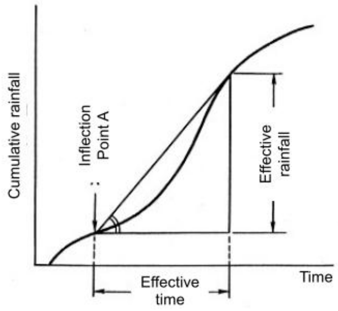
8) calculate the effective rainfall (R_E) accumulated rainfall from the inflection point A to inflection point B.



$$R_i = \sum_{c}^{d} CH$$ where, d = inflection point B

9) calculate the effective time
effective time is the raining hours from inflection point A up to an effective rainfall, where usually up to inflection point B.

$t_E = t_d - t_c$ where, t_E = effective time
t_d = time at inflection point B
t_c = time at inflection point A

10) calculate the effective rainfall intensity (I_E)
effective rainfall intensity is a value derived by dividing the effective rainfall (RE) by the effective time.

$$I_E = \frac{R_E}{t_E}$$

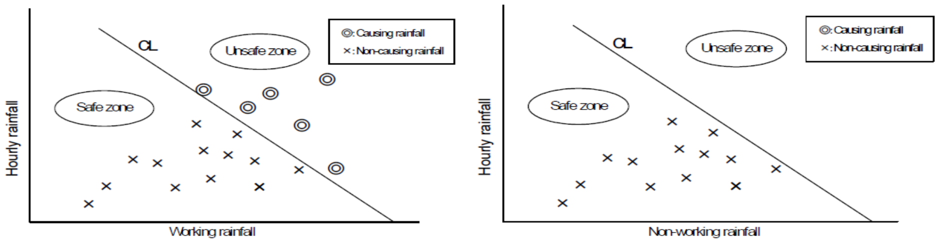
11) record the calculation result values from the various rainfall indexes parameter above into the appropriate form (form 1 for causing rainfall or rainfall data at the time when banjir bandang occurred (Appendix E.1) and form 2 for non-causing rainfall or rainfall data which are not the time when banjir bandang occurred (Appendix E,2)) and complete the other parameter adjust the existing format

12) depict the calculation result of rainfall index an X-Y graph by placing :

	The X axis / abscissa	The Y axis / ordinate
Causing rainfall	The working rainfall up to 1 hour before the occurrence of banjir bandang (column (j) form 1)	One-hour rainfall immediately before the occurrence of banjir bandang (column (k) form 1)
Non-causing rainfall	The working rainfall up to before the start of a maximum hourly rainfall (column (g) form 2)	The maximum hourly rainfall in a series of rain (column (e) form 2)

Working rainfall (R_W) is a cumulative rainfall that takes into account the effect of an antecedent rainfall (R_A).

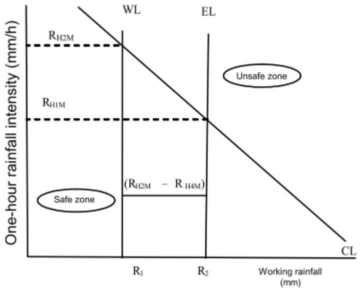
13) setting of the critical line (CL) a boundary line that is drawn on rainfall index, which distinguishes the occurrence and non-occurrence of a debris flow, with separate the causing rainfall and non-causing rainfall with draw a boundary line as the picture below.



14) determine the maximum hourly rainfall as R_{H1M} value and the maximum 2-hourly rainfall as R_{H2M} reference to table of the timing of a warning issuance and an evacuation instructions below

Type	Timing of issuance/instruction	Forecasted rainfall during the spare hours
Issuance of a warning	2 hours before reaching the CL	Past maximum 2-hour rainfall (R_{H2M})
Instruction of an evacuation	1 hour before reaching the CL	Past maximum 1-hour rainfall (R_{H1M})

15) draw a line perpendicular to the CL up to resulting the value of R_1 as the perpendicular from R_{H2M} which functioning as a hazard warning lines (WL or a standard line that indicates the standard rainfall for warning) and R_2 as the perpendicular from R_{H1M} which functioning as an evacuation line (EL or a standard line that indicates the standard rainfall for evacuation) as shown in the picture below



16) test the generated results by calculating :
- investigation of the separability of CL by using the following equation (the greater the value of S_c that's mean the result have a good separability is).

  $S_c = \frac{K_{nc}}{K_n}$ where, K_n = the total number of non-causing rainfalls

  K_{nc} = the number of non-causing rainfalls that come in the safe zone
- investigation of the frequency of warning issuance and evacuation instruction by using the following equations

  $F_w = \frac{k_{yw} + k_{nw}}{n}\ (time/year)$ dan $F_e = \frac{k_{ye} + k_{ne}}{n}\ (time/year)$

  where, F_w = frequency of warning issuance
  F_e = frequency of evacuation instruction
  k_{yw} = the number of data in which the total working rainfall of a causing rainfall (column (q) form 1) exceed R_1
  k_{ye} = the number of data in which the total working rainfall of a causing rainfall (column (q) form 1) exceed R_2
  k_{nw} = the number of data in which the total working rainfall of a non-causing rainfall (column (n) form 2) exceed R_1
  k_{ne} = the number of data in which the total working rainfall of a non-causing rainfall (column (n) form 2) exceed R_2
  n = the number of years in which the data are collected
- investigation of the non-hit rate (a measure of inaccuracy that assessed value approximate) of warning issuance and evacuation instruction by using the following equations for assessing the adequacy of a forecasted rainfall used for the setting of the EL and WL

  $M_w = \frac{k_{nw}}{n}\ (time/year)$ and $M_e = \frac{k_{ne}}{n}\ (time/year)$

  where, M_w = non-hit rate of warning issuance
  M_e = non-hit rate of evacuation instruction

17) after confirming the adequacy and get the compatible standard, then we can establish that :

Standard rainfall for warning	=	**R_1** (mm)
Standard rainfall for evacuation	=	**R_2** (mm)

B) B Method

1) do the same steps with A method step 1) until 11)
2) depict the calculation result of rainfall index an X-Y graph by placing :

	The X axis / abscissa	The Y axis / ordinate
Causing rainfall	working rainfall up to the occurrence of banjir bandang (column (l) form 1)	the effective rainfall intensity up to the occurrence of banjir bandang (column (p) form 1)
Non-causing rainfall	working rainfall up to inflection point B (column (k) form 2)	the effective rainfall intensity up to inflection point B (column (m) form 2)

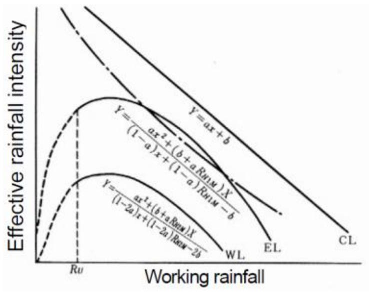
3) setting of the critical line (CL) with separate the causing rainfall and non-causing rainfall with draw a boundary line
4) determine the equation of CL with assume that Y = aX + b, where Y as effective rainfall intensity and X is working rainfall, while the value of a and b is the value from CL equation
5) determine the maximum hourly rainfall as R_{H1M} value and the maximum 2-hourly rainfall as R_{H2M} same as before reference to table in A method step 14)
6) setting of the evacuation line (EL) based on the calculation result by using the equation below :

$$Y = \frac{aX^2 + (b + a.R_{H1M})X}{(1-a)X + (1-a)R_{H1M} - b}$$

7) setting of the warning line (WL) based on the calculation result by using the equation below :

$$Y = \frac{aX^2 + (b + a.R_{H2M})X}{(1-2a)X + (1-2a)R_{H2M} - 2b}$$

8) plot the two line results onto a graph until produce the result like a picture below



9) test the generated results by calculating :
   - investigation of the separability of CL by using the same equation from A method
   - investigation of the frequency of warning issuance and evacuation instruction by using the following equations

     $F'_w = \frac{k'_{yw} + k'_{nw}}{n}\ (time/year)$ dan $F'_e = \frac{k'_{ye} + k'_{ne}}{n}\ (time/year)$

     where,

where,	F'_w	=	frequency of warning issuance
	F'_e	=	frequency of evacuation instruction
	k'_{yw}	=	the number of data in which the total working rainfall of a causing rainfall exceeds the WL
	k'_{ye}	=	the number of data in which the total working rainfall of a causing rainfall exceeds the EL
	k'_{nw}	=	the number of data in which the total working rainfall of a non-causing rainfall exceeds the WL
	k'_{ne}	=	the number of data in which the total working rainfall of a non-causing rainfall exceeds the EL

n = the number of years in which the data are collected

- investigation of the non-hit rate of warning issuance and evacuation instruction by using the following equations for assessing the adequacy of a forecasted rainfall used for the setting of the EL and WL

  $M'_w = \frac{k'_{nw}}{n}\ (time/year)$ dan $M'_e = \frac{k'_{ne}}{n}\ (time/year)$

  where, M'_w = non-hit rate of warning issuance
  M'_e = non-hit rate of evacuation instruction

10) after confirming the adequacy and get the compatible standard, then we can establish that :

    standard rainfall for warning = $\boldsymbol{Y} = \frac{aX^2+(b+a.R_{H2M})X}{(1-2a)X+(1-2a)R_{H2M}-2b}$

    standard rainfall for evacuation = $\boldsymbol{Y} = \frac{aX^2+(b+a.R_{H1M})X}{(1-a)X+(1-a)R_{H1M}-b}$

    where, $(\boldsymbol{X} \geq \boldsymbol{R_u})$ and a,b always constant.

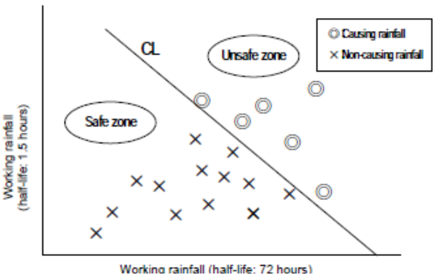
    R_U is a working rainfall value below which is usually uninfluential to the occurrence of a banjir bandang.

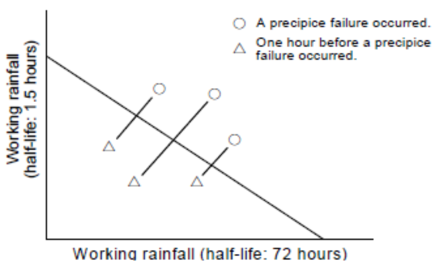
C) Committee Method

1) arrangement the collecting data according to the measurement time
2) calculate the working rainfall by employing 12 hours the half-life time when the half-life is 1.5 hours and 574 hours when the half-life is 72 hours based on this equation:

   $R_w = \sum \alpha_{1i}\ x\ R_{1i} \cdot \alpha_{1i} = 0{,}5^{i/T}$

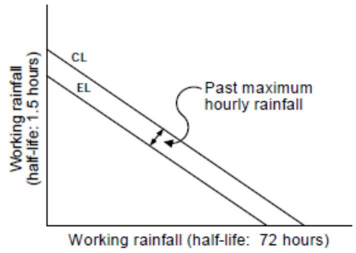
   where, R_{1i} = one-hour rainfall at the time i -hours ago
   α_{1i} = deduction coefficient at the time i - hour ago
   T = half-life (hour)
3) record the calculation result values from the various rainfall indexes parameter above into the appropriate form (form 3 for causing rainfall (Appendix E.3) and form 4 for non-causing rainfall (Appendix E,4)) and complete the other parameter adjust the existing format
4) depict the calculation result an X-Y graph by placing the working rainfall with half-life 72 hours as the abscissa/axis X and the working rainfall with half-life 1.5 hours as the ordinate/axis Y
5) setting of the critical line (CL) same with A method step 13). CL is drawn between working rainfall 1 hour before the occurrence and working rainfall at the time of disaster occurence as seen in the picture below.



