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CRiED Center for Research in Isotopes and Environmental Dynamics

Time changes in radiocesium concentration in aquatic systems affected by the Fukushima Daiichi NPP accident

Yuichi Onda, Keisuke Taniguchi, Hiroaki Kato, Kazuya Yoshimura, Yoshifumi Wakiyama, Sho Iwagami, Maki Tsujimura, Aya Sakaguchi

Center for Research in Isotopes and Environmental Dynamics
University of Tsukuba

筑波大学
University of Tsukuba

Masatoshi Yamamoto
LLRL, Kanazawa University

Mapping of radio-Cs
2 km mesh in Fukushima pref.

- Sampling area: in 80 km from Fukushima-daiich NPP
- Sampling :
  First campaign : 6th/June – 14th/June
  Second campaign : 27th/June – 8th/July
- Sampling participants: more than 1000 people
- Cooperative institutes and companies:
  94 universities (hospitals), 14 companies
- Sampling points: about 2200
- Sample numbers: about 11000
- Analytical institutes: 20

Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

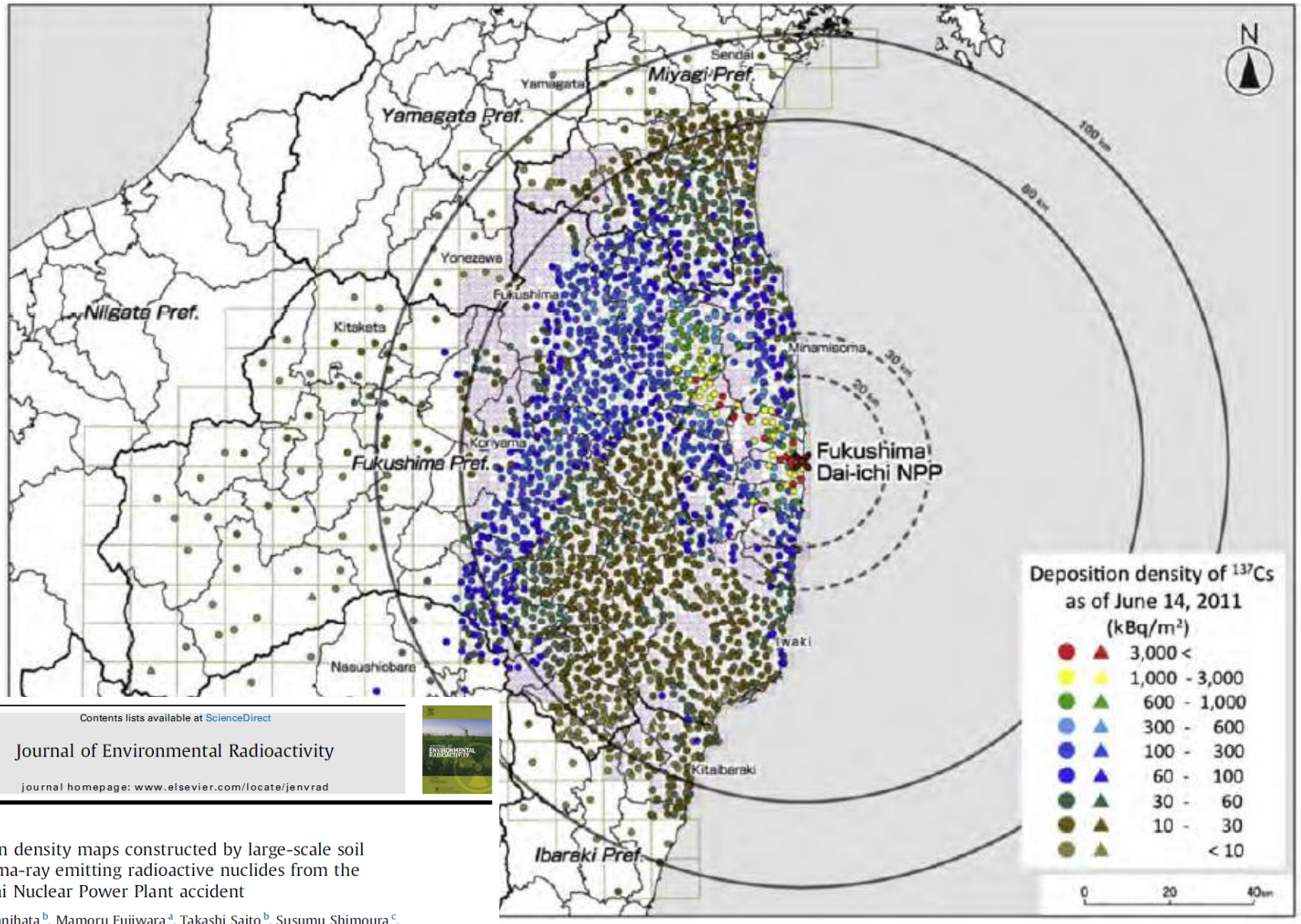
journal homepage: www.elsevier.com/locate/jenvrad

Soil sampling and analytical strategies for mapping fallout in nuclear emergencies based on the Fukushima Dai-ichi Nuclear Power Plant accident

Yuichi Onda [a, *], Hiroaki Kato [a], Masaharu Hoshi [b], Katsuo Takahashi [c], Minh-Long Nguyen [d]

[a] Center for Research in Isotopes and Environmental Dynamics, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan
[b] Research Institute for Biology and Medicine, Hiroshima University, 1-2-3 Kasumi, Minami-Ku, Hiroshima 734-8553, Japan
[c] Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University, 1-3-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8526, Japan
[d] Soil and Water Management and Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, Austria

Thank you for the IAEA' s support!(protocol, standard material etc)



oactivity per unit ground area is shown by the colored mark at the soil sampling location.

Contents lists available at ScienceDirect

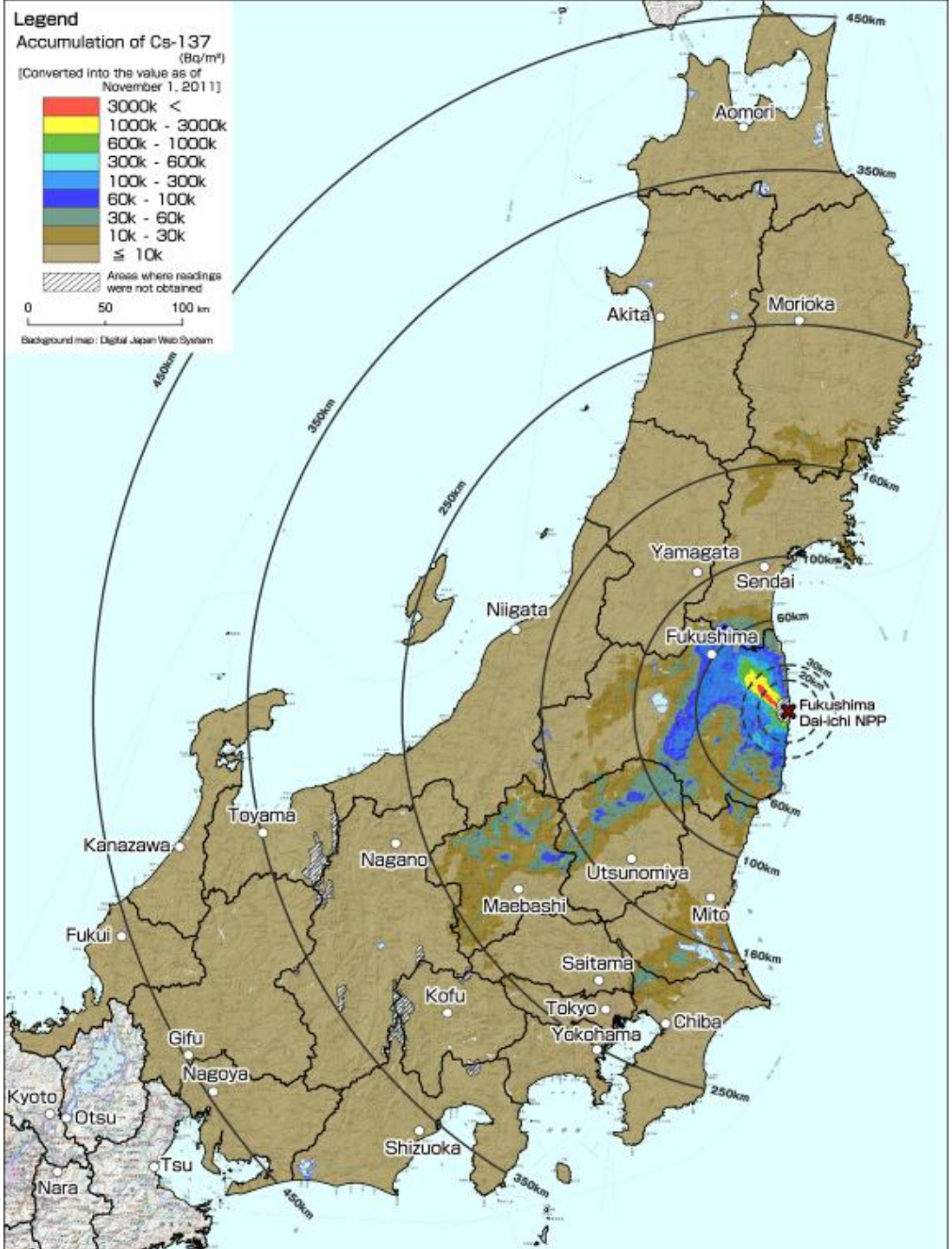
Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad

Detailed deposition density maps constructed by large-scale soil sampling for gamma-ray emitting radioactive nuclides from the Fukushima Dai-ichi Nuclear Power Plant accident

