19th Annual Joint Seminar between Korea and Japan

"Eco-DRR measures against water disaster-principles and application"

The Sumjin-gang River Flood in 11 Aug. 2020 (photo by by Hyo-Seop Woo)

Thursday 19 August

Seoul, Korea

Organized by Korean Committee on Ecology & Infrastructure Engineering

Contents

Local Organizing Committee

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Seminar Schedule

Thursday 19 August

Venue (Online Seminal)

09:00 ~ 09:00	Opening
09:30 ~ 10:30	Session 1 (Oral presentations)
10:30 ~ 11:00	Coffee break
11:00 ~ 12:00	Session 2 (Oral presentations)
12:00 ~ 13:00	Lunch
13:00 ~ 13:45	Section 3 (Oral Presentations)
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14:15 ~ 15:00	Session 4 (Oral Presentations)
15:00	Closing

Session Schedule

Opening

Thursday 19 August 09:00 ~ 09:30

Chair : Chang-Lae JANG

Session 1 : River Morphology and Riparian Vegetation

Thursday 19 August 09:30 ~ 10:30

Session Chair : Takeyoshi CHIBANA (The University of Tokyo)

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S-01	09:30 ~ 09:45	**Mi-Kyoung CHOI** Integrated Hydraulic Modelling, Water Quality Modelling and Habitat Assessment for Sustainable Water Management	
S-02	09:45 ~ 10:00	**Yuji TODA** Development of Vegetation Dynamics Model Accounting Above- and Below-ground Biomass Exchange and Its Application to Riparian Vegetation Management	
S-03	10:00 ~ 10:15	**Chan-Joo LEE** A Method of Land Surface Classification for Riparian Vegetation Management Based on Remote Sensing Data	
S-04	10:15 ~ 10:30	**Eun-Kyung JANG** Applying of Point Cloud to Realize Vegetation Shape and 2D Numerical Modeling Reflecting Flow Resistance Due to Vegetation	

Session 2 : Measurement and Modelling

Thursday 19 August 11:00 ~ 12:00

Session Chair : Won KIM (KICT)

No.	Time	Presenter / Presentation	page
S-05	11:00 ~ 11:15	**Woo-Chul KANG** Interdisciplinary Approaches for Erosion and Sedimentation	
S-06	11:15 ~ 11:30	**Ryota TSUBAKI** Bedload Transport Measurement in a Bifurcated Gravel-Bed River	
S-07	11:30 ~ 11:45	**Tae-Un KANG** Numerical Simulation of Driftwood Generation and Deposition Patterns by Tsunami Flow	
S-08	11:45 ~ 12:00	**Takeyoshi CHIBANA** Classification of River Basins Focusing on the Geographical Characteristics of Residential Area for Flood Control Measures	

Session 3 : Environmental Managements and Ecosystem

Thursday 19 August 13:00 ~ 13:45

Session Chair : Ryota TSUBAKI (Nagoya University)

No.	Time	Presenter / Presentation	page
S-09	13:00 ~ 13:15	**Sung-Uk CHOI** Improving Downstream Fish Habitats using Selective Withdrawal in a Large Dam	
S-10	13:15 ~ 13:30	**Yuexia ZHOU** Mapping Ecosystem Services Potential on Flood Disaster Risk Reduction	
S-11	13:30 ~ 13:45	**Byung-Woong CHOI** Integrated Hydraulic Modelling, Water Quality Modelling and Habitat Assessment for Sustainable Water Management	

Session 4 : River Management

Thursday 19 August 14:15 ~ 15:00

Session Chair : Sung-Uk CHOI (Yonsei University)

No.	Time	Presenter / Presentation	page
S-12	14:15 ~ 14:30	**Tetsuro TSUJIMOTO** Current Direction of “Science and Engineering on River Ecosystem”	
S-13	14:30 ~ 14:45	**Won KIM** The flood impact of the vegetation in the Sumjin-gang-river in 2020 flood event	
S-14	14:45 ~ 15:00	**Mahito KAMADA** Governance for Realizing Multifunctional Floodplain; Flood Control, Agriculture, and Biodiversity in Yolo Bypass Wildlife Area, California, USA	

Abstracts for Presentation

Session 1

River Morphology and Riparian Vegetation

Integrated River Management of flow regime, geomorphic parameters and species diversity

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The riverbed changes by erosion, transport, and deposition depending on the flow rate and flow of sedimentation, and the consequences of the riverbed change are shown in the form of channels (single, meandering, braided, etc.) and the structure of habitats (riffle and pool, wetlands, backwater, etc.). The integrated management have to consider linking them in order to maintain ecological and sustainable river. In spite of the monitoring of flow rates, sediment volume, and biological surveys is being carried out steadily, and also providing aerial photos every two years, the linked research is not enough in Korea.
This study introduces the integrated river management framework by linking flow regime (discharge or sediment) with geomorphology (habitat diversity, structure) and ecology (abundance of endangered species).

