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研究課題名(和文) Long-term dynamics of radiocesium in aquatic ecosystems of Fukushima and Chernobyl contaminated areas

研究課題名(英文) Long-term dynamics of radiocesium in aquatic ecosystems of Fukushima and Chernobyl contaminated areas

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研究成果の概要(和文)：気候、地形、降下物における放射性セシウム(r-Cs)の存在形態の特性が環境中r-Csの移行と自然減衰の速度の違いにつながることを示された。福島はチェルノブイリに比べ年間降水量が多く、台風シーズンに最大の暴風雨が発生する。2019年台風ハギビスは、河川流域や氾濫原にr-Csの再分布を引き起こし、場合によっては自然除染をもたらした。さらに集水域が急傾斜のため浸食性が高く、粒子状r-Csの流出が多い。河川・湖沼における放射性核種長期動態の半経験的拡散モデルを開発し、福島とチェルノブイリのデータセットを用いて検証を行った。河川・湖沼における放射性核種長期動態の再構築手法を提案し底質コアに適用した。

研究成果の学術的意義や社会的意義

The project provided assessment of the current state and prediction of r-Cs long-term dynamics in aquatic ecosystems of the Fukushima contaminated areas. Data obtained can be used by decision makers. Results were disseminated through mass media and meetings with people in Fukushima Prefecture.

研究成果の概要(英文)：The peculiarities in climate, geomorphology and radiocesium (r-Cs) speciation in the fallout were demonstrated to lead to differences in migration rates of r-Cs in the environment and rates of its natural attenuation. The climate conditions for the Fukushima Prefecture of Japan are characterized by higher annual precipitation as compared with Chernobyl with maximum rainstorm events during typhoon season. Typhoons Hagibis in 2019 demonstrated the substantial redistribution of r-Cs on river watersheds and floodplains and in some cases natural self-decontamination occurred. Steep slopes of Fukushima catchments are conducive to higher erosion and higher particulate r-Cs wash-off. A semi-empirical diffusional model for radionuclide long-term dynamics in rivers and lakes was further developed and validated using the Fukushima and Chernobyl datasets. A methodology for reconstruction of radionuclide long-term dynamics in rivers and lakes was proposed and applied for bottom sediment cores.

研究分野：Dynamics of environmental radioactivity

キーワード：Fukushima Chernobyl environment contamination radiocesium fate and transport rivers lakes

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1 . 研究開始当初の背景 / Background at the Beginning of the Study

Research of long-term dynamics of radionuclides in the environment continues to be of high relevance, both scientifically and practically, today when over 36 years have passed after the Chernobyl accident and 11 years after the Fukushima Dai-ichi nuclear power plant (FDNPP) accident. Climate and geographical conditions for Fukushima Prefecture and Chernobyl zone differ essentially and hence migration rates and solid-liquid distribution of r-Cs are different in Fukushima and Chernobyl areas (Konoplev et al., 2022). What is more, r-Cs deposited on the catchments and water bodies in Fukushima Prefecture is different from Chernobyl depositions in terms of speciation. Because of the complexity of processes involved, there are still many open questions as to how radionuclides in Fukushima aquatic ecosystems will behave in future. This project provided prediction of radionuclides dynamics in Fukushima water bodies based on obtained data and results. Also, given that fish is an important component of Japanese diet, we studied r-Cs transfer to various kinds of fish as a function of its age and size, and clarified prediction of r-Cs dynamics in fish.

2 . 研究の目的 / Purpose of the Study

The proposed project was aimed to study and compare long-term dynamics of radiocesium in rivers and other water bodies (reservoirs, lakes and ponds) of two areas contaminated following the major nuclear accidents (Chernobyl and Fukushima). Experimental studies were conducted to identify similarities and differences in the behavior of Chernobyl- and Fukushima-derived r-Cs in these water bodies, with a view to understand how environmental conditions such as climate, geology and geomorphology influence the fate and transport of accidentally released r-Cs in soil-water environment and its transfer to fish. Integrating research of different types (environmental media and biota) in the framework of one project was carried out in framework of the project.

Specific tasks of the project included:

- Characterization and prediction of r-Cs vertical distribution in catchment soils of contaminated areas both in Chernobyl and Fukushima.
- Assessment and prediction of chemical speciation of r-Cs in soils and sediments of aquatic ecosystems.
- Quantification and predict the long-term dynamics of dissolved and particulate r-Cs in rivers, reservoirs and lakes/ponds of the contaminated areas and its solid/water distribution as a function of time and solid and water phase chemical composition.
- Quantification of r-Cs transfer from water and sediments to fish as a function of fish species, fish size and water chemistry.
- Identification of similarities and differences in behaviour of Fukushima- and Chernobyl-derived r-Cs in aquatic ecosystems to improve the predictive power of semi-empirical and numerical models for long-term.