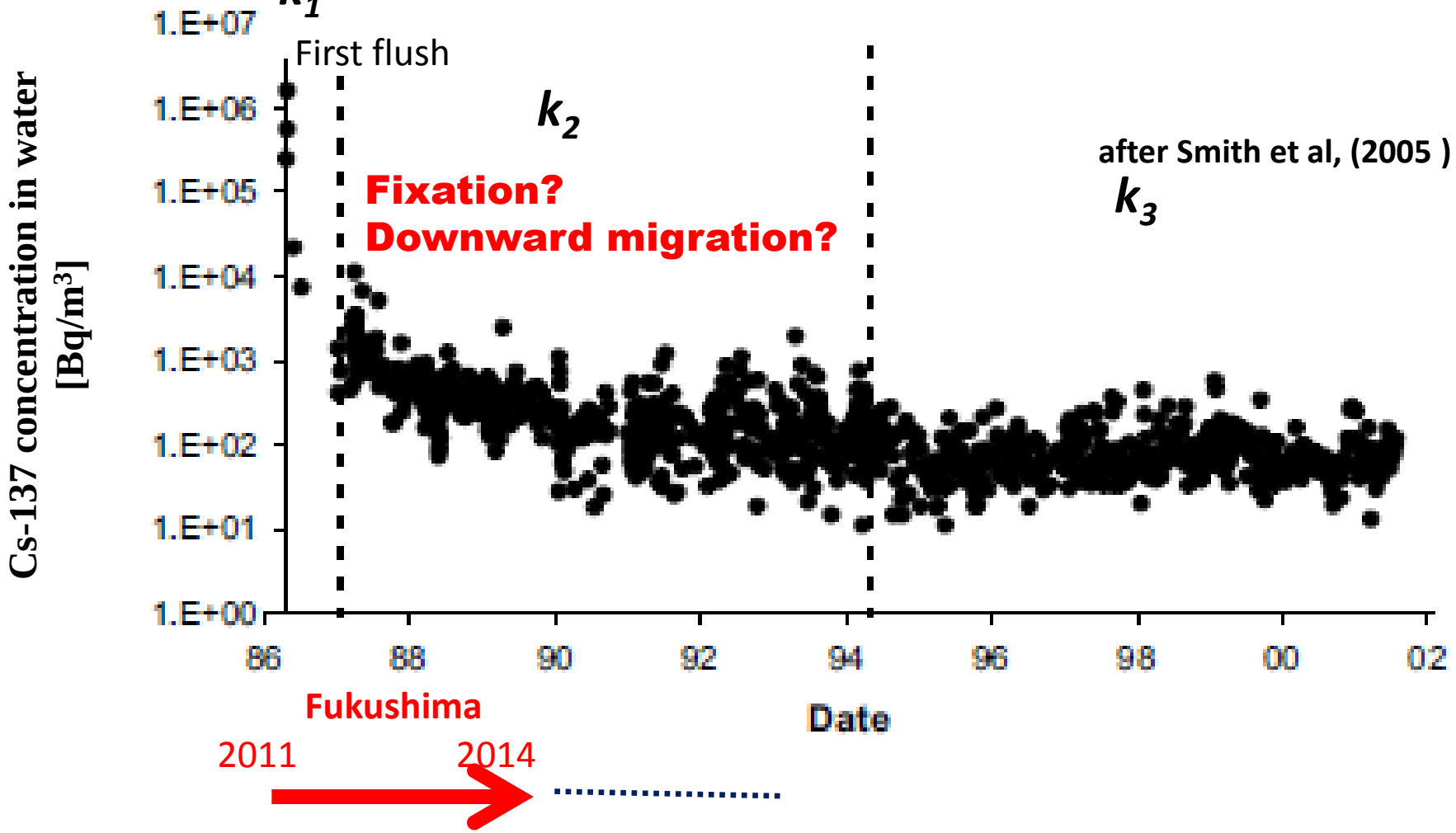
Kimiaki Saito [a,*], Isao Tanihata [b], Mamoru Fujiwara [a], Takashi Saito [b], Susumu Shimoura [c], Takaharu Otsuka [c], Yuichi Onda [d], Masaharu Hoshi [e], Yoshihiro Ikeuchi [f], Fumiaki Takahashi [a], Nobuyuki Kinouchi [a], Jun Saegusa [a], Akiyuki Seki [a], Hiroshi Takemiya [a], Tokushi Shibata [g]

[a] Japan Atomic Energy Agency, 2-2-2 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100-8577, Japan
[b] Osaka University, 10-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan
[c] University of Tokyo, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan
[d] University of Tsukuba, 1-1-1 A-405 Tennodai, Tsukuba, Ibaraki 305-8572, Japan
[e] Hiroshima University, 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8553, Japan
[f] Japan Chemical Analysis Center, 295-3 Sannocho, Inage-ku, Chiba-shi 263-0002, Japan
[g] Japan Radioisotope Association, 2-28-45 Honkomagome, Bunkyo, Tokyo 113-8941, Japan


Legend
Accumulation of Cs-137
(Bq/m²)
[Converted into the value as of November 1, 2011]
3000k <
1000k - 3000k
600k - 1000k
300k - 600k
100k - 300k
60k - 100k
30k - 60k
10k - 30k
≦ 10k
Areas where readings were not obtained
0 50 100 km
Background map : Digital Japan Web System
450km
350km
250km
160km
100km
60km
30km
20km
Aomori
Akita
Morioka
Yamagata
Sendai
Niigata
Fukushima
Fukushima Dai-ichi NPP
Toyama
Kanazawa
Nagano
Utsunomiya
Maebashi
Mito
Fukui
Saitama
Kofu
Tokyo
Chiba
Yokohama
Gifu
Nagoya
Kyoto
Otsu
Tsu
Nara
Shizuoka

Time Change of Cs-137 concentration in water in Ukraine

$$C_R(t) = D_c(\alpha e^{-(\lambda+k_1)t} + \beta e^{-(\lambda+k_2)t} + \gamma e^{-(\lambda+k_3)t})$$



June 2011- 2014 (funded by MEXT, NRA)

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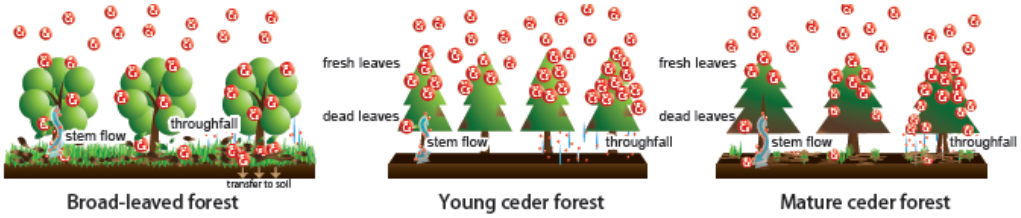
Relational expression of basic data for estimetion of the migration process. Provide the initial value and parameter for modeling research.

Tokyo Institute of Tech / IBARAKI Univ / MRI

The measurement of the entrainment of soil fine particles including radionuclide.



Broad-leaved forest　Young ceder forest　Mature ceder forest

Quantification of the lateral soil move of the radionuclide with the soil erosion.

Univ of TSUKUBA

High precision measurement of Air filters

OSAKA Univ

A shift of radionuclides to cedar pollen and diffusion due to the pollen.

NAGOYA Univ

The real condition survey of a shift of radionuclides from forests to soil

Tokyo Institute of Tech / IBARAKI Univ

Entrainment from forests and soil

Transfer from forest to soil

CHIBA Univ / Univ of TSUKUBA

Land use distinction by the GIS and construction of the erosion model

Forests

Runoff to rivers by soil erosion

Field

Paddy Field

Transfer to reservoirs, ponds and dams

sampling of suspended sediments

sampling of suspended sediments

Distribution in soil and Percolation

Univ of TSUKUBA / Tokyo Institute of Tech

Groundwater

Migration to ground water

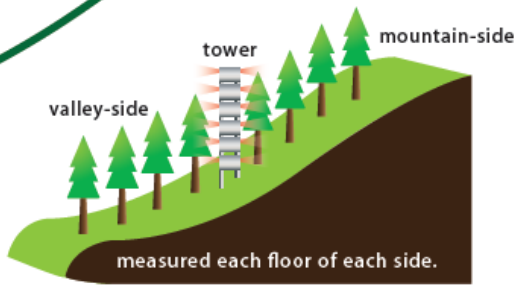
Shift to stream water

Separation of organic components in the suspended sand

transition to a

FUKUSHIMA Univ

Riverflow monitoring
Runoff modeling



Measurement of radionuclides in the field by portable Ge detector

Prediction of the migration of radionuclides in the future to use Air-Borne censor calibration

Abundunce of Cs-134, 137, I-131 and actual condition of lower penetration

caluculate the amount of radionuclides Cs-134, 137 from soil to rivers and ponds, also from rivers to ocean

Univ of TSUKUBA / HIROSHIMA Univ

upstream

midsteam

downstream

KYOTO Univ

The measurement of runoff sediments and

Journal of Environmental Radioactivity 139 (2015) 240–249

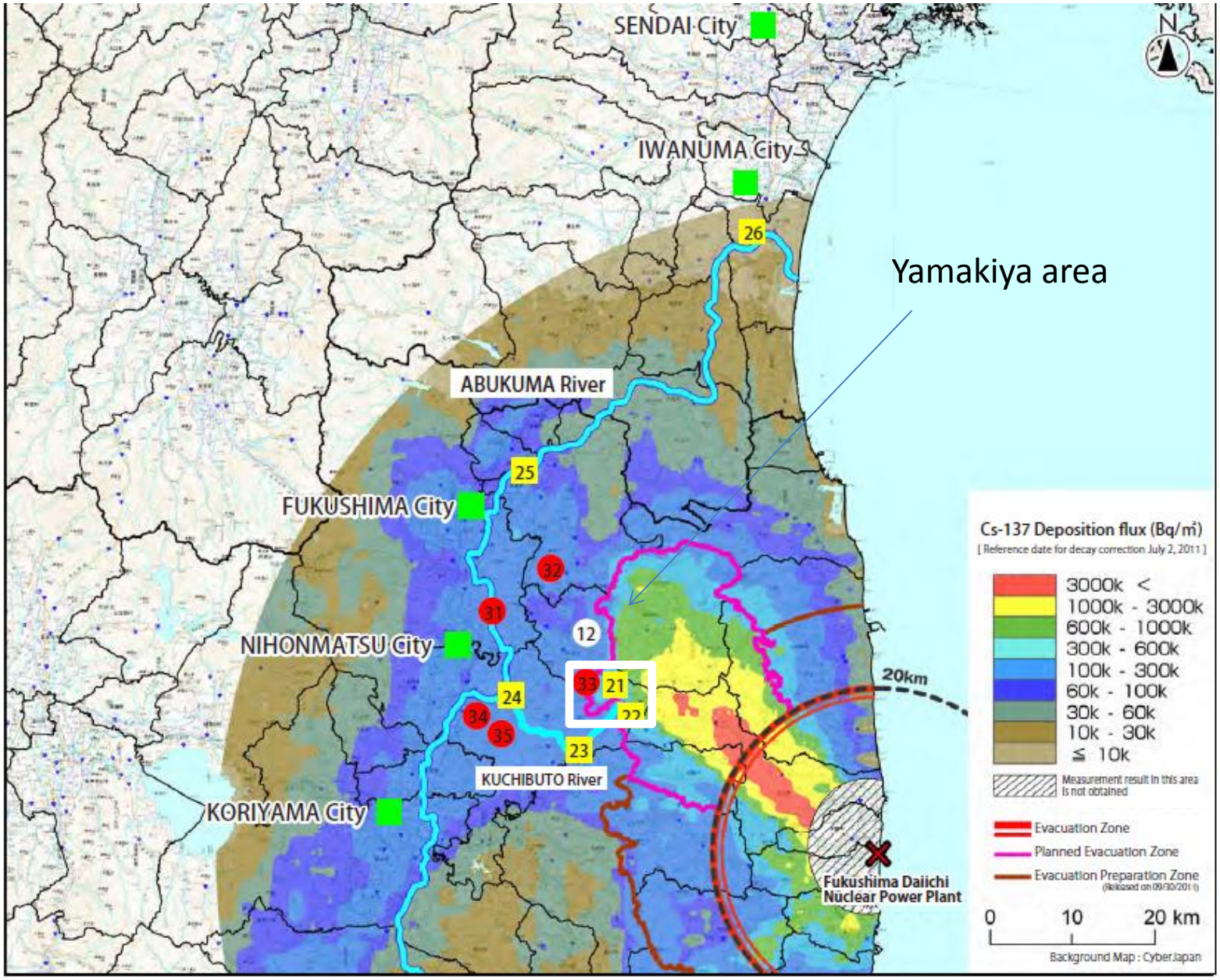
Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad

