第Ⅱ部門

Integrated Analysis of Rainfall-Runoff and Flood Inundation by the RRI Model in the Chikusa River Basin

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1. Introduction

The Sayo river, which is located at the western part of Hyogo prefecture, was flooded due to severe rainfall caused by Typhoon No 9 in August in 2009. It mainly rains at the upstream in the Sayo river basin in August 9 and 10. During the flood event, a large area was inundated especially in the Sayo river basin due to overtopped water, flow from mountainous areas, tributaries and inland water. 20 persons were killed and missed by flash flood during evacuation. Rainfall-runoff-inundation model has been mostly applied to such river scale floods. The previous study shows that the RRI is applied to large scale flooding in Asian countries such as 2011 Thai floods. Satellite data or empirical equation is mostly used for topography or river cross section due to a lack of local information in the previous study. On the other hand there are sufficient data by remote sensing such as laser topography or radar rainfall. Moreover, the flood records are specified by a prefecture. Therefore the RRI can be applied with more detailed data and validated by field observed data including inundation depth or inundation area. This research emphasizes the significance of integrated analysis of rainfall runoff and flood inundation by simulating 2009 Sayo flood using the detailed information.

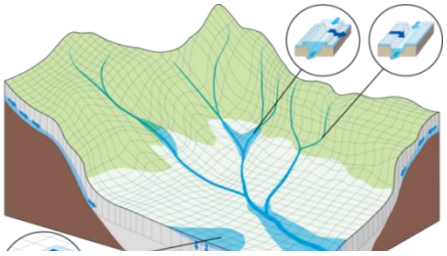

Figure 1 Structure of RRI model

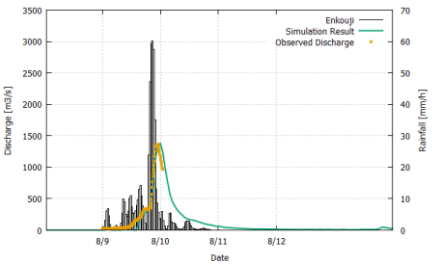

Figure 2 Discharge in Enkouji

2. Model structure overview

Rainfall-runoff-inundation (the RRI) model is used in this research. The RRI model is a 2D grid cell based hydrodynamic model capable of simulating for both rainfall runoff and flood inundation processes at each grid cell in a river basin[1)]. Flow direction is decided based on water level, which is typically decided by topography in a distributed model. It simulates hydrological processes such as lateral surface/subsurface flow and infiltration at each grid cell.

3. Simulation condition

The 2009 flood event is analyzed by the RRI model. The model area is the entire Chikusa river basin and two small basins, which is analyzed at each 100m grid. The duration for analysis is six days from 8 to 13 in August. This study used Radar AMeDAS rainfall, which is an hourly rainfall provided every 30 minutes by Japan Meteorological Agency. The rainfall is accurate, which is observed by radar devices and validated by ground rain gauge. Flow direction is decided using laser topography at each 5 m grid. The geometry of a river is reflected in the model. 57 rivers are modeled, which are used for current inundation model[3)]. In this research, the geometry of four rivers is calculated based on the topography and the arbitrary cross section provided by Hyogo prefecture, and besides other rivers are modeled based on empirical equations. Taking account into this short duration and relatively steep topography in Japan, the effect of evaporation is not considered in this research.

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4. Results and discussion

Estimated discharge and water level are in agreement with the observations qualitatively as shown in Figure 2. Figure 3 illustrates estimated inundation extents also show similar pattern to recorded inundation area above Kamigoori station. As shown in Figure 4, estimated inundation extent becomes more severe after 21:00, which corresponds to the actual situation, and besides the simulation indicates that river flood and runoff from mountains inundate the Sayo town hall. In addition, inundation extents in the Kuzaki district and nearby the Kamigoori town imply that countermeasures such as closure of water gate or river improvement strongly affect the estimated results. In those areas, the effect for flood prevention activity and a river cross section should be updated and should be considered. Estimated peak water depth is 1.15 m by simulation and actual depth is 0.98 m in Sayo town hall. Estimated peak water depth also corresponds to actual one in Enkouji town.

