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HYDRAULICS-ECOLOGY COOPERATIVE RESEARCH ON RIVER ECOSYSTEM

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Abstract:

Most of research in river hydraulics has supported hydraulic design of river projects particularly related to flood protection, and recently its role has expanded toward conservation of river environment, particularly eco-system conservation. Since the River Act Japan revised in 1997 and the river environment enhancement became one of major purposes of river management as well as flood risk mitigation and water resources utilization, research activities for required knowledge and techniques supporting assessment, restoration and enhancement of river environment have been vigorous. However, it includes knowledge and techniques out side of our familiar fields, which are biology limnology and ecology. Ecohydraulics is a newly developed field, and several research groups have already started activities internationally. In Japan, the river ecological research groups have begun the cooperative studies in multidisciplinary fields by targeting several special rivers. Before 1999, they have started in the Tama as a regulated gravel river, the Chikuma as a less-regulated gravel river, and the Kizu as a sandy river. Needless to say, the river ecosystem is formed as a system composed of various species of organism on a dynamic system in a river. Without any collaboration of various fields of science, who can understand the dynamism of the ecosystem, and who can find the mitigation way after various human activities degrades the river ecosystem? Or with whom can the river managers or administrators consult for mitigation or restoration of degraded ecosystem? The cooperative research and its output are absolutely necessary.

The basic concept is firstly “habitat”, which support the life cycles of various organisms. Most of organisms rely on their habitats on the hydro- and geo- dynamics of rivers as well as vegetation there. We have to understand the physical dynamics of rivers, and the dynamic system of various organisms on it with interaction among various organisms’ activities. Sometimes we have to know the feedback between hydro- geo dynamics and biological activities.

We would say that there are three typical flow regimes in a river: large flood occurring once a few years, medium flood occurring a few times in a year, and daily regime. The first governs the meso-scale morphology in a river such as bars, which is here called “structure”. The second governs the so-called “texture” on it such as micro-scale morphology such as secondary channel, backwater, a series of side pools, etc.; the segregation of surface bed materials such as fine sand patches, gravel stripes, etc.; and various categories of vegetation cover such as grass, bushes, shrub and forest. The flow regime fluctuation determines their “durations”. Not only terrestrial areas but also aquatic spaces have those characteristics. For example, the daily watercourse has “riffle-pool” structure, and it brings not only a good habitat for fish but also it drives active exchange between surface water and subsurface water, which governs the water quality. The “texture” supports habitat, their spatial distribution and arrangements are essentially governed by the “structure”, and the bio-dynamism, combination of individual organisms’ life cycles, is governed by the “duration”. In this sense, we have to focus on these three key-words: structure, texture and regime, when we discuss the river ecosystem.

The following three examples are introduced from the outputs from the Kizu river ecological study activity:

(1) Temporary water such as a series of side pools provides refuge from the flood for fish. We clarified how the side pools are connected when the water stage rises up as a flood. They are connected from the downstream to make backwater and it makes possible for fish to enter such a calm area, and even if all the pools are connected and the flow flows from the upstream, the velocity is never accelerated to the dangerous level.

(2) Depending on the texture particularly determined by size distribution of the surface-layer material, some organisms utilize such characterized areas as habitat for a part of their life cycles. The fine sand patch is utilized as a nest of an antlion. The gravel zones are utilized as nesting points for three species of plover somehow separately depending on their favors, while these three species of plover have feeding spots on the same fresh deposit at the fringe of the bar. When the flow regime is too stable, such fringe area is changed to a grass belt and the plovers loose their feeding spots.

(3) Depending on the surface-flow characteristics particular on the surface-flow undulation, water penetrates into the sand-bar body and forms the sub-surface flow field. At the entrance of the sub-surface flow, the floating materials such as POM (particulate organic matter) are trapped, and such a filtering effect keeps the water quality. In other words, repeating floods refresh the filters, otherwise the permeability at the entrance will be seriously damaged. Frozen-core sampling research revealed the existence of organisms even in hyporheic zone, and the research investigating the changes of nitrate-ion concentration and stable isotope ratio suggested denitrification effect in subsurface flow zone.