Editorial

Outline of the national mapping projects implemented after the Fukushima accident


SENDAI City
IWANUMA City
26
Yamakiya area
ABUKUMA River
25
FUKUSHIMA City
32
31
NIHONMATSU City
12
33
21
24
34
35
23
KUCHIBUTO River
KORIYAMA City
20km
Fukushima Daiichi Nuclear Power Plant
N
Cs-137 Deposition flux (Bq/㎡)
[Reference date for decay correction July 2, 2011]
3000k <
1000k - 3000k
600k - 1000k
300k - 600k
100k - 300k
60k - 100k
30k - 60k
10k - 30k
≦ 10k
Measurement result in this area is not obtained
Evacuation Zone
Planned Evacuation Zone
Evacuation Preparation Zone
(Released on 09/30/2011)
0
10
20 km
Background Map : CyberJapan

Yamakiya Study site

Cs transfer from forested ar

Kotaishi catchment

Pasture B plot

Iboishi catchment

Pasture A plot

N

Forest
Cropland
Grassland
Paddy field
City
River

Cs transfer in forest

Broadleaf

Young cedar

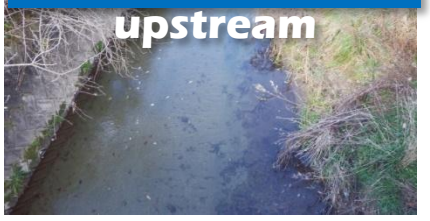
Mature cedar

Young cedar plot

River monitoring sites

Mizusakai

Kuchibuto upstream



Ishidaira

Pasture C plot

Cropland B1, B2

Cropland A1, A2

Paddy field (scraped, control)

Sediment and Cs yield from various land

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Soil Erosion Plots

Bare land

Cultivated (gentle)

Grass land

Cultivated (Steep)

Forest (young ceder)

Pasture A

Pasture B

Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

journal homepage: www.elsevier.com/locate/jenvrad

Evaluation of radiocaesium wash-off by soil erosion from various land uses using USLE plots

Kazuya Yoshimura*, Yuichi Onda, Hiroaki Kato

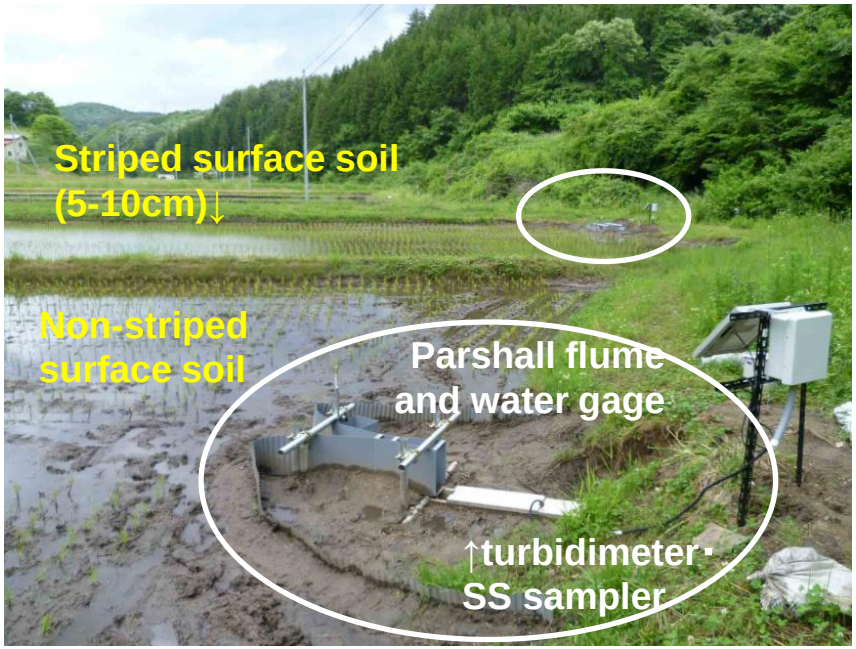
Center for Research in Isotopes and Environmental Dynamics, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan

University of Tsukuba 筑波大学

CRiED Center for Research in Isotopes and Environmental Dynamics

Migration with cultivation

Migration of radionuclides from paddy field to river (and plant) by rice cultivation.



SS sampler

Environmental Science Processes & Impacts

PAPER

Cite this: DOI: 10.1039/c4em00262h

Radiocesium discharge from paddy fields with different initial scrapings for decontamination after the Fukushima Dai-ichi Nuclear Power Plant accident

Taeko Wakahara,*[a] Yuich Onda,[b] Hiroaki Kato,[b] Aya Sakaguchi[c] and Kazuya Yoshimura[b]

University of Tsukuba
筑波大学

CRiED Center for Research in Isotopes and Environmental Dynamics

Observation of suspended sediment discharge from paddy field by puddling

Environmental Science
Processes & Impacts

ROYAL SOCIETY OF CHEMISTRY

PAPER

Cite this: DOI: 10.1039/c4em00262h

Radiocesium discharge from paddy fields with different initial scrapings for decontamination after the Fukushima Dai-ichi Nuclear Power Plant accident

Taeko Wakahara,*[a] Yuich Onda,[b] Hiroaki Kato,[b] Aya Sakaguchi[c] and Kazuya Yoshimura[b]

Experimental site

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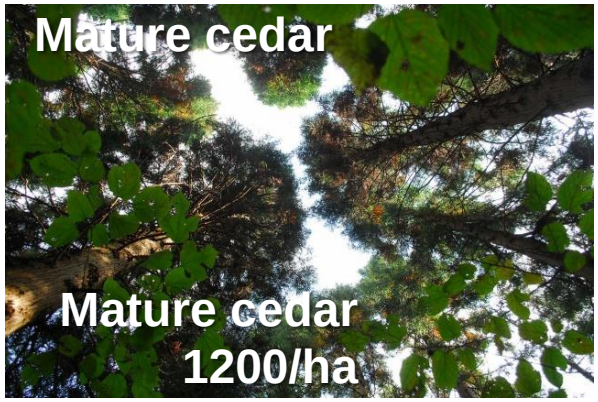

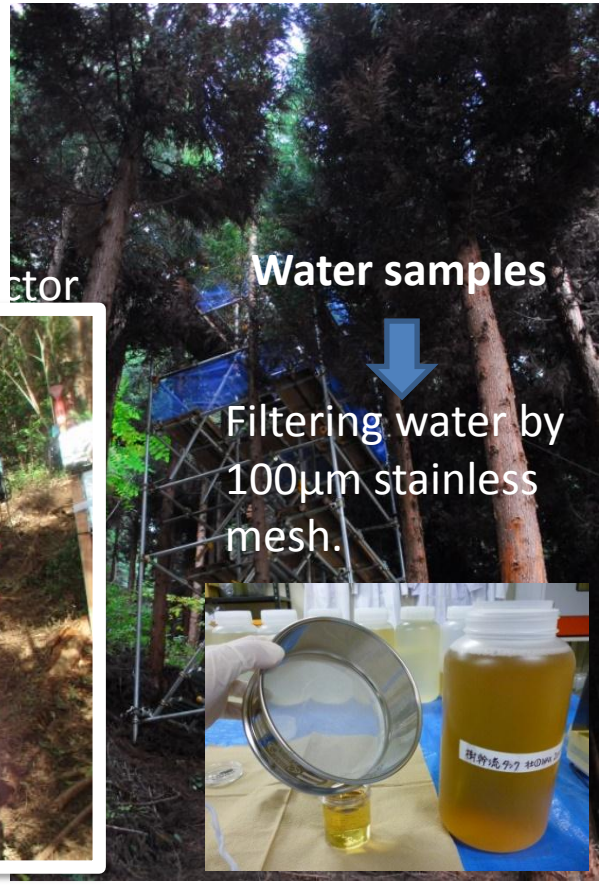

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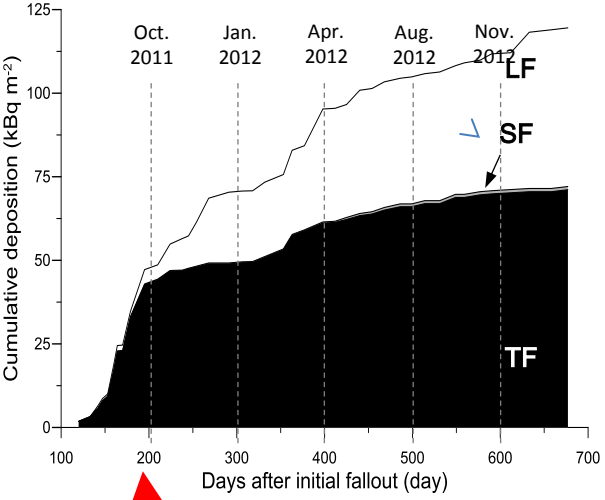
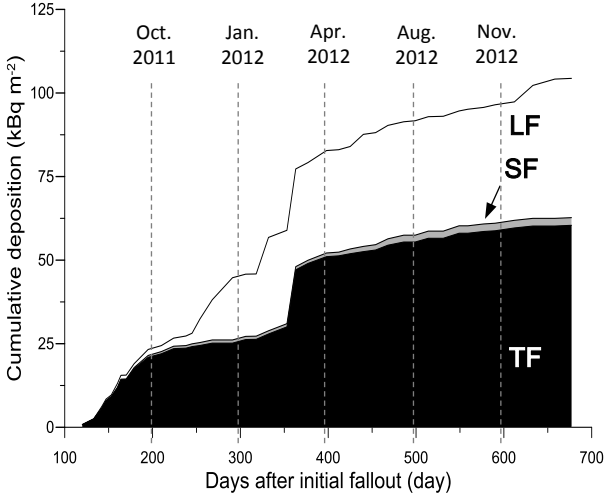
Throughfall + Litterfall input

Cumulative Cs-137 deposition (Bq m^{-2}) onto forest floor

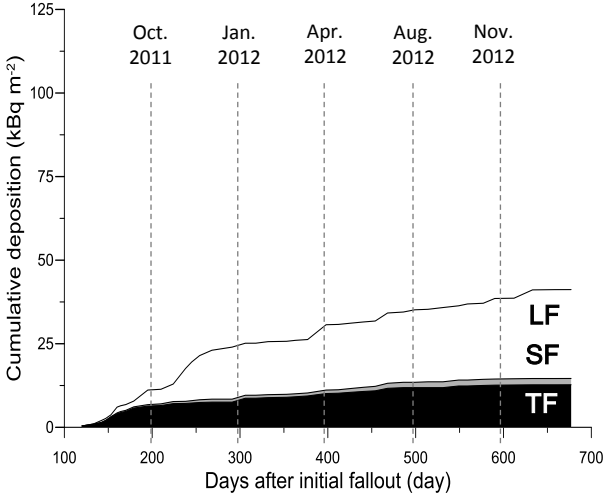
(a) Mature cedar



(b) Young cedar



(c) Broad-leaved



200 days after the NPP accident

JER (under review)

GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L20403, doi:10.1029/2012GL052928, 2012

Interception of the Fukushima reactor accident-derived ^{137}Cs, ^{134}Cs and ^{131}I by coniferous forest canopies

Hiroaki Kato,[1] Yuichi Onda,[1] and Takashi Gomi[2]

Received 13 July 2012; revised 17 September 2012; accepted 18 September 2012; published 19 October 2012.

Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

Short Communication

The role of litterfall in transferring Fukushima-derived radiocesium to a coniferous forest floor

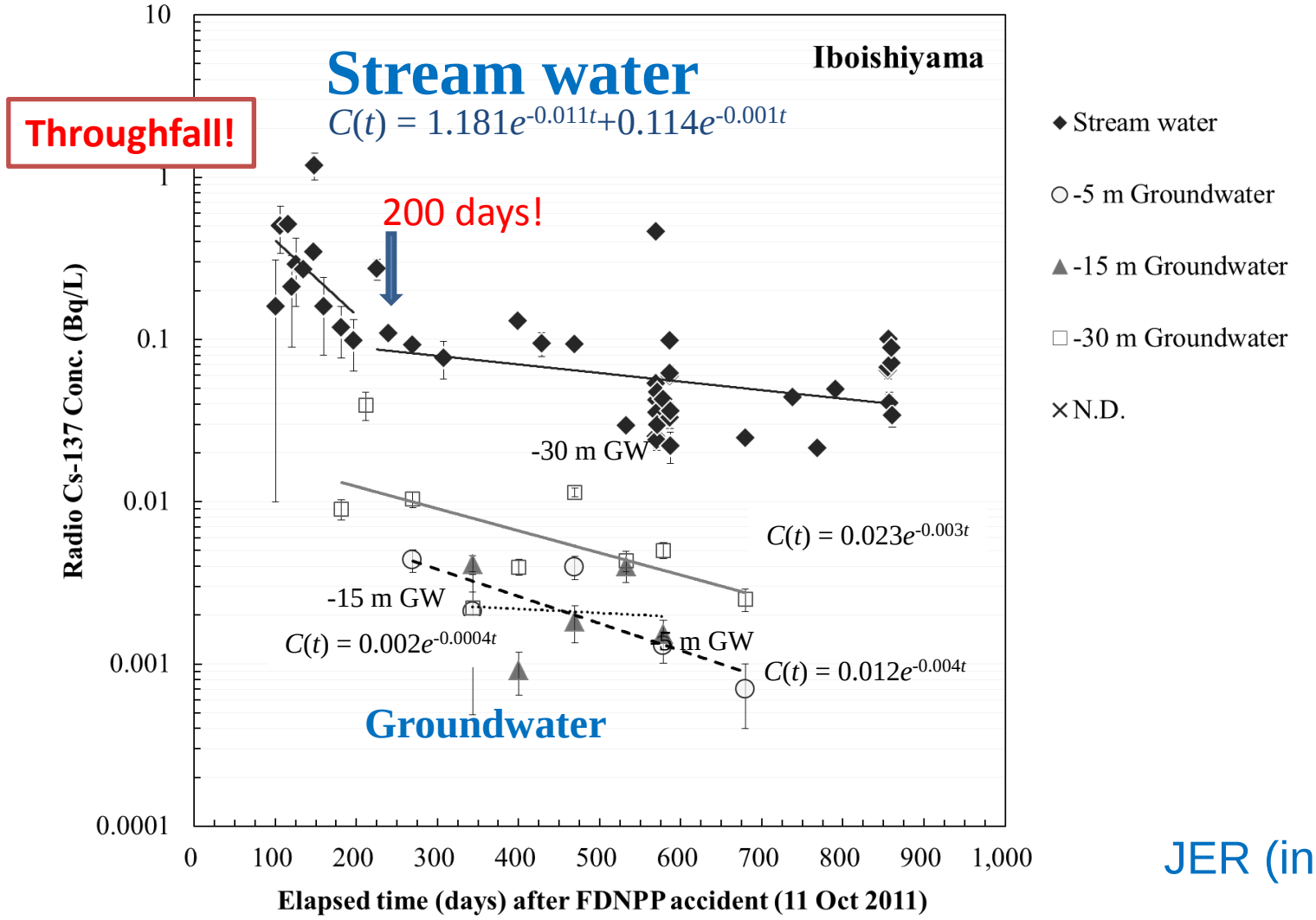
Mengistu T. Teramage [a,*], Yuichi Onda [a], Hiroaki Kato [a], Takashi Gomi [b]

Science of the Total Environment 493 (2014) 701–707
Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

Modeling of leachable ^{137}Cs in throughfall and stemflow for Japanese forest canopies after Fukushima Daiichi Nuclear Power Plant accident

Nicolas Loffredo [a,*], Yuichi Onda [a], Ayumi Kawamori [b], Hiroaki Kato [a]

Headwater catchment



JER (in press)

Time series of dissolved ^{137}Cs concentration in stream water at Iboishiyama and time series of dissolved ^{137}Cs concentration in groundwater at Iboishiyama with exponential approximate line.

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Soil Erosion Plots

Bare land

Cultivated (gentle)

Grass land

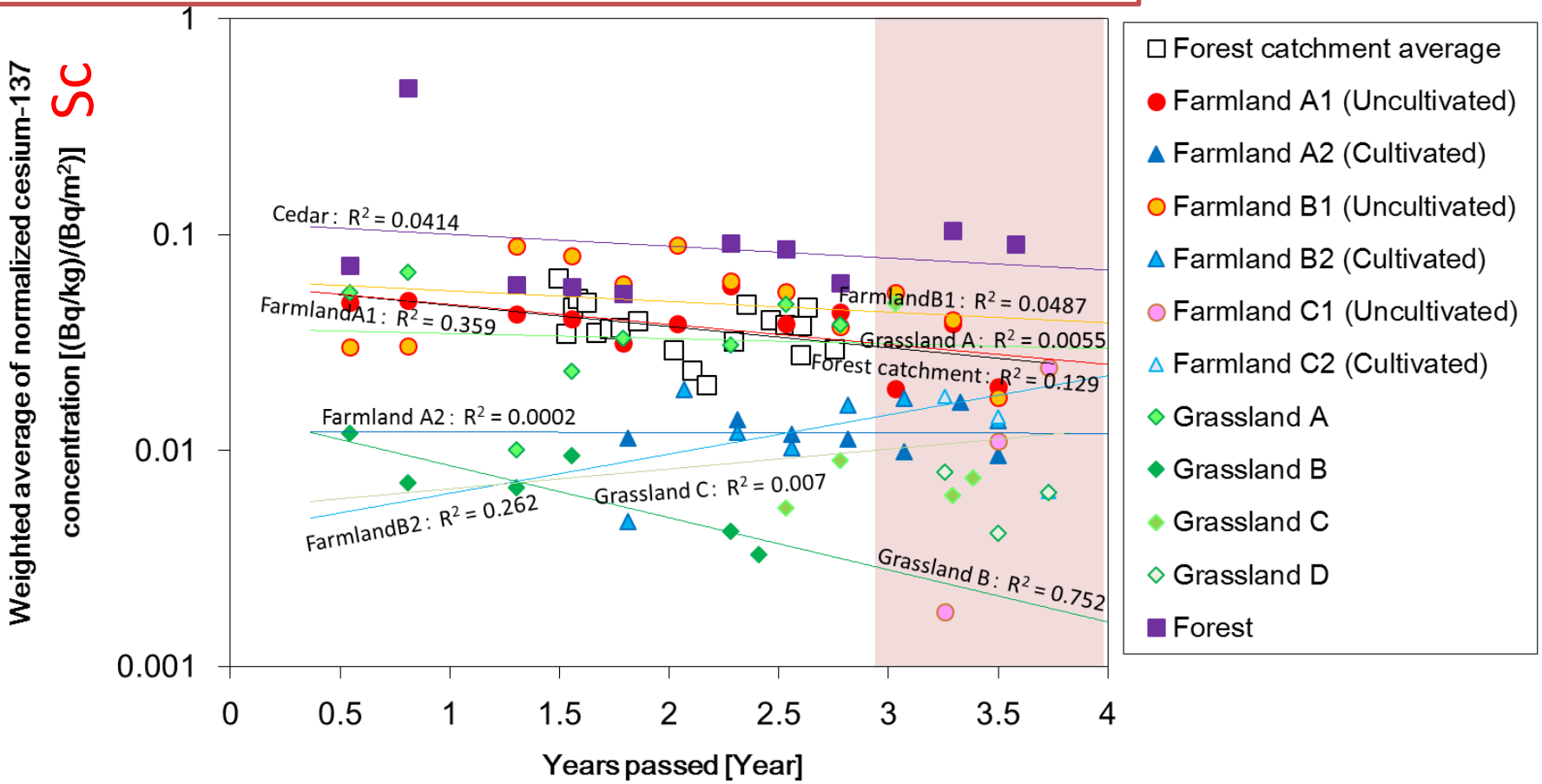
Cultivated (Steep)

Forest (young ceder)

Pasture A

Pasture B

Normalized Cs-137 cocentration (Sc):
^{137}Cs concentration per unit deposition density



Temporal change in normalized cesium-137 concentration in sediment discharge from each plot. Each point

$Sc_{uncultivated}(t) = 0.0619 \exp(-0.196t)$

$Sc_{cultivated} = 0.0137$ （Averaged value of the 2 plots (A2,B2)

$Sc_{grassland} = 0.0134$ （average value of grassland A,B,C)

Normalized Cs-137 Concentration (Sc)

