Study of Hydrology based on Climate Changes Simulation Using SWAT Model At Jatiluhur Reservoir Catchment Area

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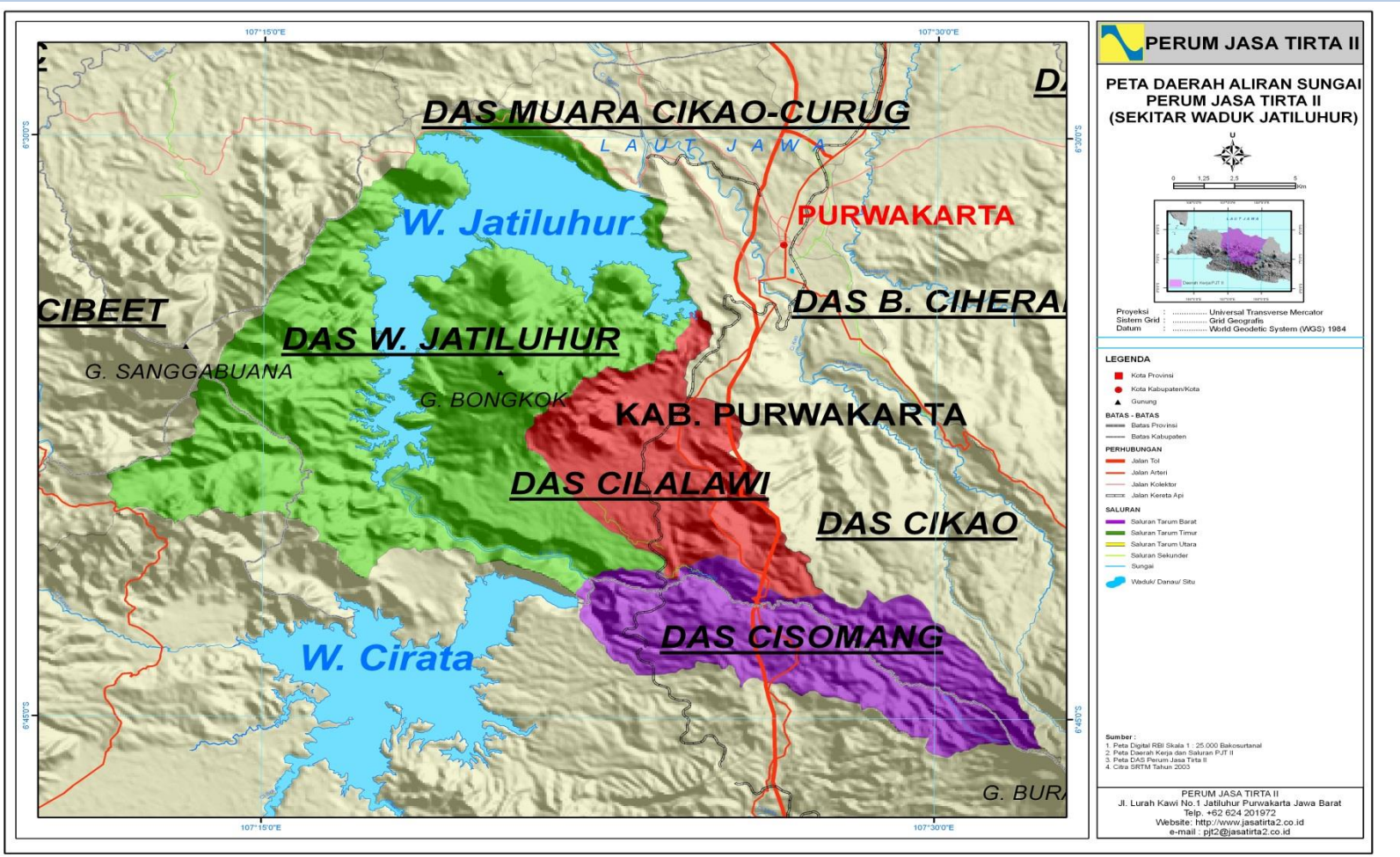
Background

- Jatiluhur reservoir is the one of the most important reservoir which located in West Java Indonesia.
- Jatiluhur Reservoir Catchment Area is located between $107^0$11'36" - $107^0$32'36" E and $6^0$29'50" - $6^0$40'45" S in West Java, Indonesia.
- The catchment area embraces 380 km^2 which is 8% of the total coverage area in the upstream of Citarum River with the total area of 4500 km^2
- Climate change will make changes in water resources. This will reduce groundwater recharge which causing drought in the dry season.
- Climate change also leads the changes in temperature, especially an increase in temperature

