# ENVIRONMENT INDEX FOR ASSESS OF ECOLOGY FUNCTION (HABITAT) FOR MULTIPLE ORGANISMS SUCH AS FISH AND BIRDS CONSIDERING FLOOD RISK IN URBAN AREA

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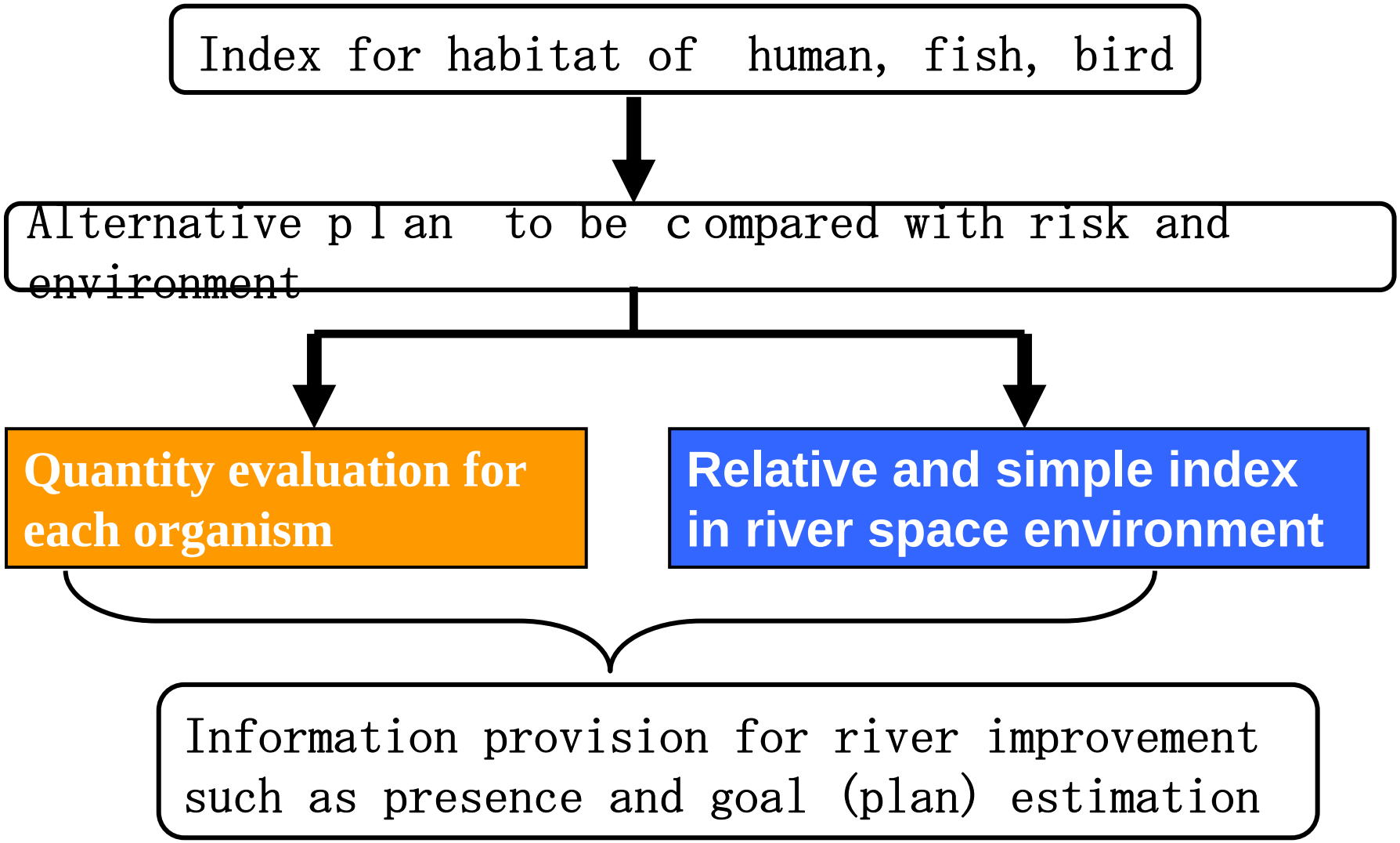
# Flooding damages in Sapporo city 1981 and river utilization

# 1981 flood on the Toyohira River and the present


# Index for river improvement considering flood risk and river environment



# For proper river management

→compare flood risk with river environment

→understand the status of the river environment and ecosystems, and to obtain information for forecasts of riparian environmental conditions

→considering various organisms

(require large amounts of comprehensive river information)

# Quantity evaluation for each organism

Inhabitant Environment (humans)

→Using Hedonic Approach—the values of goods and services in one market transfer into values such as land prices

