第Ⅱ部門

Estimating Watershed Runoff and Sediment Yield Using Physically Based Distributed Hydrological Model (*Case Study of the Upper Citarum Watershed-Indonesia*)

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1. Introduction

The more increasing population rate and economic condition in Indonesia result in the more change of land use pattern. The rapid land use change practice has enhanced occurrence disasters such as floods, droughts and high-rate sedimentations. Those disasters have all been found to occur in main watersheds of West Java Province, which include the Citarum Watershed. Seven major sub-streams in the upper Citarum watershed are Citarik, Ciwidey, Cihaur, Cika-pundung, Cirasea and Cisangkuy River. The total area of the Upper Citarum Watershed is 2310 km^2.

The Upper Citarum Watershed has been a well-populated urban area and agricultural area. With the development of economic growth, people need more and more space to expand the human activities. Rapid land use changes from forest to agriculture and from agriculture to urban and industrial development reduce watershed capacity and thus increase the threats to flooding and sedimentation in the downstream areas and waterbodies.

The question is how much this anthropogenic effect causes the changes the current flood and sedimentation. To answer this question, a physically based, cell distributed rainfall-sediment-runoff model is applied to simulate runoff, erosion, and sedimentation.

2. Application of Cell Distributed Rainfall-Runoff Model as Preliminary Research

The concept of the original rainfall-sediment-runoff model considering the sediment movement on a watershed scale is to combine sediment yield, deposit, and transportation processes with the grid-cell based Kinematic Wave Runoff (KWR) model. For preliminary research a physically based Cell Distributed Rainfall-Runoff Model-CDRM (Kojima and Takara, 2003) is applied for evaluating land use change effects on hydrological response in the Cisangkuy River-Upper Citarum Watershed with the totalarea 201.5 km^2.

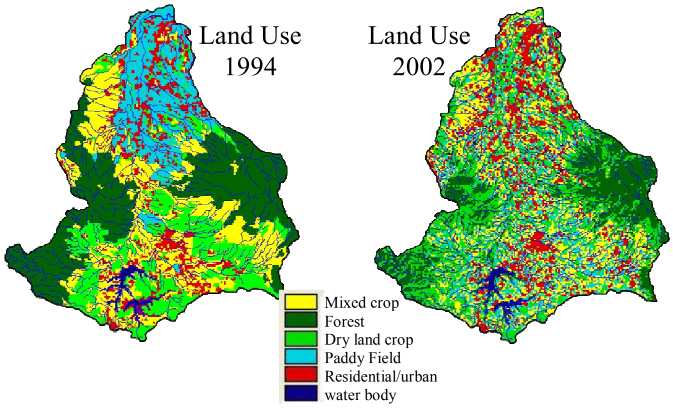

Fig. 1 Land Use conditions of The Cisangkuy Sub-Watershed.

The Cisangkuy Sub-Watershed is an example of the miss land use management practices. The land use changes over a 9-year period were observed between 1994 and 2002. This shift of land use has contributed mostly to the decrease of the percentage of the watershed covered by forest which amounts to over 29.2% in 1994 to 15.8% in 2002, while the area covered by paddy fields include grass land unmanaged decreased from 23.6% in 1994 to 17.3% in 2002, while the agriculture land, and the urban area covered increased from 35.7% and 10.4% in 1994 to 50.9% and 14.7% in 2002 (**Fig. 1**).

The simulation results (**Fig. 2**) with different heavy rainfall event showed a consistent change in the simulated hydrograph, developing higher and faster peak discharge using the 2002 land use data as compared to floods simulated using the 1994 land use data. Evaluation of the effects of land use changes over the 9 years on hydrological response (peaks discharge) indicate increase in peaks discharge (flood event) by 17.3 % and decrease in time to peaks.