JATILUHUR RESERVOIR CATCHMENT AREA

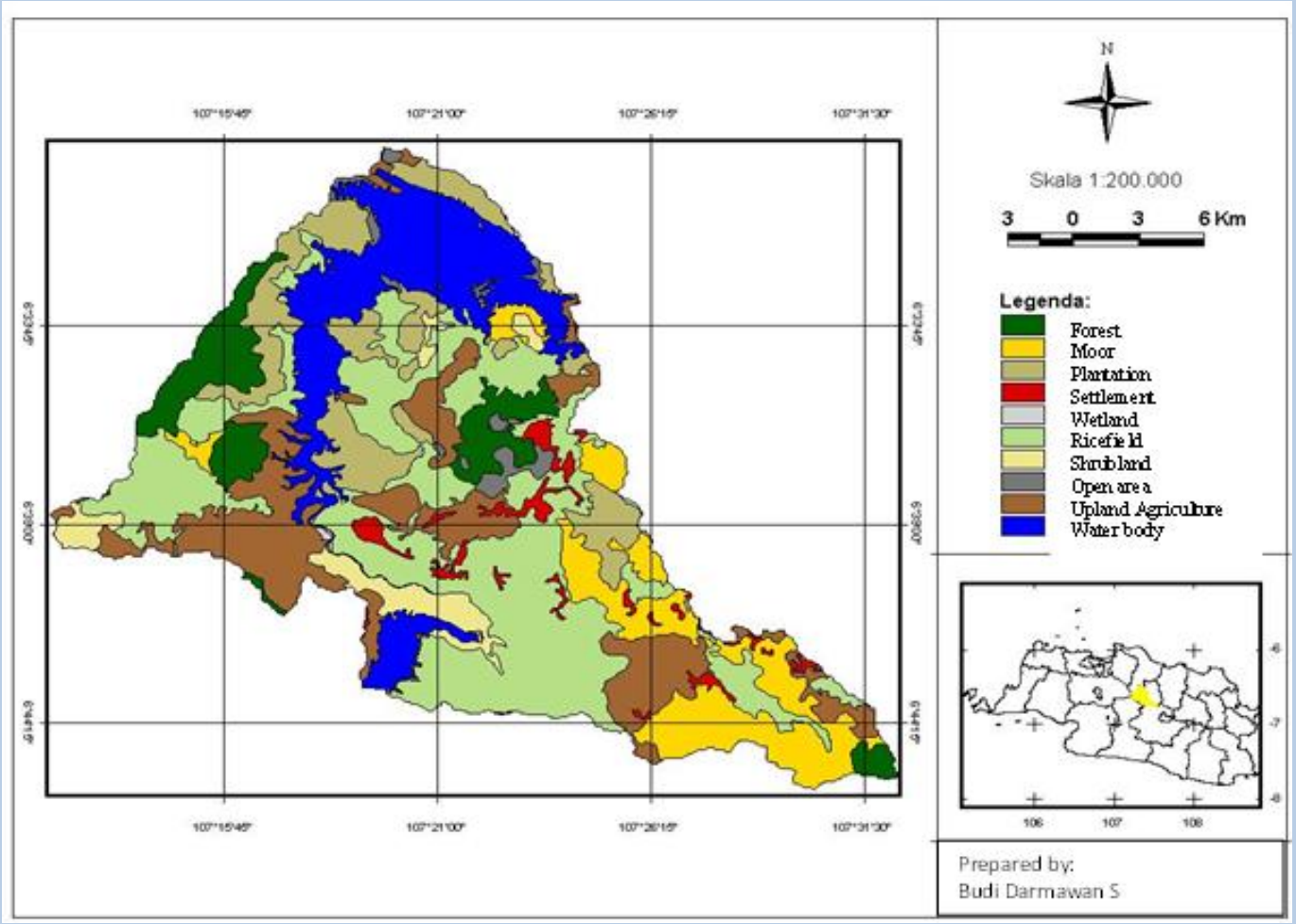


General Condition

Climate

Parameter	Value
average rainfall	213.54 mm
average Maximum temperature	32.45^{0}C
average Minimum temperature	20.72^{0}C
Average monthly solar radiation	16.65 MJ/m^2/day
Average humidity	90.33%
average of evapotranspiration	1.10 mm/day

Land Cover Map



Land Cover

Jatiluhur catchment area has 10 land cover types include secondary forests, mixed farms, plantations, settlements, wetland, rice fields, bushes, open land, moor/fields, and bodies of water. The dominant land cover types are fields (31.16%).

MATERIAL

- The materials used in this study is soil map scale of 1:100,000,
- Map of the earth scale 1:25,000,
- DEM (Digital Elevation Model) map,
- Land cover map of 2009,
- Discharge stream data, river channel data, rainfall data and climate data,
- Physical soil properties of the data

Sub Basin Process

- Threshold 25 km^2
- 13 sub-watersheds
- 299 HRUs

Calibration

- Model calibration process conducted by compares the results of model calculations with discharge field measurement data (actual) in 2009 from Cisomang stations

Scenario

- Scenario 1: increase in precipitation by 10%
- Scenario 2: decrease in rainfall by 15%
- Scenario 3: an increase in temperature by 1ºC
- Scenario 4: an increase in rainfall of 10% and a temperature of 1 ºC.