3 . 研究の方法 / Research Methods

Samples of water from rivers, lakes, reservoirs and ponds, suspended and bottom sediments, fish and soils on the catchments were periodically collected. Soils were collected on catchments and floodplains using 30-cm core sampler. Bottom sediments were collected by conventional method using standard sediment corers and grab samplers. Sediments/soil cores were sliced at 1 to 2 cm intervals and the dry solid were measured for ^{137}Cs and ^{134}Cs to obtain an activity-depth profile. R-Cs speciation were characterized in terms of proportion of exchangeable, bound by organic matter and nonexchangeable forms. Dissolved K^+ , NH_4^+ , Na^+ , Ca^{2+} , Mg^{2+} in water were measured by ion chromatography, and stable $^{133}\text{Cs}^+$ was measured by ICP-MS. Soils and sediments were characterized in terms of organic matter content and mineralogy. R-Cs deposition was assessed on the base of inventories in soils of catchments. Water samples of suitable volume (to make sure r-Cs detection both in solution and on suspended matter) were be filtered *in-situ* using "Midia" system and/or in laboratory using 0.45 μm membrane filter. Fish was be collected by conventional techniques using gill nets. ^{137}Cs and ^{134}Cs activity concentrations in all collected samples was measured by gamma-spectrometry using a high-purity germanium detector (HPGe) CANBERRA GC3018 (Konoplev et al., 2021a; Konoplev et al., 2021b).

Data on r-Cs dynamics in Chernobyl rivers (Pripyat, Sakhan, Braginka etc.) and lakes (Glubokoe etc.) were taken from the literature and data bases available to project participants. Dynamics of

r-Cs both in Fukushima and Chernobyl were be modelled and predicted using analytical, empirical and semi-empirical models (Konoplev et al., 2021b; Konoplev et al., 2022a; Konoplev et al., 2022b) as well as numerical models (MOIRA, COASTOX and THREEETOX) integrated in the Hydrological Dispersion module of EC RODOS system (Zheleznyak et al., 2022).

4 . 研究成果 / Research Results

It was shown that wash-off is the principle long-term process responsible for r-Cs secondary contamination of surface waters on accidentally contaminated areas. For its characterization the particulate and dissolved wash-off ratios were proposed. Both of them were found to decrease in the mid- and long-term as a result of r-Cs depletion in the topsoil layer due to its vertical migration in catchment soils.

The processes of wash-off, river transport and radionuclide vertical migration in catchment soils were considered in an integrated way by the proposed semi-empirical diffusional model. This is a novel approach enabling description of changes in the particulate and dissolved ^{137}Cs wash-off ratios using only two physically meaningful parameters D_{eff} - the ^{137}Cs effective dispersion coefficient in the topsoil layer and K_d - the ^{137}Cs apparent distribution coefficient.

The mid- to long-term monitoring data for both Chernobyl and Fukushima rivers did not reveal any time trend in the apparent ^{137}Cs distribution coefficient K_d despite distinct interannual variations. Comparison of collected data set for Chernobyl rivers Pripyat and Dnieper with obtained and available data for Fukushima rivers Ukedo and Ohta confirmed that the apparent $K_d(^{137}\text{Cs})$ value for Fukushima rivers is about an order of magnitude higher than for Chernobyl rivers.

The radiocesium dynamics was analyzed based on results of sampling campaigns in high-flow events. The episodic sampling at the river mouth of the Abukuma river during typhoon Hagibis revealed that substantial amount of ^{137}Cs is desorbed from suspended solids into seawater, elevating ^{137}Cs concentration in seawater. From the results obtained in three events in Niida, Ukedo and Takase rivers during 2019-2020, variations in both the dissolved and particulate ^{137}Cs concentrations appeared to reflect the spatial pattern of the ^{137}Cs inventory in the catchments, rather than variations in physico-chemical properties of suspended sediment and water.

Sampling campaigns during high-flow events were conducted on three major rivers flowing in the southern part of coastal area: the Natsui, Fujiwara, and Same rivers. A small river flowing in vicinity of Fukushima Dai-ichi Nuclear Power Plant, the Ottozawa river, has been monitored with hydrological monitoring instruments.

Data on changes in radiocesium inventories on different floodplain levels were collected and generalized for the Niida River basin and along the valley bottom of the Abukuma River. The data was derived using a variety of techniques, including analysis of ^{137}Cs depth distributions, evaluation of sediment and sediment-associated ^{137}Cs at artificial plastic lawn-grass mats, assessment of river bottom transformation based on satellite image interpretations and field survey with measurement of air dose rates. All these findings helped us to better understand the transformation of floodplain contamination levels after ordinary and extreme floods.

Particulate ^{137}Cs wash-off ratios from the catchments of the Fukushima area display only minor differences compared to those in the Chernobyl area, being at the lower limit of the Chernobyl values. Somewhat lower values of $N_p(^{137}\text{Cs})$ in the Fukushima area were explained by higher values of the effective dispersion coefficient $D_{\text{eff}}(^{137}\text{Cs})$ in typical Fukushima soils.

Dissolved ^{137}Cs wash-off ratios for Fukushima catchments were found to be at least an order of magnitude lower than those for Chernobyl, mainly due to an order of magnitude difference in the ^{137}Cs distribution coefficients for the Fukushima and Chernobyl rivers.