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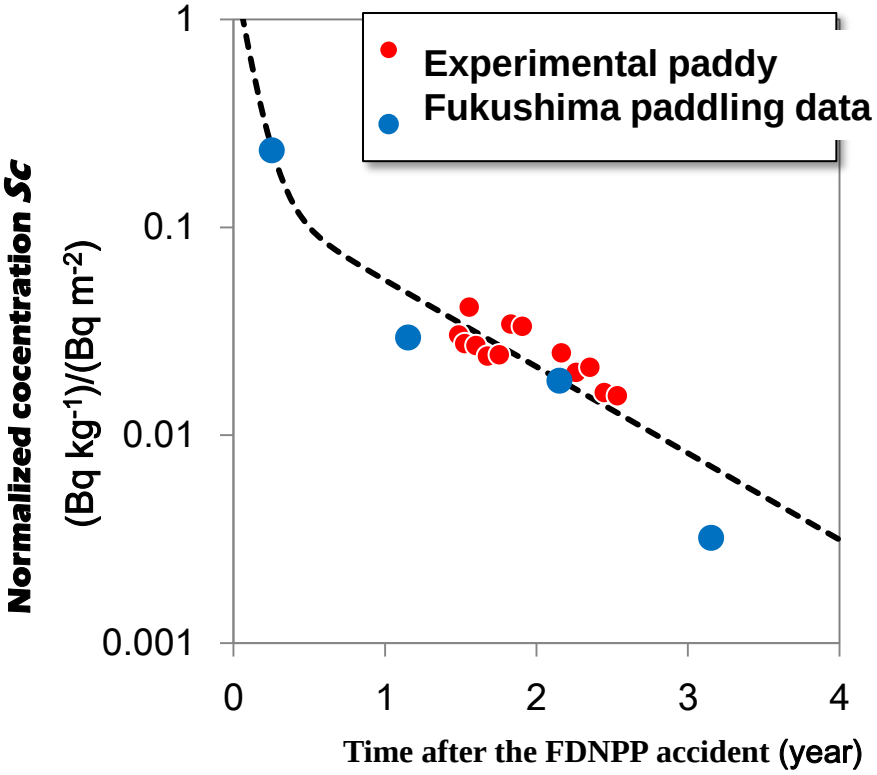
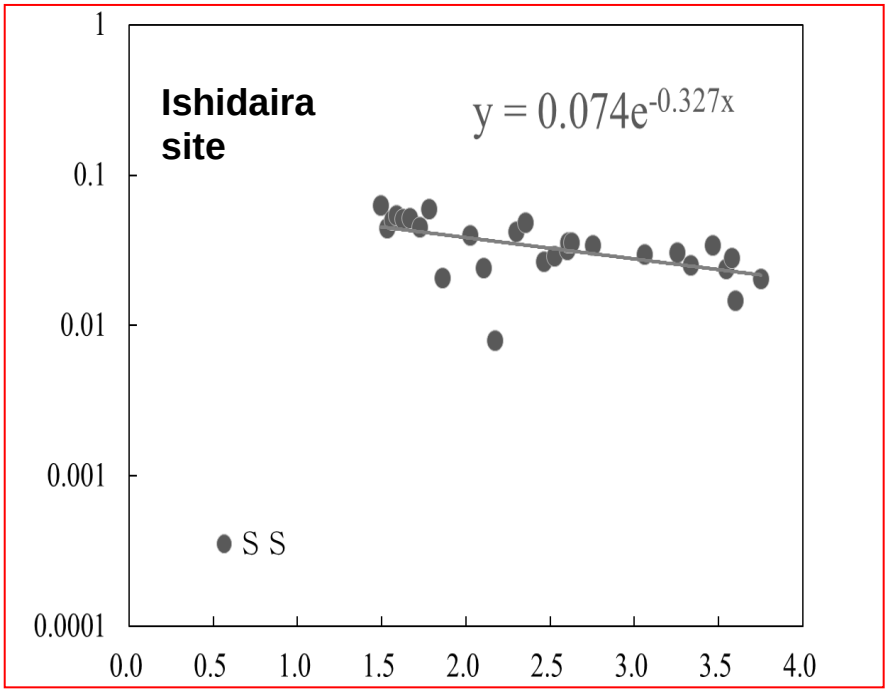
Paddy field *Sc(t)*

$Sc_{paddy}(t) = 1.62e^{-10.1t} + 0.145e^{-0.958t}$



Forest catchments *Sc(t)*

$Sc_{forest}(t) = 0.074e^{-0.327\,t}$



【Outline of observation equipment】

- Suspended sand sampler
- Pressure water level sensor
- Turbidimeter
- Rain gauge
- Data logger and solar panel

Photo 1 Suspended sand sampler

Photo 3 Turbidimeter

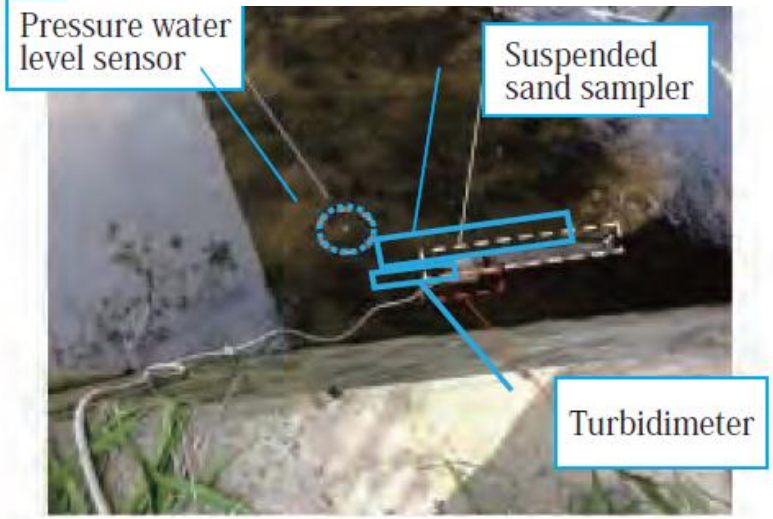


Photo 4
Installation of suspended sand sampler, turbidimeter sensor an pressure water level sensor (Upstream of Kuchibuto River)

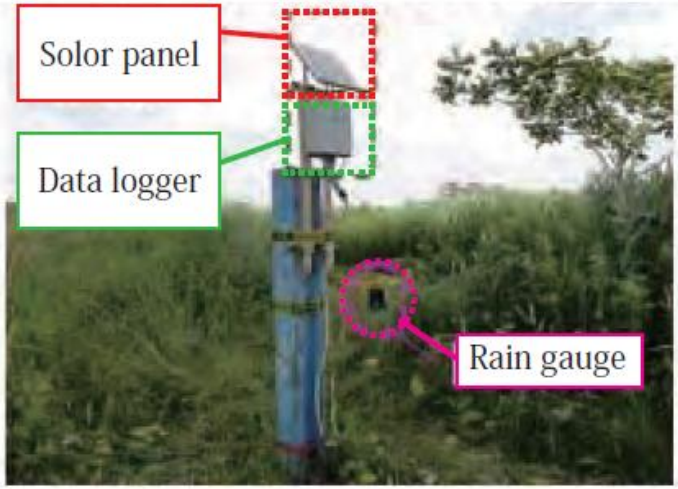
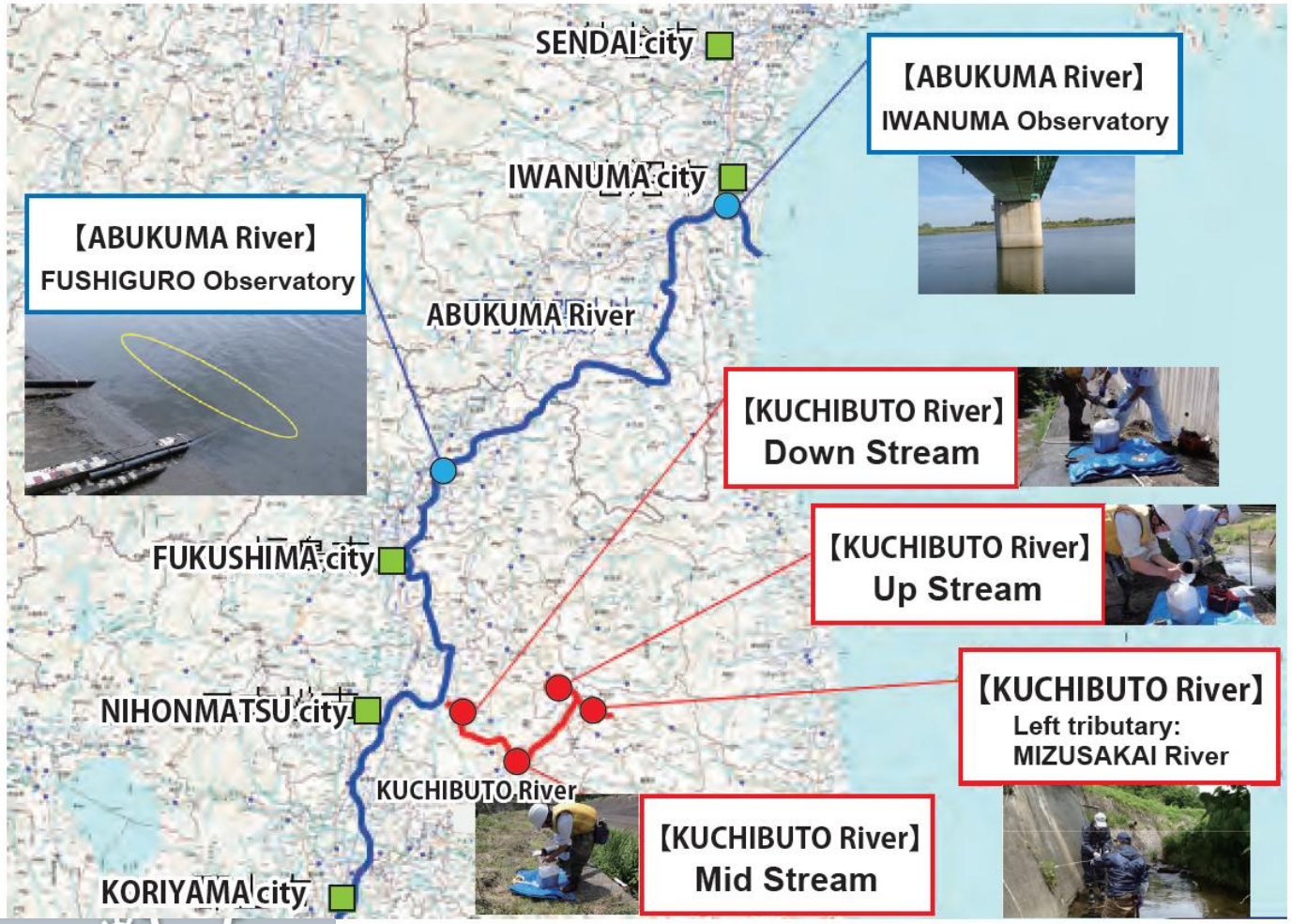


Photo 5
Installation of data logger, solar panel and rain gauge (Iwanuma observatory)

Radionuclide migration to rivers and ocean (initial 6 sites)



SCIENTIFIC REPORTS

OPEN

SUBJECT AREAS:
ENVIRONMENTAL MONITORING
SUSTAINABILITY

Received
21 November 2013
Accepted
17 December 2013

Initial flux of sediment-associated radiocesium to the ocean from the largest river impacted by Fukushima Daiichi Nuclear Power Plant

Yosuke Yamashiki[1], Yuichi Onda[2], Hugh G. Smith[3], William H. Blake[3], Taeko Wakahara[4], Yasuhito Igarashi[5], Yuki Matsuura[6] & Kazuya Yoshimura[2]

