SAC20/ 11/ 2

Progress of catchment studies in the EANET countries

Network Center for the EANET

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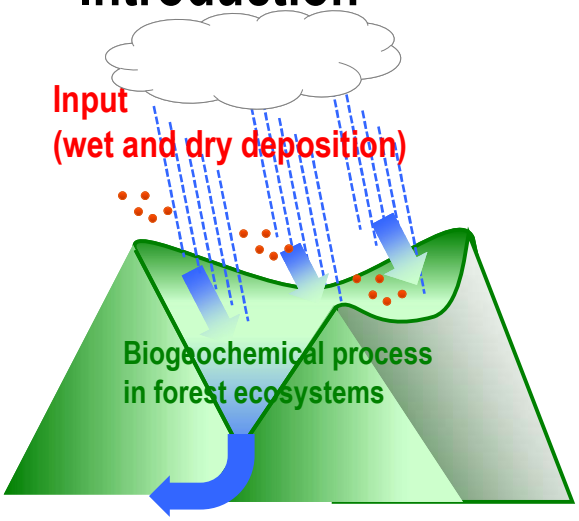
Introduction



- Water soluble substances derived from atmospheric deposition are flowed/cycled with hydrological and biogeochemical processes in terrestrial ecosystems, and part of them are finally flowed into rivers and streams.
- As the output, the river water chemistry may have reflected the atmospheric input and reactions in the ecosystems.
- The observational method utilizing a catchment/watershed has been widely used in the United States and Europe, for integrated assessment of effects of atmospheric deposition on ecosystems.

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Introduction (continued)

- The Scientific Advisory Committee (SAC) and its Task Force on Soil and Vegetation Monitoring (TFSV) recommended to promote catchment analysis and develop the monitoring methods for the EANET.
- Asia Center for Air Pollution Research (ACAP) as the Network Center for the EANET (NC) has been promoting catchment analysis in cooperation with SAC and TFSV, according to recommendations in the strategy papers.
- In this report, the recent progress of catchment analysis in the EANET is overviewed with major outputs, such as scientific papers.

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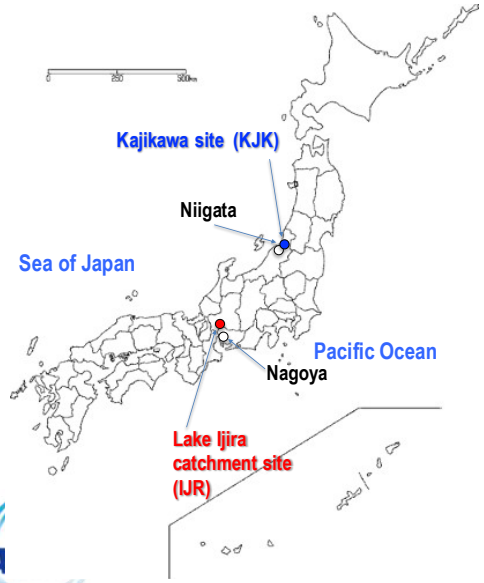
Major outputs:
Catchment analysis in Japan-1



- Lake Ijira catchment (IJR) was registered as the first EANET site for the regular catchment-scale monitoring. The data since 2007/2008 were submitted to the EANET, while historical data since the 1980's were also available.
- ADORC/ACAP established the small catchment plot, Kajikawa site (KJK), in 2002, to develop the monitoring method and assess effects of transboundary air pollution.
- The project at KJK has been functioning as the base for international joint research projects with the EANET countries, such as Thailand and Malaysia.

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Major outputs:
Catchment analysis in Japan-2

- **Inomata Y et al. 2019. Science of the Total Environment 691, 779-788:**

The paper suggested that rainwaters collected at IJR in the Pacific side had also been influenced by transboundary air pollution, based on the sulfur isotopic analysis of rainwater samples in Japanese monitoring sites including IJR and KJK (cooperated with the national monitoring in Japan and Kanazawa University).

Table 1. Relative source contributions estimated using the sulfur isotopic ratios in rainwater (Inomata et al. 2019).
KAJ: Kajikawa site, IJI: Lake Ijira site, TRB: transboundary, DOM: domestic, DMS: dimethyl sulfate

Annual averaged sulfur isotopic ratios, relative source contributions, and atmospheric sulfate deposition from each source.

