Defining the ecological hydrology of Taiwan rivers

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Natural Flow Regimes

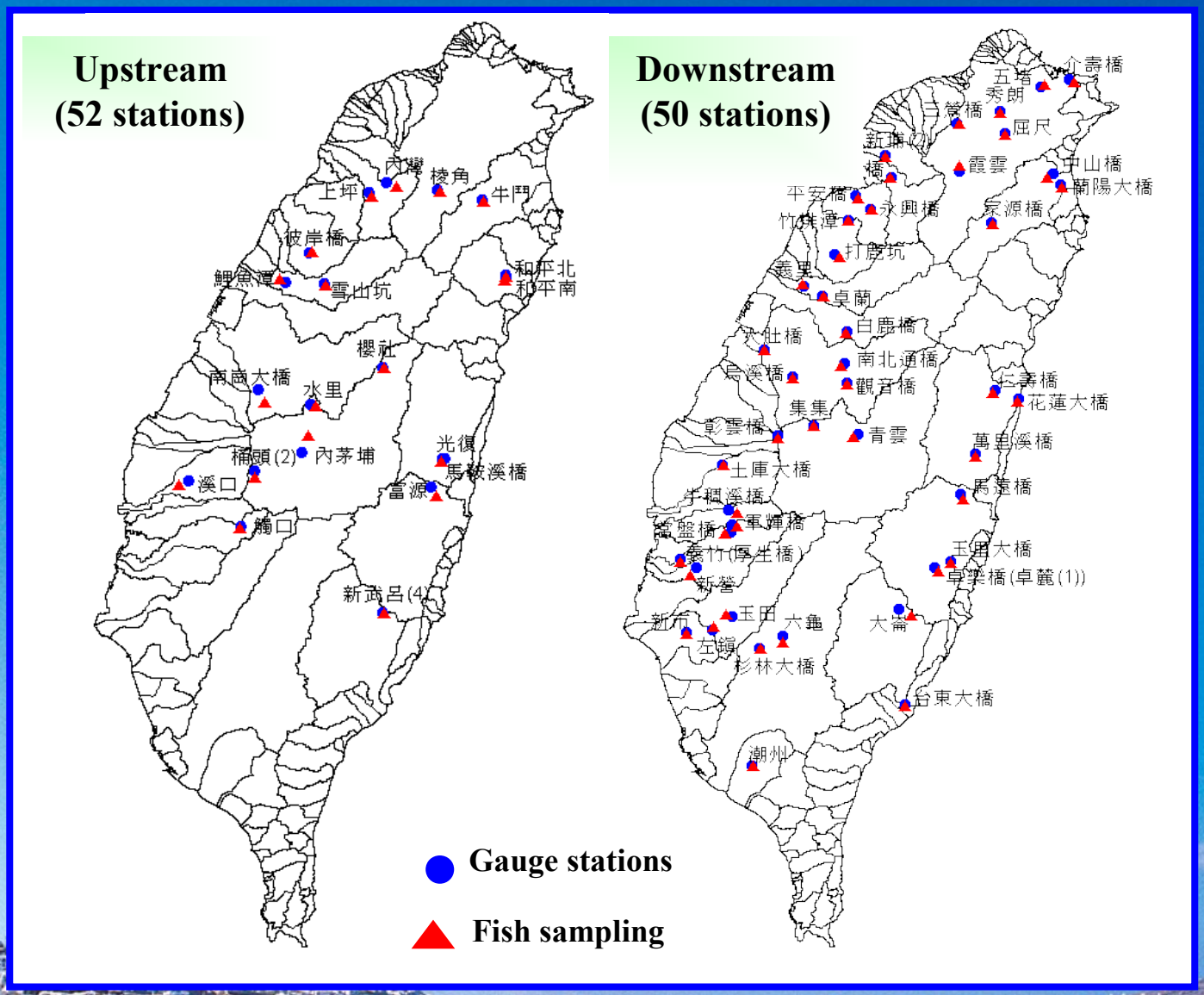
- An Regimes incorporates the hydrograph to relate flow stage with the channel structure to provide habitat for organisms
- There is a growing use of hydrologic indicators to describe flow needs for organisms in riverine ecosystems.
- The Taiwan Ecohydrology Indicator System was developed to identify hydrologic statistics most appropriate to Taiwan fisheries.

Taiwan Ecohydrology Indicator System (TEIS)

TEIS use hydrologic statistics to understand flow variability and how it is related to the response of riverine ecosystems to natural and altered flow regimes.