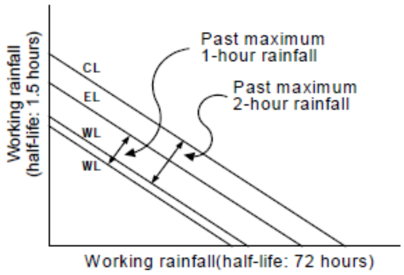


6) determine the maximum hourly rainfall as R_{H1M} value and the maximum 2-hourly rainfall as R_{H2M} reference to A method step 14)

7) setting of the evacuation line (EL) with drawing a line parallel to the CL from R_{H1M} as shown in the picture below



8) setting of the warning line (WL) with drawing a line parallel to the CL from R_{H2M} , and for the comparator also drawing a line parallel to the EL from R_{H1M} as shown in the picture below



9) test the generated results by same step with A and B method
10) after confirming the adequacy and get the compatible standard, then we can establish the standard rainfall for warning issuance and for evacuation instruction.

D.1.2 Case when daily rainfall data are accumulated

In that case, the standard rainfalls must be set using only the total rainfall which is obtainable from daily rainfall data, which a rainfall gauging station located in or around the target area is selected as the representative rainfall gauging.

1) determine the rainfall indexes based on some definitions rather different from previous methods such as the following :
   - 1-day rainfall = rainfall on the day a banjir bandang disaster occurred
   - 2-day rainfall = the total of the rainfall on the day a banjir bandang disaster occurred and the rainfall on the previous day
   - 3-day rainfall = the total of the rainfall on the day a banjir bandang disaster occurred and the rainfalls on the previous two days
   - Cumulative rainfall = cumulative rainfall of a series of rain including the day a banjir bandang disaster occurred
   - Working rainfall = the total of the cumulative rainfall and the antecedent rainfall (the basic idea same with A and B method)

   If the number of disaster occurrence is few, rainfalls that had large 1-day, 2-day, and 3-day rainfalls shall be taken out from among non-causing rainfall data with assume that a disaster occurred on the day of the largest 1-day rainfall.
2) record the values of rainfall indexes above into the form 5 as shown in Appendix E.5
3) setting of the critical standard with comparing the lowest value of causing rainfalls and the highest value of non-causing rainfalls. The rainfall index exhibiting the highest separability between the two rainfalls shall be used to establish the standard rainfall showing the critical state preceding the occurrence of disasters.
4) for setting the standard rainfalls for warning and evacuation, the accuracy of the timing become inaccurate because it must wait for the data obtained for 1 day. In the daily rainfall gauge, it is possible to read the scale of the stored water every hour. Hence,

presupposing that the rainfall can be gauged every hour during the warning period using some means as shown above, the standard rainfalls based on the total rainfall can be set in the same way as done in A, B, and Committee Method reference to the table of timing of warning issuance and evacuation instruction below.

Type	Timing of warning/evacuation	Forecast rainfall during the hours shown left
Issuance of a warning	2 hours before reaching the critical rainfall	Past maximum 2-hour rainfall / probable 2-hour rainfall
Instruction of an evacuation	1 hour before reaching the critical rainfall	Past maximum 1-hour rainfall / probable 1-hour rainfall

In that case, if the data still difficult to obtainable, they can be specified from the hourly rainfall data obtained in other areas which have similar the daily rainfall characteristics.

D.2 Setting of standard rainfall in case when banjir bandang causing rainfall data are not accumulated

If the rainfall data related to the occurrence of disasters may not be accumulated, it is still possible to establish the standard rainfall for warning and evacuation if those non-causing rainfalls are analyzed. Also, the standard rainfall can be tentatively set up by referring to the analysis results of rainfalls in other regions with having the same climate condition.

D.3 Setting of standard rainfall in case when rainfall data are not available at all

Use the nearby areas standard rainfall or the other areas that has a topography, geology, climatology and hydrology conditions are the same. Especially for the banjir bandang disaster risk area but the rainfall data are not available at all, the following things should be done to obtain information in decision-making of warning issuance and evacuation instructions before the disaster occurred:

1) Install the rainfall gauging station
   A rainfall gauging station shall be installed in and data collection should begin as soon as possible, so that the rainfall data obtained can be used for decision making related to the warning issuance and evacuation instructions. It can be installed near the office of a disaster prevention organization if the disaster hazard area is relatively small and the rainfall characteristics of the area is roughly identical to that around the office. Usually a rain gauge can represent rainfall conditions with a radius of approximately 20-25 km region around it. Appendix G showed the example of simple rain gauge, manually with handmade, and the modern gauge
2) If a rainfall gauging station is installed, a disaster forecast can be started using the standard rainfalls currently employed in other areas which having a similar topography, geology, and weather conditions as the tentative measures. As the disaster forecast method, A, B, or Committee Method shall be used. As time advances, the rainfall data will increase, the standard rainfalls are reviewed, revised, and upgraded to a highly sophisticated disaster forecast system.

Appendix E

(informative)

Form for setting the standard rainfall

E.1 Form for recording the causing rainfall data (Form 1)

(a)	(b)	(c)	(d)	(e)	(f)	(g)						(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
Reference No.	Mountain stream	Address	No. of debris flow hazard stream	Occurrence date/time	Continuous rainfall (RC) (date/time-date/time)	Antecedent rainfall (R_A)						Antecedent working rainfall (R_{WA})	Cumulative rainfall up to 1 hour before the occurrence of debris flow	Working rainfall up to 1 hour before the occurrence of debris flow (h)+(i)	One-hour rainfall immediately before the occurrence of debris flow	Working rainfall (R W) up to the occurrence of debris flow (j)+(k)	Initial rainfall (R_I)	Effective rainfall (R E) up to the occurrence of debris flow (i)+(j)-(m)	Effective time	Effective rainfall intensity (I_E) (n)/(o)	Total working rainfall (f)+(h)	Distance between mountain stream and rainfall gauging	Remarks
						2 days before	3 days before	4 days before	.....	14 days before	Half-life												

E.2 Form for recording the non-causing rainfall data (Form 2)

(a)	(b)	(c)						(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(q)	(s)
Reference No.	Continuous rainfall (RC) (date/time-date/time)	Antecedent rainfall (R_A) (mm)						Antecedent working rainfall (R_{WA}) (mm)	Maximum hourly rainfall of non-causing rain (date/time-date/time)	Cumulative rainfall up to before the start of a maximum hourly rainfall (mm)	Working rainfall up to before the start of a maximum hourly rainfall (d)+(f) (mm)	Initial rainfall (RI) (date/time)	Cumulative rainfall up to Inflection Point B (date/time)	Effective rainfall (R E) up to Inflection Point B ((i) – (h))	Working rainfall up to Inflection Point B ((d) + (i)) (mm)	Effective time (i)-(h) (hour(s))	Effective rainfall intensity (I_E) (j)/(l) (mm/jam)	Total working rainfall (b)+(d) (mm)	Remarks
		2 days before	3 days before	4 days before	.....	14 days before	Half-life												

E.3 Form for recording the data on causing rainfall for Committee method (Form 3)

	Item	Application
(a)	Reference No.	
(b)	Type of failure	Precipice failure (collective occurrence), precipice failure (individual occurrence), debris flow, etc.
(c)	Hazard area/mountain stream	
(d)	Address/lot	
(e)	No. of hazard area/hazard stream	
(f)	Amount of sediment moved	
(g)	Damage	
(h)	Date/time of occurrence	
(i)	Representative gauging station	
(j)	Distance to the representative gauging station	
(k)	Working rainfall one hour before a disaster occurred (half-life: 72 hours)	Depicted in the X-Y graph
(l)	Working rainfall one hour before a disaster occurred (half-life: 1.5 hours)	
(m)	Working rainfall at the time a disaster occurred (half-life: 72 hours)	
(n)	Working rainfall at the time a disaster occurred (half-life: 1.5 hours)	
(o)	Remarks	

E.4 Form for recording the data on non-causing rainfall for Committee method (Form 4)

	Item	Application
(a)	Reference No.	
(b)	Representative gauging station	
(c)	Continuous rainfall (date/time – date/time, total rainfall)	Same as Method A and B
(d)	Maximum hourly rainfall during a continuous rainfall (date/time, rainfall value)	
(e)	Working rainfall at the time of a maximum hourly rainfall (half-life: 72 hours)	
(f)	Working rainfall at the time of a maximum hourly rainfall (half-life: 1.5 hours)	
(g)	Time at which a maximum working rainfall occurred.	The time when $\sqrt{x^2 + y^2}$ is at its maximum during a series of rain. (Time when the distance from the origin becomes the largest).
(h)	Working rainfall at the time of a maximum working rainfall (half-life: 72 hours)	Depicted in the X-Y graph.
(i)	Working rainfall at the time of a maximum working rainfall (half-life: 1.5 hours)	
(o)	Remarks	

E.5 Form for recording the rainfall indexes used for the total rainfall-based setting method (Form 5)

No. of a series of rain	1-day rainfall	2-day rainfall	3-day rainfall	Cumulative rainfall	Working rainfall
Causing rainfall					
1					
2					
…					
Non-causing rainfall					
1					
2					
…					

Appendix F
(informative)
Example of calculation of the standard rainfall value for banjir bandang early warning

Here is an example of calculating the standard rainfall value that has been done in Jember area:

F.1 Rainfall data

Table F.1 – kali Jompo rainfall data sampling

Date	Time	Rainfall	Series number
18/03/2010	15:00	0	
18/03/2010	16:00	0	
18/03/2010	17:00	0	
18/03/2010	18:00	0	
18/03/2010	19:00	0,5	1
18/03/2010	20:00	0	
18/03/2010	21:00	0	
18/03/2010	22:00	0	
18/03/2010	23:00	0	
……..	….	…	…
20/03/2010	17:00	0	
20/03/2010	18:00	6,1	2
20/03/2010	19:00	0	
20/03/2010	20:00	0	
20/03/2010	21:00	0	
20/03/2010	22:00	0	
20/03/2010	23:00	0	
21/03/2010	0:00	0	
21/03/2010	1:00	0	
21/03/2010	2:00	0	
21/03/2010	3:00	0	
21/03/2010	4:00	0	
21/03/2010	5:00	0	
21/03/2010	6:00	0	
21/03/2010	7:00	0	
21/03/2010	8:00	0	
21/03/2010	9:00	0	
21/03/2010	10:00	0	
21/03/2010	11:00	0	
21/03/2010	12:00	0	
21/03/2010	13:00	0	
21/03/2010	14:00	0	
21/03/2010	15:00	0	
21/03/2010	16:00	0	
21/03/2010	17:00	2,3	
21/03/2010	18:00	0,5	
21/03/2010	19:00	0	
21/03/2010	21:00	0	
21/03/2010	22:00	0	
21/03/2010	23:00	0	
22/03/2010	0:00	0	
22/03/2010	1:00	0	
22/03/2010	2:00	0	
22/03/2010	3:00	0	
22/03/2010	4:00	0	
22/03/2010	5:00	0	
……..	….	…	…
25/03/2010	15:00	0	
25/03/2010	16:00	2,5	3
25/03/2010	17:00	58,2	
25/03/2010	18:00	3,6	
25/03/2010	19:00	0	
……..	….	…	…

The first column in Table F.1 is date of rainfall data, the second column is the time of data was recorded, the third column is the quantity of rainfall per hour in mm units, and the fourth column is id number from “a series of rain” where the definition will be explained on the next chapter.