The temporal trends for the ^{137}Cs wash-off ratios, both in Chernobyl and Fukushima areas were satisfactorily described by the proposed model. This proposed model can be used as a tool to predict ^{137}Cs wash-off after a nuclear accident.

Long-term regular monitoring at the ponds in Okuma Town was carried out. Important parameters of radiocesium behavior such as rate constant of ^{137}Cs leaching from glassy hot particles (k_l) in soil-water system and exchangeable radiocesium interception potential (RIP^{ex}) have been determined. Scientific rationale was provided for the observed seasonal variation of dissolved ^{137}Cs in ponds: it appeared to be associated with temperature dependence of ^{137}Cs desorption from frayed edge sites (FES) of micaceous clay minerals. Based on data of the conducted field works, the activation energy (E_a) of this process was also estimated. The value of E_a was confirmed by Fukushima rivers observations jointly with members of Radioecology Project.

It was shown that bottom sediments of lakes and dam reservoirs can provide an insight into understanding the dynamics of ^{137}Cs strongly bound to sediment particles. A number of cores of bottom sediments were collected in deep parts of lakes Glubokoe, Azbuchin, and Cooling Pond in close vicinity of the Chernobyl NPP in Ukraine, in Schekino reservoir (Upa River) in the Tula

region of Russia (2018) and in Ogaki reservoir (Ukedo River) in Fukushima contaminated area (2019). Each layer of bottom sediments could be attributed to a certain time of suspended particles sedimentation. With ^{137}Cs activity concentration in a given layer of bottom sediments corresponding to ^{137}Cs concentration on suspended matter at that point in time, we were able to reconstruct the post-accidental dynamics of particulate ^{137}Cs activity concentrations. Using experimental values of the distribution coefficient K_d , changes in the dissolved ^{137}Cs activity concentrations were estimated. The estimates of particulate and dissolved ^{137}Cs concentrations in Chernobyl cases were in reasonable agreement with monitoring data and predictions using the semi-empirical diffusional model. However, both the particulate and dissolved ^{137}Cs activity concentrations and wash-off ratios in the Ukedo River declined faster during the first eight years after the FDNPP accident than predicted by the diffusional model, most likely, due to greater natural attenuation and, to some extent, remediation measures implemented on the catchments in Fukushima.