- General flow variables
- High/low flow variables
- Frequency variables
- Time variables

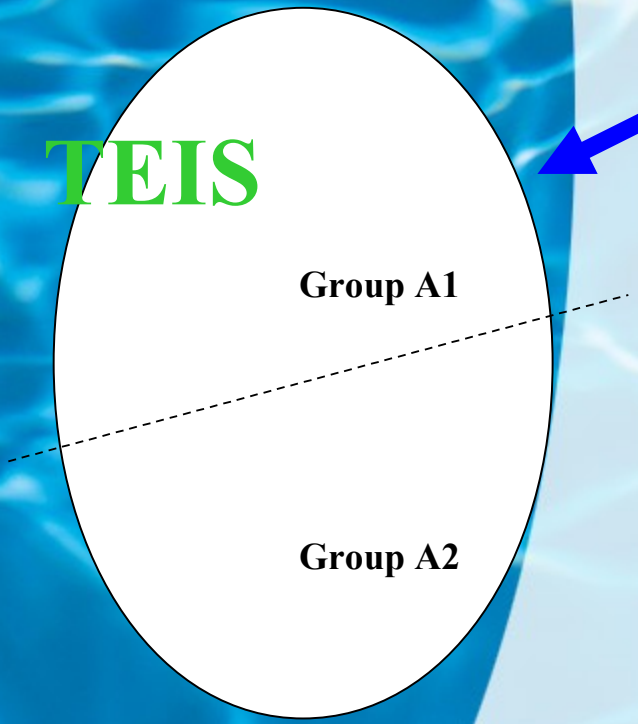
Gauge Stations and Fish Sampling Sites



ANOVA of TEIS statistics from nine basins

Two-way ANOVA analysis

Questions: What is the relation between TEIS and basins or upper-lower stream?



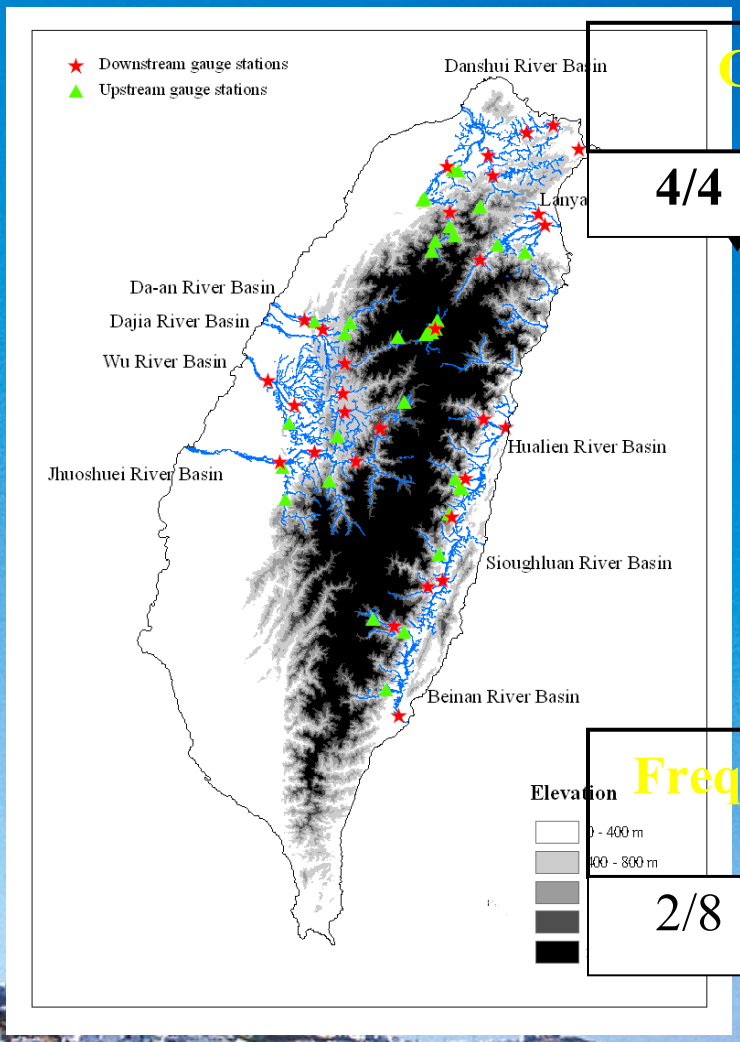
Factor A (basin)

or Factor B (upper-lower stream) or both

F test ：

Sufficient difference of TEIS between A1 and A2?

Two-way ANOVA analysis



General flow variables

4/4	1/4	0/4

High/low flow variables

11/14	0/14	1/14

Factor B : Basins

Danshui River Basin
Dajia River Basin
Wu River Basin
Jhuoshuei River Basin
Beinan River Basin
Sioughluan River Basin
Hualien River Basin
Da-an River Basin

Frequency variables

2/8	**8/8**	0/8

Time variables

2/4	3/4	**2/4**

Redundancy of Taiwan Ecohydrology Indicators

Development of Taiwan Ecohydrology Indicators

Questions: Too many index?
Multicollinearity between index?