	Period	Annual average sulfur isotopic ratio(‰)		Annual average sulfate deposition (mg m^{-2} d^{-1})					Annual average relative contribution (%)				
		$\delta^{34}S$ ave	$\delta^{34}Snss$	Sea salt	TRB	DOM	Asian dust	DMS	Sea salt	TRB	DOM	Asian dust	DMS
RIS	2014–2016	10.8 ± 1.4	3.5 ± 1.8	4.3 ± 0.9	4.5 ± 0.7	1.3 ± 0.3	–	–	37 ± 3	48 ± 6	16 ± 4	–	–
TAP	2013–2014	10.2 ± 3.4	1.9 ± 3.2	2.5 ± 0.2	2.6 ± 0.5	2 ± 0.6	–	–	44 ± 7	31 ± 8	26 ± 1	–	–
SAD	2014–2016	11.5 ± 1.4	4.2 ± 2.8	4.2 ± 3.9	1.5 ± 0.3	0.8 ± 0.3	5.2 ± 0	–	44 ± 4	31 ± 10	19 ± 1	6 ± 9	–
MAK	2013–2015	8.7 ± 0.8	3.3 ± 2	7.1 ± 2.2	6.9 ± 0.5	3.4 ± 0.8	1.0 ± 0.5	–	31 ± 3	44 ± 3	24 ± 2	3 ± 2	–
KAJ	2014–2016	6.9 ± 0.9	3.1 ± 1.4	3.7 ± 0.4	5.8 ± 1.6	3.0 ± 0.6	–	–	22 ± 2	48 ± 5	30 ± 4	–	–
OKI	2014–2016	13.2 ± 1.2	4.4 ± 2.2	4.8 ± 3.2	2.8 ± 1.9	0.9 ± 0.4	–	0.1 ± 0	45 ± 3	36 ± 7	17 ± 1	–	4 ± 0
IJI	2014–2016	4.2 ± 0.7	2.5 ± 1.3	0.8 ± 0.2	4.3 ± 0.9	3.3 ± 0.3	–	–	10 ± 1	50 ± 4	40 ± 3	–	–
TKY	2014–2016	2.9 ± 0.7	1.0 ± 1.3	0.5 ± 0.2	1.5 ± 0.8	3.3 ± 0.2	–	–	10 ± 1	24 ± 11	68 ± 12	–	–
HED	2014–2016	15.1 ± 1.5	4.5 ± 2.1	3.9 ± 0.6	2.0 ± 0.8	0.7 ± 0.1	–	0.1 ± 0	55 ± 8	32 ± 9	11 ± 1	–	6 ± 0
OGA	2014–2016	15.7 ± 3	5.0 ± 4.8	3.7 ± 0.8	1.1 ± 0.2	0.2 ± 0.1	–	1.3 ± 0.5	56 ± 6	19 ± 4	4 ± 2	–	20 ± 6
HAP	2015–2016	4.3 ± 0.7	3.6 ± 1.2	0.2 ± 0	4.5 ± 0.1	0.3 ± 0	–	–	3 ± 2	87 ± 2	10 ± 4	–	–

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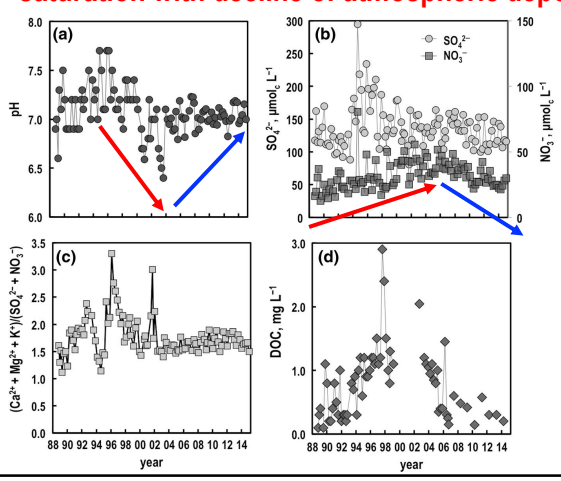
Major outputs:
Catchment analysis in Japan-3

- **Sase H et al. 2019. Biogeochemistry 142, 357-374:**

The paper suggested that IJR has been recovering from acidification/nitrogen saturation with decline of atmospheric deposition.



- **It was also suggested that most of sulfur derived from atmospheric deposition was accumulated within the catchment based on the sulfur isotopic analysis.**

(cooperated with the national monitoring in Japan)

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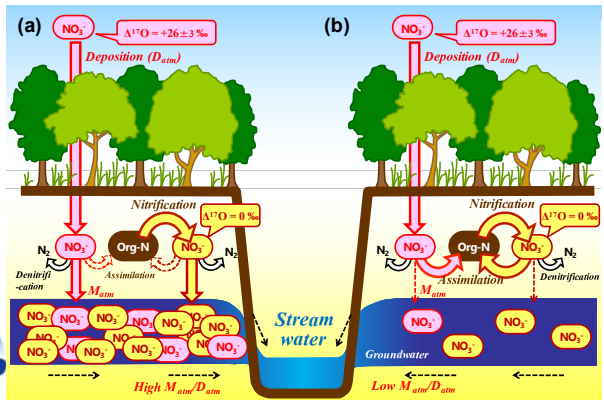
Major outputs:
Catchment analysis in Japan-4

- Nakagawa F et al. 2018. Biogeosciences 15, 7025-7042:

The paper suggested that export flux of unprocessed atmospheric nitrate relative to the deposition flux in each forest ecosystem would be applicable as an index for nitrogen saturation based on the isotopic analysis of ^{17}O excess ($\Delta^{17}O$).