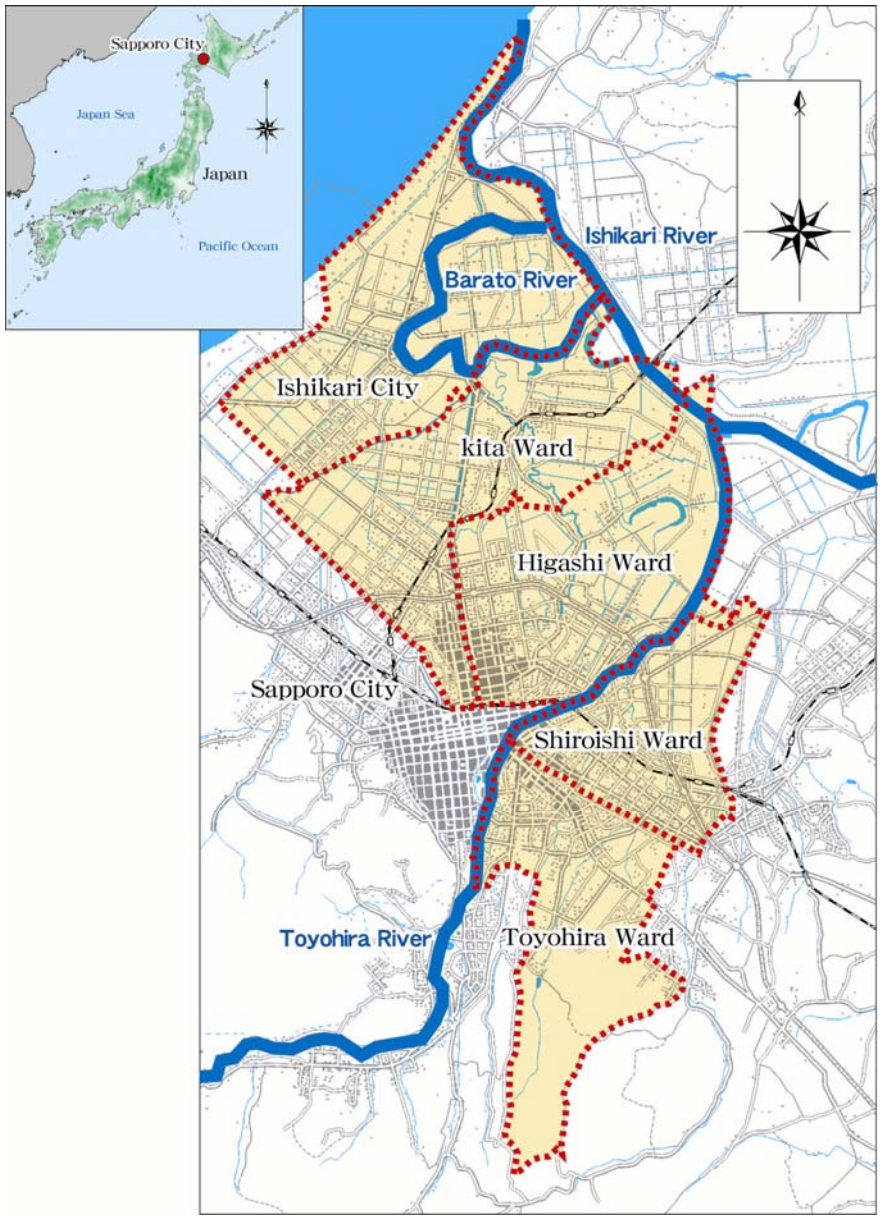
Habitat (fish)

→Using Energy balance budget model by river physical environment

Habitat (bird)

→Using riparian woods area of river space

# The map of Investigation region using Hedonic Approach

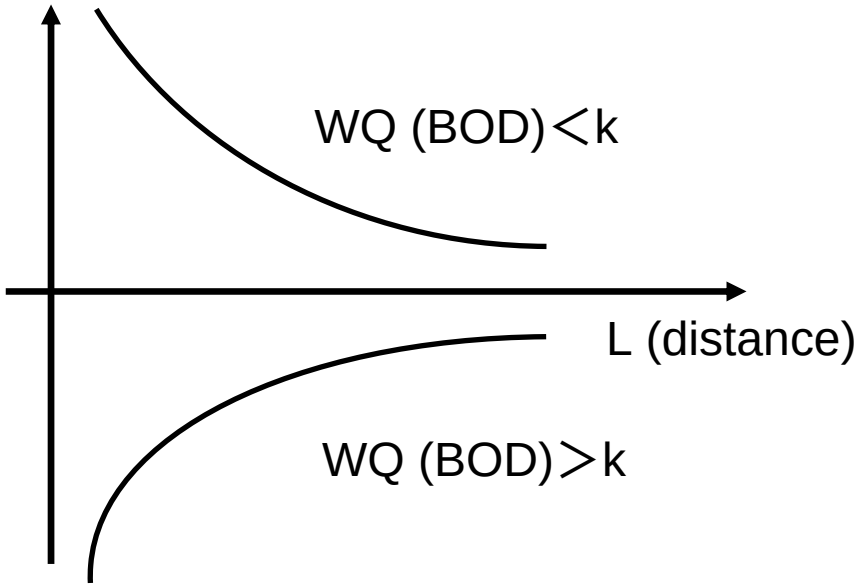



# Result of the estimated land price func

| Variables | | Parameter | t- value | p - value |
|---|---|---|---|---|
| | Constant | 24.733 | 15.695 | below0.001 |
| $X_1$ | First half of 1997 | 1.124 | 2.772 | 0.006 |
| $X_2$ | Second half of 1997 | 0.976 | 4.095 | below0.001 |
| $X_3$ | First half of 1998 | 0.972 | 3.962 | below0.001 |
| $X_4$ | Second half of 1998 | 0.925 | 3.958 | below0.001 |
| $X_5$ | First half of 1999 | 0.347 | 1.469 | 0.142 |
| $X_6$ | City planning(area only for low-rise dwellings) | −0.462 | −3.413 | 0.001 |
| $X_7$ | Urbanization zone =1 | 1.928 | 5.519 | below0.001 |
| $X_8$ | Plot size(LN) | −0.464 | −3.059 | 0.002 |
| $X_9$ | A land suitable for an apartment | 0.553 | 2.275 | 0.023 |
| $X_{10}$ | Sum total length of lot facing road/ Plot size | 13.069 | 7.426 | below0.001 |
| $X_{11}$ | Directions to road | 0.203 | 2.854 | 0.004 |
| $X_{12}$ | Shape of lot (Land of an irregular type form=1) | −0.617 | −5.391 | below0.001 |
| $X_{13}$ | Road status(Public road =1) | 1.231 | 3.071 | 0.002 |
| $X_{14}$ | Largest road width(LN) | 0.593 | 3.683 | below0.001 |
| $X_{15}$ | Classification of land (Housing =1) | 0.312 | 2.208 | 0.028 |
| $X_{16}$ | Access (public transport) | −0.07538 | −15.033 | below0.001 |
| $X_{17}$ | Distance to subway station (LN) | −1.91 | −12.698 | below0.001 |
| $X_{18}$ | Distance to small park (LN) | −0.09387 | −1.408 | 0.16 |
| $X_{19}$ | Distance to large park (LN) | −0.144 | −2.212 | 0.027 |
| $X_{20}$ | Distance to school (LN) | −0.304 | −3.645 | below0.001 |
| $X_{21}$ | Water quality (Large-scale three rivers) | 9.93E-02 | 2.351 | 0.019 |
| $X_{22}$ | Water quality (Three rivers nearby) | 2.31E-02 | 1.521 | 0.129 |
| $X_{23}$ | Past flood | −0.151 | −7.122 | below0.001 |
| $X_{24}$ | Future flood simulation | −0.26 | −4.951 | below0.001 |
| Sample size | | 809 | | |
| Adjusted R2 | | 0.753 | | |