Explain variances of principle component analysis of TEIS

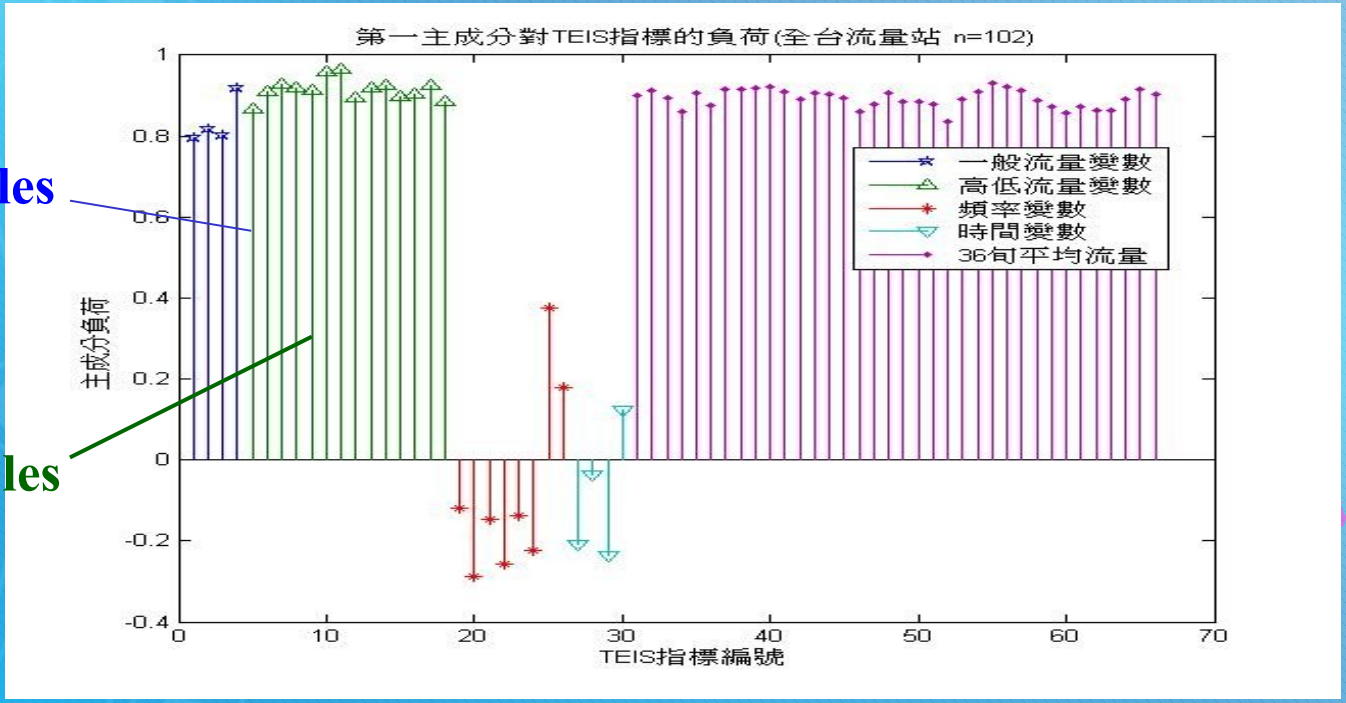
	Principle component (%variance)			First three PCA variances
	I	II	III	
Upstream (n= 52)	65.9	10.5	7.6	84.0
Downstream (n= 50)	65.9	10.6	7.1	83.6
Total (n=102)	66.4	10.0	7.6	84.0

