

ABSTRAK

PENGEMBANGAN KURVA KEKRITISAN SUMBER DAYA AIR BERDASARKAN PERUBAHAN GUNA LAHAN DI DAERAH ALIRAN SUNGAI CITARUM HULU

Oleh

Hadi Nurcahyo

NIM : 35011012

(Program Studi Doktor Teknik Sipil)

Perkembangan Kota/ Wilayah dengan efek perubahan guna lahan memberi tekanan pada daerah aliran sungai (DAS) mempengaruhi karakteristik aliran. Tekanan tersebut mempengaruhi kapasitas DAS dalam mentransformasikan hujan menjadi limpasan dan air tanah. Kondisi tersebut tercerminkan pada karakteristik aliran sungai yang dapat menjadi penanda proses kekritisan sumber daya air DAS.

Penelitian bertujuan mengembangkan kurva kekritisan untuk memetakan kekritisan sumber daya air. Kurva kekritisan dikembangkan dengan pendekatan hubungan karakteristik aliran sebagai fungsi kondisi guna lahan, karakteristik fisik DAS dan kondisi hujan. Dengan bantuan pemodelan variabel hujan dan karakteristik DAS dikontrol untuk mempelajari ciri kekritisan aliran atas pengaruh perubahan guna lahan.

Kurva kekritisan dalam kemampuan memetakan kekritisan dikembangkan dan diuji pada lokasi DAS Citarum Hulu menggunakan data hujan dan debit harian dalam periode 30 tahun (1981-2010), tiga peta guna lahan tahun 1986, 2004, 2010 dan data karakteristik fisik DAS.

Penelitian melalui 4 proses: (i) kajian historis hubungan hujan, debit sungai dan kondisi guna lahan (ii) parameterisasi kekritisan dalam hubungan perubahan guna lahan dan karakteristik aliran (iii) pengembangan konsep kurva kekritisan (iv) pemodelan untuk mengoperasionalkan kurva kekritisan dan menguji sensitifitasnya.

Kurva kekritisan menggunakan kurva durasi aliran (*Flow Duration Curve*) dan kurva turunannya sebagai parameter aliran. Metode *Curve number* sebagai parameter guna lahan. Kurva kekritisan dikembangkan dan diuji melalui perlakuan variabel dan perubahan parameter untuk mengetahui bagaimana perilaku aliran apabila kondisi guna lahan berubah atau dirubah. Perlakuan variabel guna lahan berdasarkan (i) perubahan guna lahan historis / eksisting, (ii) perubahan guna lahan terkontrol menjadi perkembangan gradual (iii) kondisi guna lahan ramalan hasil pemodelan guna lahan.

Hasil penelitian menunjukkan kurva kekritisian mampu memetakan kekritisian sumber daya air dengan hasil sbb : (i) kekritisian dicirikan dengan peningkatan aliran tinggi dan penurunan aliran rendah sejalan dengan perubahan kondisi guna lahan yang meningkatkan kondisi kekedapan (ii) proses kekritisian mempunyai rentang dengan pola tidak linier, ditandai dengan keberadaan dua *threshold* membentuk tiga fase kekritisian (iii) pola tiga fase kekritisian dengan ciri ; fase pertama DAS dalam kondisi aliran stabil, fase kedua DAS dalam kondisi perubahan aliran tingkat rendah sampai sedang, fase ke tiga DAS dalam kondisi perubahan aliran tingkat tinggi (iv) hasil pemetaan kekritisian menyatakan DAS Citarum Hulu berada pada fase tiga.

Tiga perangkat lunak mendukung pemodelan adalah ArcSWAT untuk pemodelan hidrologi, SWATCUP untuk proses kalibrasi/validasi dan LanduseSim untuk simulasi guna lahan ramalan. Sesuai kebutuhan pemetaan kekritisian ketiga model dipasangkan dengan pendekatan kontinyu, simultan dan interaktif berbasis spasial.

Kata kunci : kekritisian, karakteristik aliran , daerah aliran sungai, penggunaan lahan, kurva kekritisian.

ABSTRACT

DEVELOPMENT OF CRITICALITY CURVE OF WATER RESOURCES BASED ON LAND USE CHANGE IN UPPER CITARUM RIVER BASIN

by

Hadi Nurcahyo

NIM: 35011012

(Doctoral Program in Civil Engineering)

The development of cities / Regions with land uses change effects put pressure on river basin. This pressure affecting its capacity in responding presipitation, in transforming it into runoff and groundwater. This condition is reflected in flow regime that can be the identifiers of water resource critical conditions in river basins.

This research aims to develop a criticality curve for the purpose of mapping critical water resources on the relationship between land use change and flow characteristics. The criticality curve was developed by approaching the distinctive relation of flow characteristic as a function of change in the physical characteristics of the river basin and rain.

By modeling, the rainfall variables and river basin characteristics were controlled to analyze charachteristics of flow affected by the change in land use. The research included four processes: (i) historical studies on the relationship between persipitation , river regime, and land use conditions (ii) parameterization of criticality in relation to changes in land use conditions and flow characteristics (iii) development of the criticality curve to measure criticality (iv) modeling to operationalize the criticality curve and test its sensitivity.

The criticality curve used the flow duration curve and its derivative curve as the flow parameter and the Curve number as the land use parameter. The criticality curve was developed and tested through treatment variable and parameter change to find out how flow behaves if land use condition changes or is changed. Land use variables were based on (i) historical / existing land use change, (ii) land use change were manipulated into gradual development with the use of curvenumber value (iii) forecasting land use conditions based on results of land use modeling,

To know its ability in mapping criticality, the criticality curve was developed and tested at upstream Citarum river basin using a 30 year period of daily rainfall and discharge data (1981-2010), three land maps of 1986, 2004, 2010, physical characteristic data of the river basin related to soil types and morphology.

The criticality curve was able to map the critical state of the water resources with the following features (i) changes in flow characteristics through increased high flow and decreased low flow in line with the change in land use causing increased imperviousness (ii) the criticality featuring a range with a non-linear pattern, characterized by the presence of a threshold forming three critical phases (iii) The three-phase pattern characteristics; the first phase of the river basin in a stable flow condition, the second phase of the river basin changed into a low to moderate flow condition. The third phase of the river basin changed into a high-level flow condition (iv) The result of criticality mapping using the criticality curve showed that upstream Citarum river basin is in phase three, high flow rate condition.

The three softwares that supported the modeling were ArcSWAT for hydrological modeling, SWATCUP for the calibration / validation process and LanduseSim for simulated land use forecast. As per the requirement of criticality mapping the three models were paired with a continuous, simultaneous and interactive-based spatial approach.

Keywords: criticality, flow characteristics, river basin, land use, criticality curve.