5. 主な発表論文等

〔雑誌論文〕 計32件（うち査読付論文 31件 / うち国際共著 27件 / うちオープンアクセス 9件）

1. 著者名 Konoplev Alexei, Wakiyama Yoshifumi, Wada Toshihiro, Igarashi Yasunori, Kanivets Volodymyr, Nanba Kenji	4. 巻 111
2. 論文標題 Behavior of Fukushima-Derived Radiocesium in the Soil?Water Environment: Review	5. 発行年 2022年
3. 雑誌名 Behavior of the Radionuclides in the Environment	6. 最初と最後の頁 33 ~ 68
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_4	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する
1. 著者名 Golosov Valentin, Konoplev Alexei, Wakiyama Yoshifumi, Ivanov Maxim, Komissarov Mikhail	4. 巻 111
2. 論文標題 Erosion and Redeposition of Sediments and Sediment-Associated Radiocesium on River Floodplains (the Niida River Basin and the Abukuma River as an Example)	5. 発行年 2022年
3. 雑誌名 Behavior of the Radionuclides in the Environment	6. 最初と最後の頁 97 ~ 133
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_7	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する
1. 著者名 Niida Takuya, Wakiyama Yoshifumi, Takata Hyoe, Taniguchi Keisuke, Kurosawa Honoka, Fujita Kazuki, Konoplev Alexei	4. 巻 821
2. 論文標題 A comparative study of riverine 137Cs dynamics during high-flow events at three contaminated river catchments in Fukushima	5. 発行年 2022年
3. 雑誌名 Science of The Total Environment	6. 最初と最後の頁 153408 ~ 153408
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.scitotenv.2022.153408	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する
1. 著者名 Konoplev Alexei, Wakiyama Yoshifumi, Wada Toshihiro, Ivanov Maxim, Komissarov Mikhail, Nanba Kenji	4. 巻 206
2. 論文標題 Reconstruction of time changes in radiocesium concentrations in the river of the Fukushima Dai-ichi NPP contaminated area based on its depth distribution in dam reservoir's bottom sediments	5. 発行年 2022年
3. 雑誌名 Environmental Research	6. 最初と最後の頁 112307 ~ 112307
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.envres.2021.112307	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Igarashi Yasunori, Nanba Kenji, Wada Toshihiro, Wakiyama Yoshifumi, Onda Yuichi, Moritaka Shota, Konoplev Alexei	4. 巻 127
2. 論文標題 Factors Controlling the Dissolved 137Cs Seasonal Fluctuations in the Abukuma River Under the Influence of the Fukushima Nuclear Power Plant Accident	5. 発行年 2022年
3. 雑誌名 Journal of Geophysical Research: Biogeosciences	6. 最初と最後の頁 6591
掲載論文のDOI (デジタルオブジェクト識別子) 10.1029/2021JG006591	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Konoplev Alexei, Laptev Gennady, Igarashi Yasunori, Derkach Hrigoryi, Protsak Valentin, Lisovyi Hlib, Korychenskyi Kyrylo, Kirieiev Serhii, Samoilov Dmitry, Nanba Kenji	4. 巻 11
2. 論文標題 Reconstruction of the Long-Term Dynamics of Particulate Concentrations and Solid?Liquid Distribution of Radiocesium in Three Severely Contaminated Water Bodies of the Chernobyl Exclusion Zone Based on Current Depth Distribution in Bottom Sediments	5. 発行年 2021年
3. 雑誌名 Land	6. 最初と最後の頁 29 ~ 29
掲載論文のDOI (デジタルオブジェクト識別子) 10.3390/land11010029	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Konoplev Alexei, Kanivets Volodymyr, Zhukova Olga, Germenchuk Maria, Derkach Hrigoryi	4. 巻 188
2. 論文標題 Mid- to long-term radiocesium wash-off from contaminated catchments at Chernobyl and Fukushima	5. 発行年 2021年
3. 雑誌名 Water Research	6. 最初と最後の頁 116514 ~ 116514
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.watres.2020.116514	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Konoplev Alexei, Wakiyama Yoshifumi, Wada Toshihiro, Udy Cameron, Kanivets Volodymyr, Ivanov Maxim M., Komissarov Mikhail, Takase Tsugiko, Goto Azusa, Nanba Kenji	4. 巻 265
2. 論文標題 Radiocesium distribution and mid-term dynamics in the ponds of the Fukushima Dai-ichi nuclear power plant exclusion zone in 2015?2019	5. 発行年 2021年
3. 雑誌名 Chemosphere	6. 最初と最後の頁 129058 ~ 129058
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.chemosphere.2020.129058	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Konoplev A. V., Kanivets V. I., Zhukova O. M., Germenchuk M. G., Derkach G. A.	4. 巻 59
2. 論文標題 Semi-Empirical Diffusional Model of Radionuclide Wash-Off from Contaminated Watersheds and Its Testing Using Monitoring Data for Fukushima and Chernobyl Rivers	5. 発行年 2021年
3. 雑誌名 Geochemistry International	6. 最初と最後の頁 607 ~ 617
掲載論文のDOI (デジタルオブジェクト識別子) 10.1134/S0016702921060021	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Takata Hyoe, Wakiyama Yoshifumi, Niida Takuya, Igarashi Yasunori, Konoplev Alexei, Inatomi Naohiko	4. 巻 281
2. 論文標題 Importance of desorption process from Abukuma River's suspended particles in increasing dissolved 137Cs in coastal water during river-flood caused by typhoons	5. 発行年 2021年
3. 雑誌名 Chemosphere	6. 最初と最後の頁 130751 ~ 130751
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.chemosphere.2021.130751	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Tsukada Hirofumi, Yamada Daigo, Yamaguchi Noriko	4. 巻 806
2. 論文標題 Accumulation of 137Cs in aggregated organomineral assemblage in pasture soils 8?years after the accident at the Fukushima Daiichi nuclear power plant	5. 発行年 2022年
3. 雑誌名 Science of The Total Environment	6. 最初と最後の頁 150688 ~ 150688
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.scitotenv.2021.150688	査読の有無 有
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1. 著者名 Konoplev Alexei, Wakiyama Yoshifumi, Wada Toshihiro, Igarashi Yasunori, Kanivets Volodymyr, Nanba Kenji	4. 巻 111
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1. 著者名 Golosov Valentin, Konoplev Alexei, Wakiyama Yoshifumi, Ivanov Maxim, Komissarov Mikhail	4. 巻 III
2. 論文標題 Erosion and Redeposition of Sediments and Sediment-Associated Radiocesium on River Floodplains (the Niida River Basin and the Abukuma River as an Example)	5. 発行年 2022年
3. 雑誌名 SPRINGER Nature	6. 最初と最後の頁 97 ~ 133
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_7	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Nanba Kenji, Moritaka Shota, Igarashi Yasunori	4. 巻 III
2. 論文標題 Dynamics of Radiocesium in Urban River in Fukushima City	5. 発行年 2022年
3. 雑誌名 Behavior of the Radionuclides in the Environment	6. 最初と最後の頁 137 ~ 152
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_8	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Wakiyama Yoshifumi, Konoplev Alexei, Thoa Nguyen, Niida Takuya, Tsukada Hirofumi, Takase Tsugiko, Nanba Kenji, Golosov Valentin, Zheleznyak Mark	4. 巻 III
2. 論文標題 Temporal Variations in Particulate and Dissolved ¹³⁷ Cs Activity Concentrations in the Abukuma River During Two High-Flow Events in 2018	5. 発行年 2022年
3. 雑誌名 Behavior of the Radionuclides in the Environment	6. 最初と最後の頁 153 ~ 175
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_9	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Zheleznyak Mark, Kivva Sergii, Pylypenko Oleksandr, Sorokin Maksim	4. 巻 III
2. 論文標題 Modeling of Behavior of Fukushima-Derived Radionuclides in Freshwater Systems	5. 発行年 2022年
3. 雑誌名 Behavior of the Radionuclides in the Environment	6. 最初と最後の頁 199 ~ 252
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/978-981-16-6799-2_11	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Konoplev Alexei V., Ivanov Maxim M., Golosov Valentin N., Konstantinov Evgenyi A.	4. 巻 381
2. 論文標題 Reconstruction of long-term dynamics of Chernobyl-derived 137Cs in the Upa River using bottom sediments in the Scheckino reservoir and semi-empirical modelling	5. 発行年 2019年
3. 雑誌名 Proceedings of the International Association of Hydrological Sciences	6. 最初と最後の頁 95 ~ 99
掲載論文のDOI (デジタルオブジェクト識別子) 10.5194/piahs-381-95-2019	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Wakiyama Yoshifumi, Konoplev Alexei, Wada Toshihiro, Takase Tsugiko, Igarashi Yasunori, Nanba Kenji, Byrnes Ian	4. 巻 381
2. 論文標題 Temporal trends of 137Cs activity concentration in pond waters in the vicinity of Fukushima Dai-ichi nuclear power plant	5. 発行年 2019年
3. 雑誌名 Proceedings of the International Association of Hydrological Sciences	6. 最初と最後の頁 101 ~ 106
掲載論文のDOI (デジタルオブジェクト識別子) 10.5194/piahs-381-101-2019	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Konoplev Alexei V., Yoshihara Toshihiro, Wakiyama Yoshifumi	4. 巻 381
2. 論文標題 Time changes of dose equivalent rate above the soil surface as indication of natural attenuation processes	5. 発行年 2019年
3. 雑誌名 Proceedings of the International Association of Hydrological Sciences	6. 最初と最後の頁 121 ~ 126
掲載論文のDOI (デジタルオブジェクト識別子) 10.5194/piahs-381-121-2019	査読の有無 有
オープンアクセス オープンアクセスとしている (また、その予定である)	国際共著 該当する

