The Spatial Relation of Evapotranspiration, Rain Intensity and Surface Runoff in Bandung Basin, Based on Satellite Image

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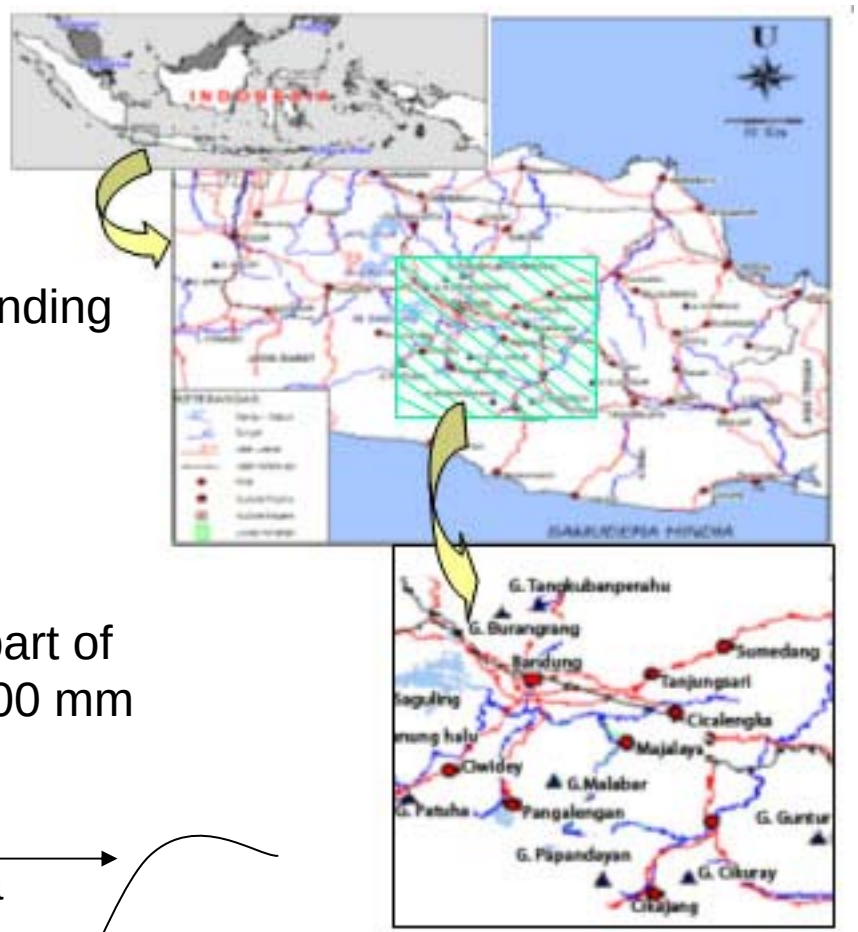
Study Area

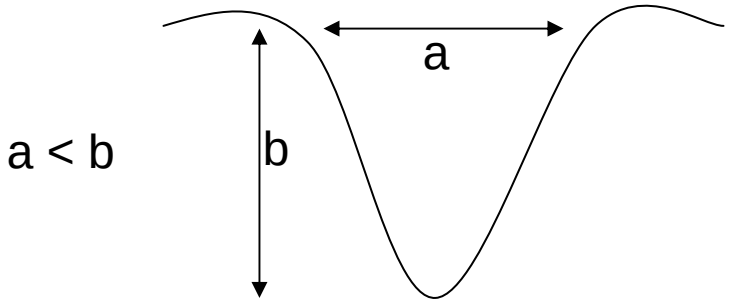
Bandung Basin is a part of West Java, Indonesia

The area, look like a cup with is surrounding with the mountain

The climate affected by monsoons and orographyc rainfall

There are heavy rainfall; as an upper part of watershed area, the rainfall around 4000 mm annually

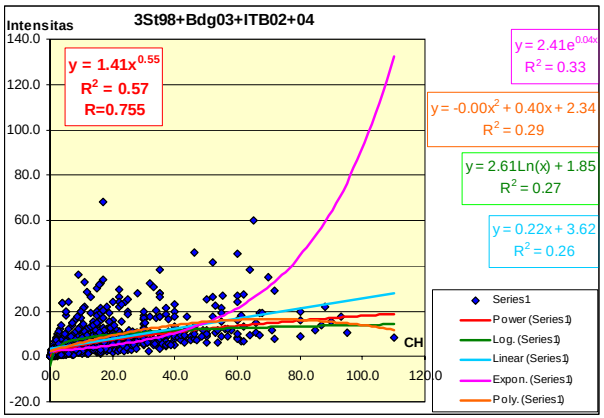




Methods

- Estimation:
  - »Rain intensity
  - »Evapotranspirasi
  - »Runoff
- Spasial correlation:

