce quenching, and to prevent the introduction of other radionuclides that might adulterate the results and use electrolytic enrichment

to raise the tritium concentration to a detectable level. One-tenth of a milliliter of the second tenth of the distillate was added to twenty milliliters of polyethylene scintillation vial and mixed with ten milliliters of PerkinElmer's OptiPhase HiSafe scintillation cocktail. We measured the tritium activity of water samples using LSC Quantulus 1220. We counted each sample for three cycles of ninety minutes and then averaged the results to determine the tritium activity. Result and discussion To create DWTS, the 3H solution was spiked with distilled water. Samples were made using various proportions of cocktail to tritiated water, with a 20 ml total vial capacity being made available. For each standard, three cycles of measurements were performed in these tests, with a counting time of ninety minutes per cycle. We were able to verify that the ideal ratio of water to scintillation cocktail was 6:14 ml for Ultima Gold LLT and 10:10 for OptiPhase Hisafe by evaluating the count rates for standard tritium solution.   Tritium in the subtropical and tropical regions, showing an average slightly lower activity compared to the northern and subarctic transition zones, follows the overall trend of radiocesium, and based on the annual global tritium prediction results from rainwater, the Indonesian region has a relatively small tritium input (0.5 – 2 TU H-3) compared with other regions. The results research show that the baseline data on tritium in seawater from the Halmahera Sea (Code: TNT) and Sunda Strait (Code TJL) is in the range of 0.44 – 0.98 TU, (n=5, triplicate) which will become reference data if there is an increase in tritium activity in seawater in the future due to the release of tritium from Fukushima Japan.

2．論文
    not yet

Development method of radioactivity measurement in drinking water sample

using TXRF

氏名：ROSIANNA Ilsa

受入研究者：赤田 尚史・田副 博文

共同研究者：NUGRAHA Djatnika Eka・YUSUF Riyaz

１．成果

Water is a basic need for humanity Water is an important aspect for living things and one of the Sustainable Development Goals（SDGs）. A thorough study was recently carried out involving 45 samples of Drinking Bottled Water（AMDK）originating from 21 cities in Indonesia. This research was conducted by measuring the content of physiochemical parameters, major, trace elements and anions. Physiochemical parameters were measured using digital pH Hanna HI98107, EC digital Hanna DiST 3 HI98303, HACH DR 900 Colorimeter, TDS meter. Concentration of Major Elements（Na, Al, Mg, K, Ca P and S）, Trace Elements (Cl, Sr, Cr, Mn, Fe, Zn, As, Sc, Cd, Sb Ba, Pb, Th and U) were measured using Total Reflection X-ray Fluorescence, which was first validated by the method using standard ICP multi-element standard solution IV as a spike sample, determination of standard internal concentration（Ge）and continued measurement by TXRF. Anion concentrations were measured using the Dionex Ion Chromatography system （ICS-210, Thermo Scientific, USA）. The results of physiochemical parameter measurements obtained successive values for TDS, EC, Turbidity, Color and pH) of 0-262（mg/L）, 0-532（μS/cm）, 0 NTU, 2-14 TCU. The concentrations of major elements were obtained in the order of concentration of Ca>Na>Mg>P>Al>S>K and trace elements Sb>Ba>Sc>Sn>Th>Br>U>Mn>Pb>Cd. Based on the results of hydrochemical analysis using the Piper diagram, most of the samples（> 90%）belong to the calcium bicarbonate waters. A small portion of the sample（<10%）belongs to sodium bicarbonate waters. The results of the analysis using correlation analysis showed that there was a strong positive correlation（0.61 - 0.80）between Ca and -Mg (0.73), K and Cl- (0.68), TDS and K (0.62), Sc and Ba (0.62), U and Sb（ 0.67）, U with Ba (0.66) and a very strong positive correlation（0.81 - 1.0）between Ba and Sb（0.98）. The results of the analysis using Hierarchical Cluster

Analysis and Linear Discriminant Analysis,　both of them did not show that the ion levels in the bottled water samples matched the　geological data. The results of the calculation of the water quality index as a whole get　an index of 100 in 45 samples of AMDK which indicates that the water quality is very　good without any threats or disturbances and the water conditions are very close or　equivalent to pure.

2．論文
　-

Capacity building for development of nuclear techniques for analysis of radionuclides and

potential toxic elements in environmental samples collected from Ruppur Nuclear Power

Plant (RNPP), Bangladesh

氏名：RAHMAN M. Safiur

受入研究者：田副 博文・Anderson Donovan

共同研究者：SUDOWE Ralf

１．成果

Bangladesh grapples with a significant electricity shortage, making it imperative for the country to bolster power generation efforts. Consequently, our government has initiated a project to establish a 2400 MWe nuclear power plant slated for commissioning in 2025. Hence, it's crucial to develop expertise in managing radioactive materials to ensure radiation safety, mitigate environmental contamination, and facilitate remediation efforts. There's been a growing interest in understanding the uptake kinetics of radionuclides and toxic elements in natural systems to comprehend the dispersion of radioactive waste and toxic elements in the environment. Monitoring radionuclides and toxic elements in vegetables, soil, sediment, rock, and water samples across Bangladesh can furnish vital insights for managing radioactive materials and trace elements in the environment. Therefore, it is important filed of study and the following two graduate (M.Sc.) students have completed their thesis under my supervision and their manuscript will be published accordingly.   TITLE: (A). The Level of Natural Radionuclides and Heavy Metals in Ground Water and Health Risk Implication (B). Assessment of Natural radionuclides in soil samples collected from industrial areas of Chittagong city, Bangladesh