As example, on that table show the series of rainfall represented by blue columns. You can see that the second series was beginning at 20’th March 2010 at 18.00 o’clock until 22’th March 2010 at 4.00 o’clock. As the definition that a series flanked with no rainfall during 24 hours before and after that series.

F.2 Calculating the rainfall index parameters

Table F.2 and F.3 show the calculation results of rainfall index parameter according with the format of Form E.1 for form 1 and E.2 for form 2.
To Form 2 in the first column (a) and the second column (b), contains the id / serial number of the rain and the initial and final time series total amount of rain the following series of rain is in units of mm. The third column (c) is the value of antecedent rainfall. Sub-columns of the third column is the amount of rain for 24 hours starting from 2 days earlier. This is because the period of rain 24 hours 1 day before the rain started the series, definitely worth 0 mm. Sub-column should show the antecedent rainfall until 14 days before the series of rain, but on the sub-column table shows only preliminary rain until 7 days before the series rain. This is because the use of "half" of 1 day. Likewise, the Form 1 by adding some information about the conditions and consequences experienced when disasters occur.

To derive the effect of an antecedent rainfall, the 24-hour rainfall of one day before the debris flow-causing rain is multiplied by the coefficient of α_1 time; and a 24-hour rainfall of two days before the debris flow-causing rain is multiplied by the coefficient of α_2 time. In this way, the 24-hour rainfall up to "t" days before, or "dt", is multiplied by the coefficient of "αt (αt < 1)" just like shown on this equation below:
$R_{WA} = \alpha_1 . d_1 + \alpha_2 . d_2 + ... +\alpha_{14} . d_{14} = \Sigma \alpha_t . d_t$
The coefficient α_t is called the deduction coefficient of t days before. And, the total of them is called the antecedent working rainfall (R_{WA}).
There are many ways to determine α_t. When the half-life is assumed to be 1 day, which means the value of α_t become ½ of α_{t-1}, then antecedent working rainfall (R_{WA}) is calculated as:
$R_{WA} = 0,5 . d_1 + 0,25 . d_2 + 0,125 . d_3 + …..$
When judging if a debris flow will occur or not, the appropriateness of judgment shall be evaluated by changing the half-life to 2 days and 3 days. The relationship between the deduction coefficient and the half-life is given by the following equation:
$\alpha_t = 0.5^{t/T}$
Where, T : day(s) of half-life; t : day(s) before the start of rainfall.
An example of deduction coefficient calculation results for the half-life (T) 1 day, 2 days, and 3 days, and days before the series of rain (causing rainfall) 1 day to 14 days is shown in Table of coefficient deduction.
If we use the half-life (T) 1 day, we can only have a preliminary rainfall data up to 7 days before the series of rain. Whereas if we use the half-life (T) 2 days, then we must have a preliminary rainfall data up to 15 days before the series of rain, and so on.
For the case of rainfall data from Kali Jompo as shown in Table F.3 column (c), because the half-life (T) that is used is 1 day, so the antecedent rainfall data can only enough up to 7 days before a series of rain.
After the mm value of each time interval of antecedent rainfall is obtained, the next stage is to measure working rainfall (R_{WA}). For example to calculate R_{WA} on series number 3, then the value of R_{WA} = 0.25*0 + 0.125*3.1 + 0.0625*2.8 + 0.03125*6.1 + 0.01563*0 + 0.00781*0.5 = 0.76 mm, where this working rainfall value is on the fourth column (d).

To determine the inflection point, as the reference, the following figure is an example of rainfall data from rain gauge station of Kali Jompo which is series of rain Jompo number 43. Inflection point A and inflection point B are shown in the direction of the arrows.

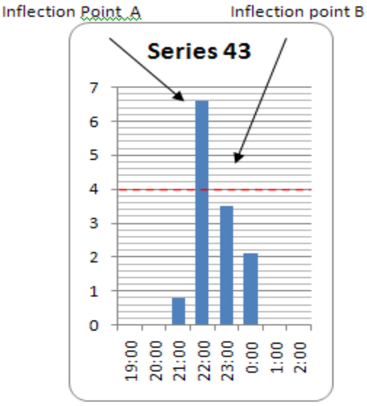


Figure F.1 - Inflection point A and inflection point B on rainfall data of Kali Jompo (series of rain number 43)

According to the series on Figure F.1, the following figure is an example of rainfall data from rain gauge station of Kali Jompo i.e. series of rain number 43. The total value of initial rainfall (RI) is shown in green circles. In this data, the accumulation is derived only from two hour data (the total rainfall from beginning of series to inflection point A = 0.8 + 6.6 = 7.4 mm).

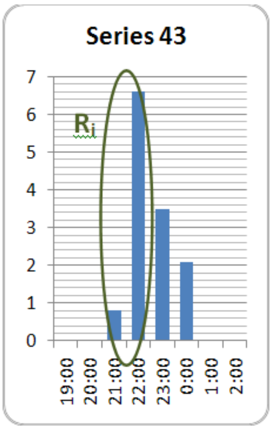


Figure F.2 - Total cumulative initial rainfall on rainfall data of Kali Jompo (series of rain number 43)

And the following figure is an example of rainfall data from rain gauge station of Kali Jompo series of rain number 43 as referring to Figure B.3, which inflection point A and B are shown in the direction of the arrow, while the effective time is the time span between point A and point B in duration 2 (two) hours.

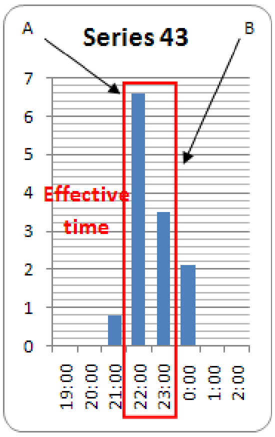


Figure F.3 - Effective rainfall, effective time, and effective rainfall intensity on rainfall data of Kali Jompo (series or rain number 43)

Table F.2 - Various values of rainfall index parameters (causing rainfall) in Form 1, from rain gauge of Kali Jompo

Form for recording the causing rainfall data (Form 1)

(a) Ref. No.	(b) Mountain stream	(c) Address	(d) No. of debris flow hazard stream	(e) Occurrence date/time			(f) Continuous Rainfall (R_C)			(g) Antecedent Rainfall (R_A)							(h) Antecedent working rainfall (R_{WA}) (mm)	(i) Cumulative rainfall up to 1hour before the occurrence of debris flow	(j) Working rainfall up to 1hour before the occurrence of debris flow (h)+(i)	(k) One-hour rainfall immediately before the occurrence of debris flow	(l) Working rainfall (R_W) up to the occurrence of debris flow (j)+(k)	(m) Initial rainfall (R_I) (date/time)	(n) Effective rainfall (R_E) up to the occurrence of debris flow (i)+(j)-(m)	(o) Effective time (hours)	(p) Effective rainfall intensity (I_E) (n)/(o)	(q) Total working rainfall (f)+(h)	(r) Distance between mountain stream and rainfall gauging station
				occurrence	inferred time		mm	date start	date end	2 days before	3 days before	4 days before	5 days before	6 days before	7 days before	Half-life (T)											
1		kec. kencong & jombang		flood	morning	04/01/2011 9:00	236,4	12/25/10 15:00	1/4/11 9:00	6,6	18,1	3,3	6,3	65,3	33,8	1 day	5,60	235,9	241,50	0,20	241,70	10,9	466,5	235	1,99	242,00	
2		kencong		flood	morning	07/01/2011 4:00	118,1	1/5/11 14:00	1/10/11 21:00	0,8	36,3	2,8	49,1	4,3	41,9	1 day	6,84	29,7	36,54	1,80	38,34	2,3	63,9	125	0,51	124,94	
3		jompo, semangir, dinoyo river		flood		03/02/2011 15:00	242,9	1/30/11 20:00	2/5/11 15:00	0	0	0	21,3	48,1	14,2	1 day	1,53	139	140,53	1,30	141,83	1,8	277,7	140	1,98	244,43	
4		panti, rambipuji		banjir bandang	evening	03/02/2011 15:00	242,9	1/30/11 20:00	2/5/11 15:00	0	0	0	21,3	48,1	14,2	1 day	1,53	139	140,53	1,30	141,83	1,8	277,7	140	1,98	244,43	
5		argopuro slopes, kec. panti		landslide	morning	04/02/2011 3:00	242,9	1/30/11 20:00	2/5/11 15:00	0	0	0	21,3	48,1	14,2	1 day	1,53	233,5	235,03	0,00	235,03	1,8	466,7	140	3,33	244,43	
6		kec. rambipuji		flood	night	24/02/2011 22:00	257,6	2/21/11 17:00	3/1/11 20:00	29,7	0	0,3	5,4	30,5	91,4	1 day	8,80	63,5	72,30	0,00	72,30	1,5	134,3	193	0,70	266,40	
7		Dusun Cempaka,Kemundungan,Gluduk, Desa Pakis		banjir bandang	night	04/03/2011 19:00	251,9	3/3/11 16:00	3/6/11 20:00	61,6	44,5	33,1	25,6	3,1	10	1 day	23,96	55,1	79,06	18,90	97,96	12,4	121,8	74	1,65	275,86	
8		desa pakis, argopuro		landslide	night	04/03/2011 19:00	251,9	3/3/11 16:00	3/6/11 20:00	61,6	44,5	33,1	25,6	3,1	10	1 day	23,96	55,1	79,06	18,90	97,96	12,4	121,8	74	1,65	275,86	
9		sungai dinoyo, kec.rambipuji		flood	afternoon	06/03/2011 18:00	251,9	3/3/11 16:00	3/6/11 20:00	61,6	44,5	33,1	25,6	3,1	10	1 day	23,96	161,8	185,76	35,70	221,46	12,4	335,2	74	4,53	275,86	

Note :
The orange column is represented the prediction time of the occurrence

Table F.3 - Various values of rainfall index parameters (non-causing rainfall) in Form 2, from rain gauge of Kali Jompo

Form for recording the non-causing rainfall data (Form 2)