Result and Discussion

- SWAT model simulation period for the Jatiluhur reservoir catchment area conducted for 5 years starting from 2005 to 2009
- Years 2005-2008 is used as the model set up
- Year 2009 used for calibration and assessment process
- Nash-Sutcliffe values is less than 0.3

Hydrological Characteristic of Jatiluhur Catchment Area June to December 2009

Month	Rainfall	Runoff	Lateral flow	Baseflow	Water Yield	Evapotranspiration
	---------- mm ----------					
6	113.41	7.36	5.66	101.32	114.26	42.3
7	43.53	7.86	3.92	70.93	82.69	10.73
8	81.36	23.49	4.39	44.35	72.18	6.06
9	71.42	7.18	3.8	46.15	57.05	35.76
10	44.44	3.11	2.4	26.16	31.62	31.67
11	385.88	103.51	11.06	37.96	152.35	56.17
12	181.86	22.12	9.14	124.17	155.29	52.87
Total	921.9	174.63	40.37	451.04	665.44	235.56

Simulation Results of Climate Change Scenario to the Runoff June to December 2009

Month	Runoff (mm)				
	Existing	S1	S2	S3	S4
6	7.36	10	4.18	7.42	10.06
7	7.86	9.93	5.11	7.98	10.07
8	23.49	28.6	16.44	23.46	28.57
9	7.18	9.54	4.26	7.05	9.38
10	3.11	4.39	1.6	3.03	4.29
11	103.51	125.54	73.33	103.23	125.21
12	22.12	28.64	13.85	22.03	28.55
Total	174.63	216.64	118.77	174.2	216.13

- The scenario of increased rainfall by 10% (S1) will increase the value of the surface flow of 21.28 - 41.16% while the decrease in rainfall scenario by 15% (S2) which reduce runoff by 29.16 - 48.55%.
- Scenario 3 (increase in temperature by 1ºC) giving effect varies to the surface flow where surface flow value increased by 0.82 - 1.53% and at the end of the simulation period decreased by 0.13 – 2.57%.
- Scenario 4 (the combination of an increase in rainfall of 10% and a temperature of 1ºC) increasing runoff by 20.96 - 37.94%.
- Increase in the percentage of surface runoff in scenario 4 is slightly lower than scenario 1 because of the combination with an increment in temperature by 1ºC
- The whole to all the simulation period from June to December 2009, the increment in precipitation by 10% and the air temperature by 1ºC will increase runoff by 23.76%.

Simulation Results of Climate Change Scenario to the Water yield June to December 2009

Month	Water yield (mm)				
	Existing	S1	S2	S3	S4
6	114.26	124.17	99.11	113.58	123.51
7	82.69	92.07	68.12	84.09	93.48
8	72.18	81.58	57.94	72.81	82.35
9	57.05	63.45	47.37	56.12	62.58
10	31.62	37.85	21.71	29.3	35.56
11	152.35	179.25	114.2	151.46	178.28
12	155.29	173.26	128.09	154.16	172.13
Total	665.44	751.63	536.54	661.52	747.89

- Scenario 1 and 4 are increasing water yield of 8.67-19.70% and 8.10-17.02%
- The scenario of decreasing rainfall by 15% and scenario of increment the temperature by 1ºC decreasing the water yield by 13.26-31.34% and 0.58 to 7.34%, respectively
- The increase of water yield will give advantage to the community around the catchment area if it can be stored in the ground so that during the dry season, the water is still available. But if the increase of water yield not properly managed, it will give negative impact such as flooding.

Simulation Results of Climate Change Scenario to the Evapotranspiration June to December 2009

Month	Evapotranspiration (mm)				
	Existing	S1	S2	S3	S4
6	42.3	42.36	42.14	40.32	40.37
7	10.73	10.75	10.67	9.27	9.28
8	6.06	6.06	6.06	7.47	7.47
9	35.76	35.79	35.69	37.55	37.6
10	31.67	31.86	31.25	32.28	32.5
11	56.17	56.24	56.06	57.52	57.62
12	52.87	52.93	52.61	54.02	54.11
Total	235.56	235.99	234.48	238.43	238.95

- Increasing in temperature causes the majority of rainfalls contribute more to evapotranspiration so that surface runoff is low
- Increasing in evapotranspiration as a result of increment the temperature by 1ºC range between 1.93 - 23.27%
- Simulation results of climate change (Hailemariam, 1999 in WWF Indonesia, 2007) for the Citarum watershed suggest that increased rainfall of 10% and a temperature of 2 - 4°C will increase the runoff annual rate of 4 to 12%.
- Increasing in temperature causes the majority of rainfalls contribute more to evapotranspiration so that surface runoff is low. Increasing in evapotranspiration as a result of increment the temperature by 1ºC range between 1.93 - 23.27%

Conclusion

- Climate change affects the hydrological characteristics of a watershed. Increasing in precipitation by 10% will increase the value of runoff of 21.28 – 41.16% while decreasing rainfall by 15% will decrease runoff by 29.16 - 48.55%.
- Decreasing of rainfall by 10% and temperature by 1ºC increasing runoff by 20.96-37.94%.
- There needs an effort for adaptation to climate change that happening so the damage can be minimize.

THANK YOU