$$y = a_1x_1 + a_2x_2 + a_3x_3 + \cdots\cdots + c$$

# Creation of a composite variable expressing the river environment-Water Quality

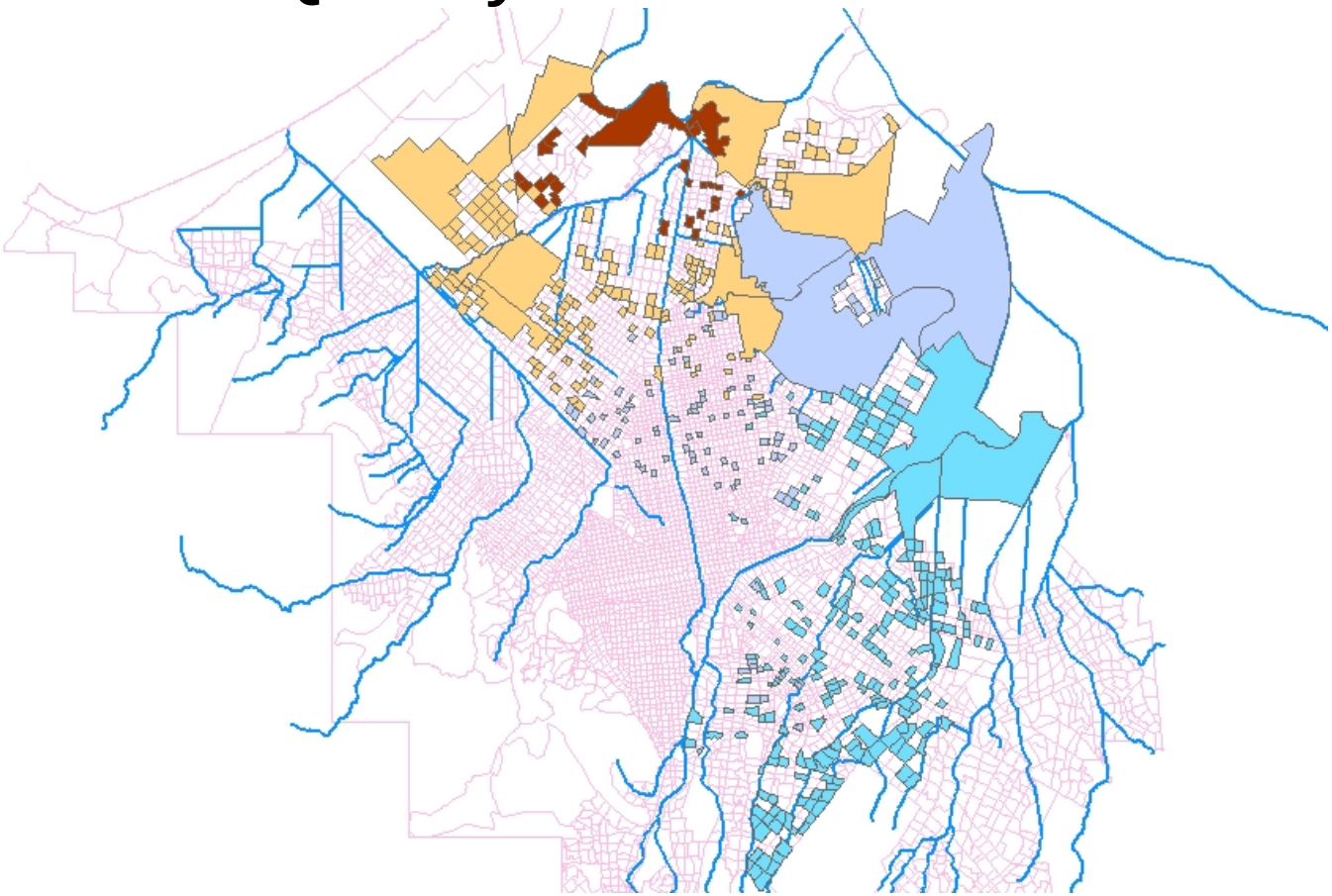



Composite variable
=Σ exp (－distance from river/ ℓ) × (k－water quality (BOD))

