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A comparative study of riverine ^{137}Cs dynamics during high-flow events at three contaminated river catchments in Fukushima

WAKIYAMA Yoshifumi[1*], NIIDA Takuya[2],TAKATA Hyoe[1],
TANIGUCHI Keisuke[3], KUROSAWA Honoka[4],
FUJITA Kazuki[5], KONOPLEV Alexei[1]

[1]Institute of Environmental Radioactivity, Fukushima University,
[2]KANSO TECHNOS, CO., LTD.,
[3]National Institute of Technology, Tsuyama College,
[4]Graduate school of Symbiotic System Science and Technology, Fukushima University,
[5]Fukushima Prefectural Centre for Environmental Creation

Based on Niida et al. (2022) *Science of the Total Environment*, **821**, 153408

Introduction

Motivations

Substantial particulate ^{137}Cs flux during high-flow events
(e.g.,Yamashiki et al., 2014; Taniguchi et al. 2019)
Influences of terrestrial ^{137}Cs on ocean (e.g., Takata et al. 2021)
Possible effect of land use composition (e.g., Laceby et al. 2016)
Limited observation in downstream sites

Comparative study at three coastal catchments
during high flow events

Factors controlling riverine ^{137}Cs concentrations

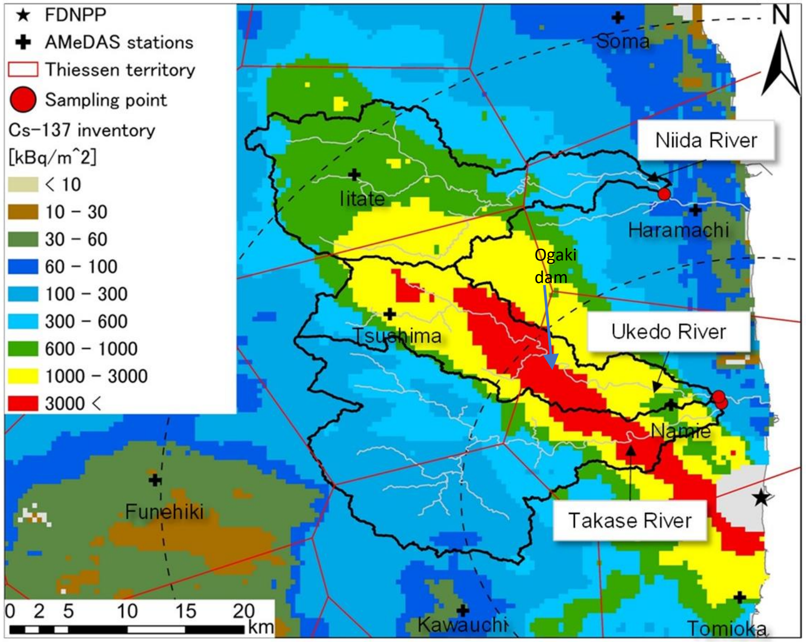
Temporal variation, properties water/SS, land use effect

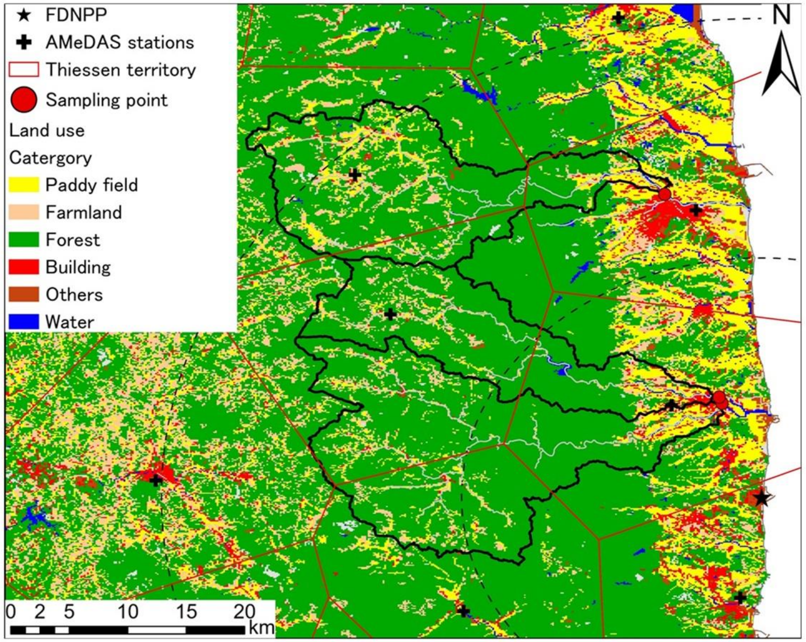
^{137}Cs flux to the ocean

Particulate, dissolved, and potential desorption

Materials and Method

Niida river (206 km^2), Ukdeo river (143 km^2), Takase rivers (262 km^2)





