Report on the visit to the University of Loughborough under the UK-Japan Collaboration Awards

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1. Outline of the visit

Drs. Hori (Kyoto University) and Oishi (Ymanashi University) visited the University of Loughborough from Dec. 3 to Dec. 7 and Dr. Tanaka visited there from Dec. 3 to Dec. 6. The main purpose of the visit was to have a deep understanding of one another's research interest and to exchange information for future collaboration. During the stay, Dec. 4 was devoted to preparation for coming workshop and meeting, a workshop was held on Dec. 5, and a follow-up meeting for collaboration project was held on Dec. 6. UK-Japan workshop on the flood risk was conducted by Dr. Linda See (University of Leeds). Three presentations were given by UK participants and three were given by Japanese participants (workshop agenda is given in the attached sheet). The presentations and discussion in workshop was so effective to deepen our understanding. In the follow-up meeting on the next day, two topics, namely, downscaling issues and flood risk assessment considering residents' response were mainly discussed as the possible collaborative research topics. After checking the data availability and necessity of model adjustment, statistical downscaling algorithm with artificial neural network developed in UK would be applied to Asian area including Japan. The possibility of application of the micro-simulation model of flood evacuation developed in Japan to urbanized area in UK was also discussed. All the members agreed to prepare the joint research project along these topics to possible application to research funds. Japanese side members are now planning to apply the joint project to Grant-in Aid in Scientific Research, Japan Society of Promotion of Science.

2. Presentation at the Workshop

Dr. Tomoharu Hori gave a presentation entitled "Microscopic Modeling of Evacuation from Flood and its Application to the Design of Flood Hazard Mitigation System" at the workshop. The presentation included two topics: one is about computer simulation model of evacuation from floods considering mental attitude of residents and the other is the optimal design scheme of in-floodplain mitigation systems maximizing success rate of evacuation.

In the first topic, a computer model is developed which simulates people's evacuation in a flood including mental decision processes. In the design of the model, determining factors of inhabitants' decision and action process in flood refuge are classified into three classes: initial factors, external factors and mental factors. Initial factors are background conditions that indirectly affect the inhabitants' reaction to the flood information and depend strongly on past experience of floods. In order to express these factors, two numerical parameters are introduced: "outlook on flood disasters" which expresses the usual attitude on flood damage, and "information reliance" which expresses the effect of information on individual ones. The external factors are rainfall and inundation conditions and provided information. Mental factors determine the way of decision-making and response to external factors. A numerical parameter "danger recognition rate" is introduces to express the inhabitants' feeling on flood danger. Then the interaction among these factors expressed by production rules and fuzzy inference rules.

In the second topic, an algorithm to search the optimal solution is proposed for the design problem of countermeasures taken in a floodplain against inundation. The design

problem is formulated as to find the land augment pattern which maximizes the evacuation success rate under the constraint of total land level augmentation volume. Two-level random search method is developed to obtain the optimal solution for the problem avoiding impractical computational burden. The method comprises of two levels of searching: one is approximate solution search process based on simple estimation of inundation levels, and the other is strict optimization stage based on the actual simulation of flood inundation. The nested coupling of those two levels of searching has considerably deduced the computational burden caused by the inundation simulation and has enabled us to get practical solution for the design problem. Using the optimization method proposed in this study, an attempt to estimate quantitatively the relation between facility-based countermeasures and so-called soft-ones for flood disaster mitigation.

Dr. Kenji Tanaka gave a presentation entitled “The Effects of Urban Heating on Development of Cumulonimbus Clouds”. In this study, the effects of urban heating on the development of the strong cumulonimbus clouds were investigated by a coupled model of a cloud resolving model CReSS and a precise land surface model SiBUC. This model (CReSiBUC) is able to include the existence of urban area and anthropogenic heat release as a part of land surface processes. To study the effects of the existence of urban area on rainfall, several numerical experiments were conducted by CReSiBUC. The case of Nerima heavy rainfall (21st July in 1999) is selected for this study. Changing the land surface conditions, four numerical experiments were designed for sensitivity test. The first simulation (CTL) had realistic land cover, second one (PDY) had imaginary land cover (urban area is changed into paddy field), the third one (UBN) had dense urban area (urban area fraction is enlarged) and forth one (ADH) had realistic land cover and imaginary (uniform) anthropogenic heat. The position of the rainfall area was shifted resulting from the fact that the strength of the surface heating was changed due to with or without urbanized surface, and concentration (density) of urban area. In the ADH simulation, a strong rainfall area was extended in the west-east direction, comparing from the CTL simulation. From these results, it is considered that the strong surface heating at urban area does change the low-level convergence. As a result of strong convergence of water vapor, the rainfall area can be shifted toward the urbanized area, and the amount and area of rainfall can be increased. Through this presentation, he showed the potential of CReSiBUC to be used for the severe storm event, especially for urban flooding problems.