- The estimated annual export flux of unprocessed atmospheric nitrate:
  - ✓ 9.4% ± 2.6% at KJK
  - ✓ 6.5% ± 1.8% at IJR

(cooperated with the national monitoring in Japan and Nagoya University)

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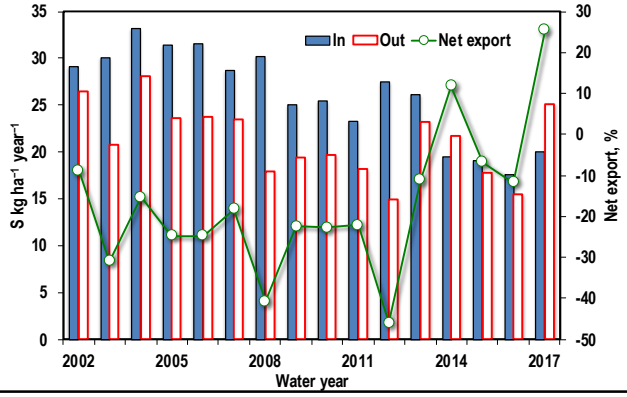
Major outputs:
Catchment analysis in Japan-5

- At KJK, it is suggested that the river water chemistry has been recovering from acidification with decline of atmospheric sulfur deposition.
- However, since ecosystem responses are slower than changes in atmospheric environment, the sulfur output exceeded the input recently, which may delay the recovery (Sase et al. under preparation).



(cooperated with the projects by Asia-Pacific Network for Global Change Research and KAKENHI, Japan)

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Major outputs:
Catchment analysis in the EANET countries-1

- International joint research projects at Sakaerat site (SKT), Thailand and at Danum Valley site (DNV), and Bintulu site (BTL), Malaysia, were conducted for the observational periods, 2005-2015, 2008-2015, and 2012-2015, respectively.
- The comparative study between KJK and Komarovka River site (KMR) in Far East Russia has been started since October 2019 with a Russian Ph.D. student in Niigata University, who was the 2017 EANET Fellowship researcher.
- Referring to catchment studies in IJR and KJK in Japan, SKT in Thailand, and DNV in Malaysia, the Guideline for Catchment-scale Monitoring was developed by TFSV and adopted at the 10th Session of SAC in 2010.
- The Philippines has just started the regular catchment monitoring in La Mesa Watershed, Metro Manila, 2019, according to the guideline.

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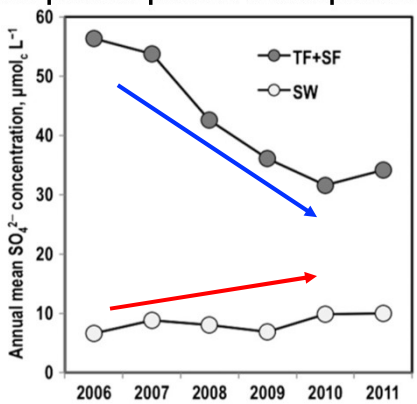
Major outputs:
Catchment analysis in the EANET countries-2

- Sase et al. 2017. Hydrological Processes 31, 836–846.

The paper suggested that stream water chemistry in the dry evergreen forest responded sensitively to seasonal changes in atmospheric conditions, such as precipitation pattern and deposition of ion constituents.



The atmospheric deposition of SO_4^{2-} declined, while the stream water concentration increased.

Fig. Annal mean SO_4^{2-} concentrations of the deposition by throughfall and stemflow (TF+SF) and stream water (SW)

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Subjects for future catchment analysis

- **Recovery from acidification:** This is also important as validation of relevant measures/policies in the region and each country.
- **Loads of atmospheric nitrogen to ecosystems and its cycle:** Nitrogen cycle is listed as one of the most important earth-system processes in the concept of **"Planetary boundaries"**. Atmospheric nitrogen has the important role in nitrogen cycle.
- **Relationship with Climate Change:** Climate change is closely related to the sulfur and nitrogen cycle, and climate change may delay recovery from acidification.

KJK is still important as the core site for cooperation with the EANET countries, including the comparative study with Russia. From a scientific point of view, **observations at the KJK will need to continue for at least the next five years**.

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Actions required at SAC20

- SAC20 is invited to review the progress of catchment analysis.

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