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Changes in physical earth-surface environments on the basis of lake-catchment systems

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1. Introduction

In general, it is difficult to establish causal relationships for global environmental issues, especially past issues. However, the lake-catchment systems may give a key to understand cause and effect in past physical environments because current sediment information (sedimentation) can be compared to present observation in the systems; environmental information, especially catchment one, may be causally connected with observational data, which means that past information recorded in sediments has a possibility to be properly interpreted. This is one of significant advantages for lake-catchment studies in environmental changes. Recently small lake-catchment systems are used for clarifying processes and mechanism of the systems with instrumental observation in addition to reconstructing near past hydro- geomorphological and human-related environments. Some examples will be shown in the presentation. An example will be given next.

2. A model for a lake-cacthment system

In general, sedimentation rate (*SR = dE/dt*) at a certain point (x, y) is expressed as partial of sediment flux J with respect to (x, y);

$$dE/dt = \partial J_x/\partial x + \partial J_y/\partial.$$

For simplicity, it is assumed that $\partial J_x/\partial x+\partial J_y/\partial y=F(C(t),D(t),L(t))$ because the flux J is considered to be a function of climatic factor (C), drainage (catchment) factor (D), and lake factor (L). Because this equation is available for any region (i), the function F and factors (C, D, L) will be discussed when using. In the simple case that catchment factor (*Di*) and lake factor (*Li*) in the i-th region are constant for the some interval (some decades) and rainfall charactor (a climatic factor) is a dominant factor for erosion, average sedimentation rate (*SRi*) is expressed;

$$SRi = RiFPi(Pi\Delta T),$$

where *Ri* is physical (environmental) factor characteristic for the i-th region, *FPi* is a function of rainfall character (a climatic factor) and $Pi\Delta T= Pi(\Delta T)$ is average rainfall during ΔT interval for the i-th region. This may be called a space-oriented model. Generally, the function *FPi* is given for each climatic zone; it will be experimentally obtained in the region with comparatively similar climatic conditions. Here, examples from some areas in Japan and Korea will be introduced. For the data obtained in the areas, a power function can be available;

$$SRi = Ri(Pi\Delta T)^b.$$

In this case *Ri* ranges from 0.015 to 0.431 (0.015, 0.045, 0.431), suggesting difference in physical (environmental) condition for the three regions. Availability of the nearly the same power function (b=0.7∼0.8) for the regions means that they may have a common structure for water discharge (input and output) (or hydro-geomorphological conditions). Generally, the effects of human activity are included in the term of *Ri*, but major activity, such as huge land transformation, may influence the function.