(a) Ref. No.	(b) Continuous Rainfall (Rc)			(c) Antecedent Rainfall (mm)						(d) Antecedent working rainfall (RWA) (mm)		(e) Maximum hourly rainfall of non-causing rain			(f) Cumulative rainfall before the start of a maximum hourly rainfall (mm)	(g) Working rainfall up to before the start of a maximum hourly rainfall (d)+(f)	(h)		(i)		(j) Effective rainfall (RE) up to Inflection Point B = (i)-(h) (mm)	(k) Working rainfall up to Inflection Point B = (d)+(i) (mm)	(l) Effective time =(i)-(h) (hours)	(m) Effective rainfall intensity =(j)/(l) (mm/hours)	(n) Total working rainfall (b)+(d)
	mm	date start	date end	2 days before	3 days before	4 days before	5 days before	6 days before	7 days before	Half-life (T)		1hourly (mm)	2hourly (mm)	(date)			Initial rainfall (RI) (mm)	Inflection point A (date)	Cumulative rainfall up to Inflection Point B (mm)	Inflection point B (date)					
1	0,5	3/18/10 19:00	3/18/10 19:00	0	0	0	0	0	0	1 day	0,00	0,5	0,5	18/03/2010 19:00	0	0,00	0,5	18/03/2010 19:00	0,5	18/03/2010 20:00	0,0	0,5	1	0,00	0,50
2	16,8	3/20/10 18:00	3/22/10 17:00	0,5	0	0	0	0	0	1 day	0,13	6,1	6,1	20/03/2010 18:00	0	0,13	6,1	20/03/2010 18:00	16,8	22/03/2010 17:00	10,7	16,9	47	0,23	16,93
3	64,3	3/25/10 16:00	3/25/10 18:00	0	3,1	2,8	6,1	0	0,5	1 day	0,76	58,2	61,8	25/03/2010 17:00	2,5	3,26	60,7	25/03/2010 17:00	64,3	25/03/2010 18:00	3,6	65,1	1	3,60	65,06
4	0,8	3/29/10 18:00	3/29/10 20:00	0	0	0	60,7	0	0	1 day	1,90	0,5	0,5	29/03/2010 18:00	0	1,90	0,5	29/03/2010 18:00	0,8	29/03/2010 21:00	0,3	2,7	3	0,10	2,70
5	2,5	4/5/10 18:00	4/5/10 21:00	0	0	0	0	0	0,3	1 day	0,00	1,3	1,3	05/04/2010 19:00	1	1,00	1	05/04/2010 18:00	2,5	05/04/2010 22:00	1,5	2,5	4	0,38	2,50
6	1,3	4/9/10 17:00	4/10/10 19:00	0	0	2,5	0	0	0	1 day	0,16	0,8	0,8	09/04/2010 17:00	0	0,16	0,8	09/04/2010 17:00	1,3	10/04/2010 20:00	0,5	1,5	27	0,02	1,46
7	2,3	4/12/10 13:00	4/12/10 14:00	0,5	0,8	0	0	0	2,5	1 day	0,24	2,1	2,3	12/04/2010 14:00	0,2	0,44	2,3	12/04/2010 14:00	2,3	12/04/2010 15:00	0,0	2,5	1	0,00	2,54
8	0,5	4/13/10 17:00	4/13/10 17:00	2,3	0,2	0,3	0	0	0	1 day	0,62	0,5	0,5	13/04/2010 17:00	0	0,62	0,5	13/04/2010 17:00	0,5	13/04/2010 18:00	0,0	1,1	1	0,00	1,12
9	0,8	4/14/10 19:00	4/14/10 19:00	0,5	2,3	0	0,3	0,8	0	1 day	0,43	0,8	0,8	14/04/2010 19:00	0	0,43	0,8	14/04/2010 19:00	0,8	14/04/2010 20:00	0,0	1,2	1	0,00	1,23
10	37,4	4/19/10 23:00	4/20/10 13:00	0	0	0	0	0,8	0,5	1 day	0,02	34,3	35,1	19/04/2010 23:00	0	0,02	34,3	19/04/2010 23:00	37,4	20/04/2010 14:00	3,1	37,4	15	0,21	37,42
11	58,1	4/21/10 21:00	4/28/10 20:00	37,4	0	0	0	0	0	1 day	9,35	16	16	21/04/2010 21:00	0	9,35	16	21/04/2010 21:00	58,1	28/04/2010 21:00	42,1	67,5	168	0,25	67,45
12	6,1	4/29/10 22:00	4/30/10 0:00	8,1	3,6	0,3	15	7,9	0,8	1 day	3,09	4	4,3	29/04/2010 23:00	1,8	4,89	5,8	29/04/2010 23:00	6,1	30/04/2010 0:00	0,3	9,2	1	0,30	9,19
13	14,5	5/2/10 15:00	5/3/10 4:00	0	6,1	8,1	0,8	0,6	12,2	1 day	1,40	11,4	11,4	02/05/2010 15:00	0	1,40	11,4	02/05/2010 15:00	14,5	03/05/2010 5:00	3,1	15,9	14	0,22	15,90
14	33,8	5/6/10 17:00	5/7/10 20:00	0	0	1,8	11,4	0	6,1	1 day	0,52	24,6	26,4	07/05/2010 18:00	5,1	5,62	3,3	06/05/2010 17:00	32,8	07/05/2010 19:00	29,5	33,3	26	1,13	34,32
15	42,5	5/9/10 19:00	5/13/10 17:00	1	26,4	3,3	0	0	0,3	1 day	3,76	16,5	16,5	13/05/2010 14:00	18,1	21,86	5,6	09/05/2010 20:00	42,5	13/05/2010 18:00	36,9	46,3	94	0,39	46,26
16	9,7	5/15/10 4:00	5/16/10 6:00	24,4	0,3	6,1	5,9	5,8	0	1 day	6,79	2,3	3,8	15/05/2010 5:00	0,8	7,59	3,1	15/05/2010 5:00	9,7	16/05/2010 7:00	6,6	16,5	26	0,25	16,49
17	36,9	5/19/10 17:00	5/19/10 18:00	0	0	4,9	4,8	0	23,9	1 day	0,64	36,6	36,9	19/05/2010 17:00	0	0,64	36,6	19/05/2010 17:00	36,9	19/05/2010 18:00	0,3	37,5	1	0,30	37,54
18	8,4	5/20/10 19:00	5/21/10 16:00	36,9	0	0	4,9	4,8	0	1 day	9,45	3,8	4,6	20/05/2010 19:00	0	9,45	3,8	20/05/2010 19:00	8,4	21/05/2010 17:00	4,6	17,9	22	0,21	17,85
19	15,6	5/23/10 18:00	5/24/10 16:00	0	8,4	0	36,6	0	0	1 day	2,19	9,1	10,7	23/05/2010 19:00	1,8	3,99	10,9	23/05/2010 19:00	15,6	24/05/2010 17:00	4,7	17,8	22	0,21	17,79
20	40,4	5/25/10 17:00	5/26/10 21:00	15,6	0	0	8,4	0,3	0	1 day	4,17	22,8	22,8	26/05/2010 21:00	17,6	21,77	17,3	25/05/2010 18:00	40,4	26/05/2010 22:00	23,1	44,6	28	0,83	44,57
21	14,5	5/28/10 9:00	5/28/10 10:00	23,1	17,3	0,3	15,3	0	4,6	1 day	8,47	9,7	14,5	28/05/2010 9:00	0	8,47	9,7	28/05/2010 9:00	14,5	28/05/2010 10:00	4,8	23,0	1	4,80	22,97
22	0,3	5/29/10 20:00	5/29/10 20:00	14,5	22,8	0,3	17,3	3,1	10,9	1 day	7,17	0,3	0,3	29/05/2010 20:00	0	7,17	0,3	29/05/2010 20:00	0,3	29/05/2010 21:00	0,0	7,5	1	0,00	7,47
23	31,2	5/31/10 14:00	6/1/10 10:00	0,3	0	14,5	22,8	17,6	0,3	1 day	1,97	17,5	17,5	31/05/2010 14:00	0	1,97	17,5	31/05/2010 14:00	31,2	01/06/2010 11:00	13,7	33,2	21	0,65	33,17
24	9,1	6/3/10 7:00	6/4/10 0:00	6,1	18,5	0	0,3	14,5	0	1 day	4,07	4,8	6,8	03/06/2010 18:00	2,8	6,87	0,8	03/06/2010 7:00	9,1	04/06/2010 1:00	8,3	13,2	18	0,46	13,17
25	39,9	6/7/10 18:00	6/7/10 19:00	0	0	1,5	2,8	0	13,7	1 day	0,29	35,6	35,6	07/06/2010 19:00	4,3	4,59	39,9	07/06/2010 19:00	39,9	07/06/2010 20:00	0,0	40,2	1	0,00	40,19
26	0,3	6/9/10 7:00	6/9/10 7:00	39,9	0	0	0	8,3	0	1 day	10,10	0,3	0,3	09/06/2010 7:00	0	10,10	0,3	09/06/2010 7:00	0,3	09/06/2010 8:00	0,0	10,4	1	0,00	10,40
27	14	6/10/10 16:00	6/11/10 8:00	0,3	39,9	0	0	0	8,3	1 day	5,13	11,5	12,2	10/06/2010 23:00	1,5	6,63	0,8	10/06/2010 16:00	14	11/06/2010 9:00	13,2	19,1	17	0,78	19,13
28	0,5	6/15/10 16:00	6/15/10 16:00	0	0	0	13,2	0	0,3	1 day	0,41	0,5	0,5	15/06/2010 16:00	0	0,41	0,5	15/06/2010 16:00	0,5	15/06/2010 17:00	0,0	0,9	1	0,00	0,91
29	8,1	6/16/10 19:00	6/16/10 19:00	0,5	0	0	0	13,2	0,8	1 day	0,34	8,1	8,1	16/06/2010 19:00	0	0,34	8,1	16/06/2010 19:00	8,1	16/06/2010 20:00	0,0	8,4	1	0,00	8,44
30	0,8	6/18/10 7:00	6/18/10 13:00	8,1	0,5	0	0	0	0,3	1 day	2,09	0,5	0,5	18/06/2010 7:00	0	2,09	0,5	18/06/2010 7:00	0,8	18/06/2010 14:00	0,3	2,9	7	0,04	2,89
31	7,4	6/24/10 6:00	6/24/10 8:00	0	0	0	0	0,8	0	1 day	0,01	4,1	4,9	24/06/2010 7:00	2,5	2,51	2,5	24/06/2010 6:00	7,4	24/06/2010 8:00	4,9	7,4	2	2,45	7,41
32	3,3	6/25/10 17:00	6/26/10 4:00	7,4	0	0	0	0	0	1 day	1,85	1,2	1,5	26/06/2010 3:00	1,8	3,65	0,3	25/06/2010 17:00	3,3	26/06/2010 4:00	3,0	5,2	11	0,27	5,15
33	0,8	6/30/10 18:00	7/1/10 10:00	0	0	0	3	0,3	7,4	1 day	0,16	0,5	0,5	30/06/2010 18:00	0	0,16	0,5	30/06/2010 18:00	0,8	01/07/2010 11:00	0,3	1,0	17	0,02	0,96
34	0,5	7/3/10 18:00	7/3/10 18:00	0	0,3	0	0	0	0	1 day	0,04	0,5	0,5	03/07/2010 18:00	0	0,04	0,5	03/07/2010 18:00	0,5	03/07/2010 19:00	0,0	0,5	1	0,00	0,54
35	0,3	7/4/10 19:00	7/4/10 19:00	0,5	0	0,3	0,5	0	0	1 day	0,16	0,3	0,3	04/07/2010 19:00	0	0,16	0,3	04/07/2010 19:00	0,3	04/07/2010 20:00	0,0	0,5	1	0,00	0,46
36	2,5	7/9/10 18:00	7/9/10 20:00	0	0	0	0,3	0	0	1 day	0,01	1,8	1,8	09/07/2010 18:00	0	0,01	1,8	09/07/2010 18:00	2,3	09/07/2010 19:00	0,5	2,3	1	0,50	2,51
37	16	7/11/10 18:00	7/12/10 17:00	0,7	0	0	0	0	0,3	1 day	0,18	7,4	7,4	12/07/2010 16:00	8,4	8,58	6,6	11/07/2010 18:00	16	12/07/2010 17:00	9,4	16,2	23	0,41	16,18
38	0,3	7/17/10 17:00	7/17/10 17:00	0	0	0	0	15,8	0	1 day	0,25	0,3	0,3	17/07/2010 17:00	0	0,25	0,3	17/07/2010 17:00	0,3	17/07/2010 18:00	0,0	0,5	1	0,00	0,55
39	6,8	7/26/10 4:00	7/28/10 8:00	0	0	0	0	0	0	1 day	0,00	2,3	2,8	28/07/2010 5:00	4,3	4,30	0,8	26/07/2010 4:00	6,8	28/07/2010 9:00	6,0	6,8	53	0,11	6,80