Three events: One in September 2019(SEP19), Two in July 2020 (JUL20-1, -2)

○*Suspended solid concentration* (SSC: mg L^{-1})

○*^{137}Cs concentration in suspended solid* (Cs_{SS}: Bq kg^{-1}) ⇒ Sequential extraction, Seawater extraction ⇒ Desorption ratio (%)

○*Stable isotope signatures* (δ^{15}N, δ^{13}C: ‰) etc

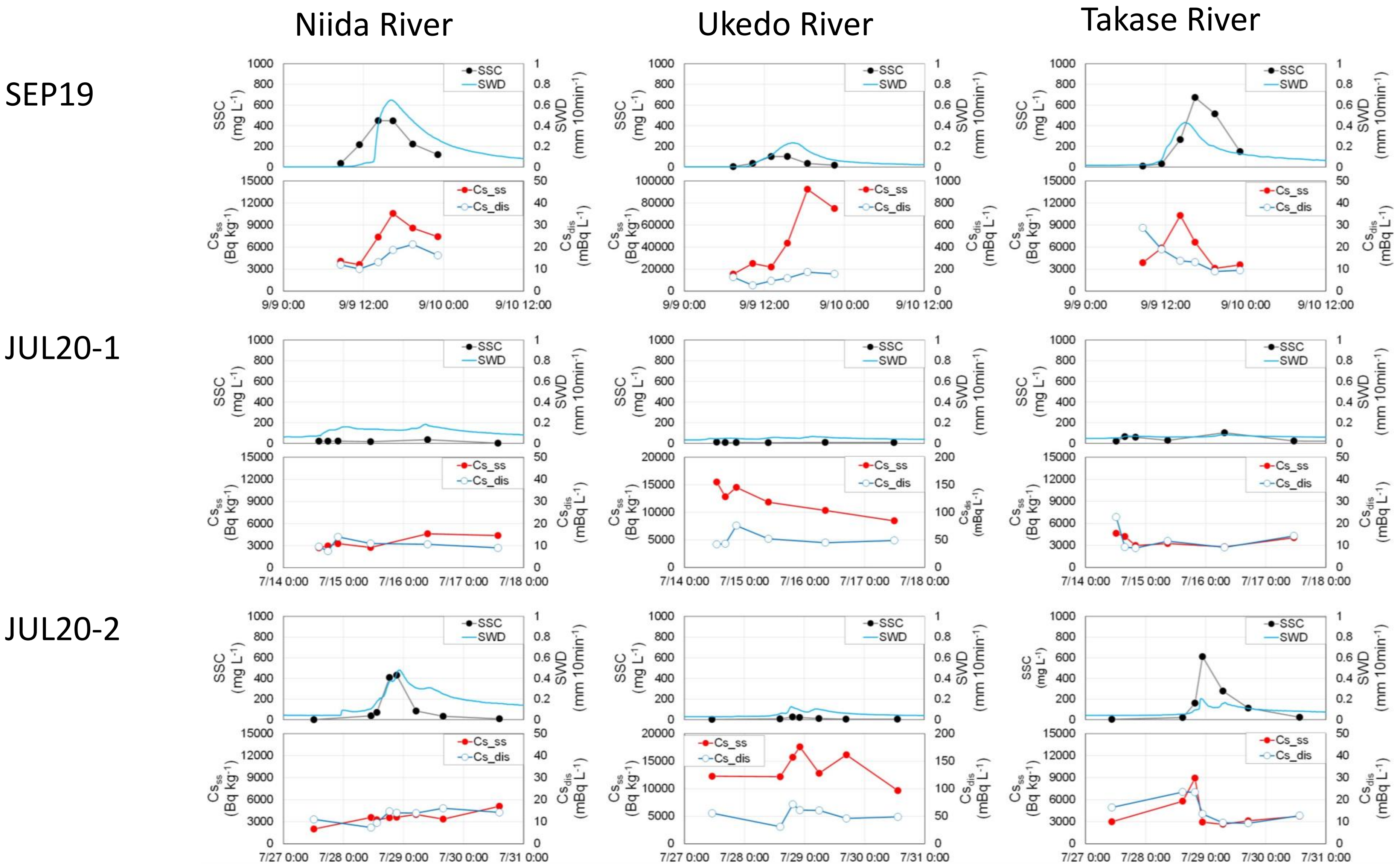
↓ *Filtration with 0.45 μm-mesh filter*