PCA Loading of new variables to TEIS

PCA 1

General flow variables

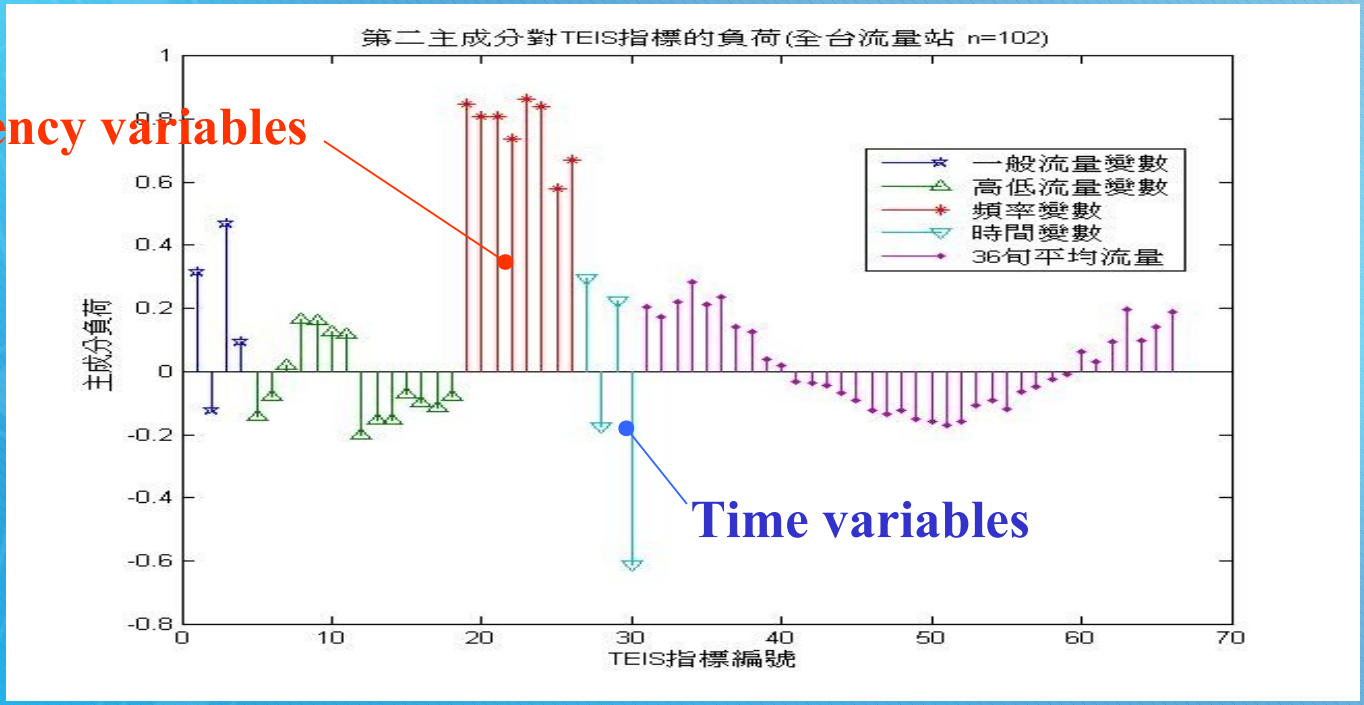
High/low flow variables



PCA 1 represent: **General flow variables, High/low flow variables, Ten-day mean streamflow**

PCA Loading of new variables to TEIS

PCA 2



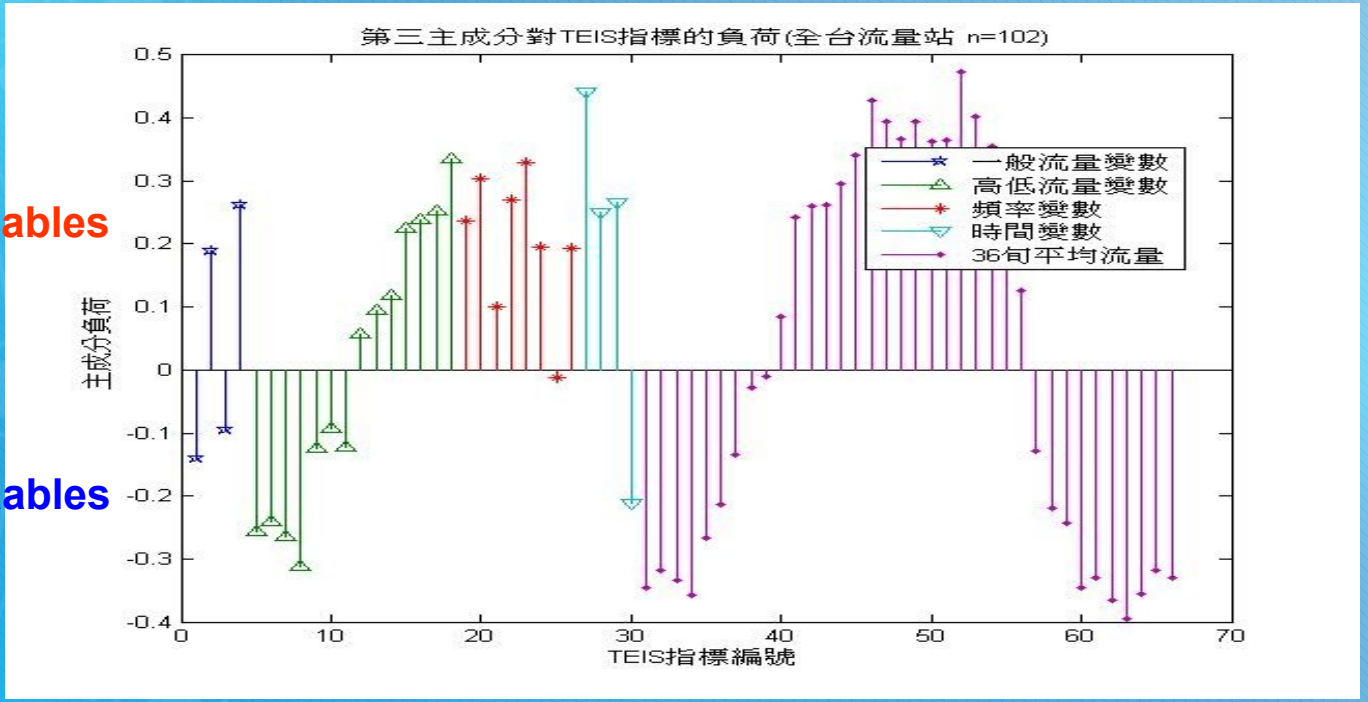
PCA 2 represent: **Frequency variables** and **Time variables**