２．論文

Two thesis for graduate students have been completed (A). The Level of Natural Radionuclides and Heavy Metals in Ground Water and Health Risk Implication (Md. Robiul Hasan (Examination Roll: 142324), Nuclear Engineering Department, Dhaka University) (B). Assessment of Natural radionuclides in soil samples collected from industrial areas of Chittagong city, Bangladesh (Md. Robiul Hasan (Examination Roll: 142316), Nuclear Engineering Department, Dhaka University)

Anthropogenic radionuclides in the Southern Ocean

氏名：CHAMIZO Calvo Elena
受入研究者：田副 博文
共同研究者：Shinonaga Taeko

１．成果

Anthropogenic radionuclides are widely distributed in the general environment due to a multiplicity of sources. Baseline levels were imposed by the atmospheric testing of nuclear weapons in the 1945-1980 period, with a maximum in the 1960s (Global Fallout). The routine operation of nuclear facilities and nuclear accidents have also introduced radionuclides in the general environment but at local and/or regional scales. To date, there exists an extensive database of anthropogenic radioactivity in the marine environment in the Northern Hemisphere. By contrast, results for the Southern Hemisphere are scarce. In this work, the anthropogenic radionuclides 237Np, 239Pu and 240Pu have been studied in surface seawater samples from the Southern Ocean using the ultrasensitive technique Accelerator Mass Spectrometry (AMS). Samples were collected at the Antarctic Ocean (51º'-67º S, 42.45º-67.29º E) by cruise KH-19-1 of research vessel R/V Hakuho Maru of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) in 2019. Pu and Np isotopes were analysed on the 1 MV AMS system at the Centro Nacional de Aceleradores (CNA, Seville, Spain). The obtained 239+240Pu and 237Np activity concentrations levels range from 1 to 2 and from 5x10-4 to 3x10-3 μBq/kg, respectively, in agreement with the observed levels in surface seawater samples all over the world far from local or regional sources. Most of the obtained 240Pu/239Pu atom ratios range from 0.17 to 0.3 in agreement with global fallout levels. Data which will be obtained continuously in this project will shed light on the levels of anthropogenic radioactivity and the behaviour of each nuclide in the marine environment surrounding Antarctica.

２．論文

Comparative assessment and analysis of radionuclide measurement in fish of Fukushima

氏名：SUDOWE Ralf

受入研究者：Anderson Donovan・田副 博文・赤田 尚史・山田 椋平

共同研究者：JOHNSON Thomas

１．成果

The Fukushima Dai-ichi Nuclear Power Plant (FDNPP) accident on March 11, 2011, led to significant radioactive contamination of terrestrial and aquatic ecosystems in eastern Japan. Monitoring radionuclide concentrations in the environment became imperative to assess risks to ecosystems, wildlife, and human health. Hirosaki University (HU) and Colorado State University (CSU) started a collaborative effort to enhance research activities and establish an international learning platform for students focused on radiation monitoring, particularly in Fukushima. The collaborative effort centered on comparing methodologies for measuring 90Sr and 137Cs concentrations in fish samples from Fukushima. Both institutes aimed to validate their respective measurement techniques and improve research capabilities. Fish samples were collected from the Yunosawa River in Aomori Prefecture, Japan (control area), and the Ogurasawa River in Fukushima Prefecture, Japan (contaminated area). Measurements of 137Cs showed good agreement between the two institutes, with 3608 ± 160 measured by CSU and 3973 ± 28 measured by HU for fish samples from the contaminated area in Fukushima. Measurements for 90Sr are still ongoing. The collaborative effort confirmed the success of the radioanalytical measurement methods used by both institutes. This validation highlights the reliability of currently used techniques for sample measurement. Future research endeavors will expand the scope to include further comparative measurements and improvements in 90Sr measurement techniques. Additionally, investigations into isotopic ratios in field sites and a comparative analysis of mass spectrometry, gas proportional counting, and liquid scintillation counting sensitivities are planned. These advancements will contribute to refining measurement techniques and enhancing the accuracy of radiation monitoring. The collaboration between HU and CSU helped by validating measurement techniques and enhancing research capabilities. This partnership aims to contribute to ongoing efforts in assessing and mitigating the impacts of radioactive contamination on ecosystems, wildlife, and human health. Through continued collaboration and research advancements, we strive to ensure the safety and well-being of communities affected by nuclear incidents.

２．論文

N/A