○*Dissolved ^{137}Cs concentration* (Cs_{dis}: mBq L^{-1})

⇓

Fluxes of Particulate, Dissolved and Desorbed ^{137}Cs

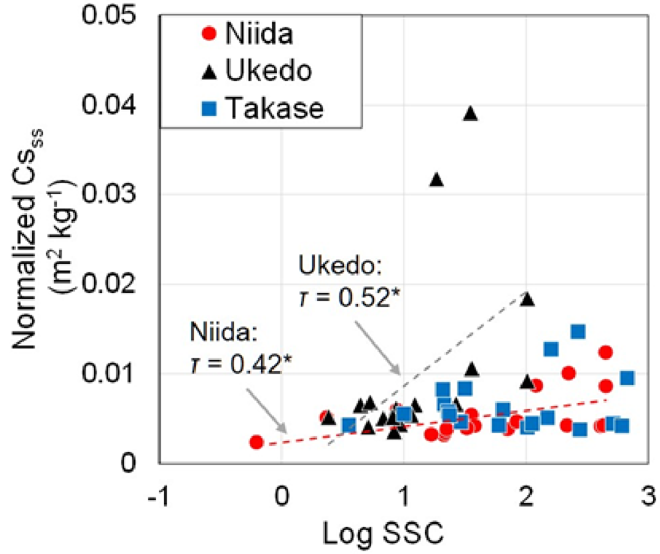
Variations in riverine ^{137}Cs concentrations



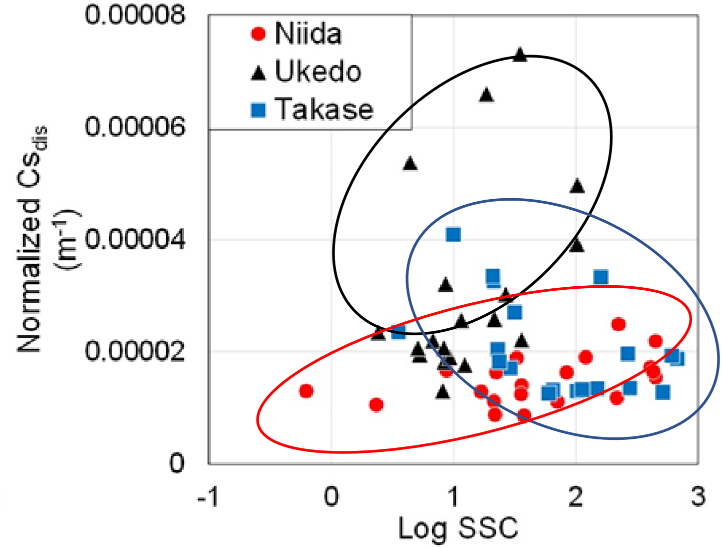
Temporal patterns in both the Cs_{SS} and Cs_{dis} differed according to the event, even within the same river catchment.