1. 著者名 Yoshihara Toshihiro, Kurita Keisuke, Matsumura Hideyuki, Yoschenko VasyI, Kawachi Naoki, Hashida Shin-Nosuke, Konoplev Alexei, Yoshida Hirohisa	4. 巻 204
2. 論文標題 Assessment of gamma radiation from a limited area of forest floor using a cumulative personal dosimeter	5. 発行年 2019年
3. 雑誌名 Journal of Environmental Radioactivity	6. 最初と最後の頁 95 ~ 103
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jenvrad.2019.03.023	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 、	4. 巻 59
2. 論文標題 s-137	5. 発行年 2019年
3. 雑誌名	6. 最初と最後の頁 656 ~ 668
掲載論文のDOI (デジタルオブジェクト識別子) 10.1134/S0869803119060055	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Wada Toshihiro, Konoplev Alexei, Wakiyama Yoshifumi, Watanabe Kenji, Furuta Yuma, Morishita Daigo, Kawata Gyo, Nanba Kenji	4. 巻 204
2. 論文標題 Strong contrast of cesium radioactivity between marine and freshwater fish in Fukushima	5. 発行年 2019年
3. 雑誌名 Journal of Environmental Radioactivity	6. 最初と最後の頁 132 ~ 142
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jenvrad.2019.04.006	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Begum Zinnat A., Rahman Ismail M.M., Ishii Kento, Tsukada Hirofumi, Hasegawa Hiroshi	4. 巻 259
2. 論文標題 Dynamics of Strontium and geochemically correlated elements in soil during washing remediation with eco-complaint chelators	5. 発行年 2020年
3. 雑誌名 Journal of Environmental Management	6. 最初と最後の頁 110018 ~ 110018
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jenvman.2019.110018	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Begum Zinnat A., Rahman Ismail M.M., Takase Tsugiko, Hasegawa Hiroshi	4. 巻 195
2. 論文標題 Formation and stability of the mixed-chelator complexes of Sr ²⁺ , Mg ²⁺ , Ca ²⁺ , Ba ²⁺ , and Y ³⁺ in solution with bio-relevant chelators	5. 発行年 2019年
3. 雑誌名 Journal of Inorganic Biochemistry	6. 最初と最後の頁 141 ~ 148
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jinorgbio.2019.03.018	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Konoplev A. V., Wakiyama Y., Wada T., Golosov V. N., Nanba K., Takase T.	4. 巻 45
2. 論文標題 Radiocesium in Ponds in the Near Zone of Fukushima Dai-ichi NPP	5. 発行年 2018年
3. 雑誌名 Water Resources	6. 最初と最後の頁 589 ~ 597
掲載論文のDOI (デジタルオブジェクト識別子) 10.1134/S0097807818040139	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Konoplev A., Golosov V., Wakiyama Y., Takase T., Yoschenko V., Yoshihara T., Parenjuk O., Cresswell A., Ivanov M., Carradine M., Nanba K., Onda Y.	4. 巻 186
2. 論文標題 Natural attenuation of Fukushima-derived radiocesium in soils due to its vertical and lateral migration	5. 発行年 2018年
3. 雑誌名 Journal of Environmental Radioactivity	6. 最初と最後の頁 23 ~ 33
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jenvrad.2017.06.019	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Begum Zinnat A., Rahman Ismail M.M., Takase Tsugiko, Hasegawa Hiroshi	4. 巻 195
2. 論文標題 Formation and stability of the mixed-chelator complexes of Sr ²⁺ , Mg ²⁺ , Ca ²⁺ , Ba ²⁺ , and Y ³⁺ in solution with bio-relevant chelators	5. 発行年 2019年
3. 雑誌名 Journal of Inorganic Biochemistry	6. 最初と最後の頁 141 ~ 148
掲載論文のDOI (デジタルオブジェクト識別子) 10.1016/j.jinorgbio.2019.03.018	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 該当する