PCA Loading of new variables to TEIS

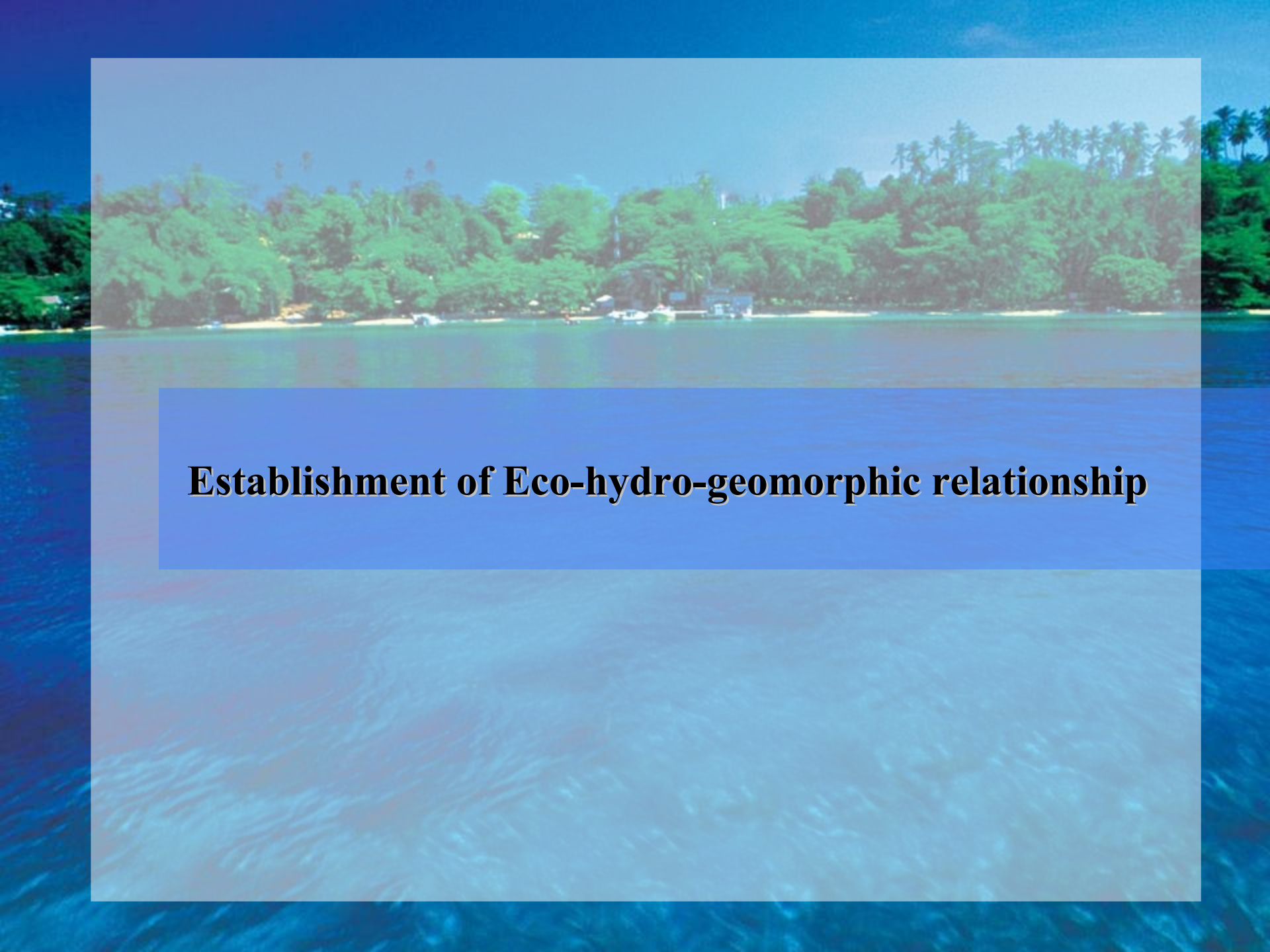
PCA 3

Wet periods variables

Dry periods variaables



PCA 3 represent: **Dry and Wet periods change**



Establishment of Eco-hydro-geomorphic relationship

Establishment of Eco-hydro-geomorphic relationship

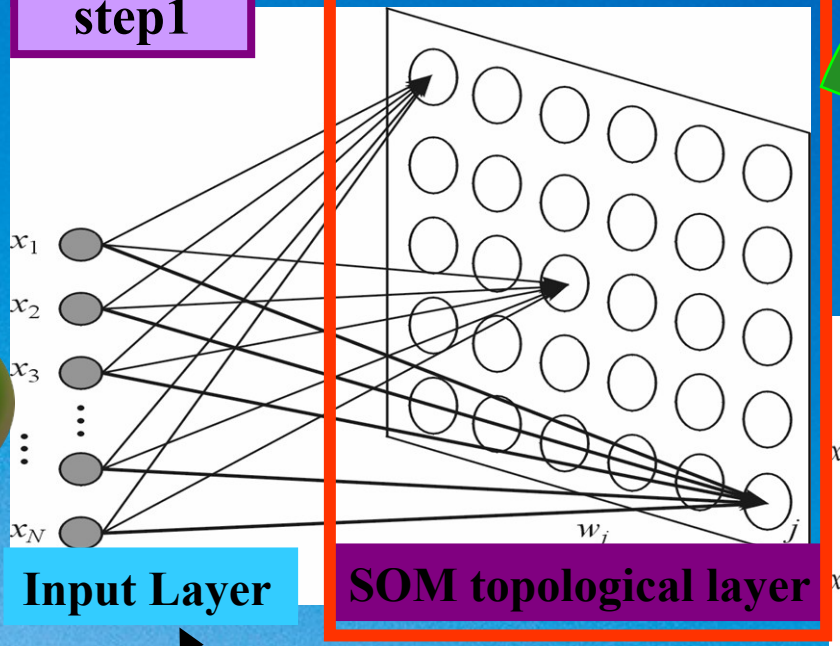
SORBNN

step1

conjunction

step2