40	12,7	7/29/10 17:00	7/30/10 0:00	4,5	0,5	1	0	0	0	1 day	1,25	10,4	10,7	29/07/2010 18:00	0,3	1,55	10,7	29/07/2010 18:00	12,7	30/07/2010 1:00	2,0	14,0	7	0,29	13,95
41	1,3	8/3/10 19:00	8/3/10 19:00	0	0	0	0,2	10,7	2,5	1 day	0,19	1,3	1,3	03/08/2010 19:00	0	0,19	1,3	03/08/2010 19:00	1,3	03/08/2010 20:00	0,0	1,5	1	0,00	1,49
42	1,3	8/5/10 18:00	8/5/10 18:00	1,3	0	0	0	0	2	1 day	0,34	1,3	1,3	05/08/2010 18:00	0	0,34	1,3	05/08/2010 18:00	1,3	05/08/2010 19:00	0,0	1,6	1	0,00	1,64
43	13	8/9/10 21:00	8/10/10 0:00	0	0	0	1,3	0	1,3	1 day	0,05	6,6	7,4	09/08/2010 22:00	0,8	0,85	7,4	09/08/2010 22:00	10,9	09/08/2010 23:00	3,5	11,0	1	3,50	13,05
44	6,9	8/15/10 18:00	8/15/10 19:00	0	0	0	0	13	0	1 day	0,20	6,4	6,4	15/08/2010 18:00	0	0,20	6,4	15/08/2010 18:00	6,9	15/08/2010 19:00	0,5	7,1	1	0,50	7,10
45	0,5	8/19/10 16:00	8/19/10 17:00	0	0	6,9	0	0	0	1 day	0,43	0,3	0,3	19/08/2010 16:00	0	0,43	0,3	19/08/2010 16:00	0,5	19/08/2010 18:00	0,2	0,9	2	0,10	0,93
46	52,8	8/21/10 16:00	8/23/10 17:00	0,2	0	0	0	6,9	0	1 day	0,16	31,5	31,5	22/08/2010 16:00	2,5	2,66	1	21/08/2010 16:00	52,5	23/08/2010 16:00	51,5	52,7	48	1,07	52,96
47	0,3	8/25/10 21:00	8/25/10 21:00	0	6,9	43,4	2,5	0	0,5	1 day	3,66	0,3	0,3	25/08/2010 21:00	0	3,66	0,3	25/08/2010 21:00	0,3	25/08/2010 22:00	0,0	4,0	1	0,00	3,96
48	12,5	8/30/10 16:00	8/30/10 17:00	0	0	0	0,3	0	0,3	1 day	0,01	12,2	12,2	30/08/2010 16:00	0	0,01	12,2	30/08/2010 16:00	12,5	30/08/2010 17:00	0,3	12,5	1	0,30	12,51
49	14,4	9/1/10 20:00	9/2/10 20:00	0	12,5	0	0	0	0,3	1 day	1,56	8,4	8,4	02/09/2010 18:00	5,3	6,86	5,3	01/09/2010 20:00	14,2	02/09/2010 19:00	8,9	15,8	23	0,39	15,96
50	35,9	9/4/10 22:00	9/9/10 0:00	0	9,1	5,3	0	12,5	0	1 day	1,66	10,1	10,1	07/09/2010 16:00	12,8	14,46	2,8	04/09/2010 22:00	35,9	09/09/2010 1:00	33,1	37,6	99	0,33	37,56
51	28,2	9/17/10 11:00	9/20/10 16:00	0	0	0	0	0	0	1 day	0,00	7,6	8,3	18/09/2010 20:00	3,8	3,80	0,3	17/09/2010 11:00	28,2	20/09/2010 17:00	27,9	28,2	78	0,36	28,20
52	1,5	9/22/10 16:00	9/22/10 17:00	0	1,1	23,3	2,8	0,3	0	1 day	1,69	1,3	1,3	22/09/2010 16:00	0	1,69	1,3	22/09/2010 16:00	1,5	22/09/2010 17:00	0,2	3,2	1	0,20	3,19
53	14,5	9/24/10 14:00	9/24/10 15:00	1,5	0	0,7	1,1	23,3	2,8	1 day	0,84	11,4	11,4	24/09/2010 15:00	3,1	3,94	14,5	24/09/2010 15:00	14,5	24/09/2010 16:00	0,0	15,3	1	0,00	15,34
54	2	9/29/10 18:00	9/29/10 19:00	0	0	0	0	14,5	0	1 day	0,23	1,5	1,5	29/09/2010 18:00	0	0,23	1,5	29/09/2010 18:00	2	29/09/2010 19:00	0,5	2,2	1	0,50	2,23
55	9,4	10/1/10 16:00	10/1/10 17:00	2	0	0	0	0	0	1 day	0,50	7,1	7,1	01/10/2010 16:00	0	0,50	7,1	01/10/2010 16:00	9,4	01/10/2010 17:00	2,3	9,9	1	2,30	9,90
56	13,7	10/3/10 17:00	10/3/10 18:00	0	7,1	2	0	0	0	1 day	1,01	10,9	13,7	03/10/2010 17:00	0	1,01	10,9	03/10/2010 17:00	13,7	03/10/2010 18:00	2,8	14,7	1	2,80	14,71
57	21,3	10/5/10 17:00	10/8/10 10:00	2,8	0	0	7,1	2	0	1 day	0,95	11,9	12,2	06/10/2010 17:00	3,3	4,25	3,3	05/10/2010 17:00	21,3	08/10/2010 11:00	18,0	22,3	66	0,27	22,25
58	29,7	10/9/10 12:00	10/13/10 0:00	5,8	12,2	3,3	0	13,7	0	1 day	3,40	6,1	6,6	10/10/2010 16:00	6,9	10,30	1,8	09/10/2010 12:00	29,7	13/10/2010 0:00	27,9	33,1	84	0,33	33,10
59	89	10/15/10 2:00	10/17/10 16:00	0	5,3	0,3	17,5	6,6	0,5	1 day	1,34	53,1	54,4	16/10/2010 16:00	4,9	6,24	3,1	15/10/2010 4:00	89	17/10/2010 17:00	85,9	90,3	61	1,41	90,34
60	37,9	10/19/10 17:00	10/24/10 16:00	0	18,1	54,9	3,1	0	1	1 day	5,80	9,9	9,9	20/10/2010 19:00	6,4	12,20	1,8	19/10/2010 17:00	37,9	24/10/2010 17:00	36,1	43,7	120	0,30	43,70
61	2,3	10/26/10 14:00	10/26/10 14:00	6,4	9,3	2,5	3,1	14,2	2,1	1 day	3,25	2,3	2,3	26/10/2010 14:00	0	3,25	2,3	26/10/2010 14:00	2,3	26/10/2010 15:00	0,0	5,6	1	0,00	5,55
62	130,5	10/28/10 14:00	11/4/10 7:00	0	0	6,4	9,3	2,5	3,1	1 day	0,75	43,7	43,7	31/10/2010 14:00	48,1	48,85	5,1	28/10/2010 14:00	130,5	04/11/2010 8:00	125,4	131,3	162	0,77	131,25
63	87,4	11/5/10 13:00	11/6/10 15:00	27	3,1	2,3	50	26,7	0,3	1 day	9,26	32,2	38,6	05/11/2010 14:00	6,4	15,66	38,6	05/11/2010 14:00	87,2	06/11/2010 14:00	48,6	96,5	24	2,03	96,66
64	27	11/7/10 17:00	11/8/10 16:00	24,4	61,5	2,9	3,6	0,3	2,5	1 day	14,11	7,1	9,4	07/11/2010 20:00	11,2	25,31	9,4	07/11/2010 18:00	27	08/11/2010 16:00	17,6	41,1	22	0,80	41,11
65	35,1	11/14/10 15:00	11/14/10 20:00	0	0	0	0	0,3	19,9	1 day	0,16	30,2	30,5	14/11/2010 16:00	0,3	0,46	30,5	14/11/2010 16:00	35,1	14/11/2010 21:00	4,6	35,3	5	0,92	35,26
66	31	11/16/10 17:00	11/17/10 17:00	0,3	30,5	0	0	0	0	1 day	3,89	27,7	27,7	17/11/2010 17:00	3,3	7,19	0,3	16/11/2010 17:00	31	17/11/2010 18:00	30,7	34,9	25	1,23	34,89
67	2,8	11/21/10 19:00	11/24/10 0:00	0	0	0	28,7	0,3	0,3	1 day	0,90	1	1	22/11/2010 17:00	0,8	1,70	0,3	21/11/2010 19:00	2,8	24/11/2010 1:00	2,5	3,7	54	0,05	3,70
68	4,3	11/25/10 16:00	11/25/10 17:00	0,7	1,3	0,8	0	0	0	1 day	0,39	4,1	4,1	25/11/2010 16:00	0	0,39	4,1	25/11/2010 16:00	4,3	25/11/2010 17:00	0,2	4,7	1	0,20	4,69
69	0,8	11/27/10 14:00	11/27/10 14:00	4,3	0	0,7	1,3	0,3	0	1 day	1,16	0,8	0,8	27/11/2010 14:00	0	1,16	0,8	27/11/2010 14:00	0,8	27/11/2010 15:00	0,0	2,0	1	0,00	1,96
70	36,9	11/28/10 15:00	11/30/10 17:00	0,8	4,3	0	0,7	1,3	0,8	1 day	0,79	11,4	20,8	28/11/2010 16:00	9,4	10,19	9,4	28/11/2010 15:00	36,9	30/11/2010 18:00	27,5	37,7	51	0,54	37,69
71	0,8	12/1/10 19:00	12/1/10 20:00	1,3	6,6	29	0,8	0	4,3	1 day	3,02	0,5	0,8	01/12/2010 20:00	0,3	3,32	0,3	01/12/2010 19:00	0,8	01/12/2010 21:00	0,5	3,8	2	0,25	3,82
72	138,9	12/2/10 23:00	12/7/10 21:00	0,8	1,3	6,6	29	0,8	0	1 day	1,69	39,4	56,9	07/12/2010 18:00	97,5	99,19	0,3	02/12/2010 23:00	138,9	07/12/2010 22:00	138,6	140,6	119	1,16	140,59
73	42,6	12/9/10 9:00	12/13/10 23:00	58,9	10,1	33,3	19,5	16,8	0,3	1 day	18,94	10,6	10,6	10/12/2010 18:00	4,1	23,04	0,3	09/12/2010 9:00	42,6	13/12/2010 23:00	42,3	61,5	110	0,38	61,54
74	182,7	12/15/10 2:00	12/23/10 20:00	1	8,9	14,7	14,2	3,3	0	1 day	2,78	25,7	43,7	19/12/2010 18:00	102,6	105,38	3,1	15/12/2010 2:00	182,7	23/12/2010 21:00	179,6	185,5	211	0,85	185,48
75	0,3	1/13/11 16:00	13/01/2011 16:00	0	9,9	12,4	14	7,4	23,6	1 day	2,75	0,3	0,3	13/01/2011 16:00	0	2,75	0,3	13/01/2011 16:00	0,3	13/01/2011 17:00	0,0	3,0	1	0,00	3,05
76	79,4	14/01/2011 19:00	1/18/11 21:00	0,3	0	0,7	5	4,9	36,1	1 day	0,63	16,3	16,3	17/01/2011 15:00	53,4	54,03	12,5	14/01/2011 20:00	79,4	18/01/2011 22:00	66,9	80,0	98	0,68	80,03
77	256,7	20/01/2011 15:00	1/26/11 15:00	1,1	24,9	2,8	14	35,8	0,3	1 day	4,56	42,2	66,6	25/01/2011 18:00	187,1	191,66	0,3	20/01/2011 14:00	256,7	26/01/2011 16:00	256,4	261,3	146	1,76	261,26
78	0,5	06/02/2011 22:00	2/7/11 0:00	3,8	5,6	94,5	94	1,3	41,9	1 day	10,84	0,3	0,3	06/02/2011 22:00	0	10,84	0,3	06/02/2011 22:00	0,5	07/02/2011 1:00	0,2	11,3	3	0,07	11,34
79	34,9	2/8/11 16:00	2/10/11 3:00	0,5	0	7,1	33,8	74	54,1	1 day	3,20	13,5	14,8	08/02/2011 19:00	15,2	18,40	15,2	08/02/2011 18:00	34,9	10/02/2011 4:00	19,7	38,1	34	0,58	38,10
80	31,2	2/11/11 14:00	2/12/11 22:00	4,6	30,3	0	0,5	3,5	5,9	1 day	5,05	13,7	15,2	12/02/2011 17:00	15	20,05	1,3	11/02/2011 14:00	31,2	12/02/2011 23:00	29,9	36,3	33	0,91	36,25
81	138,7	2/14/11 18:00	2/18/11 7:00	1	23,4	1,3	0,8	18,9	5,8	1 day	3,62	52,9	80,8	14/02/2011 19:00	2	5,62	54,9	14/02/2011 19:00	138,7	18/02/2011 8:00	83,8	142,3	85	0,99	142,32
82	29,7	2/20/11 5:00	2/20/11 6:00	0,3	2,3	39,6	5,1	91,4	0	1 day	4,43	27,4	29,7	20/02/2011 5:00	0	4,43	27,4	20/02/2011 5:00	29,7	20/02/2011 6:00	2,3	34,1	1	2,30	34,13