1. 著者名 Morishita Daigo, Wada Toshihiro, Noda Takuji, Tomiya Atsushi, Enomoto Masahiro, Sato Toshiyuki, Suzuki Shunji, Kawata Gyo	4. 巻 85
2. 論文標題 Spatial and seasonal variations of radiocesium concentrations in an algae-grazing annual fish, ayu <i>Plecoglossus altivelis</i> collected from Fukushima Prefecture in 2014	5. 発行年 2018年
3. 雑誌名 Fisheries Science	6. 最初と最後の頁 561-569
掲載論文のDOI (デジタルオブジェクト識別子) 10.1007/s12562-018-1280-8	査読の有無 無
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

1. 著者名 Shunsuke Nakamura, Tsugiko Takase, Dai Oyama	4. 巻 in printing
2. 論文標題 Synthesis of 2,6-di(1,8-naphthyridin-2-yl)pyridines functionalized at the 4-position: Building blocks for suitable metal complex-based dyes	5. 発行年 2019年
3. 雑誌名 SYNTHETIC COMMUNICATIONS	6. 最初と最後の頁 in printing
掲載論文のDOI (デジタルオブジェクト識別子) なし	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

1. 著者名 Kosei Wadayama, Tsugiko Takase, Dai Oyama	4. 巻 4
2. 論文標題 fac-Bromido/chlorido(0.50/0.50)[3-carbamoyl-1-(1,10-phenanthroline-2-ylmethyl)pyridinium-k2N,N']tricarbonylmanganese(I) 0.46-bromide 0.51-chloride methanol monosolvate	5. 発行年 2019年
3. 雑誌名 IUCrData	6. 最初と最後の頁 x181792
掲載論文のDOI (デジタルオブジェクト識別子) 10.1107/S2414314618017923	査読の有無 有
オープンアクセス オープンアクセスとしている(また、その予定である)	国際共著 -

1. 著者名 Dai Oyama, Ryosuke Abe, Tsugiko Takase	4. 巻 375
2. 論文標題 Coordination chemistry of mononuclear ruthenium complexes bearing versatile 1,8-naphthyridine units: Utilization of specific reaction sites constructed by the secondary coordination sphere	5. 発行年 2018年
3. 雑誌名 Coordination Chemistry Reviews	6. 最初と最後の頁 424-433
掲載論文のDOI (デジタルオブジェクト識別子) なし	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

1. 著者名 Tsugiko Takase, Ryosuke Abe, Dai Oyama	4. 巻 E74
2. 論文標題 Crystal structure of a dinuclear ruthenium(II) complex with a bent CO ₂ bridge	5. 発行年 2018年
3. 雑誌名 Acta Crystallographica	6. 最初と最後の頁 1097-1100
掲載論文のDOI (デジタルオブジェクト識別子) なし	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

〔学会発表〕 計31件（うち招待講演 8件 / うち国際学会 9件）

1. 発表者名 A. Konoplev, T. Yoshihara, Y. Wakiyama
2. 発表標題 DYNAMICS OF DOSE EQUIVALENT RATE ABOVE THE SOIL SURFACE AS INDICATOR OF NATURAL ATTENUATION PROCESSES
3. 学会等名 INSINUME 2019, Kusadasi, Turkey, 23-26 April 2019 (招待講演)
4. 発表年 2019年～2020年

1. 発表者名 Alexei Konoplev, Maxim Ivanov, Valentin Golosov, Evgenyi Konstantinov
2. 発表標題 Reconstruction of long-term dynamics of Chernobyl-derived ¹³⁷ Cs in Upa river based on current vertical distribution in bottom sediments of the Scheckino dam reservoir and its semi-empirical modeling
3. 学会等名 RANC 2019, May 5-8, 2019 / Budapest, Hungary (招待講演)
4. 発表年 2019年～2020年

1. 発表者名 A. Konoplev, G. Laptev, H. Lisovyi, Y. Igarashi, K. Nanba
2. 発表標題 Vertical distributions of Chernobyl-derived ¹³⁷ Cs and ²⁴¹ Am in bottom sediments of water bodies in the exclusion zone represent long-term dynamics of water contamination
3. 学会等名 5th International Conference on Environmental Radioactivity, 8 -13 September 2019 Prague, Czech Republic
4. 発表年 2019年～2020年