Step of rain intensity estimation



The formulation tend to power law

Empirically approach of rainfall duration and rain intensity

	Data (1220)					
	Plengan 1998	Cileunca 1998	Cipanunjang 1998	Bandung 2003	ITB 2002	ITB 2004
Durasi	$CH = 8{,}25t^{0{,}66}$ $R^2 = 0{,}42$	$CH = 15{,}00t^{0{,}66}$ $R^2 = 0{,}35$	$CH = -0{,}073t^2 + 5{,}170t + 5{,}004$ $R^2 = 0{,}413$	$CH = 2{,}76t^{0{,}91}$ $R^2 = 0{,}40$	$CH = 1{,}73t^{1{,}15}$ $R^2 = 0{,}62$	$CH = 2{,}52t^{0{,}85}$ $R^2 = 0{,}36$
Intensitas	$i = 4{,}16e^{0{,}02CH}$ $R^2 = 0{,}19$	$i = 3{,}49CH^{0{,}38}$ $R^2 = 0{,}15$	$i = 1{,}87CH^{0{,}44}$ $R^2 = 0{,}26$	$i = 1{,}11CH^{0{,}67}$ $R^2 = 0{,}53$	$i = 1{,}25CH^{0{,}48}$ $R^2 = 0{,}55$	$i = 1{,}59CH^{0{,}68}$ $R^2 = 0{,}51$
Durasi	$CH = 11{,}26t^{0{,}68}$ $R^2 = 0{,}34$				$CH = 2{,}14t^{1{,}00}$ $R^2 = 0{,}48$	
Intensitas	$i = 2{,}41CH^{0{,}42}$ $R^2 = 0{,}21$				$i = 1{,}42\,CH^{0{,}61}$ $R^2 = 0{,}51$	
Durasi	$CH = 10{,}39t^{0{,}55}$ $R^2 = 0{,}33$					
Intensitas	$i = 2{,}16CH^{0{,}43}$ $R^2 = 0{,}23$					
Durasi	$CH = 6{,}78t^{0{,}77}$ $R^2 = 0{,}33$					
Intensitas	$i = 1{,}37CH^{0{,}57}$ $R^2 = 0{,}46$					
Durasi (895)	$CH = 4{,}19t^{1{,}03}$ -> $t = \sqrt[1{,}03]{\frac{CH}{4{,}19}}$ -> Rt= 0,53 -> Ri(1) = 0,52 Ri(2/3) = 0,55 $R^2 = 0{,}46$					
Intensitas (895)	$i = 1{,}41CH^{0{,}55}$ $R^2 = 0{,}57$ ->Ri= 0,55					

$I = 1{,}41(R)^{0{,}55}$ and $R^2 = 0.57$

$$t = \sqrt[1.03]{\frac{R}{4.19}}$$

The result of rain intensity estimatation

No	Observation station	Coordinate		Dayly Rainfall	Rain estimation	
		X	Y		Intencity	Duration
1	Bandung	107.612	-6.885	2.9355	2.5313	0.7079
2	Batujajar	107.455	-6.951	3.5161	2.7955	0.8435
3	Chincona	107.575	-7.187	4.5806	3.2332	1.0904
4	Cibeurem	107.562	-6.924	1.3871	1.6760	0.3419
5	Cicalengka	107.617	-6.968	2.6774	2.4064	0.6474
6	Cililin MM	107.949	-6.961	0.0645	0.3101	0.0174
7	Ciparay	107.702	-7.021	6.2258	3.8277	1.4688
8	Cisalak pesanggrahan	107.742	-6.715	6.8710	4.0410	1.6164
9	Cisondari	107.479	-7.092	8.7097	4.6039	2.0348
10	Ciwidey	107.464	-7.104	12.5806	5.6359	2.9079
11	Gambung	107.516	-7.137	2.7097	2.4223	0.6550
12	Jatinangor	107.771	-6.916	6.9355	4.0618	1.6311
13	Jatiroke	107.786	-6.929	5.6452	3.6270	1.3356
14	Malabar	107.694	-7.236	0.9032	1.3238	0.2254
15	Montoya	107.393	-6.910	1.6774	1.8607	0.4112
16	Paseh	107.736	-7.054	6.2903	3.8494	1.4836
17	Saguling DAM	107.325	-7.004	8.2258	4.4615	1.9250
18	Sukawana	107.585	-6.781	3.5806	2.8236	0.8585
19	Ujungberung	107.722	-6.927	5.4516	3.5581	1.2912