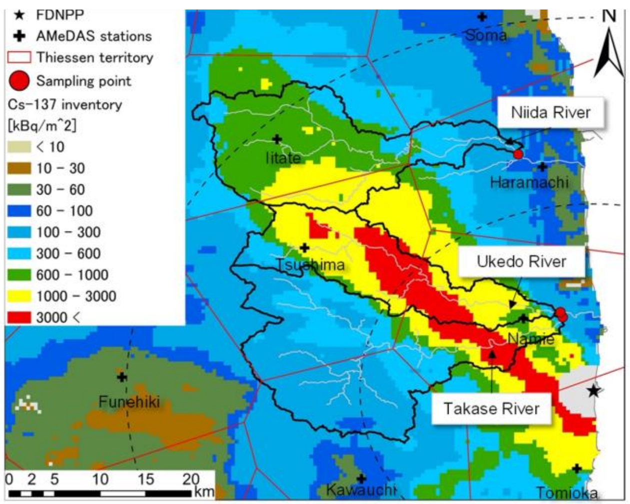
Variations in riverine ^{137}Cs concentrations

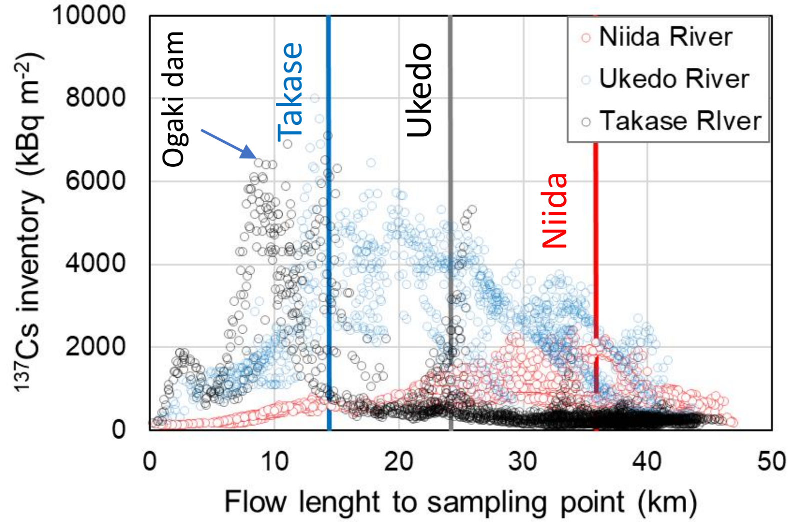
^{137}Cs in SS



Dissolved

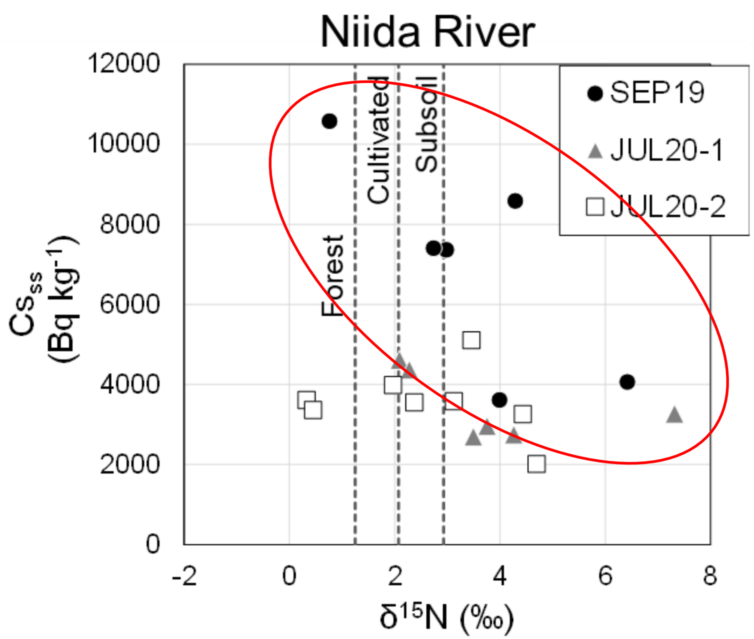