1. 発表者名 Konoplev A., Laptev G., Golosov V., Ivanov M., Igarashi Y., Nanba K.
2. 発表標題 Vertical distribution of Chernobyl-derived ¹³⁷ Cs in bottom sediments represents long-term dynamics of water contamination
3. 学会等名 American Geoscience Union Fall Meeting, San Francisco CA, USA, 9-13 December 2019 (国際学会)
4. 発表年 2019年～2020年

1. 発表者名 Konoplev Aleksei
2. 発表標題 Long-term dynamics of radionuclides in the soil-water environment: Fukushima and Chernobyl
3. 学会等名 SPERA Conference 2018, Perth, Australia (国際学会)
4. 発表年 2018年

1. 発表者名 Konoplev A., Wakiyama Y., Nanba K., Golosov V., Onda Y.
2. 発表標題 Fate and Transport of Accidentally Released Radionuclides in Soil-Water Environment: Fukushima and Chernobyl
3. 学会等名 AGU Fall Meeting, washington DC, USA (国際学会)
4. 発表年 2018年

1. 発表者名 Konoplev Aleksei
2. 発表標題 Similarities and differences in behavior of Chernobyl derived and Fukushima Dai-ichi derived radionuclides in the environment
3. 学会等名 Fukushima Research Conference on Development of Analytical Techniques in Waste Management (FRCWM 2018), Tomioka, Japan (招待講演)
4. 発表年 2018年

1. 発表者名 Konoplev Aleksei
2. 発表標題 Long-term dynamics of radiocesium in soil-water environment: Chernobyl and Fukushima
3. 学会等名 Radiochemistry 2018, St-Petersburg, Russia (招待講演)
4. 発表年 2018年

1 . 発表者名 Konoplev Aleksei
2 . 発表標題 Comparative analysis of radiocesium dynamics in the environment: Fukushima and Chernoby
3 . 学会等名 Ecological, Industrial and Energetic Safety, Sevastopol, Russia
4 . 発表年 2018年

1 . 発表者名 I.M.M. Rahman, Z.A. Begum, B. Ahmmad, H. Tsukada, and H. Hasegawa,
2 . 発表標題 Effect of extraction variables for the chelator-assisted washing remediation of strontium and geochemically-related elements from soils
3 . 学会等名 67th Annual Meeting of Japan Society for Analytical Chemistry, Sendai, Japan
4 . 発表年 2018年

1 . 発表者名 Z.A. Begum, I.M.M. Rahman and H. Hasegawa
2 . 発表標題 Equilibrium constant for the complexation of mixed chelators (GLDA and HIDS) with Sr and geochemically-related elements (Mg, Ca, Ba) in aqueous solution
3 . 学会等名 67th Annual Meeting of Japan Society for Analytical Chemistry, Sendai, Japan
4 . 発表年 2018年

1 . 発表者名 Noriaki SETO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of an atomic interior surveying robot -Strength Evaluation of sampling arm unit using low melting point alloy
3 . 学会等名 The Fourth Conference for R&D Initiative on Nuclear Decommissioning Technology by the Next Generation (NDEC4)
4 . 発表年 2019年

1 . 発表者名 Kazuki Funakoshi, Luis Canete, and Takayuki Takahashi
2 . 発表標題 Development of a small glider type UROV for environmental surveying -Basic study of buoyancy controller using carbon dioxide cylinder
3 . 学会等名 SICE Tohoku Chapter workshop
4 . 発表年 2019年

1 . 発表者名 Noriaki SETO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of an atomic interior surveying robot -Strength evaluation of sampling arm unit using low melting point alloy
3 . 学会等名 19th Annual Conference of SICE System Integration Division
4 . 発表年 2018年

1 . 発表者名 Ryo KANNO, Mizuho HIRAO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Study of hydrofoil characteristics for development of glider type small underwater robot for environmental survey,
3 . 学会等名 19th Annual Conference of SICE System Integration Division
4 . 発表年 2019年

1 . 発表者名 Noriaki SETO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of an atomic interior surveying robot -Prototyping of sampling arm unit using low melting point alloy
3 . 学会等名 IRID Symposium
4 . 発表年 2018年

1 . 発表者名 Noriaki SETO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of an atomic interior surveying robot -Prototyping of sampling arm unit using low melting point alloy
3 . 学会等名 2018 JSME Conference on Robotics and Mechatronics
4 . 発表年 2018年

1 . 発表者名 Mizuki TANAKI, Mizuho HIRAO, Ryo KANNO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of a small and modular glider UROV for environmental surveying -Examination for operating time shortening for small buoyancy engine using hydrogen storage alloy
3 . 学会等名 2018 JSME Conference on Robotics and Mechatronics
4 . 発表年 2018年

1 . 発表者名 Ryo KANNO, Mizuki TANAKI, Mizuho HIRAO, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Wing simulation for glider type small underwater robot for environmental survey -Comparative Study of model experiment and simulation
3 . 学会等名 2018 JSME Conference on Robotics and Mechatronics
4 . 発表年 2018年