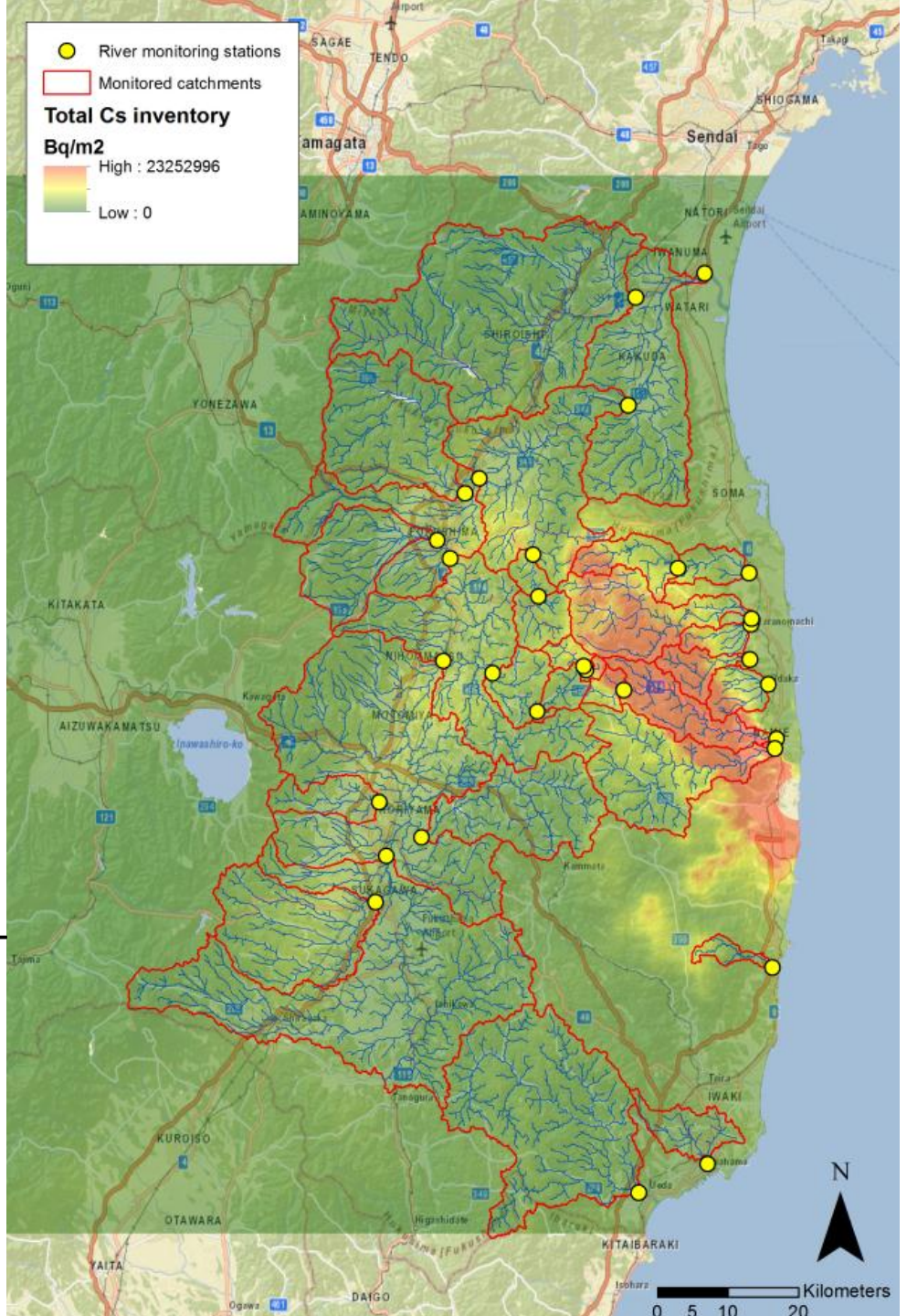
From 10 August 2011 to 11 May 2012 The total flux of radiocesium into the Pacific Ocean estimated was corresponding to 1.13%of the total estimated radiocesium fallout over the basin catchment.

River monitoring sites

1. **Longer-term Abukuma sites (n = 6):**
   - Established from June 2011

2. **New sites (n = 24):**
   - Abukuma Basin and small coastal catchments
   - Established in October-December 2012

- Catchment areas range from 7.6 – 5,170 km^2
- Average inventories based on MEXT
- Cs-137: 19-2380 kBq m^{-2}



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Landuses in Abukuma catchments and 6 long-term sites

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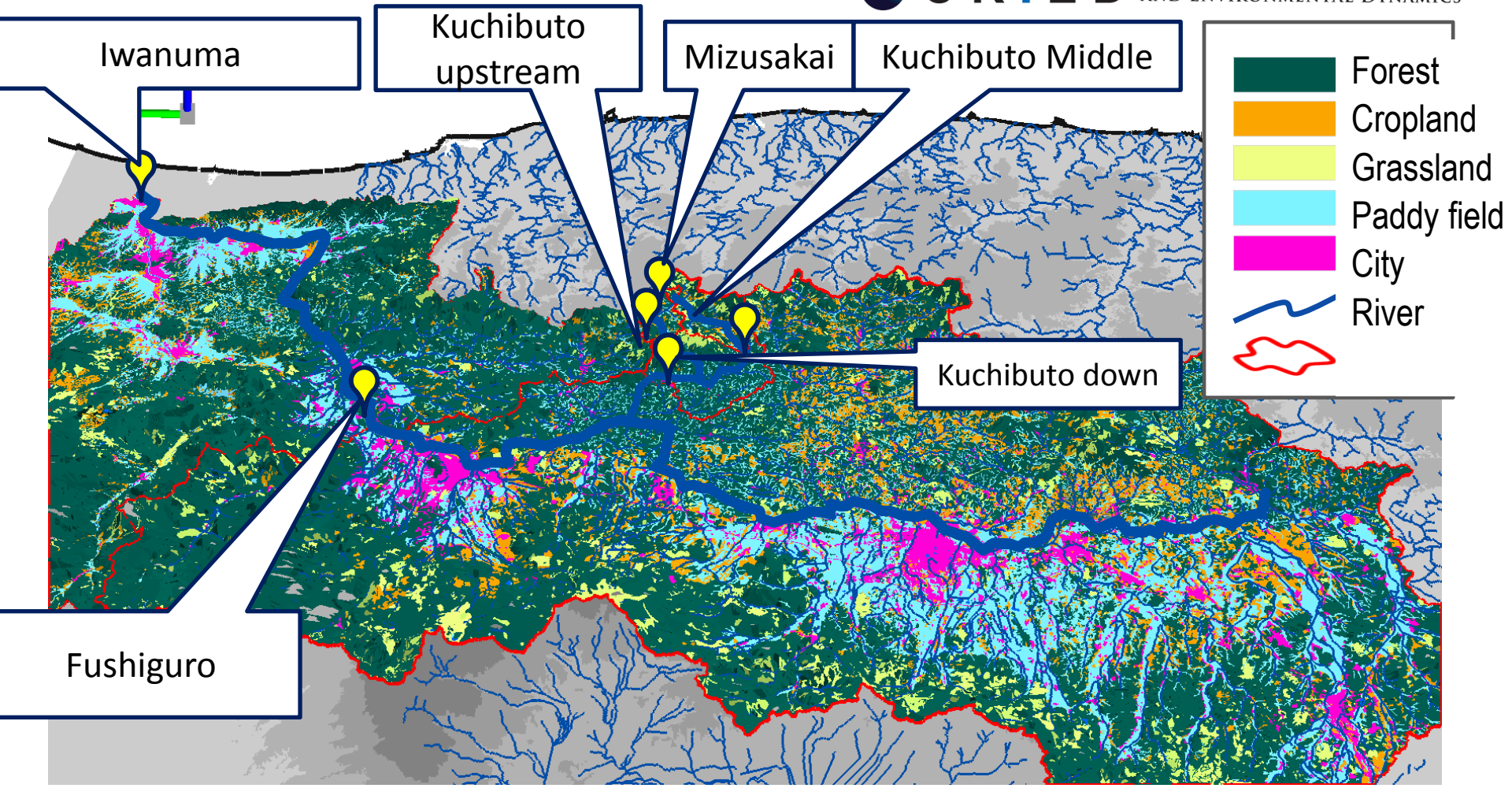
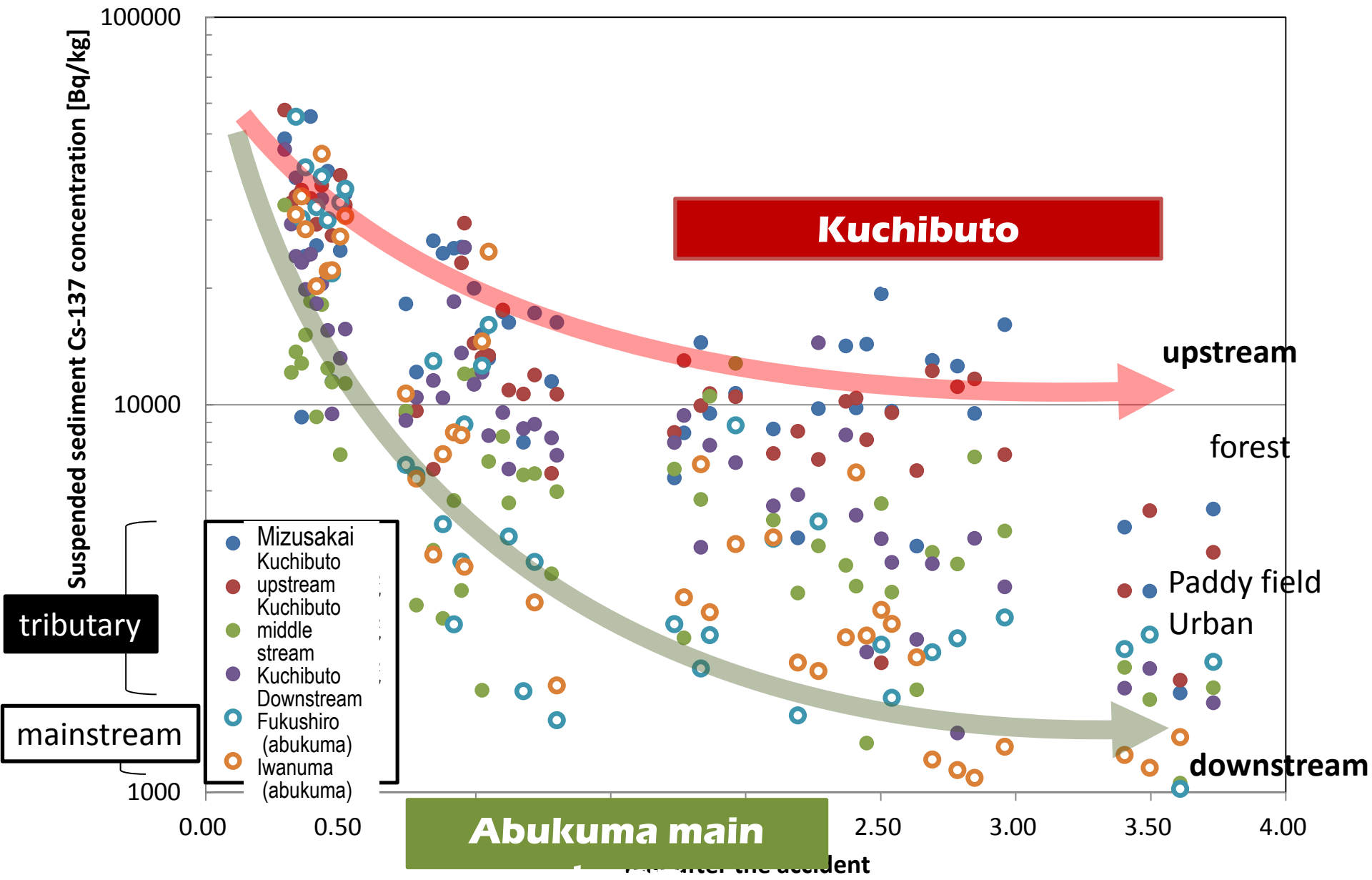
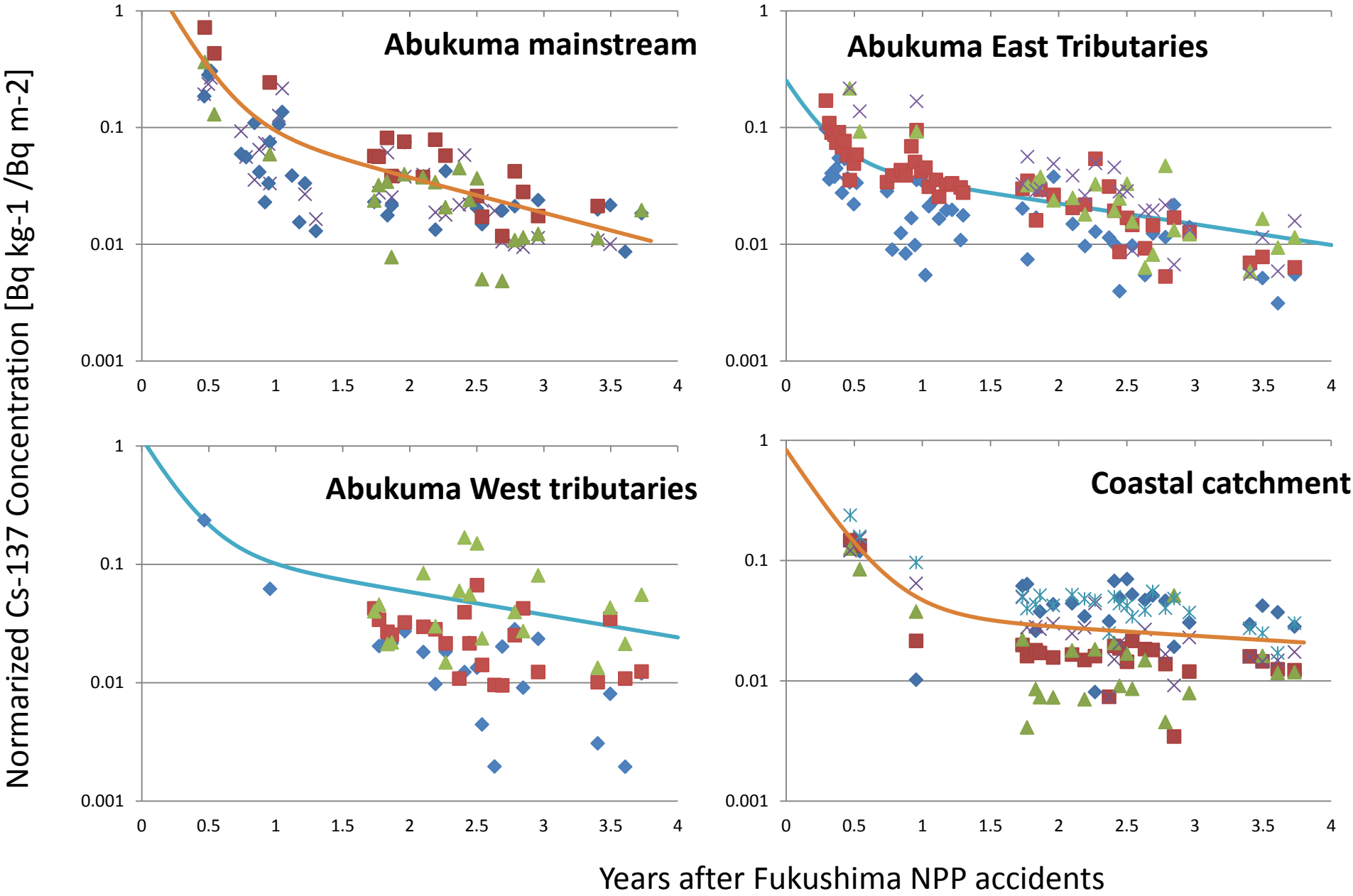


