Simplified Flood Inundation Model Integrating with Rainfall-runoff Processes

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1. Introduction

Flood hazard is one of the most harmful disasters in the world. Many more intensive rainfall events happen, which suggests flooding will become more frequent and potentially causes greater damage. As the occurrence of flood event has become common in many parts of the world, the needs to obtain reliable information on flood characteristics are increasing with the dramatically rising of people’s awareness. Whilst the increase of flood damage for singular event is partly resulted by the tendency that much more people live in floodplains or low-lying areas and consequently causes that society becomes more exposed to flood damages.

Recently a shift in paradigms is observed from a technical oriented flood protection towards flood risk management, and the emphasis of disaster risk reduction has changed from an impacts-led approach to a vulnerability-led approach. Therefore it is necessary to study on regional vulnerability for flood hazard.

In order to explore the spatial distribution of flood hazard vulnerability, a grid cell based simplified flood inundation simulation integrating with rainfall runoff processes is proposed. According to the prediction result, flood characteristics can be analyzed, especially which can identify the flood-prone area.

2. Model methodology

Distributed temporal-spatial information of a flood event is of the utmost importance for flood disaster mitigation as well as for flood vulnerability assessment. A physically based flood inundation simulation model is developed in this study, which is based on simplified process representation capable of simulating dynamic flood inundation. This consists of a one-dimensional channel flow solved using a finite difference scheme and a two-dimensional flow model with unsaturated, saturated and overland flow. This 2-D flow model takes into account three types of flow: unsaturated flow in capillary pore, saturated flow in non-capillary pore and surface flow on soil surface, depending on the depth of flow.

The water surface elevation for river segments is calculated using the 1-D kinematic wave model solution. The overland surface flow routing is calculated by the 2-D pond model, which is to treat each cell as a storage volume, and the change in cell volume over time is equal to the fluxes into and out of it. Meanwhile stage-discharge relationship for saturated-unsaturated soil layers is adopted to calculate water fluxes between cells. The exchange of flow between channel network and flood plain or low-lying area is simulated depending on the relative water surface elevations, that is to say, surface flow can be either away from river or into river (Figure 1).

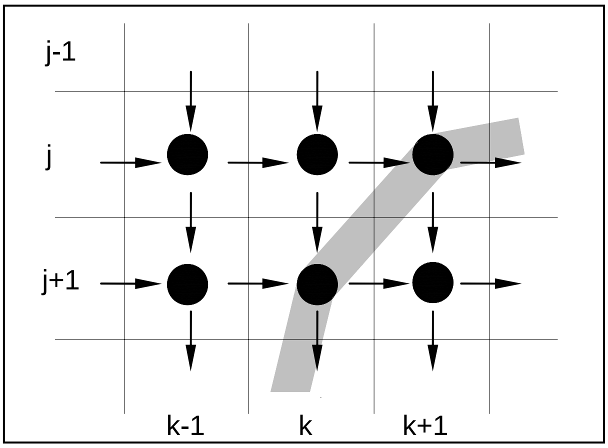

Figure 1 Schematic drawing of 2-D overland flood routing and channel routing scheme

Finally through the application of the model in the Yodo River Basin in Japan, the simulation results are tested and validated.