Acknowledgement: habitat diversity, modeling, endangered species

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Development of Vegetation Dynamics Model Accounting Above- and Below-ground Biomass Exchange and Its Application to Riparian Vegetation Management

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Recently, the overgrowth of riparian vegetation has become a problem for river management. While the cutting or root removal of the vegetation is conducted, the vegetation recovers rapidly just after the cutting. Therefore, it is necessary to understand the middle- and/or long-term response of riparian vegetation with consideration of the reproduction of vegetation and to establish an appropriate method of vegetation management. In this study, a numerical simulation considering biomass transportation between above- and below-ground parts is developed (Fig.1), and the effect of vegetation management is verified. As the result, the simple cutting of the above-ground part leads to rapid regrowth of vegetation, however, the effect is improved by applying the root removal at the same time (Fig.2).

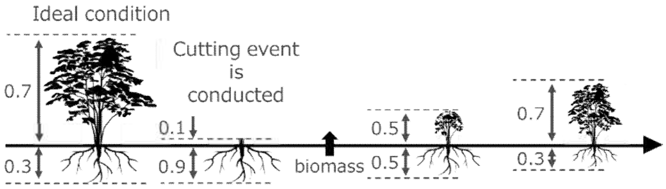

Fig. 1 Concept of above- and below-ground biomass exchange in the model

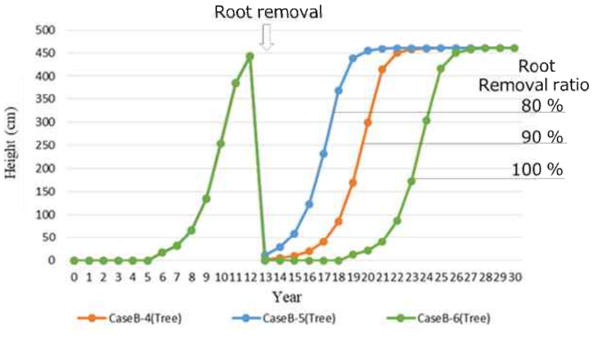

Fig. 2 Effects of root removal ratio on regrowth of vegetation

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A method of land surface classification for riparian vegetation management based on remote sensing data

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Vegetation colonization along rivers is one of the key issues in river management practice as well as in academic fields such as hydraulics, geomorphology, and ecology. The river vegetation is directly linked to the harmony of conflicting values of flood management and ecosystem conservation. In Korea, since the 2000s, the issue of river vegetation and land formation has been continuously raised under various conditions, such as the regulating rivers downstream of the dams, the small eutrophicated tributary rivers, and the floodplain sites for the four major river projects. In this background, this study proposes a method for classifying the distribution of vegetation in rivers based on remote sensing data, and presents the results of applying this to Naeseong Stream. This study uses images from ESA Sentinel 1 and 2 satellites provided through Google Earth Engine. For the ground truth, manually classified map on the surface of Naeseong Stream in 2016 were used, where the area is divided into eight types including water, sand, and herbaceous and woody vegetation. The classification is made with random forest classification technique, one of the machine learning algorithms. 1,000 samples were extracted from 10 pre-selected polygon regions, each half of them were used for training and validation. The accuracy is 82~85%. The model established through training was also applied to images from 2016 to 2020, and the process of changes with time was presented. The technical limitations and improvement measures of this paper were considered. By providing quantitative information of the vegetation distribution, this technique is expected to be useful in management practices such as thinning and rejuvenation of riparian vegetation as well as in flow modeling of rivers.