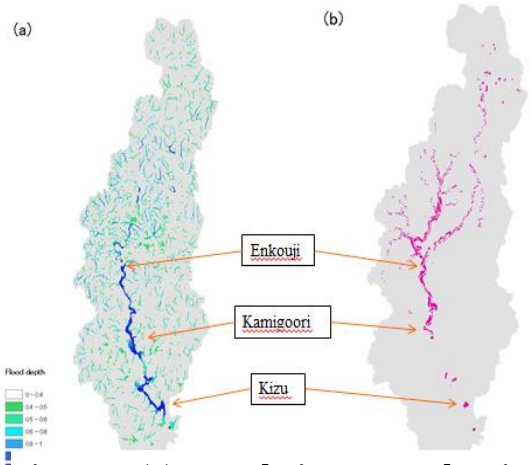

Figure 1 (a) Inundation extent by simulation and (b) actual Inundation extent

5. Conclusion

Estimated discharge and water level are compared with the observation qualitatively. Estimated inundation extents show similar patter to recorded inundation area in the Kuzaki district and in the Sayo river basin. Estimated peak water depth also corresponds to flood record in Enkouji town and Sayo town hall. The RRI also shows movement of inundation in urban area in the Sayo town, which corresponds to flood records. Moreover, river floods, tributaries and runoff from mountains cause the severe inundation in the Sayo river basin and Kuzaki district. As a future work, the tributaries should be modeled more precisely.

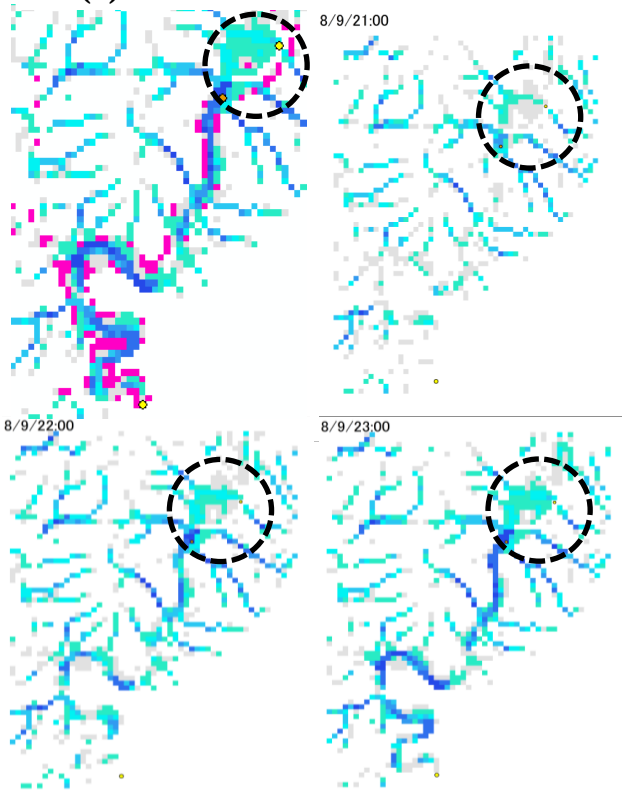

Figure 4 Inundation extent in urban area in Sayo town from 21:00 to 23:00 on August 9

Reference

[1] T. Sayama, Y. Tatebe. & S. Tanaka. (2013) An Emergency Response-type Rainfall-Runoff-Inundation Prediction for 2011 Thailand Flood ,JSCE, Vol. 69, No. 1, pp. 14-29.

[2] Crisis & Environment Management Policy Institute. (2010) Investigation on action as a disaster subculture in Kuzaki district in Sayo town for 2009 Sayo typhoon & flood disaster (in Japanese)

[3] Department of disaster recovery in Hyogo prefecture. (2011) Promotion to disaster mitigation for storm and flood damage (in Japanese)

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