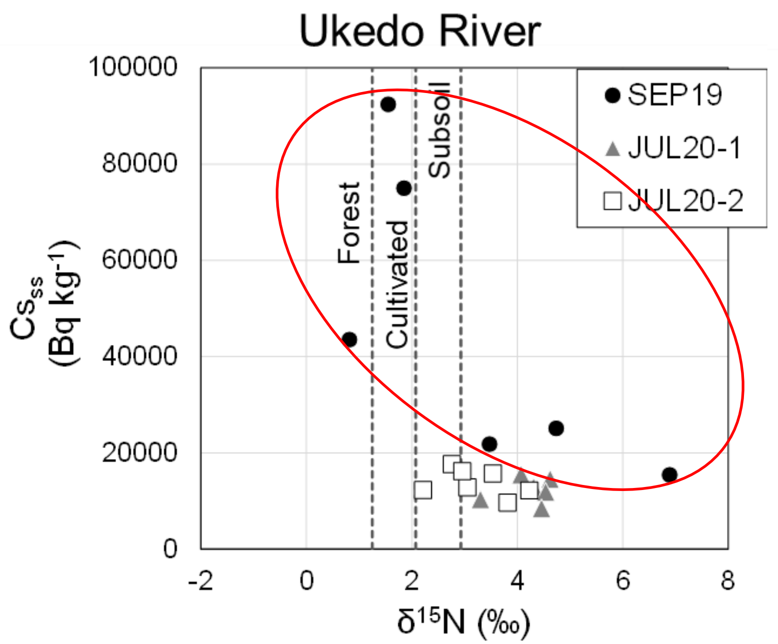


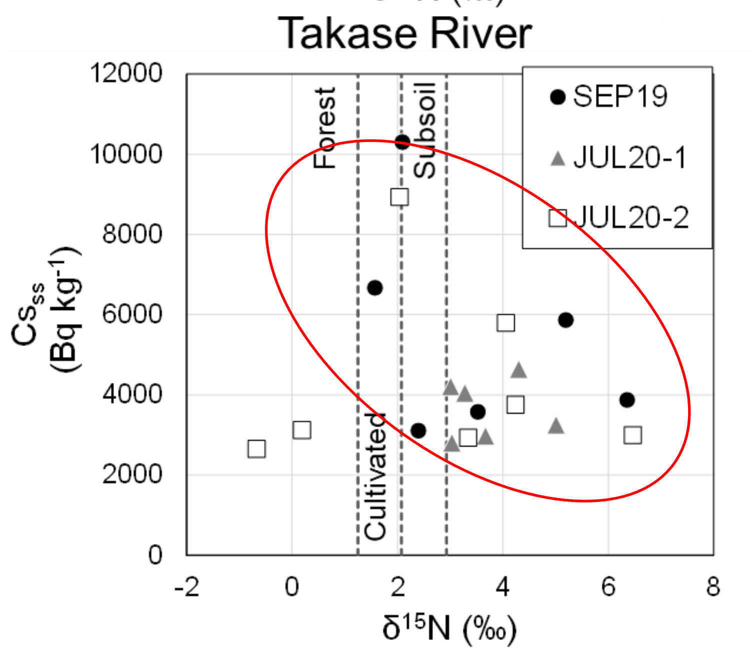


Spatial variation of the ^{137}Cs inventory were likely reflected in the riverine ^{137}Cs concentrations in the studied catchments.