Three rivers of Ishikari, Toyohira, Barato ： k＝3、ℓ＝10000

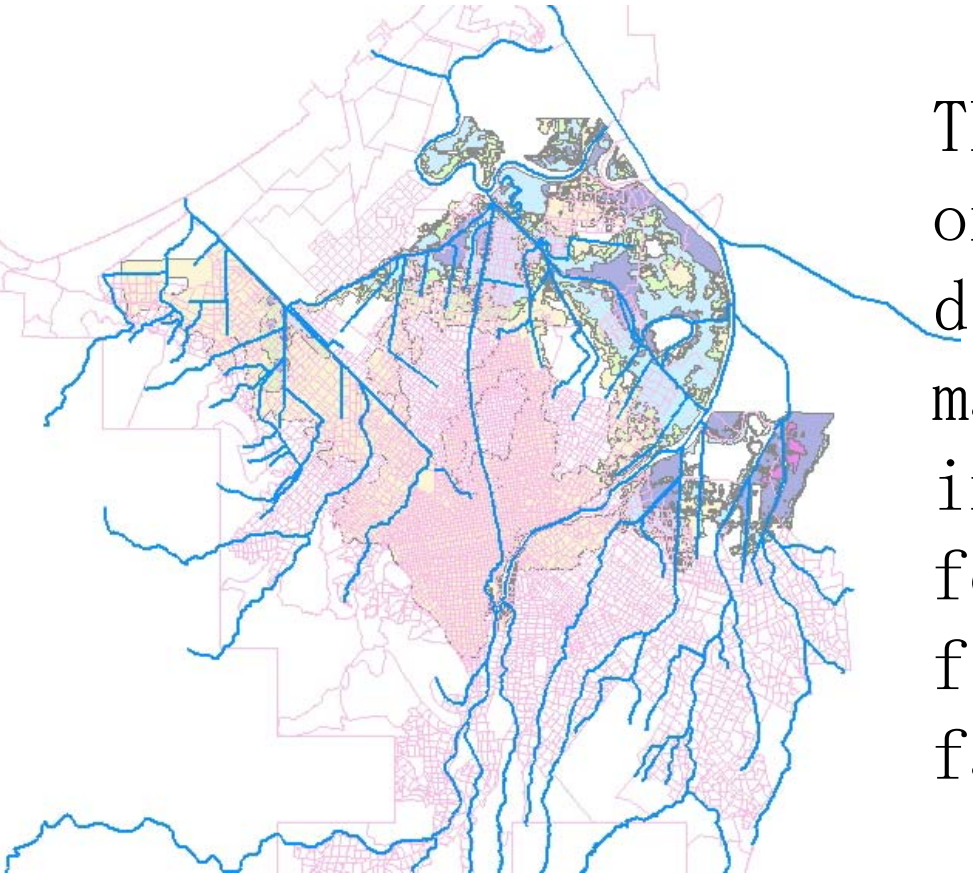
Smaller rivers within 1 km of the plot ： k＝0、ℓ＝1000

# Results of composite variable-3large rivers-Water Quality



Toyohira,Ishikari river have good quality
Barato River has poor quality

# Creation of a flood future risk

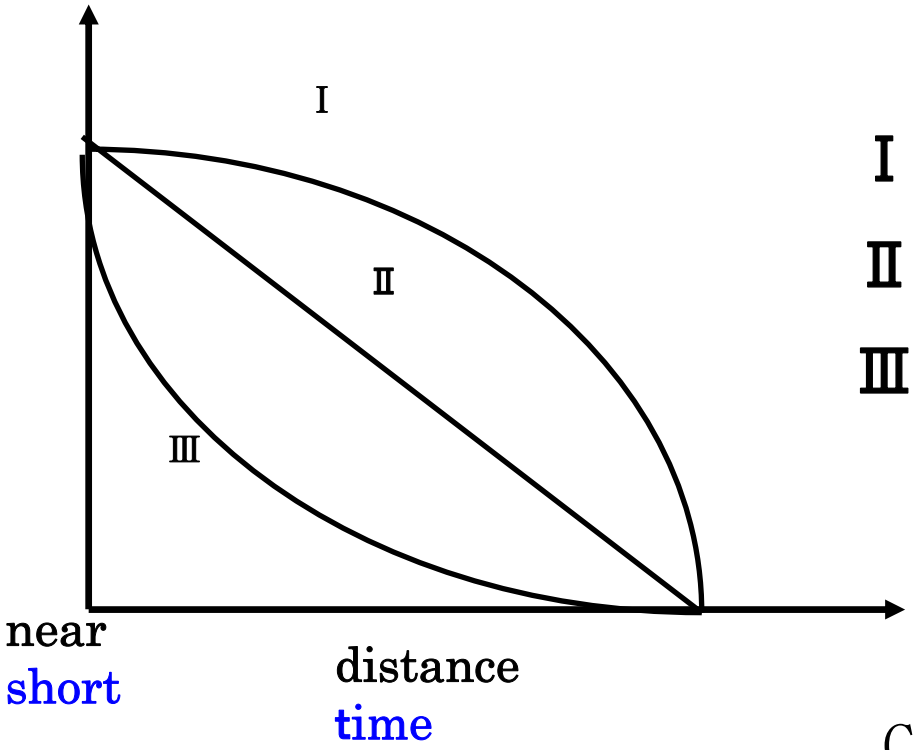


The variables were based on a publicly distributed flood hazard map that shows inundation depth forecasts by area for a flood that assumes bank failure

inundation depth :0m＝0、 0.5m＞ ＝1、0.5m～1.0m ＝2、1.0m～2.0m＝3、2.0m＜ ＝4

# Creation of a composite variable expressing a flood past risk

**d=Distance of the subject location from the flooded locations**
**t=Time elapsed since flooding**




**Ⅰ：ln(d)、ln(t)**

**Ⅱ：d、t**

**Ⅲ：exp(d) 、 exp(t)**

Composite variable
=Σ exp (d) * ln (t)