Empirical estimating the rain intensity from 19 rainfall stations; with coordinates

Referred to Mononobe method and formulae: it is tend to power law

Estimate by least square correlation:

$I = 1{,}41(R)^{0{,}55}$ and $R^2 = 0.57$

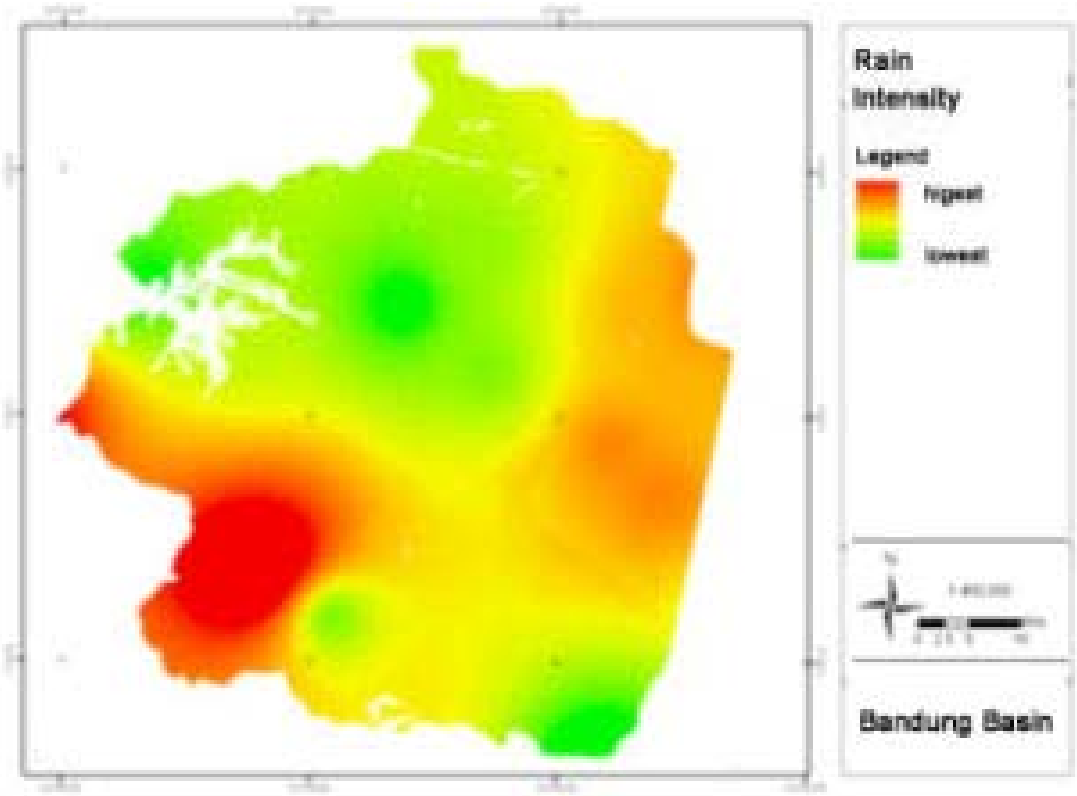
The origin of Mononobe formulae

$$t = \sqrt[0,475]{\frac{R}{422}} \qquad R = 422t^{0.475}$$

$$t = \sqrt[1.03]{\frac{R}{4.19}}$$

Obtained

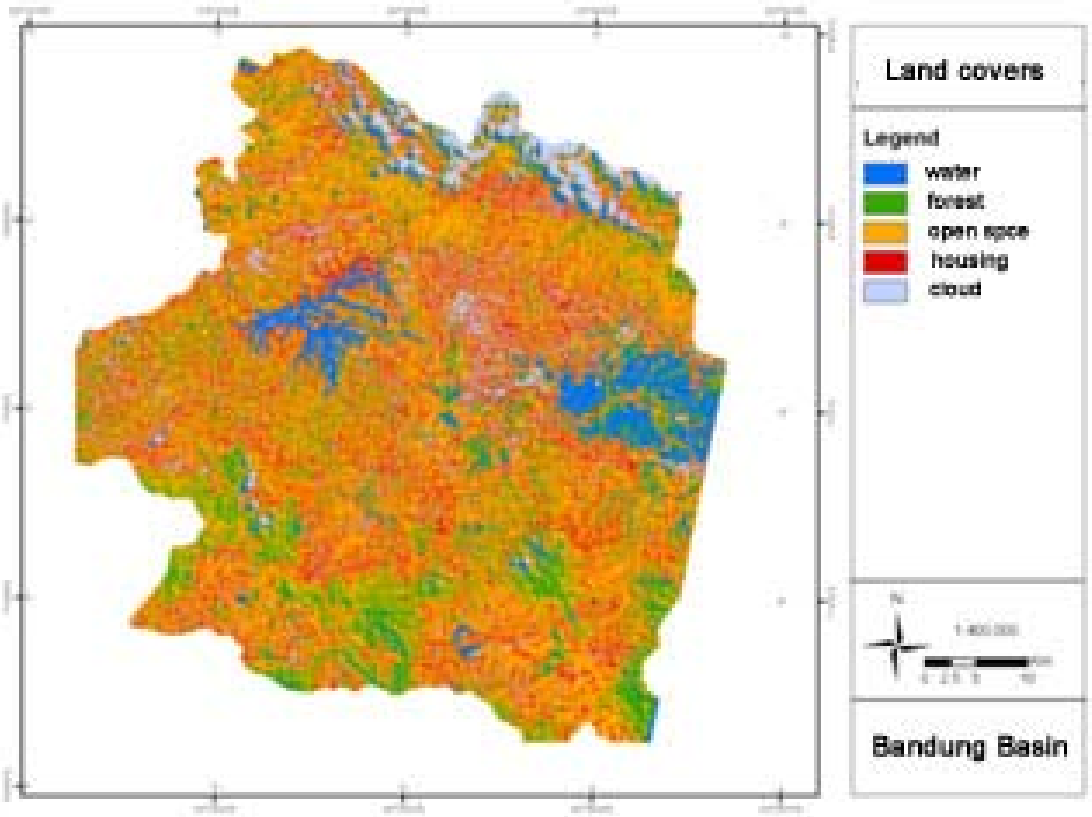
Rainfall intensity isohyet



The technical of intensity isohyet building

Accompanied with bandung land cover image by technology GIS

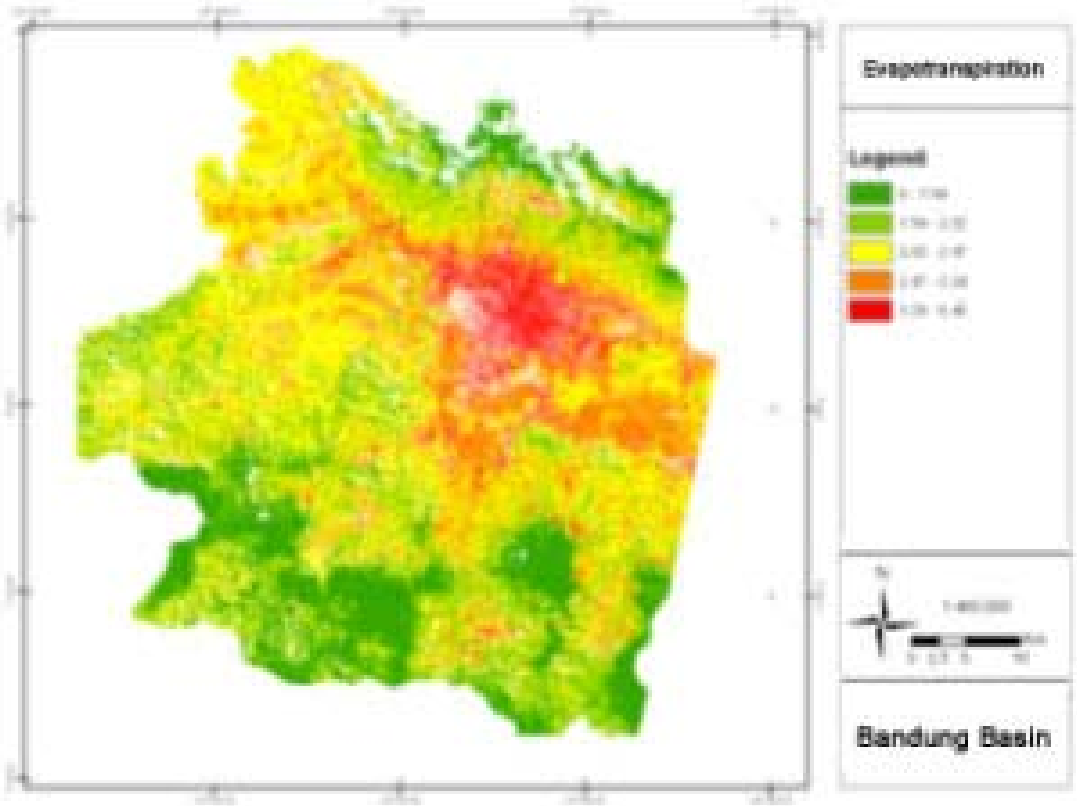
Land cover image



LANDSAT 7 ETM+ composite image bands 452 processing

Classification by unsupervised classification using maximum likelihood method