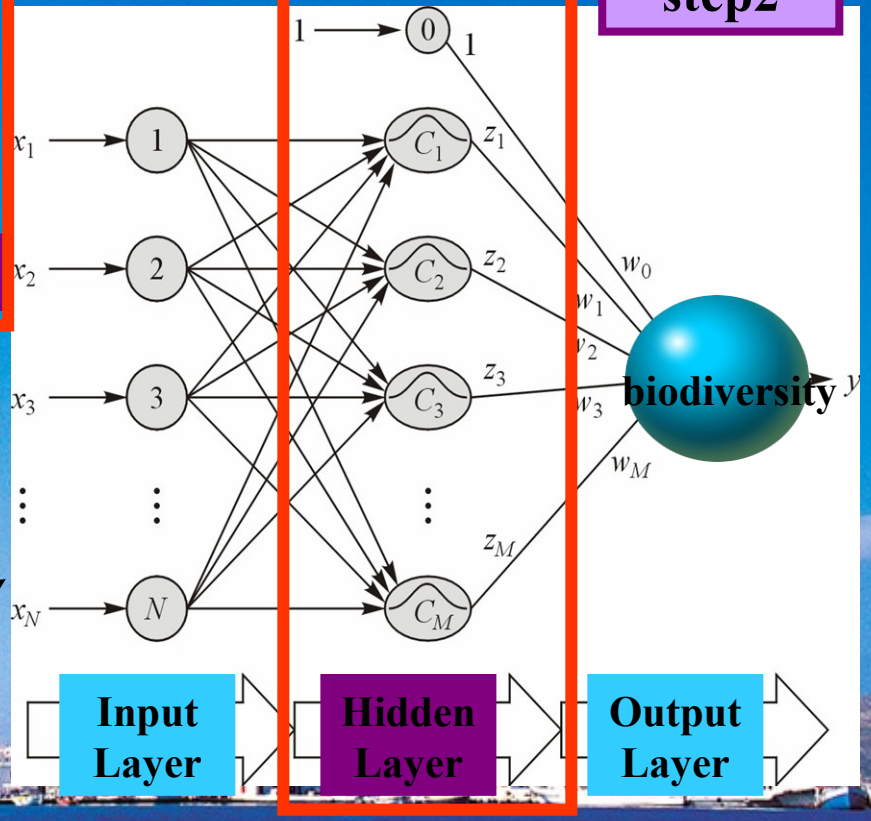
TEIS



Input Layer

SOM topological layer

SOM



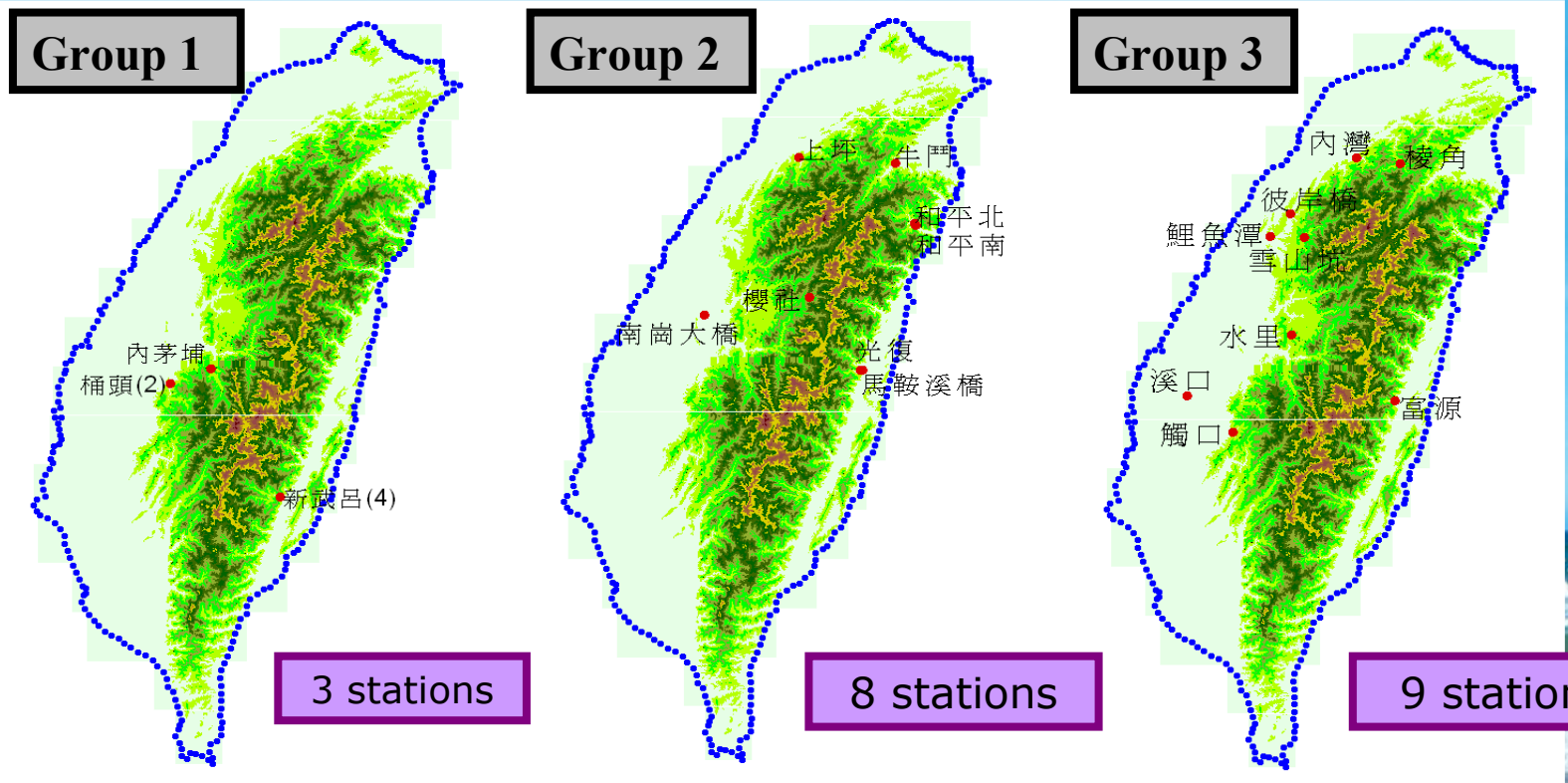
RBFNN

Input Layer

Hidden Layer

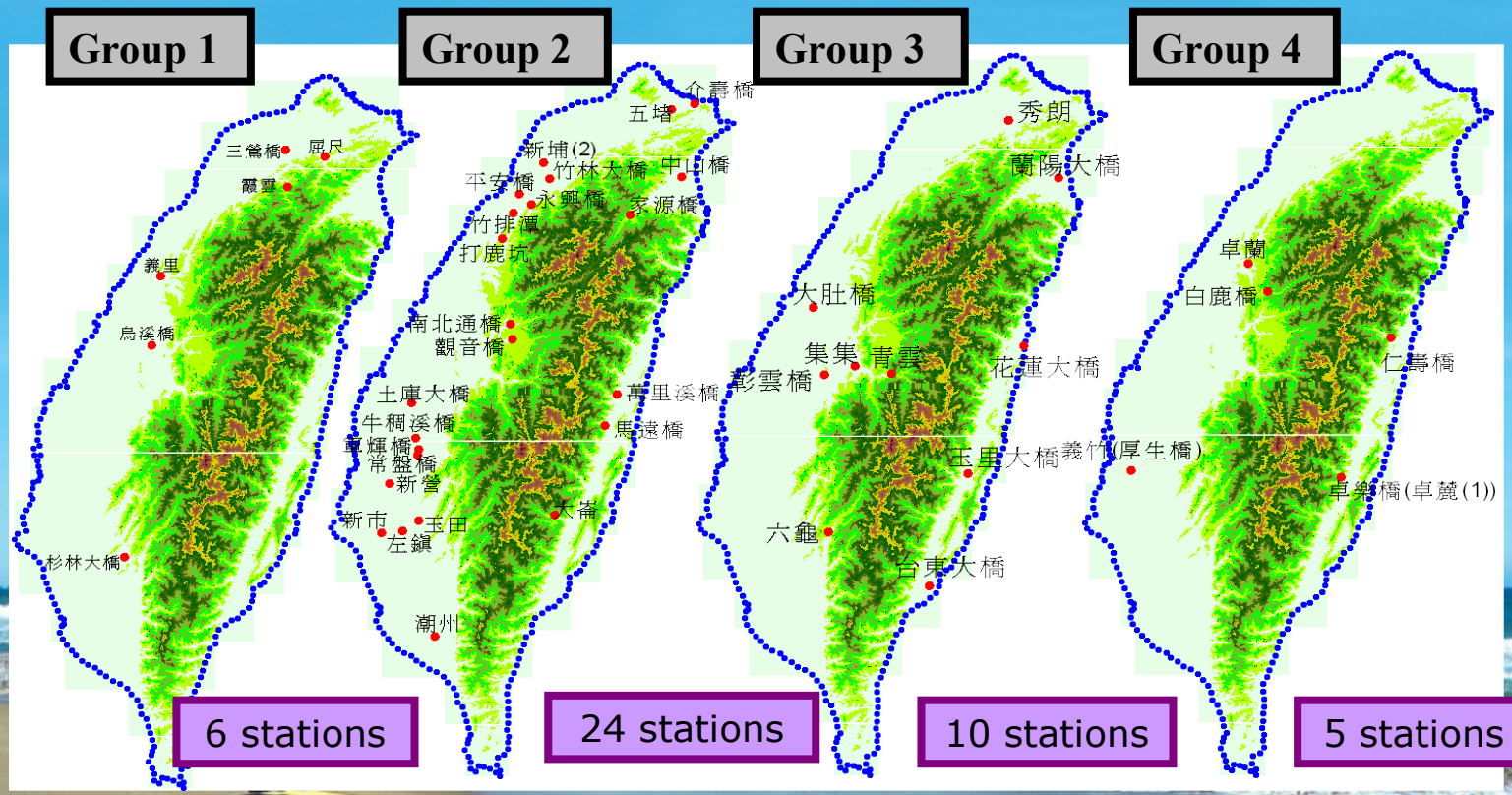
Output Layer

Ecohydrology Regionalization (I)



mean	SI	area (km^2)	height(m)	slope
Group 1	0.76	421.79	335	3.96
Group 2	1.48	230.68	273.88	3.78
Group 3	1.72	89.63	258.78	7.98

Ecohydrology Regionalization (II)



mean	SI	area (km²)	height(m)	slope
Group 1	1.68	719	119.50	4.38
Group 2	1.72	200.42	104.63	3.84
Group 3	1.81	1520.20	106.20	6.27
Group 4	1.98	567.60	234.80	0.88

Taiwan provides a dense network of gauging stations; The TEIS includes hydrologic statistics that reflect unique characteristics of Taiwan's water resources and ecology.

- We examines data from monitoring stations in Taiwan and the TEIS to define and refine environmental flow options in Taiwan.
- TEIS statistics provide a detailed picture of natural flows that can be associated directly with the autecology of Taiwan's fisheries.
- An analysis of variance indicated differences between upstream, more natural, and downstream, more developed, indicators in the same basin.


Thank you