# Fish and Bird Habitat Model

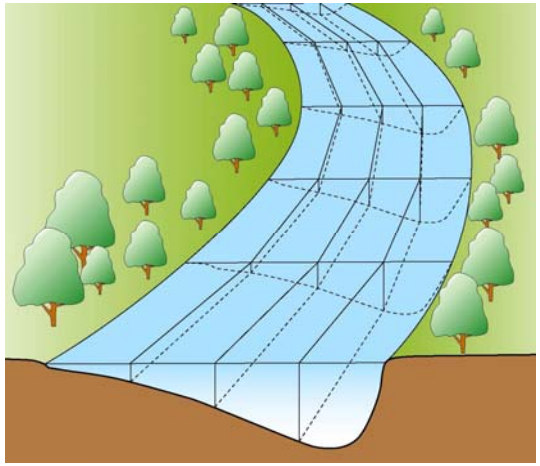
fish

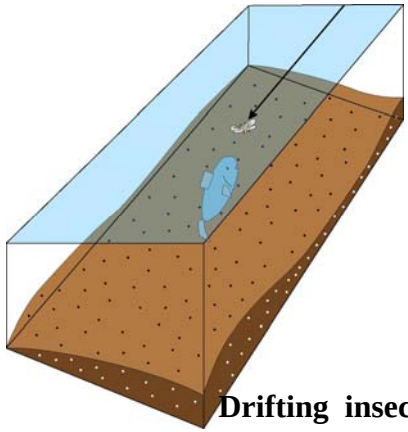
bird

Analysis of relationship

Physical and organism data

# Fish（cherry salmon）habitat model



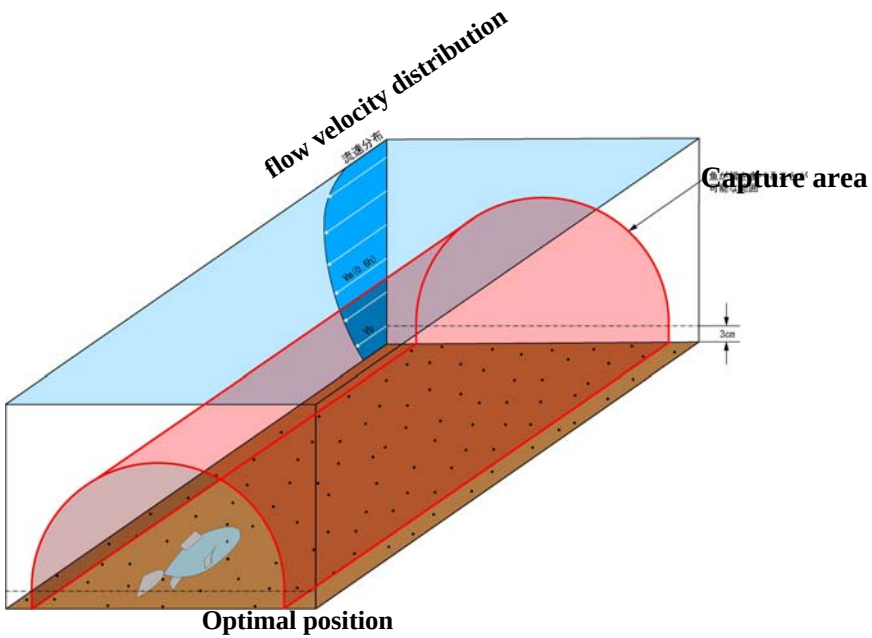


Drifting insect

$$NEI = GEI - SC$$

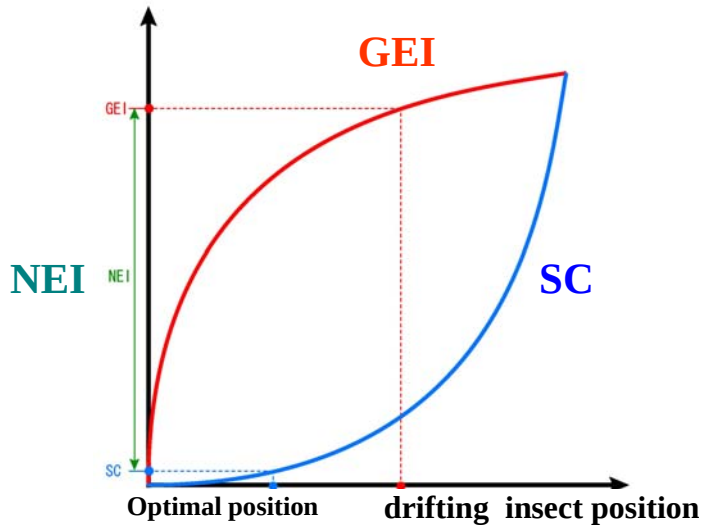
$$GEI\ (cal/h) = CA \cdot Vfg \cdot D \cdot I$$

CA (m2): Capture area
Vfg (m/s): Flow velocity at a feeding depth
D (cal/g): Drifting insects, converted into energy
(4,823 cal/g (dry weight))
I (g/m3·h): Drifting insect supply rate