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Applying of Point Cloud to Realize Vegetation Shape and 2D Numerical Modeling Reflecting Flow Resistance Due to Vegetation

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The excessive influx of vegetation into the river system, survival, and increased flow resistance within the river reduces flow velocity and increases the flood level. The necessity of a comprehensive analysis on river hydraulics, water quality, environment, and ecology in response to vegetation succession is increasing. On the other hand, it is difficult to obtain various types of analysis information/details and solutions due to the inability to accurately predict the value of vegetation flow resistance in river systems. The study's core goal is to analyze the flow of vegetation channels to estimate the flow resistance by accurately calculating the area occupied by vegetation. Through various studies to consider the effect of vegetation characteristics on flow, parameters related to vegetation characteristics are quantified and used for hydraulic numerical modeling. In this case, hydraulic numerical modeling is usually based on calibrated resistance coefficient values or similar field reference values. In addition, in general, vegetation is determined through similar equations, in which drag due to viscosity and pressure are calculated using an approximation derived by the cylinder type. However, it is not easy to accurately input the exact quantity of leaves, the height of all vegetation, and branches. Recently, a spatial analysis method employing an approach that detects vegetation shape through a 3D scanner has been used. Since millions of precise large-scale cloud data points are collected through 3D scanning, the physical parameters of vegetation represented by stem-leaf-branches can be more accurately collected and utilized in the analysis. In addition, a two-dimensional numerical modeling study was conducted by reflecting the three-dimensional voxel graphic information of vegetation.

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Session 2

Measurement and Modelling

Interdisciplinary Approaches for Erosion and Sedimentation

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South Korea is experiencing many local and concentrated sediment problems. Many researchers have conducted various research, such as developing method for estimating total sediment load, and empirical and statistical models. It has continuously necessitated the development of a reliable and consistent approaches for understanding erosion and sediment processes.

First, this paper focuses on developing an empirical model for predicting specific sediment load in South Korean river. The Modified Einstein Procedure (MEP) and series expansion of the modified Einstein procedure (SEMEP) were used to determine the total sediment load at 35 gauging stations. The Flow Duration – Sediment Rating Curve (FD-SRC) method was used to determine the specific sediment yield for all gauging stations. The specific degradation of 35 river stations in South Korea ranged from 10 to 1,000 tons/km2·yr. Based on the results, the empirical models were developed through multiple regression analysis and model tree data mining technique.

Second, the geospatial analysis using satellite images and aerial photographs enables evaluation of the prediction methodology. The predictabilities of the developed models were observed to depend on the type and characteristics of their catchments. The geospatial analysis could clearly show unique features effecting erosion and sedimentation such as wetland, water, and, urbanized area that were used in the proposed models.

As a future work, I am focusing on proposing a new methods of estimating total suspended sediment load, river bed change, and sediment transport using an Unmanned Underwater Vehicle (UUV). The suggested Interdisciplinary methodologies could provide accurate prediction for the specific sediment yield of target area and can be assist in identifying watersheds, which require sustainable sediment management.

Acknowledgement : This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2021R1C1C101040411).

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Bedload transport measurement in a bifurcated gravel-bed river

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The natural gravel-bed river tends to have a braided bedform and shows active morphological changes with each flood. With the decrease in disturbance intensity during floods and the increase in vegetation cover, the flow is concentrated in the main channel, and the bedform changes to a meandering morphology. The meandering of the concentrated main channel causes localized scouring, which interferes with river structures such as banks. In addition, the transition from a braided river to a meandering river impairs the ecological functions provided by natural gravel rivers. In order to prevent this transition of river morphology to a meandering river, a project to re-opened an old buried secondaly channel is implemented in the Satsunai River in the Tokachi River system. This river excavation is combined with flushing flow from an upstream dam located upstream.

This study focused on one of the re-opened secondary channels and conducted a field survey including bedload measurements using hydrophone devices. In this presentation, the results of the three-year survey are reported. The time series of bedload measured at the same location in the secondary channel differed every year, suggesting that sediment transport in the secondary channel was not the same for each flushing flow implementation. The variation of the measurement results from year to year means the success in destabilizing sediment transport, which is the objective of river excavation. However, the results also imply that the response of the bedform to river excavation is very complex. Further field observations are needed to deepen our understanding of the effects of river excavation and flushing flow on changes in riverbed morphology.