1 . 発表者名 Mizuho HIRAO, Ryo KANNO, Mizuki TANAKI, Luis CANETE, and Takayuki TAKAHASHI
2 . 発表標題 Development of a small glider type UROV for environmental surveying
3 . 学会等名 2018 JSME Conference on Robotics and Mechatronics
4 . 発表年 2018年

1. 発表者名 Noriaki SETO, Luis CANETE, Takayuki TAKAHASHI
2. 発表標題 Development of an atomic interior surveying robot arm
3. 学会等名 Fukushima Research Conference on Development of Analytical Techniques in Waste Management (FRCWM2018)
4. 発表年 2018年

1. 発表者名 Konoplev A., Golosov V., Wakiyama Y., Nanba K., Onda Y., Takase T.
2. 発表標題 VERTICAL AND LATERAL MIGRATION OF FUKUSHIMA-DERIVED RADIOCESIUM WITHIN NIIDA RIVER CATCHMENT
3. 学会等名 ICCE symposium 2018 "Climate Change Impacts on Sediment Dynamics: Measurement, Modelling and Management, Moscow, Russia (国際学会)
4. 発表年 2018年

1. 発表者名 Wakiyama Y., Konoplev A., Wada T., Takase T., Igarashi Y., Nanba K., Byrnes I.
2. 発表標題 Temporal trends of ¹³⁷ Cs activity concentration in pond waters in the vicinity of Fukushima Dai-ichi nuclear power plant
3. 学会等名 ICCE symposium 2018 "Climate Change Impacts on Sediment Dynamics: Measurement, Modelling and Management, Moscow, Russia
4. 発表年 2018年

1. 発表者名 Wakiyama Y., Matsumura M., Matsunaka T., Hirao S., Sasa K.
2. 発表標題 Behavior of ¹²⁹ I in the Abukuma River water during two high-flow events in 2018
3. 学会等名 European Geoscience Union General Assembly 2021, Vienna, Austria (国際学会)
4. 発表年 2021年

1. 発表者名 Protsak V., Laptev G., Derkach G., Korychenskyi K., Prokopchuk N., Nanba K., Igarashi Y., Konoplev A., Kireev S., Smith J.
2. 発表標題 Development of the method of radiography for evaluation of the characteristics of fuel particles in aquatic bodies in Chernobyl Exclusion zone
3. 学会等名 European Geoscience Union General Assembly 2021, Vienna, Austria (国際学会)
4. 発表年 2021年

1. 発表者名 Laptev G., Protsak V., Voitsekhovich O., Zheleznyak M., Konoplev A., Igarashi Y., Kivva S., Pylypenko O., Sorokin M., Bezhenar R., Kireev S.
2. 発表標題 Temporal changes of mobile forms of Sr-90 at Pripyat River floodplain near Chernobyl NPP: measurements and risk assessments for river water contamination
3. 学会等名 European Geoscience Union General Assembly 2021, Vienna, Austria (国際学会)
4. 発表年 2021年

1. 発表者名 Konoplev A.
2. 発表標題 Fukushima and Chernobyl: similarities and differences of radiocesium fate and transport in soil-water environment
3. 学会等名 American Geoscience Union General Assembly 2021, New Orleans, USA (国際学会)
4. 発表年 2021年

1. 発表者名 Konoplev A.
2. 発表標題 Radionuclide behavior in contaminated areas: Mayak, Chernobyl, Fukushima
3. 学会等名 IAEA International Winter School on Radiochemistry. Moscow, Russia (招待講演) (国際学会)
4. 発表年 2021年

1. 発表者名 Konoplev A., Wakiyama Y., Wada T., Golosov V., Igarashi Y., Takata H., Nanba K.
2. 発表標題 Behavior of Fukushima-derived radiocesium in soil-water environment. Long-term trends
3. 学会等名 Fukushima 10 years: Forest, River, Ocean, and Food. Remaining issues for restoration. Fukushima (招待講演)
4. 発表年 2021年

1. 発表者名 Konoplev A.
2. 発表標題 Fukushima and Chernobyl: similarities and differences in behavior and long-term dynamics of radionuclides in soil-water environment
3. 学会等名 International Scientific Conference CONTEMPORARY ISSUES OF RADIOBIOLOGY – 2021. GomeI, Belarus (招待講演)
4. 発表年 2021年

1. 発表者名 Konoplev A.
2. 発表標題 Fukushima and Chernobyl: similarities and differences in behavior of radionuclides in the environment
3. 学会等名 V International Conference MODERN PROBLEMS OF GENETICS, RADIOBIOLOGY, RADIOECOLOGY AND EVOLUTION 2021. Erevan, Armenia (招待講演)
4. 発表年 2021年

〔図書〕 計1件

1. 著者名 Nanba K., Konoplev A., Wada T.	4. 発行年 2022年
2. 出版社 SPRINGER NATURE	5. 総ページ数 510
3. 書名 Behavior of Radionuclides in the Environment III: Fukushima	

〔産業財産権〕

〔その他〕

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6. 研究組織

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7. 科研費を使用して開催した国際研究集会

〔国際研究集会〕 計0件

8. 本研究に関連して実施した国際共同研究の実施状況

共同研究相手国	相手方研究機関
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