$$SC\ (cal/h) = 0.9906 \bullet BW^{0.784} \bullet e^{(0.0186 \cdot Vfc)}$$

BW (g): Body weight
Vfc (m/s): Flow velocity at position for rest



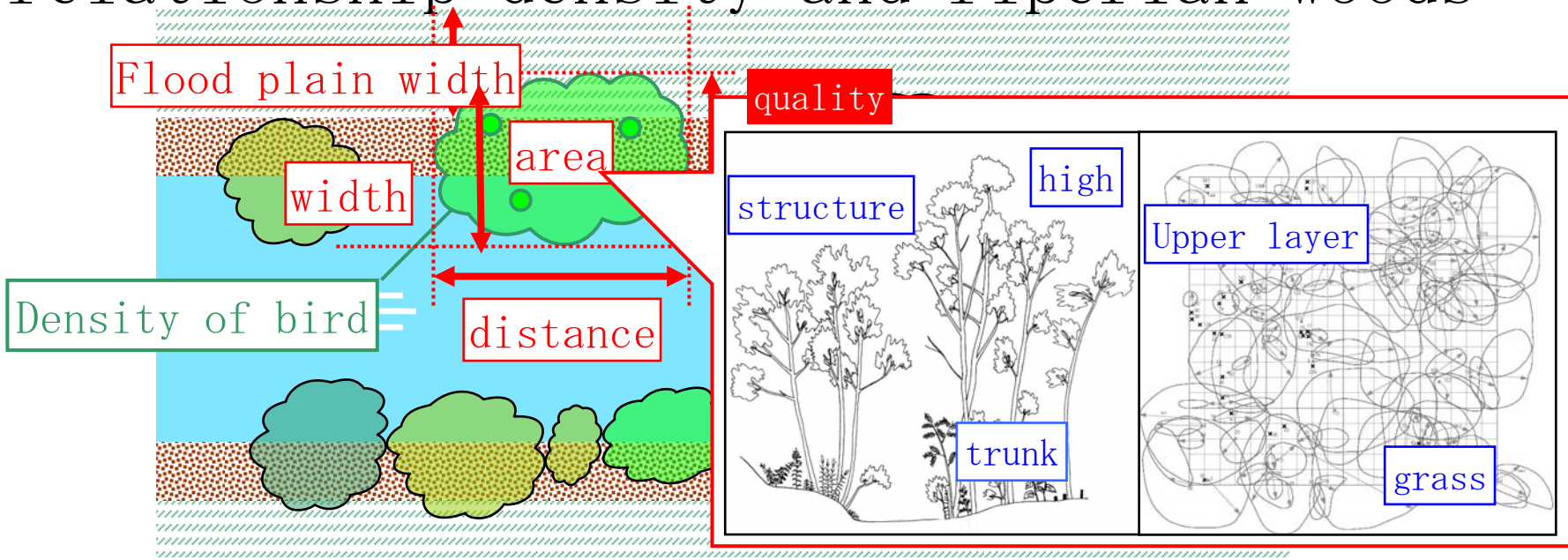
# Results of Fish Estimation Value (NEI)

| River system | Max | Min | Average | Points |
|---|---|---|---|---|
| FUSHIKO | 400 | −10 | 88 | 11 |
| HASSAMU | 87 | −9 | 6 | 11 |
| SOUSEI | 71 | −10 | 8 | 8 |
| SHOUJINN | 268 | −15 | 31 | 9 |
| MOTSUKISAMU | 767 | −11 | 148 | 10 |
| TUKISAMU | 150 | −12 | 187 | 9 |
| ATSUBETSU | 101 | −18 | 11 | 11 |
| MAKOMANAI | 1683 | 38 | 305 | 7 |
| KOTONIHASSAMU | 174 | −16 | 44 | 8 |
| NAKA | 22 | −9 | 0.5 | 5 |
| SHINHASSAMU | 12 | −25 | −8 | 7 |
| SHIN | −4 | −13 | −7.1 | 7 |