F.3 Setting the rainfall standard by A method

CL line should be drawn to divide 2 areas of rainfall point data in the safe zone (non-causing rainfall) and the unsafe zone (causing rainfall). For the case of rainfall data from Kali Jompo as shown in figure below.

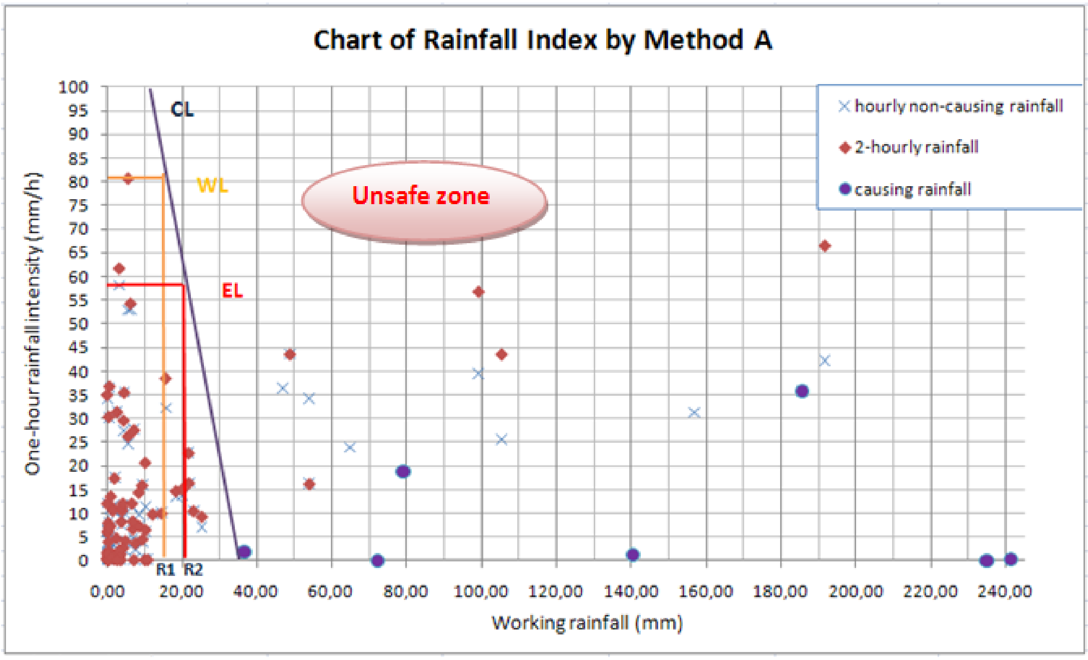


Figure F.4 - Determining CL, WL, and EL on rainfall data from Kali Jompo rain gauge station

In determining WL and EL, the maximum 2-hourly rainfall data is represented by red dots, while the maximum hourly rainfall data is represented by a cross (x). The maximum 2-hourly rainfall data point is right on the Critical Line. On that point, a line is drawn parallel with Y-axis. This line is the Warning Line where the intersection point with X-axis is the R2 point. To determine EL we use the reference point of maximum hourly rainfall. The line that is parallel with X-axis is drawn through that point. At the intersection point with the CL, a line drawn parallel to the Y-axis. This line is EL where the intersection point with X-axis is the R1 point.

So for the case rainfall data from Kali Jompo by Method A, the standard rainfall or working for issuance a warning or R1 ≈ ±15 mm, and standard rainfall for evacuation or R2 ≈ ±20 mm.

F.4 Setting the rainfall standard by B method

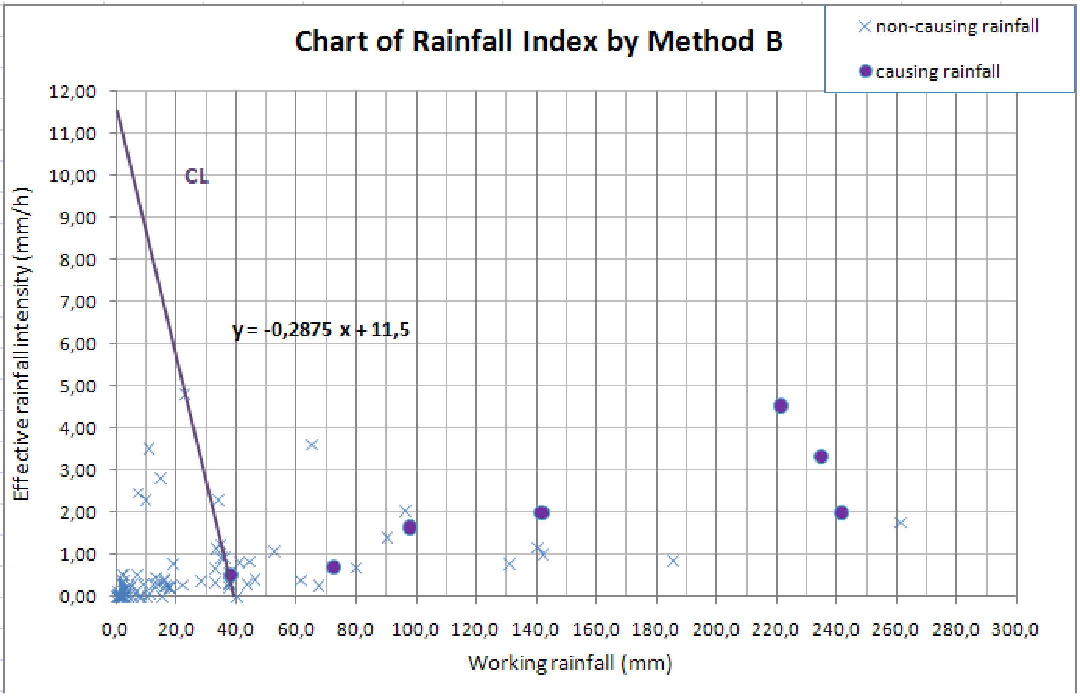


Figure F.5 - XY graph of rainfall index from rainfall data of Kali Jompo by using Method B

For causing rainfall data types, Critical Line should divide 2 areas which are safe zones and unsafe zone, on the right top and left of the line respectively. But for the case of rainfall data from Kali Jompo that is shown in figure above.

After determining Critical Line is done, next is finding the equation line of the Critical Line, where in Figure D.7.1 is y = -0.2875x + 11.5.

We set that the coordinate of point P is (23 ; 4.8). The value of point P is obtained from Table F.3 which is series of rainfall number 21. Therefore the maximum hourly rainfall of the series (R_{H1M}) is 9.7 mm.

The next step is to find coordinate point P'(R_P',I_P') by equation (1) and (5) as following:
$R_P' = R_P - R_{H1M} = 23 - 9.7 = 13.3$ mm.

$$I_P' = \frac{R_P - R_{H1M}}{\frac{R_P}{I_P} - 1} = \frac{(R_P - R_{H1M})I_P}{R_P - I_P} = \frac{(23 - 9.7)\,4.8}{23 - 4.8} = \frac{63.84}{18.2} = 3.508\,mm$$

so the coordinate of P' is (13.3 ; 3.508).

Critical Line is expressed by equation Y = -0.2875X + 11.5, where Y = aX + b, so a = -0.2875 and b = 11.5, then equation of Evacuation Line is expressed as:

$$Y = \frac{aX^2 + (b + a.R_{H1M})X}{(1-a)X + (1-a)R_{H1M} - b} = \frac{-0.2875X^2 + (11.5 - 0.2875 * 9.7)X}{(1 + 0.2875)X + (1 + 0.2875) * 9.7 - 11.5}$$

$$Y = \frac{-0.2875X^2 + (11.5 - 2.78875)X}{(1.2875)X + 12.48875 - 11.5} = \frac{-0.2875X^2 + 8.71125X}{1.2875X + 0.98875}$$

$$Y = \frac{-0.2875X^2 + 8.71125X}{1.2875X + 0.98875}$$

For determining Warning Line (WL), we use maximum 2-hourly rainfall, therefore according to Table D.5.2, the value of R_{H2M} = 14.5 mm.

First we find coordinate of P'' (R_P'',I_P'') through equation:
$R_P'' = R_P - R_{H2M} = 23 - 14.5 = 8.5$ mm.

$$I_P'' = \frac{'''R_P - R_{H2M}}{\frac{R_P}{I_P} - 1''''''''''} = \frac{(R_P - R_{H2M})I_P}{R_P - I_P} = \frac{(23 - 14.5)\ 4.8}{23 - 4.8} = 2.242\ mm$$

so coordinate P'' is (8.5 ; 2.242).

Equation of WL is obtained through equation line as following:

$$Y = \frac{aX^2 + (b + a.R_{H2M})X}{(1-2a)X + (1-2a)R_{H2M} - 2b} = \frac{-0.2875X^2 + (11.5 - 0.2875 * 14.5)X}{(1 + 2 * 0.2875)X + (1 + 2 * 0.2875)14.5 - 2 * 11.5}$$

$$Y = \frac{-0.2875 + 7.33125X}{1.575X - 0.1625}$$

For the final result, the standard rainfall based on Method B for warning the equation is:

$$Y = \frac{-0.2875X^2 + 7.33125X}{1.575X - 0.1625}$$

and the standard rainfall based on Method B for evacuation is:

$$Y = \frac{-0.2875X^2 + 8.71125X}{1.2875X + 0.98875}$$

where ($X \geq R_U$); R_U = the value of working rainfall which is usually un-influential to the occurrence of a banjir bandang; and Y = effective rainfall intensity (mm/hour).

For that results, we can plot the CL, EL, and WL like the figure below.

