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主 論 文 の 要 旨

論文題目 STUDY ON REMOVAL PROCESSES OF RIPARIAN VEGETATION DURING FLOODS IN BRAIDED GRAVEL- BED RIVER（礫床網状河川における洪水時の植生流出過程に関する研究）

氏　　名 ISLAM Deen

論 文 内 容 の 要 旨

Since around 1960, when Japan entered a period of high economic growth, many dams have been built to control floods, generate electricity, and secure water for various uses. A dam reduces peak flows and sediment supply below that necessary to rework the entire channel bed, then vegetation become established on the bed and the bank. Although this riparian vegetation may represent a benefit in terms of overall biological diversity within the river ecosystem, they generate several problems from a hydraulic perspective. The potential drawbacks can be grouped into two categories, namely; increased total roughness in the channel at high flows, possibly leading to more frequent flooding of adjacent lands; and delivery of wood elements into the channel, leading to potentially dangerous plugs downstream at critical sections (e.g., bridge piers, weirs, narrow cross sections).

There is an increase awareness that river needs more room in order to safeguard flood safety under human made control conditions. Across Japan, the increased presence of riparian vegetation within river channels as well as the higher presence of wood on bars has been leading river managers often pushed by local people and municipalities to frequently cut riparian woodlands and remove trees and logs from the channel. These river maintenance activities are being justified as a measure to reduce hydraulic hazards but actually lack any sound scientific approach, and the economic rationale (cost- benefit balance) itself is arguable. One of the aims to remove vegetation to get a sustainable river management that can reduce flood hazards without less disturbing ecosystem. This new approach requires understanding of interaction between vegetation dynamics and flow characteristics. More specifically, it requires a better understanding of the interaction between vegetation removal, hydrodynamic parameter and river morphology. Vegetation removal processes of riparian vegetation during floods are the topic of this thesis.

The gravel bed and braided Tenryu River dam downstream has been selected for this present study. Time series of hydrologic data (flood flow, water elevation), river topographical data

and aerial photograph has used as means to progress the method. In Chapter Two, morphological change of river as a long term basis has been analyzed. River bed elevation has changed significantly at the cross-section which means Tenryu River has dynamic character like scouring and deposition in the downstream area. Braided multiple bar pattern has a tendency to alternate bar pattern due to the establishment of vegetation but still in the arena of the braided nature. Number of middle sand bar reduced to half within period of above forty years from 1962 to 2006 gives the bar pattern as an alternate state. After having an idea about the trend of Tenryu River, the research is then focused on vegetation dynamics through aerial photograph analysis.

In Chapter Three, long term trend of vegetation dynamics have been performed using satellite image and relate those vegetation change with a series of annual maximum flood flow. Less vegetation invasion has been observed in the seventies before dam construction when peak flood flow occurred with sediment transport. After dam construction in eighties, vegetation invasion increases initially in the flood plain then vegetation established in the middle sand bar area. During this period, vegetation destruction also increases then the pre-dam condition which motivates further to find out the removal condition by hydrodynamic process. In relation to flood characteristics, the highest magnitude of flood flow years shows more vegetation destruction. In contrast, low magnitude of flood flow year gives more vegetation invasion as well as less vegetation destruction.

Since, high magnitude of flood flow year accelerates vegetation removal/destruction, a two dimensional flood numerical analysis is performed to quantify the parameter responsible for vegetation removal in Chapter Four. Annual maximum flood flow and corresponding water elevation has been used as an input value as they have considered more potentiality to remove vegetation removal. First, hydrodynamic parameter in the form of Shield stress or non-dimensional shear stress, bed shear stress, drag moment and the ratio of bed shear stress to critical shear stress has been figured to find the suitable parameter responsible for vegetation washed out. Out of them, bed shear stress and drag moment found suitable to remove plant vegetation within threshold value. A random check of numerical result and aerial photograph gives good outcome of vegetation removal.

The process then further progressed to validate this parameter in a spatial scale by using aerial photograph analysis and flood flow simulation parameter in Chapter Five. Out of various available image and topographic year data, the two most closed data set (1982 and 2003) has been selected to find out maximum satisfied outcome. Validation of these years has reported fairly good agreement but still some misjudgments exist. Two types of misjudgment have been appeared, namely; type I and type II. Type I misjudgment defines vegetation has been washed out by aerial photograph but not washed out by flood flow simulation. Type II misjudgment is meant by vegetation not washed out in the aerial photograph but washed by numerical analysis. Possible causes of misjudgment hypothesized as using of coarse resolution of computation, absence of sediment transport process in the numerical simulation and some river management activities done by River managers.

Finally, the research concentrated to find out the possible causes to improve validity of numerical analysis to remove vegetation. Then, the effect of sediment transport process on vegetation removal has been observed in Chapter Six. Bedload transport equation has only been used since suspended sediment load has been washed out from the system during high flood flow and thus, bed load is responsible for river morphology change. At first, river bed level obtained from numerical simulation for 1982 flood is validated with the measured 1983 river bed level data at cross-section level. Then, river morphology of 1982 and 2003 shows local scouring and deposition which have been selected for minimize the type I misjudgment. Local scouring of 0.5 at cross-section is considered as a threshold value to remove vegetation sediment transport process. By comparing aerial photograph and flood flow simulation, about 35 % and 26 % of vegetated grid cells can be washout in 1982 and 2003, respectively. By including sediment process in the numerical simulation, the possibility of vegetation removal can increase about 9 % which reduce the gap between aerial photograph and flood simulation. Finally, numerical analysis can simulate 86 % of total vegetation removal in comparison with aerial photograph analysis.