Makomanai river

Sosei river

# Bird habitat model
# -relationship density and riperian woods

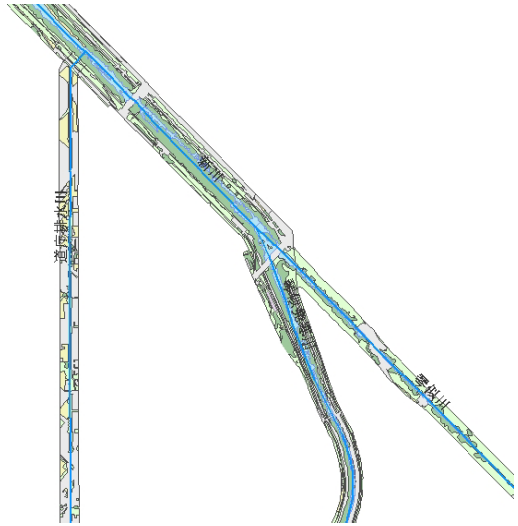


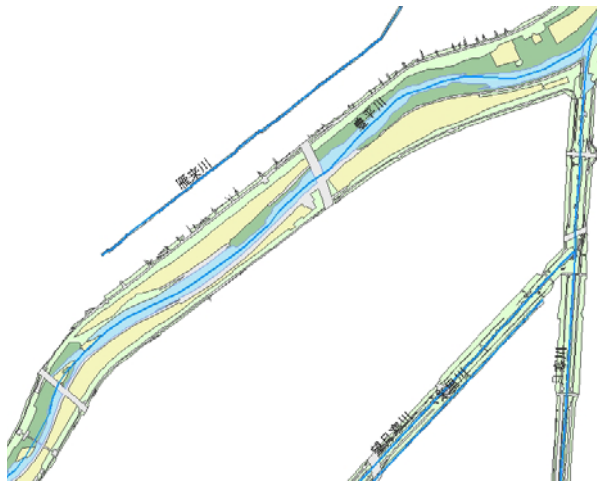

Statistics Analysis

Density of bird
～ Area of riperian woods

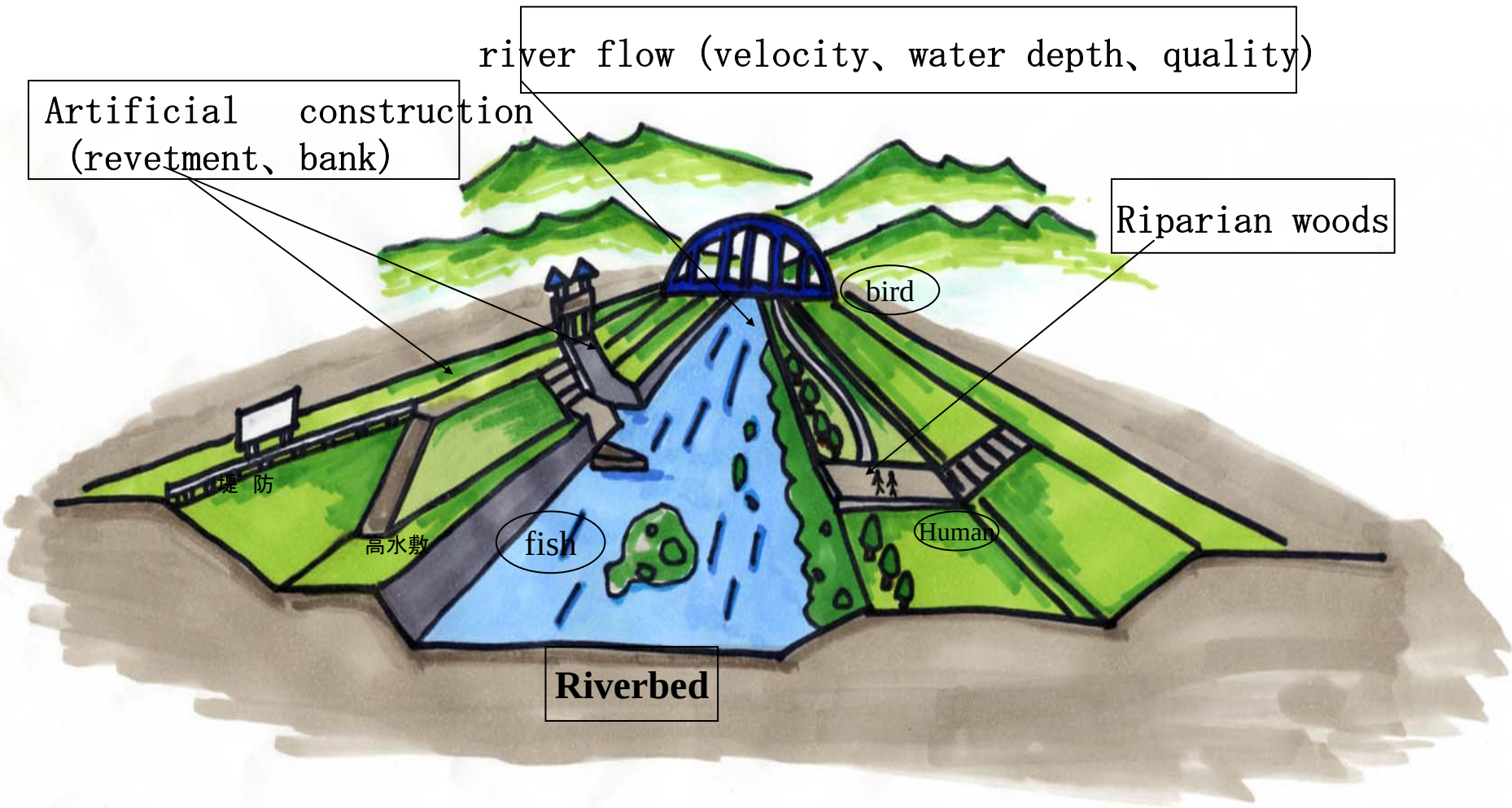
# Results of of riperian woods Area

| River system | River woods area (thousand m2) | Ratio of woods (prevent flow) | Points |
|---|---|---|---|
| FUSHIKO | 41.8 | 0.05 | 189 |
| HASSAMU | 22.6 | 0.05 | 137 |
| SOUSEI | 125.9 | 0.22 | 602 |
| SHOUJINN | 219.1 | 0.56 | 295 |
| MOTSUKISAMU | 65.2 | 0.15 | 292 |
| TUKISAMU | 204.9 | 0.24 | 734 |
| ATSUBETSU | 1112.7 | 0.32 | 782 |
| MAKOMANAI | 330.4 | 0.55 | 328 |
| KOTONIHASSAMU | 455.8 | 0.42 | 308 |
| YASUHARU | 7.8 | 0.06 | 215 |
| KOTONI | 120.8 | 0.21 | 206 |





# Relative and simple index in river space environment




**Physical components（elements）of river environment**

# Using Principle component analysis（PCA）

Composite variables (Y1-Yq) obtained by PCA are expressed by the following equation:

$$Y\ m1 \sim m\,q \quad = a1qX1 + a2qX2 + \cdots + aqq\ Xq$$

Where,
X1-Xq :Physical component data of the river environment:
Y1- Yq ：first principal component, q-th principal component
a1q-aqq :Eigenvalue vectors.
Number of study points: m

# Example of Toyohira river

collect data of GIS ,picture ,outline investigation

**picture**

**Environment classification**

# Elements of River Physical Environment

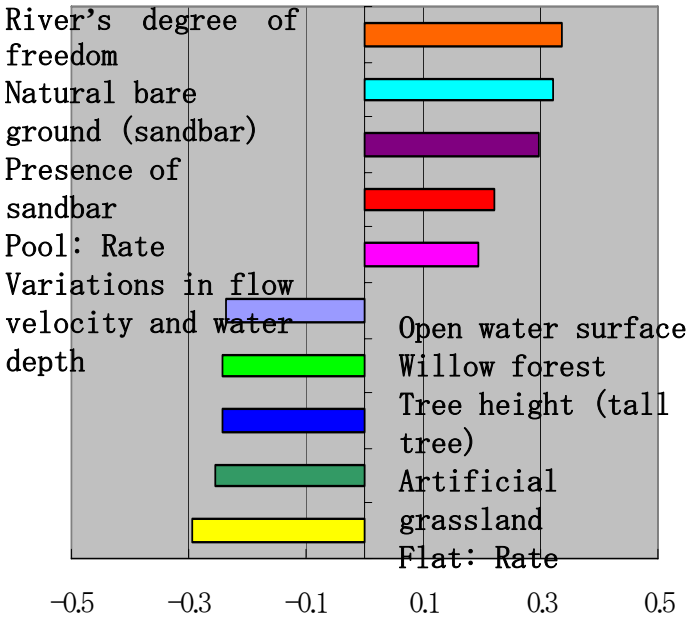
【Area 】
Willow forest
Locust tree
Planted tree
Tall herbaceous plants
Short herbaceous plants
Artificial grassland
Grass-free playgrounds and parks
Artificial bare ground
Artificial structure
Natural bare ground
Open water surface