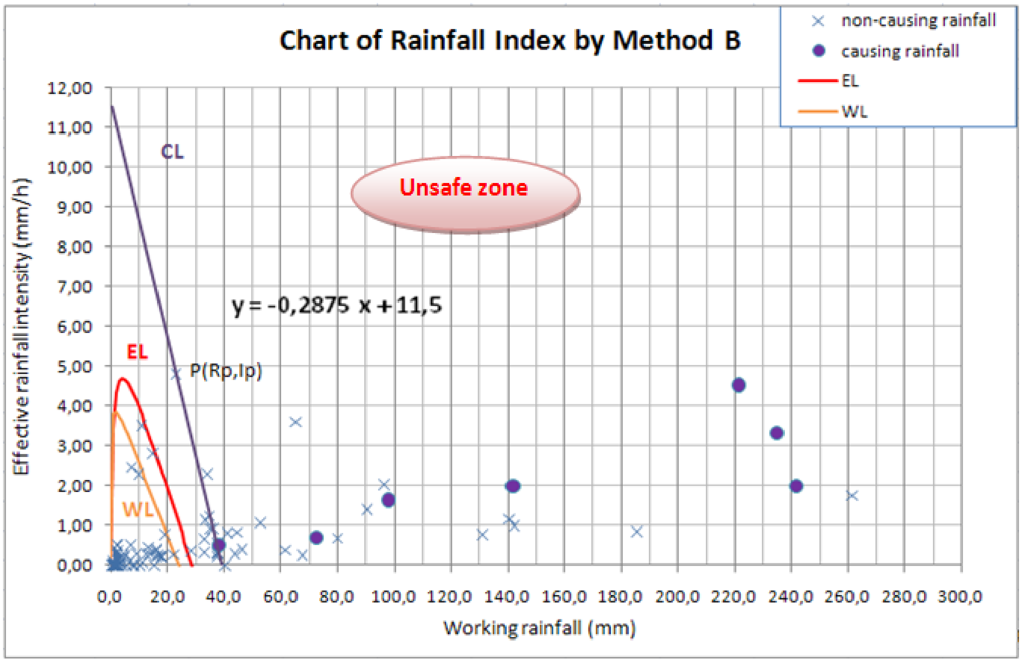


Figure F.6 - Plotting result of CL, EL, and WL

F.5 Setting the rainfall standard by Committee method

In accordance with the above explanation, that the data of Kali Jompo which is non-causing rainfall, refers to the position of maximum rainfall in a series of rain. Table D.8.1 below show working rainfall at T = 72 and T=1.5 from rainfall data of Kali Jompo. Values in the fourth column are obtained by referencing to the position/time of occurrence of maximum rainfall in a series of rain as shown in the third column (e).

Table F.4 - The values of working rainfall of Kali Jompo rainfall data by using Committee Method

(a) Ref. No.	(b) Continuous Rainfall (Rc)			(e) Maximum hourly rainfall of non-causing rain			Working rainfall for Committee method	
	mm	date start	date end	1hourly (mm)	2hourly (mm)	(date)	T = 1.5 h (12 h)	T = 72 h (574 h)
1	3	3/18/10 19:00	3/19/10 0:00	0.5	0	3/18/2010 19:00	0.00	#N/A
2	132.6	3/20/10 18:00	3/23/10 0:00	7.9	15.8	3/22/2010 17:00	3.02	#N/A
3	513.3	3/25/10 16:00	3/26/10 0:00	64.3	128.6	3/25/2010 18:00	39.23	120.68
4	5	3/29/10 18:00	3/30/10 0:00	0.8	1.6	3/29/2010 20:00	0.51	228.35
5	15.6	4/5/10 18:00	4/6/10 0:00	2.5	5	4/5/2010 21:00	2.61	51.18
6	3	4/10/10 19:00	4/11/10 0:00	0.5	1	4/10/2010 19:00	0.00	18.20
7	4.8	4/12/10 13:00	4/12/10 15:00	2.3	2.5	4/12/2010 14:00	0.13	15.65
8	8.8	4/13/10 17:00	4/15/10 0:00	0.8	1.6	4/14/2010 19:00	0.00	12.73
9	81.7	4/19/10 23:00	4/20/10 18:00	35.1	69.4	4/20/2010 0:00	21.61	38.36
10	99.1	4/21/10 21:00	4/23/10 17:00	16	32	4/21/2010 21:00	0.00	56.87
11	143	4/24/10 18:00	4/26/10 0:00	14	28	4/25/2010 20:00	10.48	129.75
12	12.5	4/27/10 15:00	4/28/10 20:00	8.1	8.1	4/28/2010 20:00	0.00	103.93
13	13.7	4/29/10 22:00	4/30/10 0:00	6.1	7.6	4/30/2010 0:00	4.37	93.01
14	134.9	5/2/10 15:00	5/3/10 0:00	14.2	28.4	5/2/2010 18:00	15.37	87.34
15	51.8	5/7/10 17:00	5/8/10 0:00	26.4	28.2	5/7/2010 18:00	1.13	64.09
16	711.7	5/9/10 7:00	5/11/10 18:00	175.3	350.6	5/11/2010 17:00	5.96	264.09
17	88.1	5/13/10 14:00	5/13/10 17:00	24.4	48	5/13/2010 17:00	28.36	450.85
18	36.7	5/15/10 4:00	5/16/10 8:00	4.8	9.4	5/15/2010 7:00	3.42	246.55
19	36.6	5/19/10 17:00	5/19/10 17:00	36.6	36.6	5/19/2010 17:00	0.00	132.92
20	22.5	5/20/10 19:00	5/21/10 18:00	4.6	9.2	5/21/2010 16:00	0.69	70.65
21	79.5	5/23/10 18:00	5/24/10 7:00	12.5	25	5/23/2010 20:00	7.58	90.64
22	214	5/25/10 17:00	5/27/10 0:00	23.1	46.2	5/26/2010 21:00	0.00	174.88
23	227.2	5/28/10 9:00	5/29/10 0:00	14.5	29	5/28/2010 10:00	6.11	188.64
24	430.9	5/31/10 14:00	6/2/10 0:00	17.5	35	5/31/2010 14:00	0.00	207.12
25	70.7	6/3/10 7:00	6/4/10 0:00	9.1	18	6/4/2010 0:00	14.14	382.51
26	243.7	6/7/10 18:00	6/8/10 0:00	39.9	79.8	6/7/2010 19:00	2.71	160.83
27	33.2	6/10/10 16:00	6/11/10 0:00	13.7	14.5	6/11/2010 0:00	9.34	215.16
28	53.1	6/15/10 16:00	6/17/10 0:00	8.1	16.2	6/16/2010 19:00	0.00	59.82
29	12.6	6/18/10 7:00	6/19/10 0:00	0.8	1.6	6/18/2010 13:00	0.80	75.90
30	187.8	6/24/10 6:00	6/27/10 0:00	7.4	14.8	6/24/2010 8:00	5.15	31.44
31	3.5	6/30/10 18:00	7/1/10 0:00	0.5	1	6/30/2010 18:00	0.00	57.44
32	3.5	7/3/10 18:00	7/4/10 0:00	0.5	1	7/3/2010 18:00	0.00	29.90
33	16.6	7/9/10 18:00	7/10/10 0:00	2.5	5	7/9/2010 20:00	2.16	12.21
34	124.7	7/11/10 18:00	7/13/10 0:00	8.4	16.8	7/11/2010 20:00	7.60	29.86
35	178.8	7/26/10 4:00	7/30/10 0:00	12.7	25	7/30/2010 0:00	19.84	132.71
36	7.8	8/3/10 19:00	8/4/10 0:00	1.3	2.6	8/3/2010 19:00	0.00	47.30
37	9.1	8/5/10 18:00	8/6/10 0:00	1.3	2.6	8/5/2010 18:00	0.00	35.32
38	32.1	8/9/10 21:00	8/10/10 0:00	13	23.9	8/10/2010 0:00	10.00	35.51
39	47.8	8/15/10 18:00	8/16/10 0:00	6.9	13.8	8/15/2010 19:00	4.03	18.11
40	4	8/19/10 17:00	8/20/10 0:00	0.5	1	8/19/2010 17:00	0.00	24.83
41	465.5	8/21/10 16:00	8/24/10 0:00	43.4	86.8	8/22/2010 17:00	19.84	62.14
42	112.2	8/30/10 16:00	8/31/10 0:00	12.5	25	8/30/2010 17:00	7.69	91.87
43	89.3	9/1/10 20:00	9/3/10 0:00	9.1	18.2	9/2/2010 20:00	8.94	133.38
44	8.4	9/4/10 22:00	9/5/10 0:00	2.8	5.6	9/4/2010 22:00	0.00	107.54
45	306.5	9/6/10 2:00	9/9/10 0:00	13.5	27	9/7/2010 22:00	20.33	225.75
46	77	9/10/10 15:00	9/12/10 17:00	9	18	9/11/2010 12:00	0.00	171.40
47	7	9/14/10 23:00	9/15/10 16:00	3	5	9/15/2010 15:00	0.00	88.83
48	379.1	9/16/10 18:00	9/20/10 22:00	15.5	30.4	9/20/2010 0:00	25.73	339.77
49	13.3	9/22/10 16:00	9/23/10 0:00	1.5	3	9/22/2010 17:00	0.82	195.80
50	148.1	9/24/10 14:00	9/25/10 0:00	14.5	29	9/24/2010 15:00	1.95	136.42
51	13.5	9/29/10 18:00	9/30/10 0:00	2	4	9/29/2010 19:00	0.94	87.25
52	82.3	10/1/10 16:00	10/2/10 0:00	9.4	18.8	10/1/2010 17:00	4.47	71.25
53	106.8	10/3/10 17:00	10/4/10 0:00	13.7	27.4	10/3/2010 18:00	6.87	103.40
54	370.7	10/5/10 17:00	10/11/10 0:00	17.5	35	10/10/2010 22:00	22.52	220.48
55	88.4	10/12/10 4:00	10/13/10 0:00	5.3	9.4	10/13/2010 0:00	7.80	252.74
56	825.2	10/15/10 2:00	10/18/10 0:00	68.1	136.2	10/16/2010 19:00	78.10	329.31
57	300.6	10/19/10 17:00	10/25/10 0:00	14.5	29	10/20/2010 19:00	2.90	389.83
58	25.3	10/26/10 14:00	10/27/10 0:00	2.3	4.6	10/26/2010 14:00	0.00	232.62
59	59.5	10/28/10 14:00	10/29/10 0:00	5.6	11.2	10/28/2010 19:00	7.44	171.89
60	965.7	10/30/10 13:00	11/1/10 18:00	50	100	10/31/2010 20:00	78.59	714.92
61	227	11/2/10 20:00	11/4/10 0:00	26.7	53.4	11/3/2010 19:00	17.15	502.22
62	1146.3	11/5/10 13:00	11/9/10 0:00	63.8	127.6	11/5/2010 23:00	105.64	956.09
63	310.4	11/14/10 16:00	11/15/10 0:00	35.1	70.2	11/14/2010 20:00	49.24	356.09
64	240.4	11/16/10 19:00	11/18/10 0:00	27.7	55.4	11/17/2010 17:00	0.00	290.51
65	19.3	11/22/10 14:00	11/24/10 0:00	1.5	3	11/22/2010 17:00	0.64	164.89
66	38.5	11/25/10 16:00	11/26/10 0:00	4.3	8.6	11/25/2010 17:00	2.58	93.72
67	1213.7	11/27/10 14:00	12/7/10 22:00	58.9	117.6	12/7/2010 21:00	77.25	560.74
68	373.9	12/9/10 9:00	12/14/10 0:00	14.7	29.4	12/11/2010 22:00	23.26	482.87
69	1440.8	12/15/10 2:00	12/24/10 0:00	66.6	132.7	12/20/2010 0:00	105.57	902.80
70	1607.7	12/25/10 15:00	1/1/11 0:00	48.8	96.6	1/1/2011 0:00	67.51	886.85

By using the values in the fourth column of Table above, then X-Y graph is made as shown in figure below. To help in the delineation of CL, we use the maximum point as a reference.