Evapotranspiration image

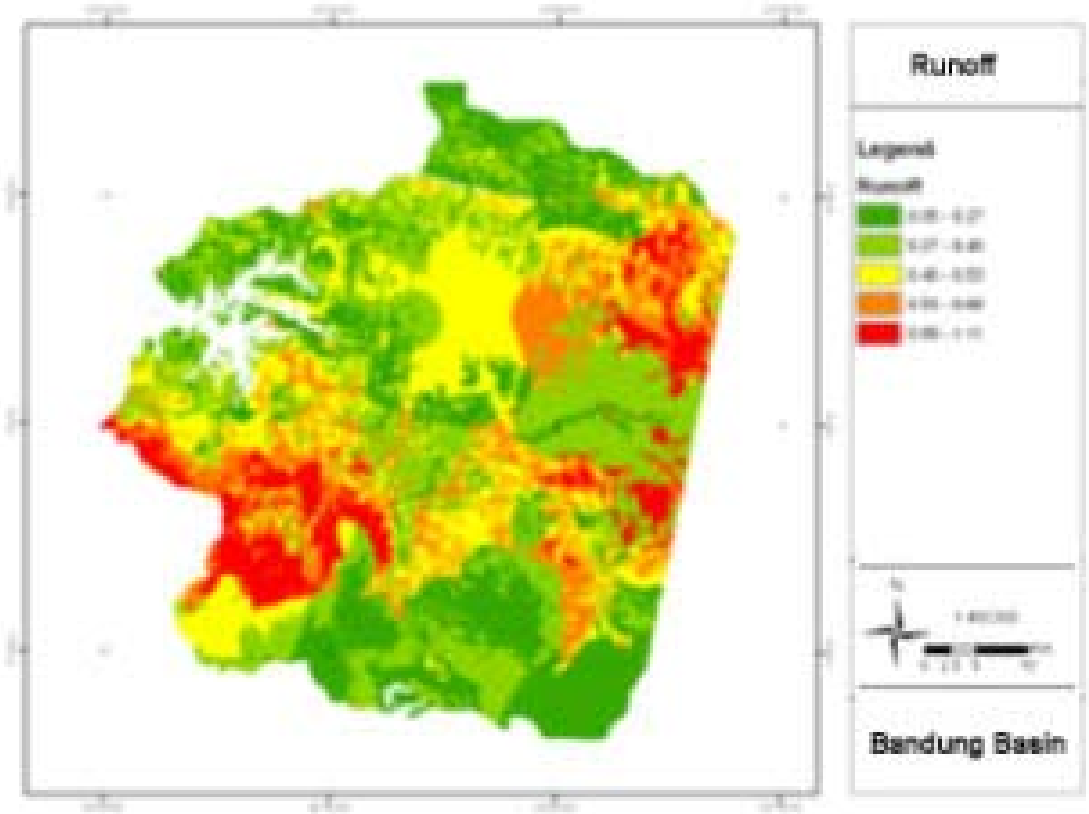


Based on Penman method: EP = [W x ()] + [(1 - W) x Ea]

After LANDSAT 7 ETM+ image band 6 and calculating and estimating the spatial land temperatur, air temperatur, air humidity, actual and saturate water vapor pressure, evaporation and it energi

Over land cover and land texture

Surface Maximum Runoff image



Based on Rational method and formulae:
$Q = C . I . A$

After estimating the runoff coefficient C as a function of land cover image, land texture, land slope

The relations

- All the relation analysis spcially by technology GIS. of obtained from the spatial correlation by ArcGIS.
- The relation of rain intensity - runoff is shown by the correlation coefficient R = 0.62; that mean there is good enough correlation;
- the relation of intensity – evapotranspiration by R = -0.19, mean that no good correlation of intensity – evapotranspiration;
- the relation of evapotranspiration – runoff by R = 0.06, mean no correlation of evapotranspiration – runoff.

Resume

- The spatial relation of :
- rain intensity – runoff positively good enough; mean the decreasing rain intensity will followed the decreasing runoff coefficient.
- rain intensity – evapotranspiration negatively no good; mean there are very small negative change of intensity will influence the evapotranspiration.
- evapotranspiration - runoff positively no good; mean there are very small positive change of evapotranspiration will influence the runoff.