

Characteristics of Ion Components of Clearwater Stream Watershed in an Agricultural Area with Multivariate Analysis

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ABSTRACT: Restoring the clear-stream environment that once existed in agricultural areas is one of the major challenges for the development of sustainable agriculture. Therefore, we analyzed the ionic components of the Rekifune and Satsunai River basins, which are regarded as clear-water basins in the Tokachi region of Hokkaido, using principal component analysis and cluster analysis based on surveys conducted in June and September 2014. The results showed that most of the sampling points in the Rekifune and Satsunai drainages were comparable to the average values of water quality assessed as clear-streams in Japan. However, in the tributaries of the Rekifune River, since Cl⁻ and Na⁺ increased characteristically, the water quality was degraded by anthropogenic pollution sources such as domestic wastewater. In the Satsunai River, the water quality of the downstream tributaries was degraded due to agriculture. In addition, in one of the tributaries, deterioration of water quality was observed only in September, and the water quality of the main river immediately after the inflow of this tributary was also affected. These results indicate that the water quality in the two basins in the predominantly agricultural area is generally good. Still, it is necessary to identify the source of pollution in some areas and take countermeasures.

Satsunai and Rekifune Rivers

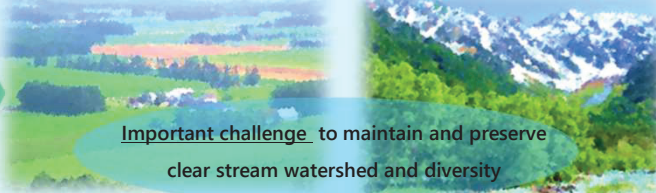
• Popular clear streams in Japan

"The Rivers Ranked by public institutions"

Satsunai River :
 No.1 at 1991, 1993, 1995 – 1997, 1999, 2003, 2006
 High ranked at 2007 ~
 by the Ministry of Land, Infrastructure, Transport, and Tourism

Rekifune River :
 No.1 at 2007, 2010 – 2012
 by the Ministry of the Environment

• Located in Large Agricultural Area



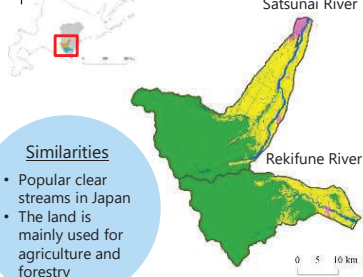
Important challenge to maintain and preserve clear stream watershed and diversity

Objective

Evaluated ion components of river water and all water quality factors using **multivariate analysis** in clear stream watersheds at a large agricultural area to develop **guidelines for preserving river environments**.

Observation in June and September 2014 during normal water level

Tokachi region, Hokkaido



Study sites

Satsunai River watershed

- **General farming**
- Wheat, potato, sugar beet, and bean
- Agricultural land occupying 30 %

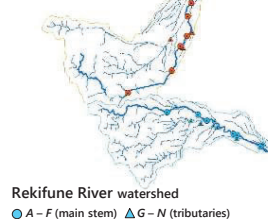
Rekifune River watershed

- **Dairy farming**
- Pasture and forage crops
- Agricultural land occupying 17 %

■ Agriculture ■ Forest ■ Urban

Sampling points

Satsunai River watershed
 ● Nos. 1-11 (main stem)
 ▲ Nos. 12-21 (tributaries)



Rekifune River watershed
 ● A-F (main stem) ▲ G-N (tributaries)

Water quality investigation

Liquid chromatography

Cl⁻ NO₃⁻ NO₂⁻ SO₄²⁻ Na⁺ K⁺ Ca²⁺ Mg²⁺

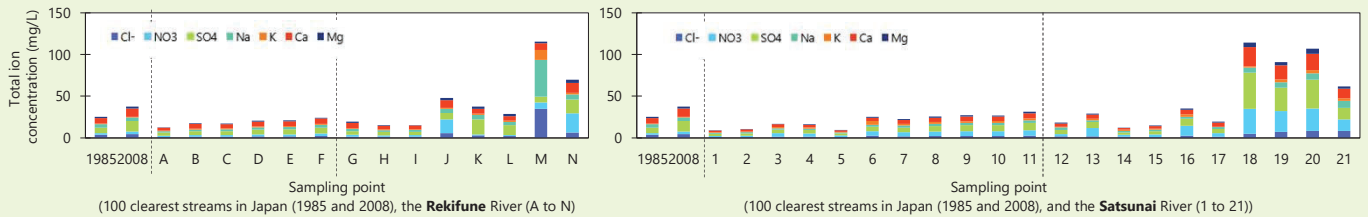
Multivariate analysis

Using R package for Principal component analysis (PCA) and Cluster analysis

Similarities

- Popular clear streams in Japan
- The land is mainly used for agriculture and forestry

Results



Compared water quality between the mean ion concentration of river water and ground water from "100 clearest streams in Japan" of 1985 and 2008 (Yabuzaki et al., 2009) as a reference.

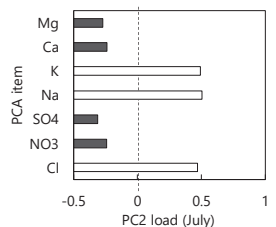
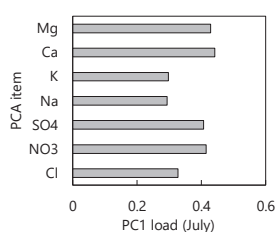
PCA Eigen vectors Cluster analysis

PCA

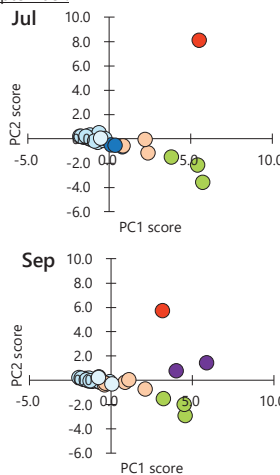
Discussion

The cumulative contribution was **95%** and **82%** from **PC1** and **PC2** in July and September observations, respectively.

The eigenvectors of the PC1 and PC2 showed a similar trend in both July and September.



	Cluster ID	Station number
July	Cluster1	1985, A-I, 1-17
	Cluster2	2008, K, L
	Cluster3	18-20
	Cluster4	J, N, 21
	Cluster5	M
September	Cluster1	1985, 2008, A-I, K, L, 1-4, 6-12, 15, 17
	Cluster2	18-20
	Cluster3	J, N, 13, 16, 21
	Cluster4	M
	Cluster5	5, 14



PC1: **Higher the positive** value means the **worse the WQ**.
 PC2: **Higher the negative** value reflects the influence of **agriculture**;
Higher the positive value reflects **anthropogenic influences** other than agriculture.

C1-C2 (Jul) & C1 (Sep): Same level of water quality concentration as the "100 clearest streams in Japan".

C3 (Jul) & C2 (Sep): Three sites in the tributaries of the Satsunai River located in the lower reaches are affected by agriculture.

C4 (Jul) & C3 (Sep): The water quality tends to deteriorate, although not as markedly as the three tributaries of the Satsunai River.

C5 (Jul) & C4 (Sep): One station of the Rekifune River is degraded by anthropogenic influences other than agriculture.

C5 (Sep): Only in September, the river is affected by anthropogenic factors other than agriculture. There is a pollution source around station 14, which deteriorates the river water quality of the main stem around station 5.