Dr. Satoru Oishi prepared two research topics for the presentation. The first one is “Meteorology Related Disaster Prevention Research in University of Yamanashi” and the other, “Psychological Approach to Improve an Awareness of Disaster Prevention in Case of Mudslide Disaster”.

In the first topic, the research methodology and current result were shown. The numerical simulation for downscaling meteorological phenomena by using non hydrostatic fine grid weather forecasting model with super computer (NEC SX series and the Earth Simulator) was shown. The objective of the downscaling was investigation of the precise effect of climate change on human life, and it has been accepted with Dr. Christian W Dawson as a cooperative research topic. In the presentation, the result of precipitation variation was shown when all the forests in Mekong River Basin were cut off. Also, the research on the advanced radar that can capture the uncertain information such as detail structure of precipitation and wind filed has been shown for discussing the optimization scheme for solving the uncertainty.

In the second research topic, the result of psychological test on disaster prevention education for pupils was introduced. A couple of result which consists of ratio of pupils who takes high risk even after education, moreover effect of psychological stimulation, and its interruption on change the disaster awareness of pupils.

3. Discussion and Future Collaborative Research

Two points were mainly discussed after the workshop: one is the importance of comparative studies in the fields of comprehensive flood risk management systems and of downscaling of GCM output, and the other is the plan to apply collaborative research proposals to possible research funds.

In the discussion about comparative study, it was emphasized that each member's model had to be applied to other members' fields to verify the performance of the models developed by the members. It is now being planned that down scaling model developed in UK will be applied to Asian area including Japan and Japanese model will be applied to European area including UK. The possibility is also being discussed to apply micro simulation model of flood evacuation to some urbanized area in UK. Dr. Linda See and Dr. Hori are now discussing the data availability for model application.

The topic on the downscaling of meteorological phenomena was deeply discussed. The several datasets on climate condition for the coming hundred years have been produced by Global Climate Models. Calculation of downscaling simulation is not technically difficult, however it is financially very difficult because it requires very expensive computational resources. Although the importance of the research on urban area in developed region was really understood by Dr. Oishi, he has focused on agricultural area in developing regions so far. Moreover, the UK researcher especially Dr. Christian W Dawson and his university college have done the research of same topics but different methodology that uses artificial neural network (ANN). Also, Dr. Tanaka has been investigated the land surface physical process on climate change. The synergy effect of Drs. Oishi, Dawson, and Tanaka is expected. Dr. Oishi can provide the down scaled information of precipitation variation of both climate change and human impact which is difficult to introduce in ANN. Dr. Tanaka can provide the physical knowledge on effect of both climate change and human impact. ANN can provide the statistical information and accuracy index for the numerical simulation and ANN can calculate faster and with low computational cost. ANN also provides the information of assumption for physical key issue through the analysis of huge amount of data. The first activity was knowledge exchange for downscaling research by ANN. They started from email discussion, then web conference will be prepared. Finally, one of us visits the other country and the both of them prepare the research environment for it. Once research environment for simultaneous discussion was established, the email discussion and web conference will be much fruitful.

On the other hand, the research of psychological approach was additional information for Dr. Hori who already had an advanced scheme to deal with risks during evacuation from flood disaster. Therefore, the psychological approach will be discussed with Drs. Hori and Oishi in Japanese first, and simultaneously they will make collaboration with appropriate UK researcher such as Dr. Linda See and Dr. Emma.

Since the downscaling issues and non-facility-based countermeasures are very important elements in assessing the future flood risk and designing effective prevention and mitigation systems, we are planning to apply collaborative research project to JSPS Grant-in-Aid in Scientific Research in next October. The title will be something like "Risk assessment and mitigation system design in water hazards through downscaling of macro-hydrologic information. – UK and Japan comparative study". Additionally, one of the PhD students at Dr. See is now planning to survey river restoration works in Japan, and Prof. Kojiri and Dr. Hori are ready to give necessary help for her.