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Numerical simulation of driftwood generation and deposition patterns by tsunami flow

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We studied a tsunami flow together with driftwood behaviors including generation by wood overturning using a numerical simulation. For this, we used an integrated 2-dimensional numerical model, which includes the depth-averaged flow model and a driftwood dynamics model (Kang and Kimura, 2018; Kang et al., 2020). The study area was Sendai in Japan, and the observation data (Inagaki et al., 2012) was analyzed to verify simulation results through comparing with driftwood deposition patterns in longitudinal direction. A simplified model was developed to consider the threshold of the driftwood generation depending on overturing phenomena caused by the drag force of water flows. To estimate the volume of driftwood generation, we calculated the total wood number within the study area using Google Earth and the work of Inagaki et al. (2012). As a result, we simulated that more 25000 driftwoods were generated and transported to inland from approximately 300,000 wood that were planted in the forest. The final distribution of the driftwood was similar to the observation data of Inagaki et al. (2012). In addition, we found that the simulation results indicated the overturned wood by the tsunami in the forest area. The reproducibility of generation and deposition patterns of driftwood showed good agreement in terms of longitudinal deposition patterns. In the future, the sensitivity analysis on driftwood parameters, such as the size of wood, boundary condition, grid size, would be implemented to predict the travel distance of driftwood. Such modeling would be a useful methodology for the prediction of disaster depending on water flow and driftwood.

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Classification of River Basins Focusing on the Geographical Characteristics of Residential Area for Flood Control Measures

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For planning basin scale flood control measures based on the geographical characteristics of each basin, this study clarified the population change on each landform type from 1995 to 2015 in each class A river basins in Japan. In this study, the population data of the national census and landform classification map for flood control were used. Throughout Japan, it was found that the population is declining at relatively high elevation places in a plain such as natural levee and dunes, while the population is still increasing at the places with high flood risk such as back marsh and old river channel. It was also clarified that in about 90% of class A river basins, the distribution of houses has become vulnerable to floods. In addition, we classified the class A river basins into 4 types focusing on the characteristics of the areal ratio and population ratio on upland in each basin. 4 types are 1. Overpopulation (population density > 4,500persons/km2), 2. Limited Upland (Areal ratio of upland in a basin < 15%), 3. Higher Population density in upland than in lowland, and 4. Higher Population density in lowland than in upland. The result implies the necessity of different strategy for Eco-DRR measures against water disaster among these four types.

Reference

T. MURAI, T. CHIBANA and S. WATANABE: Classification of River Basins Focusing on the Geographical Characteristics of Residential Area for Flood Control Measures, Advances in River Engineering, Vol.27, pp.603-608, 2021 (in Japanese).

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Session 3

Environmental Managements and Ecosystem

Improving Downstream Fish Habitats using Selective Withdrawal in a Large Dam

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This study investigated the use of selective withdrawal in a large dam in Korea to improve the quality of downstream fish habitats. The original purpose of selective withdrawal was to supply clean water from the dam to the downstream area during the occurrence of highly turbid water. A coupled hydrodynamic and habitat modeling approach was used. The study area was a stream reach located downstream of the dam. To compute the change of the water temperature in the reservoir, the CE-QUAL-W2 model was used. Using the results from the CE-QAUL-W2 model, the temperature of the water discharged from the dam was computed for various schemes of selective withdrawal operations. Hydrodynamic simulations were performed using the HEC-RAS model, and the distributions of the flow depth, velocity, and water temperature were obtained over the study area. Physical habitat simulations (PHSs) were carried out using habitat suitability curves (HSCs) for target fish species. Results from the PHSs indicated that fish habitats in the regulated streams can be seriously degraded due to cold water release from the dam, but its impact can be reduced significantly using selective withdrawal operations.

Acknowledgement: This work is supported by the National Research Foundation of Korea (NRF) grant funded by the Korea Government (NRF2020R1A2B5B01098937).

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Mapping Ecosystem Services Potential on Flood Disaster Risk Reduction

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1. Background and Introduction

Since the flood disaster always exert significant pressure and bring much damages on human societies, assessment of an ecosystem capacity to regulate and prevent the floods can provide important enlightenment for the environmental management. In this study the ecosystem services capacity was assessed based on their capacities on the water retention and penetration.

First, the landcover types was analyzed by using the ArcGIS, and then the flood regulate capacity of each land cover type was evaluated by referring the related research results. Second, the risk of the flood disaster area was mapped by using the flood inundation depth. Finally, the ecosystem services potential on flood regulation was evaluated by combing the ecosystem services capacity and the flood inundation condition.

