SCIENTIFIC SUPPORT TO ECOSYSTEM CONSERVATION IN STRREAM RESTORATION IN EAST ASIA

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In Monsoon Asia, development of urban area with agricultural and industrial activities to support urbanization has changed the river landscape drastically, and most of people would improve the river environment for the sustainable development with higher quality of life. In other word, serious weather represented by typhoons brings the flood risk, and high density of population is supported by agriculture characterized by rice paddy field that needs large amount of water. And, urbanized areas and paddy fields are protected by continuous flood levee. Higher quality of life requires hydropower. The multipurpose dams are constructed for flood control and water resources. Such human activities have changed the river basin as well as rivers severely, and most of people have started to take care of river and river-basin environment. In the area where hardware such as water supply and sewage system were achieved, the instream water quality has been somehow improved, and then, river restoration, which had been called "close-to-nature river improvement," was attempted mainly by learning much from western countries. The characteristics of rivers and ecosystem on them in Monsoon Asia, however, must be quite different from those in western countries. Then, we started the efforts to understand the river and ecosystem of Monsoon Asian rivers by cooperative research of river engineering and ecology through the studies in the fields.

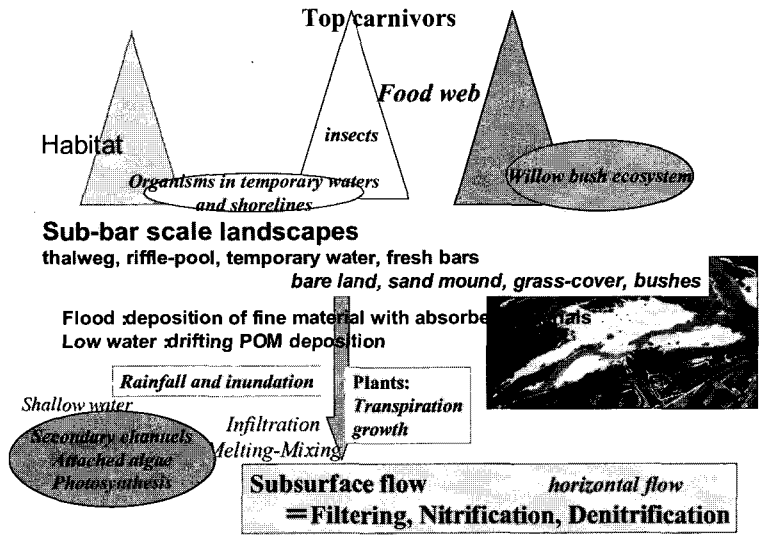
When we consider the ecosystem along river, we have to understand the dual-way relations or services between non-organic characteristics of rivers (morphology and water flow, quantity and quality of water and sediment) and organic aspects (organisms living on the riverine area and their roles or services). The former is represented by the concept of "habitat." The various landscapes (morphology with flow, sediment transport and vegetation) in a river provide habitats for various organisms. On the other hand, the integrated system composed of various landscapes with organisms living there should have roles or services on the river characteristics and moreover on the river basin. For example, organisms with morphology in rivers should have some services to purify water flowing in the river. It is a result of transport and change of the biophilic elements such as Nitrogen. Nitrogen is a typical index of water quality. This may belong to the latter of the dual-way services.

It is also important that the river system has a hierarchy system from macro to micro-scales as follows: river basin, river from headwater to sea, segment (mountain river, fluvial fan river, alluvial plain river, estuary, *etc.*), reach, unit composing reach, sub-unit scale (various landscape with scales smaller than the unit of reach).

Focusing particularly on a reach among various scales demonstrates the interactions among flow, sediment transport, river morphology and vegetation, and we developed the fluvial hydraulics of flow with vegetation. In Monsoon Asian rivers, the growth of

vegetation is more active than other countries, and it is often destroyed by flood. For example, rapid growth of vegetation may bring a serious error on prediction of bed degradation at downstream of dams as an example, and without any modeling on growth and decay of vegetation, we cannot predict the vegetation cover in riverine area, which is a key of riverine ecosystem.

In the scale of a reach, some attempts to understand the two aspect of river ecosystem: habitat evaluation and evaluation of transport and change in biophilic elements represented by Nitrogen. The figure in the below illustrates the framework of these two aspects of ecosystem role of a reach in a river discussed in this paper.



We discussed the two aspects separately for the time being. However, the ecosystem composed of organisms connected by food web is also a kind of flow and change in biophilic elements. In near future, these two approaches should be combined to obtain advanced understanding of the ecosystem to reach strategies for ecosystem conservation. On the other hand, we have to expand the network of information of knowledge in river and ecosystem and technology for assessment and restoration.