Time change of suspended sediment concentration in 6 long-term sites

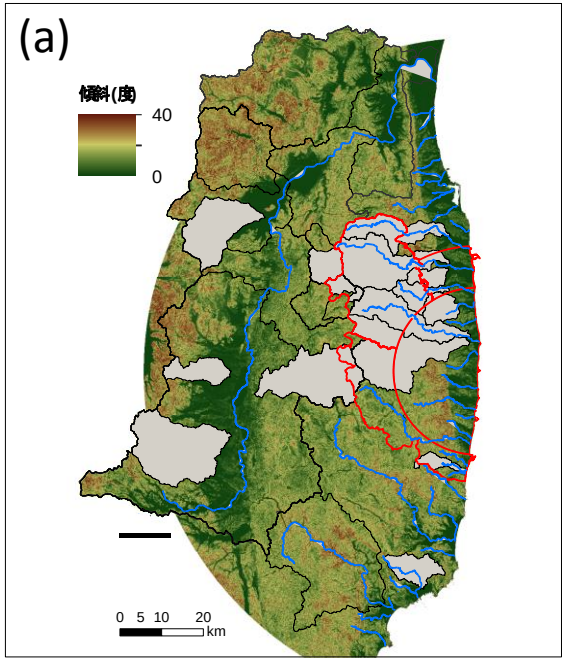


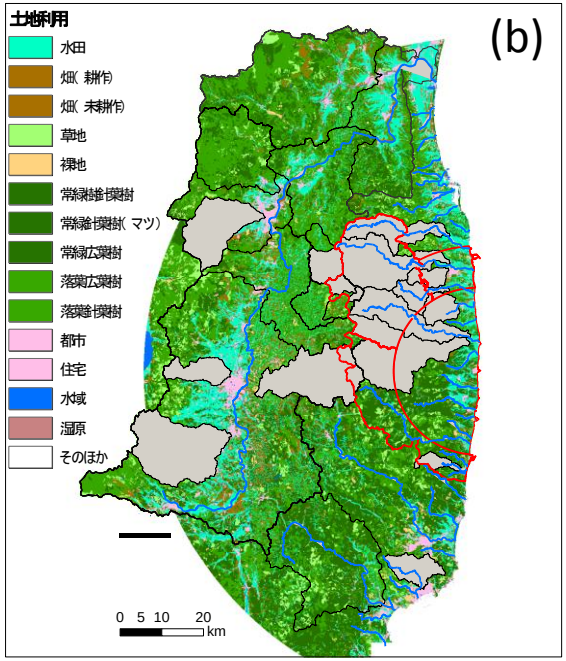
Time change of Suspended sediment Cs-137 concentration for 30 sites



USLE-based soil erosion calculation (25m-grid)

Slope(*S*)

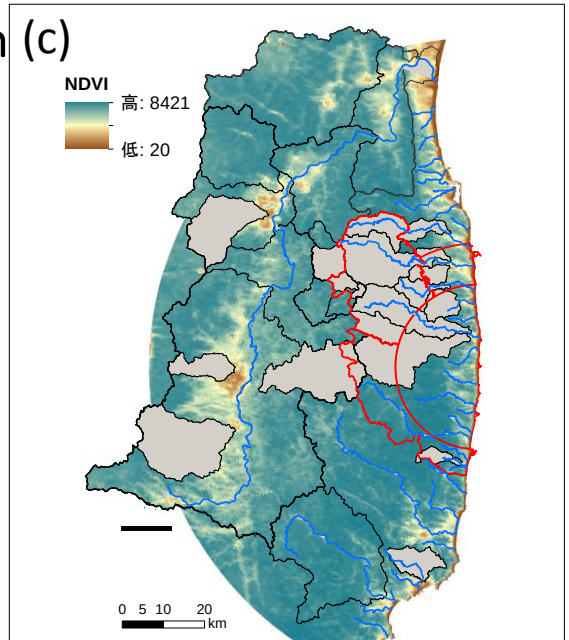


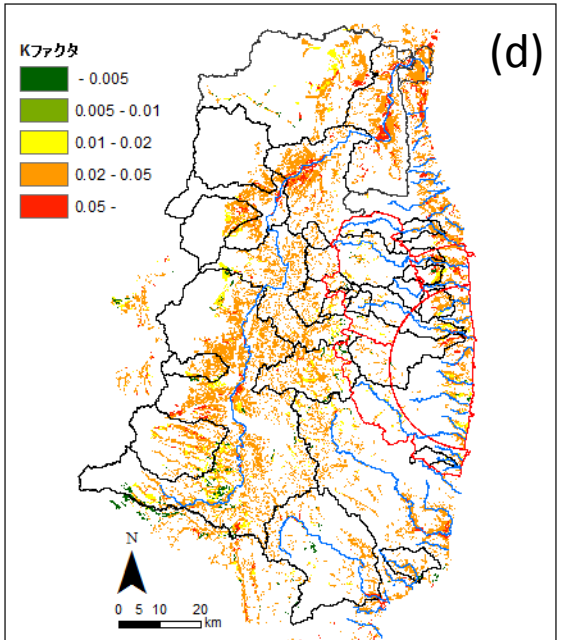


Landuse

Calculation: 1 month step

Vegetation factor (*C*)



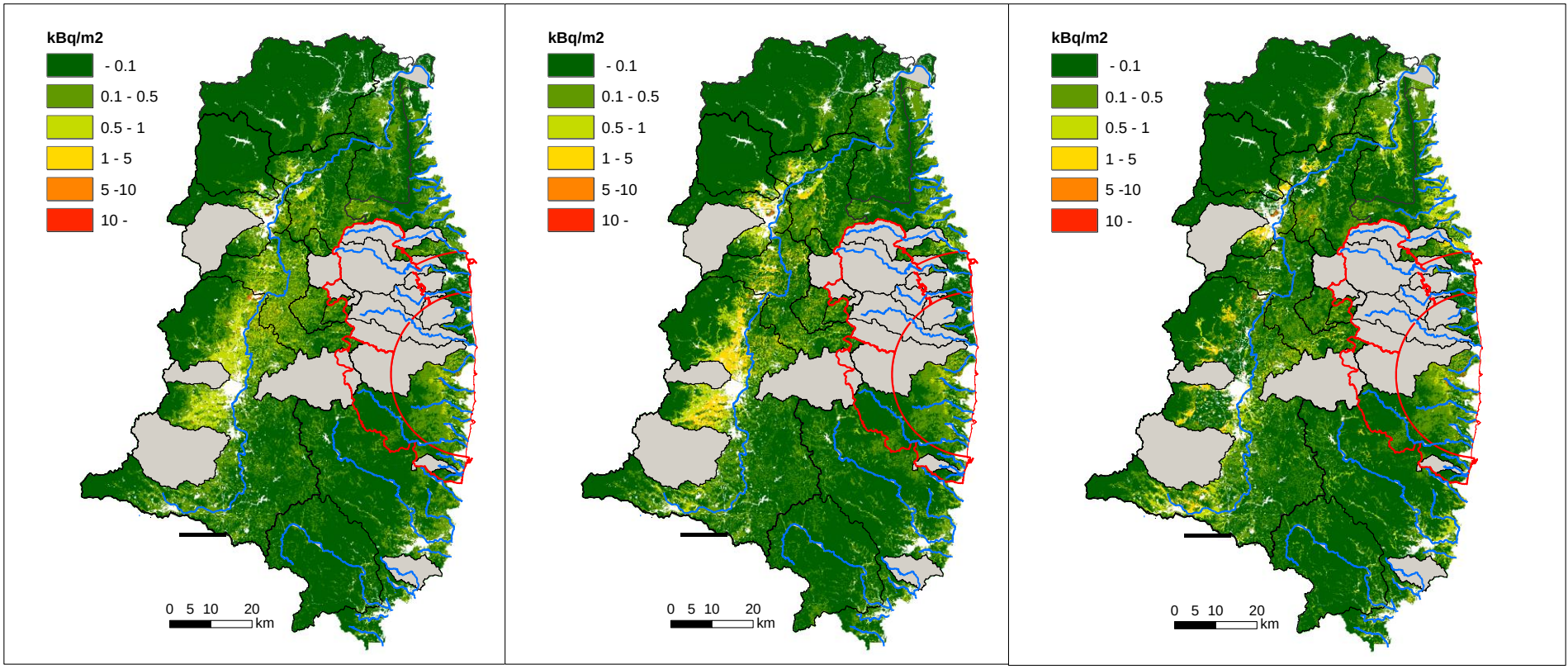


K factor

Input parameters ; Rainfall (Thiessen-based),
***Sc (t)* of each land use :paddy:using the monthly discharge data** Wakahara et al. 2014)