2. Methods

The study area here is Inba-numa basin, where is located near to Tokyo Bay. The advanced land observing satellite data and the farmland polygon data from MAFF were used for the classification of the land cover in the study area. The ecosystem capacity of the land cover was clarified into 5 classes (0~4: with capacity of 0~very high) based on their water potential and penetration capacities. The flood disaster risk was clarified into 5 classes (1~5) based on the flood inundation depth. And then the ecosystem potential on flood disaster risk reduction was evaluated by using the matrix of flood risk and ecosystem services capacity [risk, capacity].

Evaluation	5	4	3	2	1	0
Landcover	/	Farmland, deciduous tree	Evergreen tree	Grasslands	Urban, Bare bars	Water area
Inundation depth	above 5.0m	2.0m~5.0m	1.0m~2.0m	0.5m~1.0m	0.0m~0.5m	No inundation

3. Results

The mapping of the ecosystem services capacity, flood risk and ecosystem potential on flood risk reduction at the study area were showed as the Fig.1, Fig.2 and Fig.3, respectively.

Fig.1 Ecosystem services capacity Fig.2 Flood disaster risk Fig.3 Ecosystem services potential based on flood risk

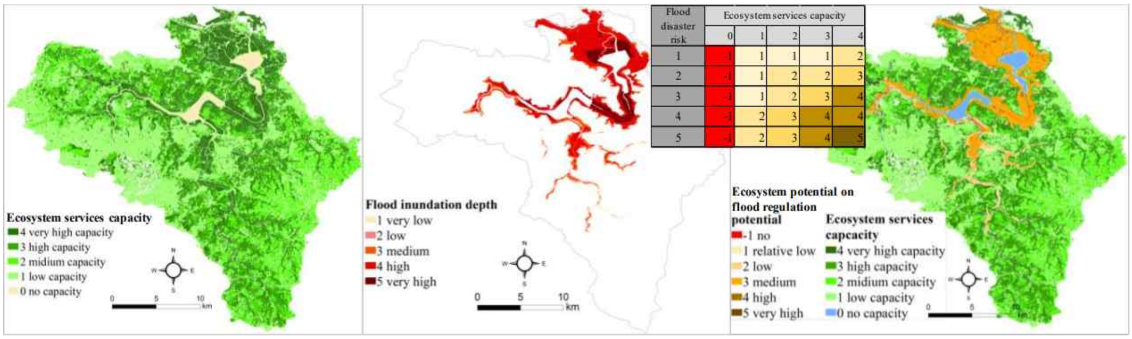

Fig.1 Ecosystem services capacity Fig.2 Flood disaster risk Fig.3 Ecosystem services potential based on flood risk

4. Conclusion and Discussion

The ecosystem services capacity may be evaluated with the landcover types. The ecosystem services potential for regulating flood may be evaluated by using the matrix of ecosystem capacity and flood risk. And the landcover type at the area with high flood risk but with no ecosystem capacity was thought be adjusted in the futur

Integrated Hydraulic Modelling, Water Quality Modelling and Habitat Assessment for Sustainable Water Management

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Recent ecological stream restoration projects have focused on expanding the water-friendly space of streams, promoting the health of aquatic ecosystems, and restoring various habitats, which raise the need for relevant research. Applying integrated environmental analysis, this study quantifies the change in hydraulic characteristics before and after the restoration projects through physical habitat simulation and links the results of physical impacts to estimate benefits of increase in water quality and aquatic ecosystem health due to the implementation of the project. For this, the study area is a 3.3 km long reach of the Anyang-cheon Stream, Korea. Field monitoring revealed that five fish species are dominant and sub-dominant, and account for 76% of the total fish community. To assess the change of before and after ecological stream restoration project, the River2D and Coastal Modelling System (CMS)-Flow 2D models were used for hydraulic and water quality simulations, respectively. For the habitat simulation, the HSI (Habitat Suitability Index) model was used. In addition, the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) was used to calculate changes in water quality index and to examine changes in habitat areas with an integrated quantitative index, the methodology of Zingraff-Hamed et al. was adopted. It was found that the ecological stream restoration project significantly increased for the eco-friendly area. In addition, the changes in water quality and habitat suitability grades before the ecological river restoration project were improved to two stages and one stage, respectively. This study applied the integrated analytical framework as a policy/project assessment tool and the results of this study will be useful for the integrated water management policy.

