Development of Ecohydraulics and River Ecosystem Management in Rivers

[Tetsuro Tsujimoto]
[Professor]
[Nagoya University]

Abstract :

River Ecosystem is recognized as an interrelating system among (A) physical basement, (B) biota and (C) biophilic elements cycle: (A) is mainly governed by fluvial hydraulics and provides habitats to (B) and suitable spaces for elementary processes of (C), while (C) supports (B). When fluxes (water, sediment, materials, temperature, *etc.*) pass through the above system, the interactions in the system become active, and various ecosystem functions appear as shown in Fig.1. Along a river, there are several characteristic mosaics with such systems, and sometimes they are recognized as series of "segments" with similar substratum size and bed-configuration patterns by engineers and as "river continuum concept" in ecology. From this view point, river ecosystem is composed of characteristic mosaics connected by water/materials/energy fluxes.

As for the subsystem (A), vegetation plays an important role in fluvial processes, and fluvial processes in streams with vegetation have become hot topics in river hydraulics. Vegetation affects flow, sediment transport and bed morphology, while morphology governs growth and decay of vegetation with flow regime. Since the vegetation affects he flood flow with higher resistance vegetation dynamics and its control are critical issue from flood management as well as ecosystem management.

Habitat suitability is another topics in ecohydraulics, which has started as "habitat hydraulics". With the knowledge of "preference curves" of individual species of organisms, hydraulic analysis can recognize nature friendly streams. Combining it with the knowledge of population dynamics, some aspect of biota can be described.

As for biota (B), life cycle and food web are especially focused on. Habitat of some species should be considered in relation to their characteristic life cycle and energy supply based on food web. And it is described as population dynamics of organisms, where that for one species is related to those for other species in its food web. Production and respiration in population dynamics are intimately related to biophilic element material cycle (C).

The recent development of ecohydraulics has supported quantitative description of the behavior of landscape mosaic, and it can clarify the ecosystem functions appearing in characteristic landscape mosaics. On the other hand, individual mosaics connected by various fluxes change the fluxes when fluxes pass through mosaics. The behavior of fluxes is essentially described by convection-diffusion equations with production-dissipation terms which are formulated depending on the characteristics of ecosystem functions of respective landscapes.

Along a river with specific longitudinal changes in size and discharge which is passing through specific landscape mosaics, temporal and longitudinal changes of various materials represented by concentration (particulate organic matters, various inorganic ions, *etc.*) and biomasses of various species can be discussed based on the above formulation (mathematical modeling), and it may describe the "river continuum concept" as shown in Fig.2. We have to be careful that such simulations are performed under several hypotheses (climate, land use, players in rivers, parameters necessary in modeling of bio-chemical actions, *etc.*).

River ecosystem has been suffered serious changes in landscapes and fluxes due to flood control, water resources development, and other human activities in watershed. The above

mentioned modeling with several hypotheses may describe a scenario how the ecosystem has been changed by alternations of fluxes and direct changes in landscapes. On the other hand, it may be helpful to design the first trial in "adaptive management" (as hypothesis driven periodic tuning) for ecosystem restoration.

The above-mentioned scenario can be extended to "eco-compatible management of river basin complex" composed of multiple river basins connected by artificial fluxes and bay area (see Fig.3).

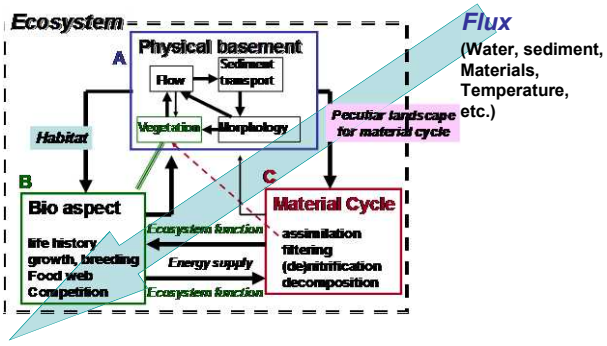

Fig.1 Landscape expressed by Interrelating system

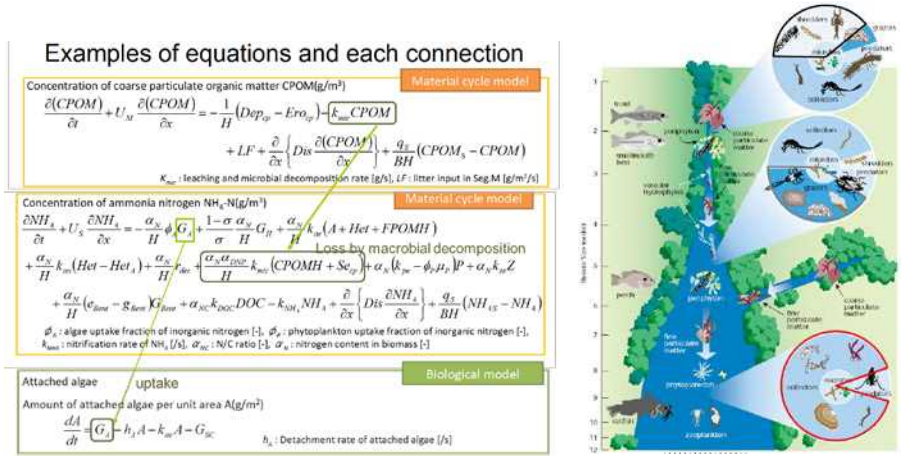

Fig.2 Examples of governing equations of fluxes with terms correlated to other fluxes and description of "river continuum concept"

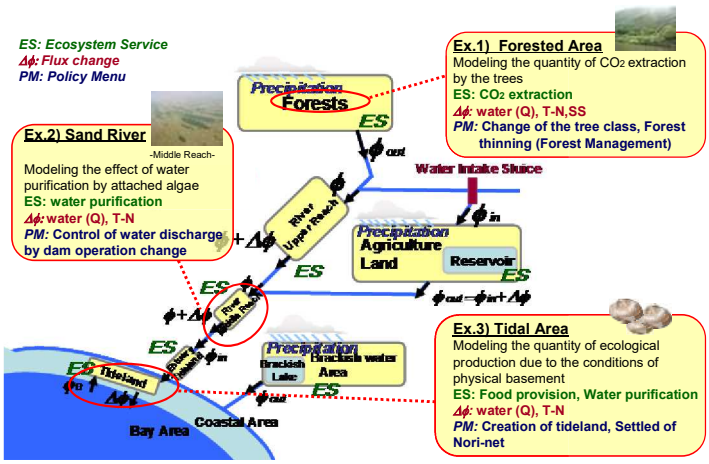

Fig.3 River basin complex composed of flux network and mosaics