【Ratio 】
Tree cover rate
Herbaceous plant cover rate
Artificial grassland
Pool
Riffle
Flat
Sandbar
Flow divergence and river bend
Degree of freedom
Flow velocity and water depth
Tributary inflow
Stream edge cover
Riparian woods on island
Tree height
Tree continuity
Bridge
Ground sill
Riverbed gradient

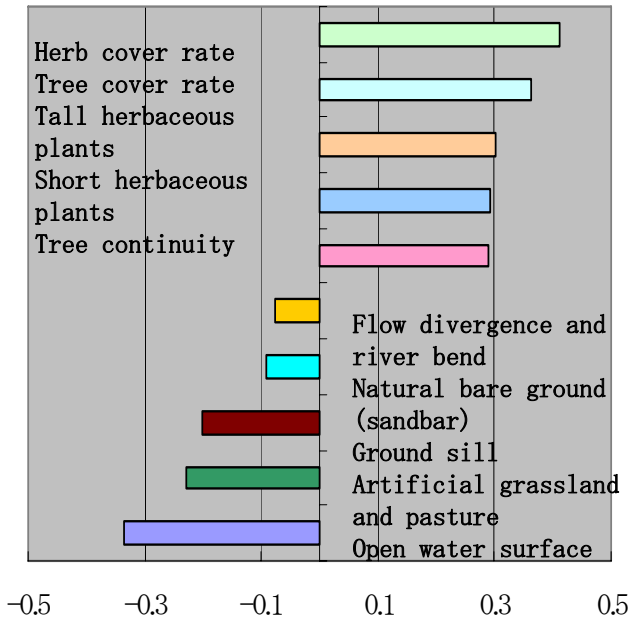
# Results of principal component analysis

# （First,Second principal component ）

## first




## second

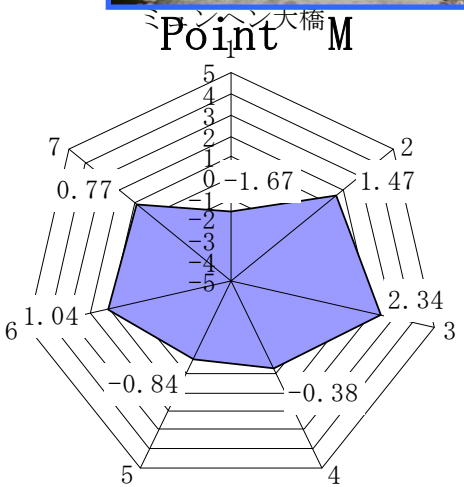


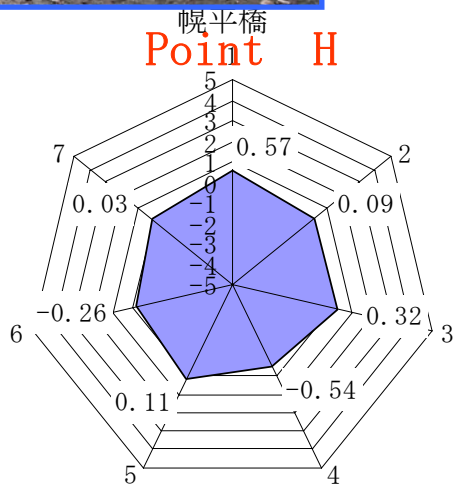

**River diversity**

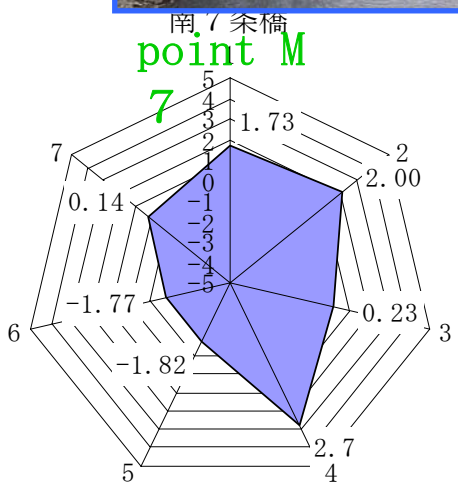
**Riparian woods (Tree) cover rate**

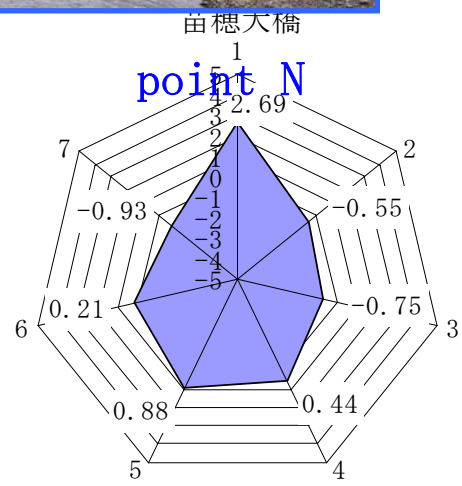
# Principal component scores at four points -relative comparison







# Characterize of this Index－Conclusion

・to assess the river environment by physical components (elements)

→ comparison of assessment between present and future river environments

・to estimate assessment for each organism such as human, fish, birds

・to make comprehensive representation of the river environment landscape by using PCA