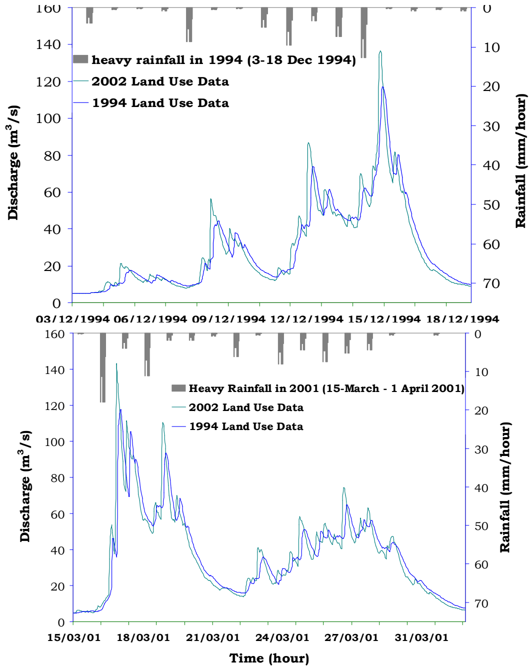

Fig. 2 Simulated hydrograph for 2 typical heavy rainfalls in 1994 using land use data 1994 and 2002.

3. Conclusion

Preliminary research shown that the simulation result is acceptable, proving that the CDRM as physically based hydrological model could be applied to the Upper Citarum Watershed.

4. Further Research

High-rate sedimentation is one of the major problems in the Upper Citarum Watershed beside flood disaster. The estimated volume of soil erosion in a sub-watershed of the Upper Citarum Watershed is 203 tone/ha/year (Pacific Consultant International, 1998). The most erosion sources in Upper Citarum Watershed from agriculture soils. Therefore, further research will be focus to investigate the erosion-sedimentation processes by storm-rainfall properties, overland flow, and leaf drip impacts considering the cohesive soils using physically-based rainfall-sediment-runoff model (Takara *et. al.*, 2001). The model simulates temporal and spatial variations of runoff, erosion and sediment dynamic on watershed as impacts from natural and anthropogenic disturbances such as rainstorm and miss land use management practices (**Fig. 3**).

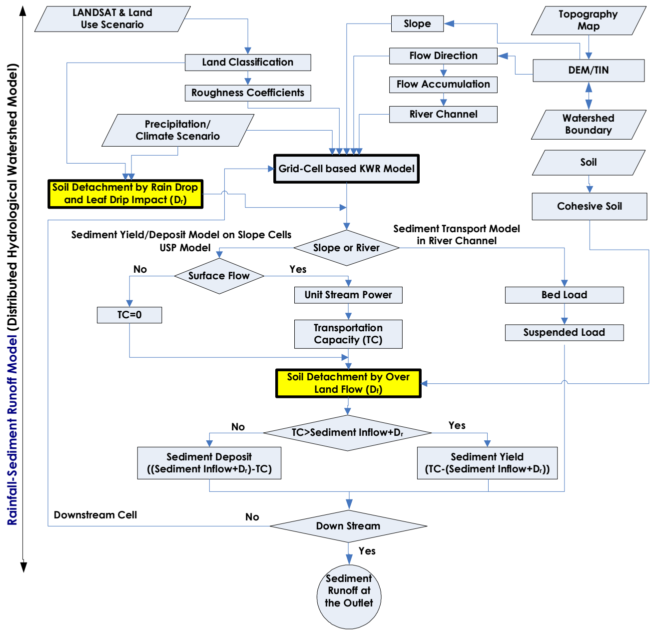

Fig. 3 The concept schematic of model.

This study would be useful for : (1) prioritize flow (flood) and sediment critical areas, and (2) spatially distributed investment prioritization for water and sediment control for reducing the runoff and sediment rate.

5. References

Kojima, T. & Takara., K. 2003. A Grid-Cell Based Distributed Flood Runoff Model and Its Performance. *Weather Radar Information and Distributed Hydrological Modeling* (Proceeding of symposium HS03 held during IUGG2003 at Sapporo, July 2003). IAHS Publ. No. 282. pp 234-240.

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