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Session 4

River Management

Current Direction of "Science and Engineering on River Ecosystem"

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Research activity on "science and engineering on river ecosystem" as fusion between ecology and river hydraulics has been developed in this quarter century with corporation among scientists, engineers and administrative officers. Typical reaches of gravel revers and sand rivers have been chosen as research fields and representative structure of river ecosystem and its functions have been investigated. Habitats of typical species, combination of various biota and resultant ecosystem function represented by interaction of bio-elements have been recognized as targets for collaborative works. Afterword, research targets have been expanded from typical reaches to segment, headwater to river mouth, and furthermore river basin. Through software to analyze river dynamics and statistical properties of biota, research activities have been popularized. While, recent serious river disasters due to heavy rainfalls have changed the concerns of river managers and even citizens from river ecosystem to flood control or disaster recovery. Under such situations, river ecosystem study should tackle with new topics: Ecosystem response for serious flood, not only water hydrograph but sediment and subsequent fluvial processes. Against current proposal of flood control and disaster mitigation, we have to investigate not only disaster management efficiency but also sustainability of river ecosystem. New strategy of "River basin disaster resilience and sustainability by all" by Japanese river bureau (MLIT) is just on a starting line, and it is also the re-start of new "science and engineering on river ecosystem." Not simple proposal of "GI" (green infrastructure) techniques, but we have to discuss how safe our basin should be (safety level against hazard level) and how individual techniques contribute its safety level in corporation with other measures. One of the keywords for this direction must be ecosystem response to huge impact brought by climate change (heavy rainfall, serious flood, levee-breach with serious inundation and sediment deposition, and furthermore additional human impacts such as flood control by dams and channelization). We should not stay on the fruitful results during this quarter century, but step-on to a next stage for new ages.

The Flood Impact of the Vegetation in the Sumjin-gang River in 2020 Flood Event

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In recent years, the vegetation in the river has been increased very rapidly all over the country in Korea regardless of the location, size, and with or without the dam upstream. The expansion of the vegetation could make the flood level higher and also change the river eco-system to the terrestrial eco-system.
In this study, we analyzed the impact of vegetation to flood levels increase in the Sumjin-gang river in the 2020 flood. The large part of the river was occupied with many kinds of vegetation, for example, the willow. The satellite image by Sentinel-2 in 2020 was used for the vegetation identification, and the density of the vegetation was graded by using NDVI and NDWI. Manning roughness coefficient, n, was used for considering the roughness of the vegetation in the 2D numerical model, NAYS2D. We compared the flood level differences with/without vegetation conditions.
We found that 56% of the river area was covered with vegetation in the research area and the flood level increase due to the vegetation was about 0.5~1.0m even though the flood in 2020 was more than 100 return period magnitude. Therefore the appropriate management of the vegetation in the river is very crucial for flood safety.

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Governance for Realizing Multifunctional Floodplain; Flood Control, Agriculture, and Biodiversity in Yolo Bypass Wildlife Area, California, USA

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Yolo Bypass (YB) is an engineered floodplain bypass for flood control in Sacrament River Valley in California, USA. Although the main purpose of the YB is to prevent the capital city of Sacramento and nearby riverside communities, the bypass provides wildlife habitats for various organisms and a good farming ground for multiple seasonal crops. Thus, we can refer to this facility as green infrastructure. We conducted interview with key persons involving in establishment and management of Yolo Bypass Wildlife Area (YBWA) in 2015, and reviewed the history of collaboration of various sectors with literature mining. Finally, we clarified the schematic relationship of stakeholders in establishment and management of YBWA in which federal, state, and local entities and individuals take years of meetings, discussions, negotiation, and trust-building to reach consensus for restoration and management of the wildlife area.

Acknowledgement: We are grateful to Ms Robin Kulakow, Mr. Jack DeWit and Mr. Jeff Stoddard for their cooperation on interview, and to Mr. Kenji Seki, Mr. Ken-ichi Yoshiya, and Ms Reiko Niwano of Ecosystem Conservation Society Japan for conducting and facilitating the survey on the Yolo Bypass Wildlife Area. This study was supported by the Environment Research and Technology Development Fund (JPMEER20154004 & 20184005).

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