Variations in riverine ^{137}Cs concentrations





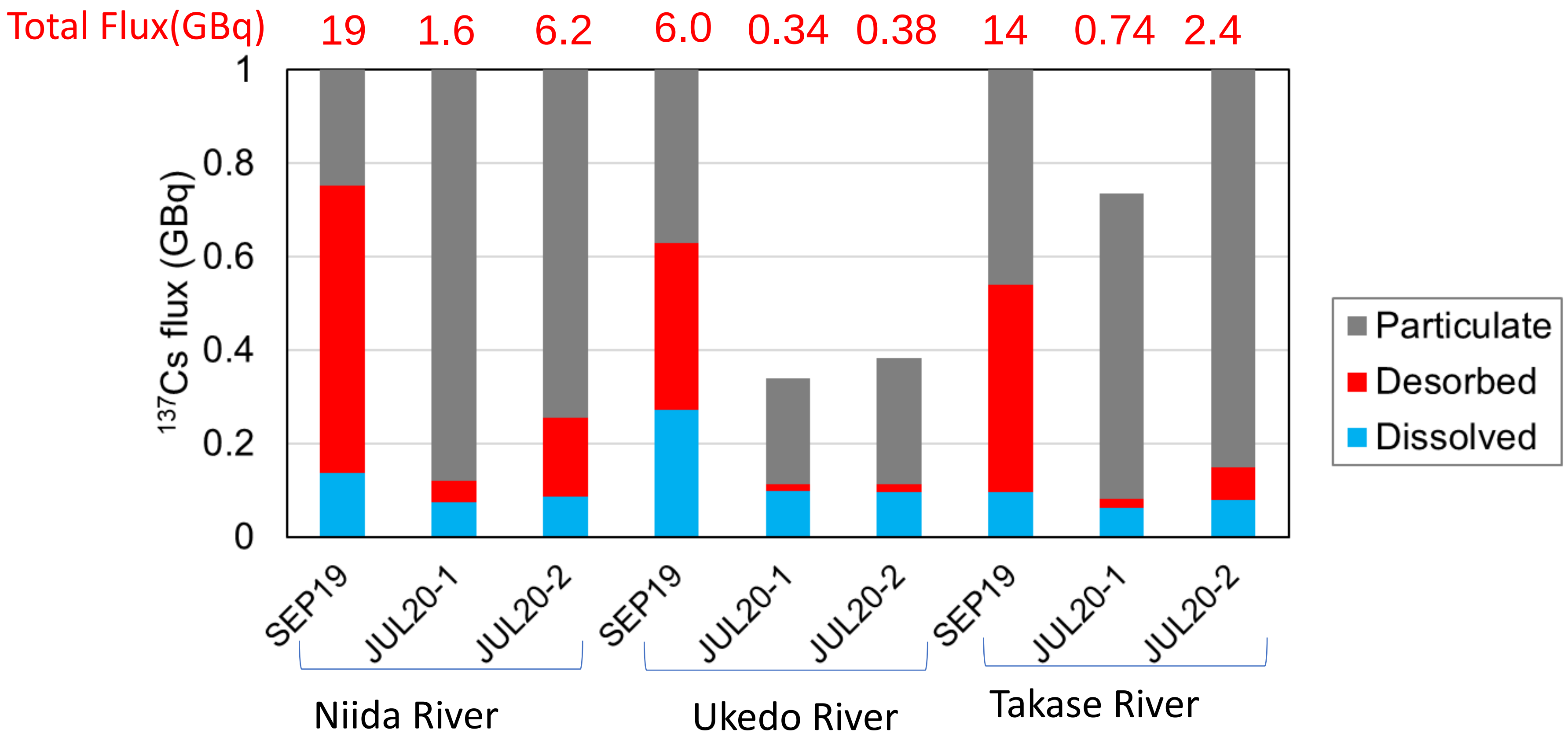


Mean $\delta^{15}N$ for sediment source was derived from Laceby et al. (2016)

High contribution of forested area likely increased the Cs_{SS} in the erosive rainfall event.

Land use effect may depend on rainfall erosivity.

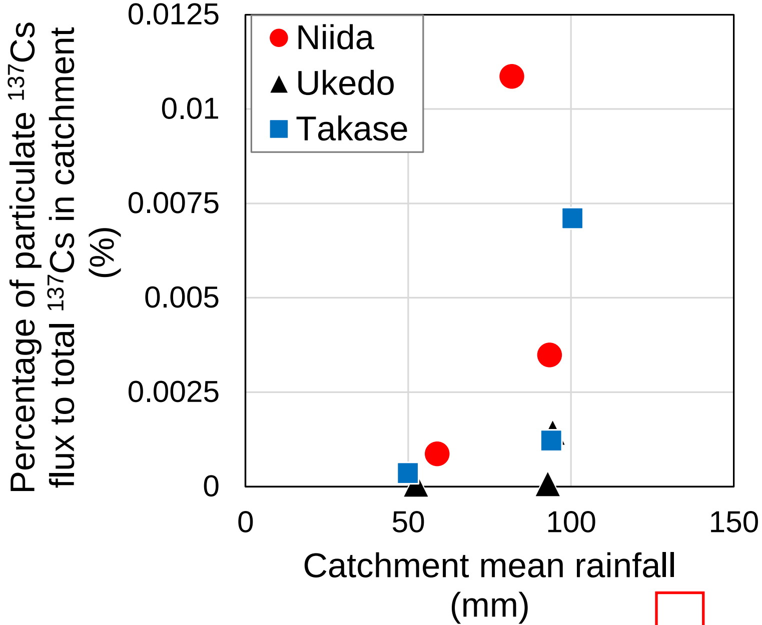
^{137}Cs flux



^{137}Cs desorbed from suspended solid to seawater (Bq)
= Particulate ^{137}Cs flux (Bq) × Desorption ratio (%)