Calculated Cs-137 migration

a) Mar.31, 2011-Oct.31, 2011 b) Nov. 1, 2011-Oct.31, 2012 b) Nov. 1, 2012-Oct.31, 2013

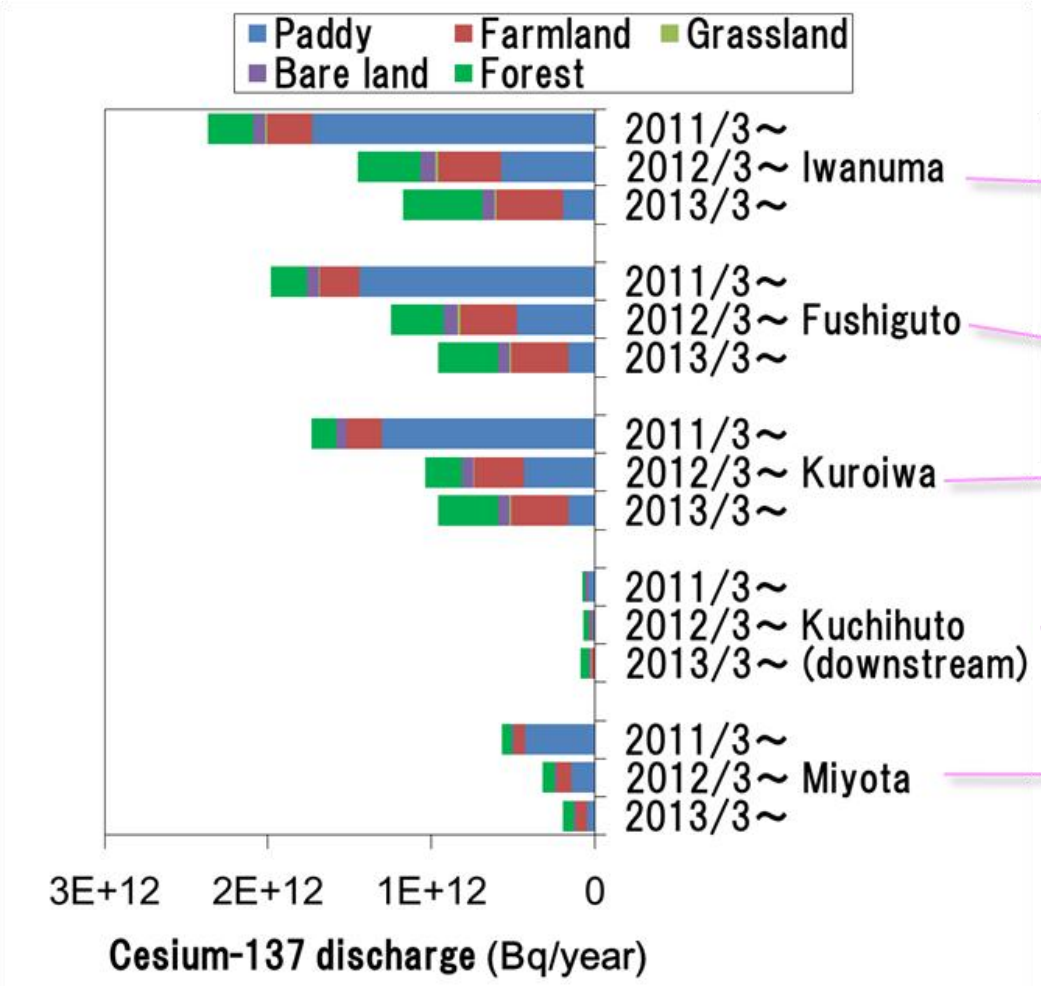


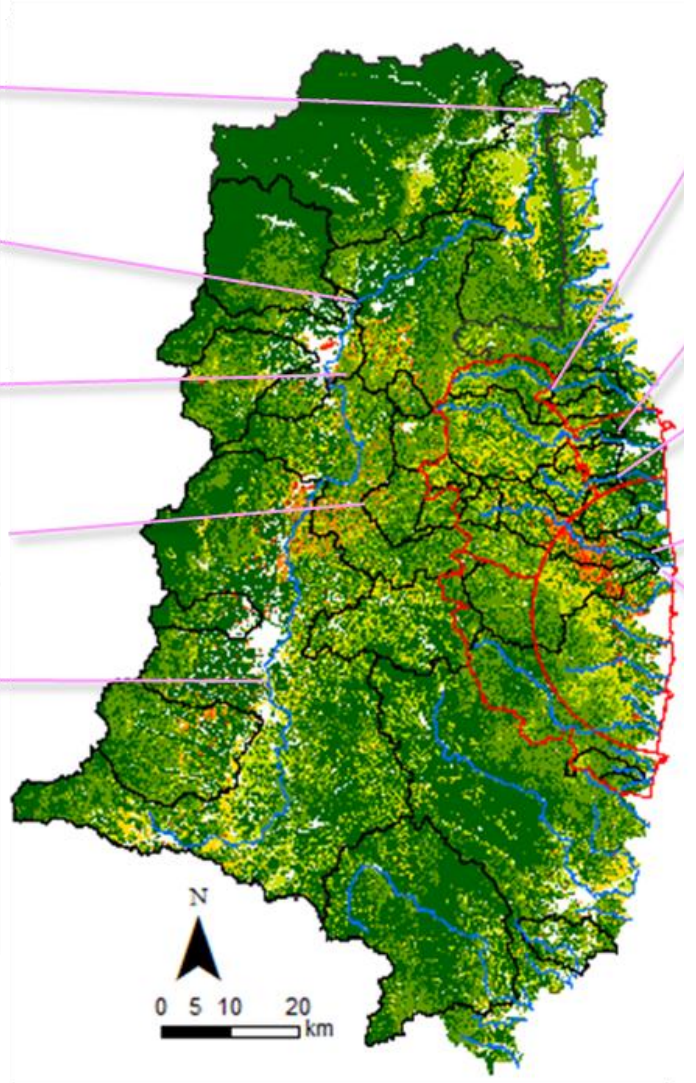
Calculation has been conducted 1 month step

Input parameter ;Rainfall (Thiessen-based**)**, ***Sc (t)*** **of each land use**

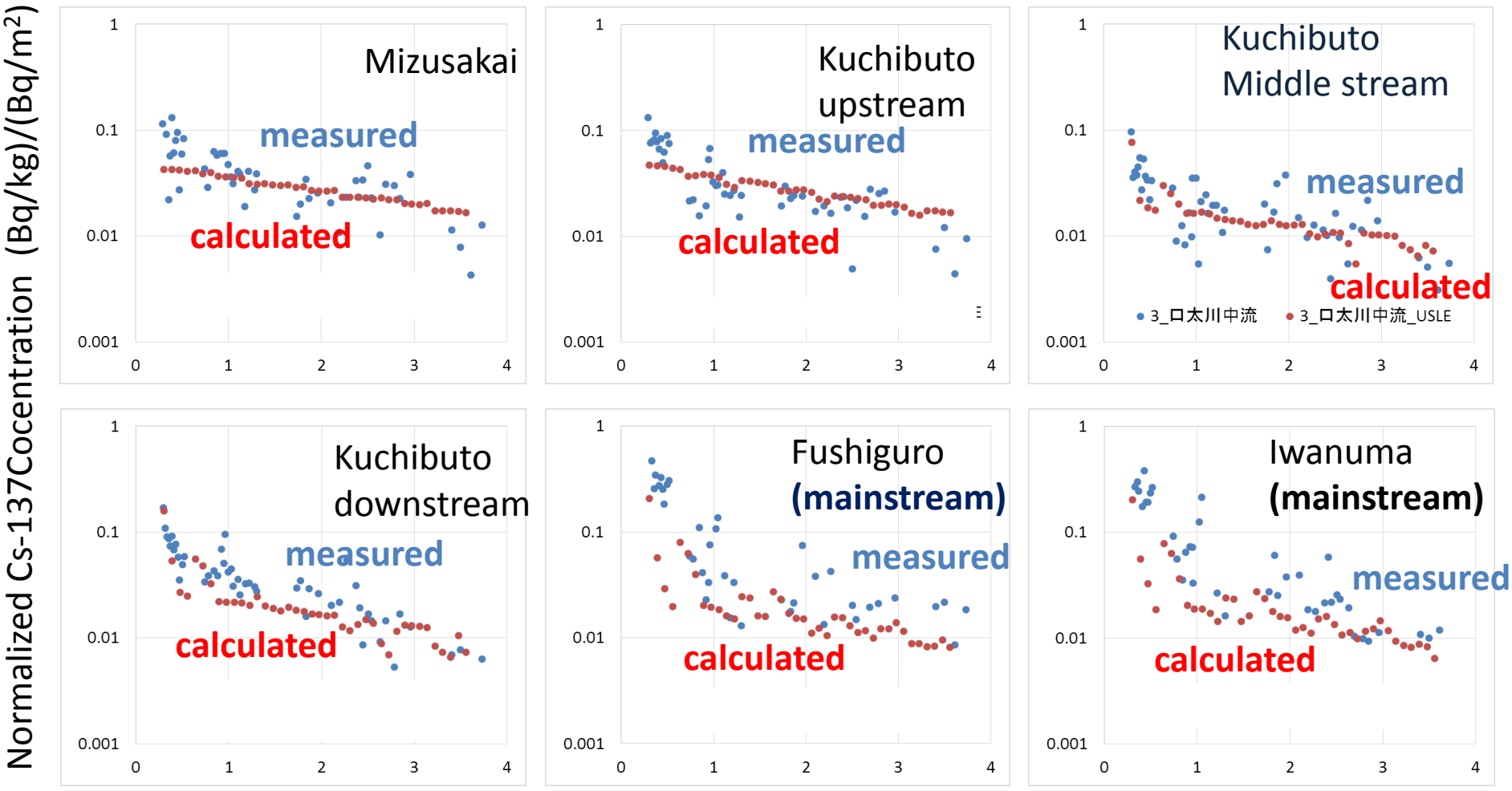
:paddy:using the monthly discharge data by Wakahara et al. 2014)

Sediement source estimates by USLE-based model





Time Changes of the Model calculation and measured value for 6 long-term monitoring sites



Conclusion

Based on intensive field monitoring from June 2011-present reveal that the time change of Cs-137 differ between land uses.

Downstream Suspended sediment concentration differs between places in by 30 locations of river monitoring data.

For accurate modelling after Nuclear Emergency, detailed field monitoring is the most important !

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