Dynamics of water quality and algal blooms in the regulated Geum River, Korea

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(a) Purpose of study or research hypothesis

In-stream structures such as dams and weirs have been considered to potentially change water quality and algal blooms by increasing hydraulic residence time. Removal or gate control of in-stream structures has been suggested as an alternative method to recover the water environment. However, it has not been determined whether this method can improve water quality and algal blooms. This is because various external-internal conditions within the large surface water make accurate analysis challenging. The aim of this study is to analyze the dynamics of water quality and algal blooms due to hydrodynamic changes using a numerical model.

(b) Key issue(s) or problem(s) addressed

Eutrophication due to nutrient enrichment can proliferate algal blooms in surface water. If algal blooms are dominated by cyanobacteria, they can harm aquatic ecosystems due to their toxicity. In general, algal blooms occur in eutrophic water under favorable temperature and moderate solar radiation. In addition, the stable condition can amplify the algal growth. This condition is prevalent in a regulated river due to in-stream structures. Moreover, since these structures have been considered to interfere with water movement and disrupt the continuity of the surface water, it has been proposed that removal of the structures is beneficial.

(c) Methodology or approach used

To analyze the hydrodynamic, water quality, and algal bloom changes due to water level management of weirs, a 3-D hydrodynamic and water quality model was used with various external and internal conditions in the 69.5 km section of the Geum River, Korea. The developed model simulated various water level management scenarios resulting from altering the operation of the three existing weirs of the Geum River.

(d) Results or conclusions derived from the project

Although increased water velocity due to gate opening decreased average algal blooms, the algal blooms worsened during summer and the peak concentration even doubled downstream. Since physical changes cannot reduce the external pollutant load, the nutrient concentration rarely fluctuated or rather increased. Especially, decreased hydraulic residence time resulted in high phosphate concentration, which was not consumed upstream by algae, moving rapidly downstream. This means that the downstream nutrients for algal growth were higher than before. In addition, the lowered depth due to gate opening increased the light availability of algae. Overall, the gate opening created favorable conditions downstream for algal growth. The reduced residence time means the increased water velocity simply moves the nutrients and algae downstream. Consequently, physical changes due to gate opening or removal could not guarantee an improvement in water quality and algal blooms.

(e) Implications of the project relevant to congress themes

Securing safe water resources should be made by decision-making based on a scientific basis. However, it

is very difficult to establish a large-scale water resource management plan because various factors such as water quantity and quality management, water cycle, policy, and economy must be considered at the same time. In this circumstance, the results of this study are proposed as a scientific basis for decision-making to secure healthy waters and ecosystems in regulated rivers.

Keywords : Harmful Algal Blooms, Hydrodynamic and Water Quality Model, Hydraulic Residence Time, Weir Gate Control, Regulated River