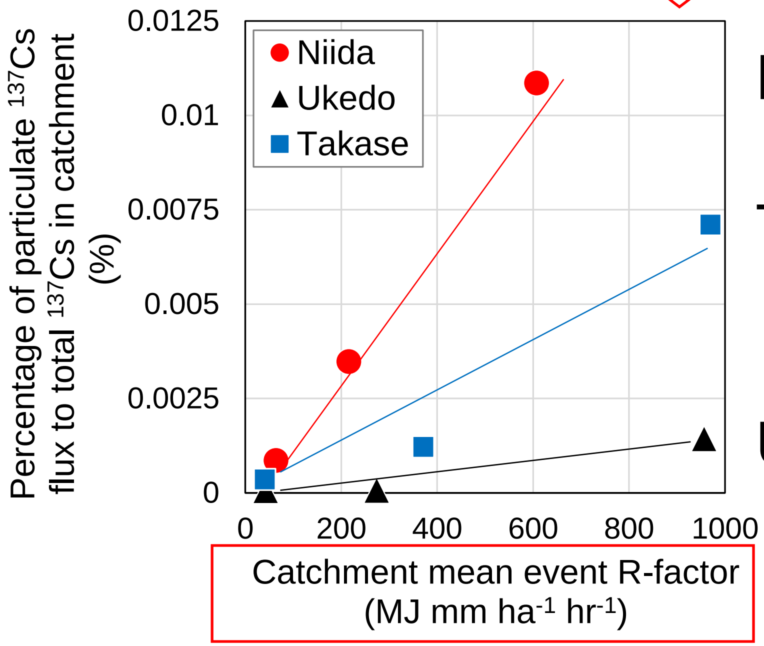
The ^{137}Cs flux ranged from 0.33 to 19 GBq.
Desorbed ^{137}Cs sometimes exceeded dissolved ^{137}Cs (0.12-6.2 times), depending on particulate ^{137}Cs flux.

^{137}Cs flux



R-factor yielded better reproduction of particulate ^{137}Cs flux than rainfall amount.
Apparent catchment erodibility depended on forest cover and dam reservoir.

R –factor in USLE (by USDA-RIST)



Niida River (68% of forest cover)

Takase River (83% of forest cover)

Ukedo River (Dam reservoir)

Summary

Factors controlling riverine ^{137}Cs concentration

- ○Spatial pattern of ^{137}Cs inventory is likely reflected to riverine ^{137}Cs concentrations
- ○$\delta^{15}N$ inferred forest's contribution to elevated ^{137}Cs concentration in suspended solid in erosive event.

^{137}Cs flux to the ocean

- ○The ^{137}Cs flux ranged from 0.33 to 19 GBq, and rainfall erosivity index yields better estimate than rainfall amount.
- ○^{137}Cs desorption was 0.12–6.2 times the direct dissolved ^{137}Cs flux, depending on particulate ^{137}Cs flux.

Underlining importance of catchment characteristic

Supplementary information of Niida et al (2022) includes all ^{137}Cs concentrations, hydrochemistry and stable isotope signatures

Table S2. Data of suspended solid concentration (SSC), ^{137}Cs concentration in suspended solids (Cs_{SS}), dissolved ^{137}Cs concentration (Cs_{dis}), apparent distribution coefficient (K_d).

River	Event	Sample ID	Sampling time (YYYY/MM/DD HH:MM)	Suspended solid concentration, SSC (mg L^{-1})	^{137}Cs concentration in suspended solid, Cs_{SS} (Bq kg^{-1})	Dissolved ^{137}Cs concentration, Cs_{dis} (mBq L-1)	Apparent distribution coefficient, K_d (L kg^{-1})
Niida River	SEP-19	ND-SEP19-1-1	2019/9/9 8:35	12.8	4060	12.0	338000
		ND-SEP19-1-2	2019/9/9 11:24	72.9	3610	10.0	361000
		ND-SEP19-1-3	2019/9/9 14:12	1260	7360	13.1	562000
		ND-SEP19-1-4	2019/9/9 16:25	402	10600	18.7	565000
		ND-SEP19-1-5	2019/9/9 19:23	210	8580	21.2	405000
		ND-SEP19-1-6	2019/9/9 23:09	394	7400	16.2	457000