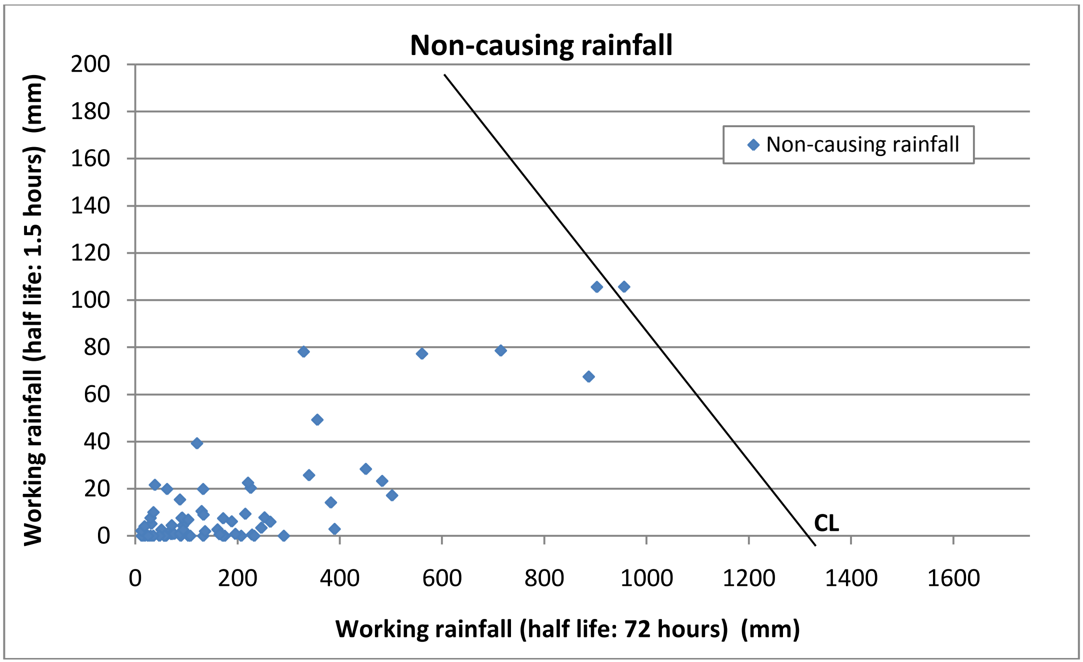


Figure F.7 - X-Y graph from working rainfall by using Committee Method

Appendix G
(informative)
Examples of rain gauge

A rain gauge installed should be able to measure the hourly rainfall by real time. Even though this type of rain gauge is not installed for some reason, it is still important to try to obtain the daily rainfall and the rainfall intensity by using a simple daily rain gauge or a hand-made rain gauge such as a cup. The following describes the examples of simple or modern rain gauge electronically.

G.1 A cup rain gauge

The easiest method of rainfall measurement is to use a container with the bottom with cylinder forms, such as a tea canister, and to collect rain water. Rainfall can be calculated by the depth of collected rain by ruler.

Figure G. 1 - Example of a cup

G.2 A plastic bottle rain gauge

The center of a bottle is cut and the top portion is attached inside out. Rainfall (cm) can be calculated by the amount of rainfall (cm^3) divided by the cross-section area of a bottle (cm^2).

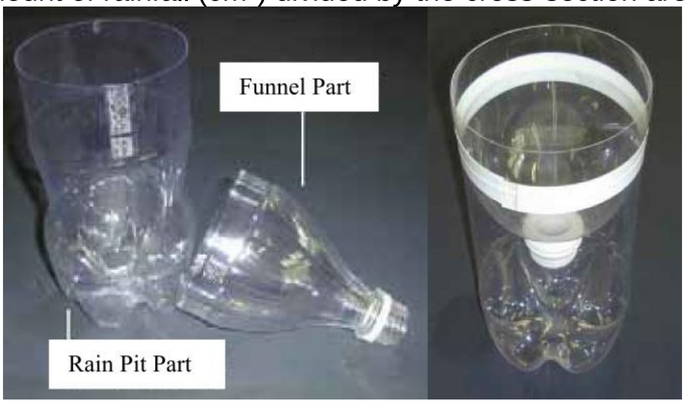


Figure G. 2 - Example of a plastic bottle

G.3 A storage type rain gauge

The rain water which collected into the storage bottle is moved to a graduated cylinder, and rainfall is calculated. Hourly rainfall can also be measured by measuring for every hour.

Figure G. 3 - Example of storage bottle

G.4 Modern rain gauge (electronic/digital)

Rainfall measuring equipment that is more modern has been found and installed in various places. Components of rain gauge are generally divided into three components:

- tube or bottle gauge
- data storage
- data communications device

One example of this rainfall gauges as shown in Figure below :

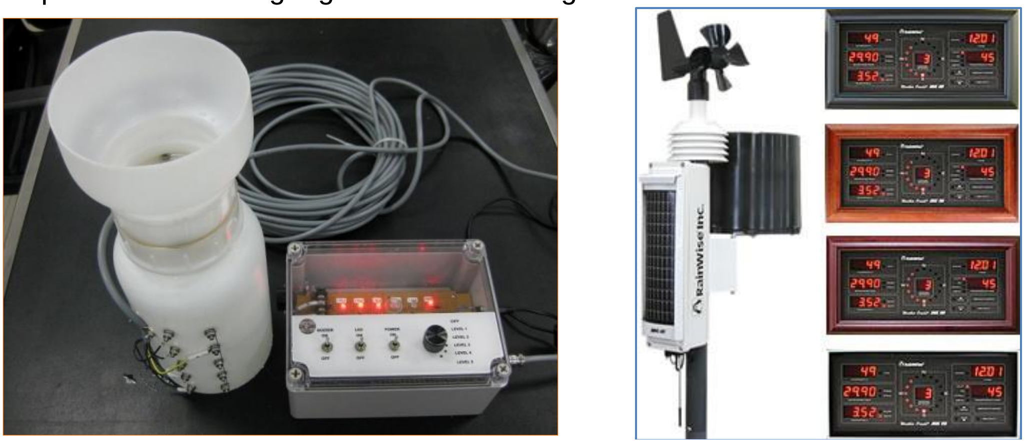


Figure G. 4 - Components of electronic and digital rainfall gauges

When doing rainfall gauging, the following are things to be considered:

- always do the equipment calibration,
- at a certain time, match the values listed in the observation tube/bottle of with a value in the data storage media,
- make sure the power supply goes well,
- make sure the data storage is not in full condition, so the data is recorded properly.

G.5 Water level measure tools

Figure G. 5 – Sample of water level measure tools

This tool is installed sidelines of the river that indicates whether there is a change either increase or decrease the height of water level due to heavy rainfall or due to the formation of natural bending in a particular area in the river flow.

When you have obtained a standard warning in accordance with their respective levels, it can be paired alarm on the device so that when the water level has reached a certain level then the alarm will automatically be read as a reminder to the team early warning or the public.

G.6 Crack gauge

Figure G. 6 – Sample of crack gauge

These devices are plugged into the ground in areas that are prone to shift an estimated area of land or natural phenomena detect flood disasters. Changes in altitude or the ground will shift measured by the weights that hang on the tool and will be measured on the pole.

Because the tool is installed in the area is quite steep, then the observations done in a somewhat tenuous. However, more intensive observations were made during the rainy season or at certain times when it is often hearing the sound of the ruins.

Appendix H
(normative)
Steps to make the SOP

H.1 Preparation

1) Choosing the stakeholders
Stakeholders to be involved in the composition of the SOP are chosen using the following methods :
    1. Preliminary discussion with the Satlak Secretary and heads of the villages in the Jember Regency to determine participant candidates, which come from among the residents and apparatus. The apparatus come from the regency level and the local government (from upstream/source areas and downstream/affected areas). The residents are villagers from the upstream and downstream areas.
    2. Suggestion for participants (from upstream and downstream areas) are given to the authorized official (Assistant II from the Jember Regency).
    3. The authorized official approves the suggestion by sending out notices to the participants, requesting them to take part in the activities.
2) Making a Criteria Parameter for the Observation of Banjir Bandang Early Warning Instruments
The parameter is created based on technical information on observational instruments related to the banjir bandang early warning. The information on the instruments' parameter has already been gathered, so the parameter will be similar to the actual situations.
The indication parameter for banjir bandang early warning instruments in activities carried out in the Jember Regency consists of three types:
    1. Rainfall gauge
    2. Water level gauge
    3. Water level sensor gauge
Below are examples of the parameter for indication and observational instruments:

Table H. 1 – Level and status of rainfall sensor and water level sensor

Level	Status	Notes
1	Beware	Start the observation/monitoring with precision
2	Warning	Start relaying information
3	Evacuation	Start the evacuation

Table H. 2 - Level and status of rainfall gauge (ARR)

Rain per hour	Accumulated Rain	Status	Notes
20 mm/hour	70 mm	Warning	Start relaying information
50 mm/hour	100 mm	Evacuation	Start the evacuation

Table H. 3 - Level and status of fissure gauge

Increase in Size	Status	Notes
2 mm/hour	Warning	Start relaying information
2 mm/hour minimum, up to 2 hours	Evacuation	Start the evacuation

3) Making disaster scenario
A disaster scenario covers events before, during and after the disaster. The purposes are to:
    1. Give a chronological and complete illustration of disasters, before, during and after.

2. Make it easier to gather information from stakeholders, in relation to activities carried out according to the sequence of events.

Table H. 4 - Examples of disaster scenarios

No	Date	Hour	Hour in scenario	Rainfall data	Rainfall data accumulated	Rainfall sensor	Water level sensor	FIELD CONDITION	Activities
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	Oct 17, 2010	13:15	13:00	0	0	Lv0	Lv0	Cloudy	
2		13:20	14:00	0	0	Lv0	Lv0	Cloudy	
3		13:25	15:00	0	0	Lv0	Lv0	Cloudy	
4		13:30	16:00	0	0	Lv0	Lv0	Start of drizzle	
5		13:35	17:00	5	5	Lv0	Lv0	Start of drizzle	
6		13:40	18:00	0	5	Lv0	Lv0	Drizzle turns into heavier rain	
7		13:45	19:00	23	28	Lv0	Lv0	Drizzle turns into heavier rain	
8		13:50	20:00	5	33	Lv1	Lv0	Drizzle turns into heavier rain	
9		13:55	21:00	0	33	Lv1	Lv0	Drizzle turns into heavier rain	
10		14:00	22:00	15	48	Lv1	Lv0	Heavy rain	
11		14:05	23:00	30	78	Lv2	Lv1	Heavy rain	
12		14:10	24:00	22	100	Lv3	Lv1	Heavy rain	
13		14:15	01:00	9	109	Lv3	Lv2	Heavy rain, fissure gauge shows fissure increases by 2 mm/hr	
14		14:20	02:00	14	123	Lv4	Lv2	Heavy rain, fissure gauge shows fissure increases by 4 mm/hr	
15		14:25	03:00	20	143	Lv4	Lv3	Heavy rain, fissure gauge shows fissure increases by 9 mm/hr	
16		14:30	04:00	82	225	Lv5	Lv4	Heavy rain, small-scale landslide	
17		14:35	05:00	52	277	Lv5	Lv5	Heavy rain, sand, rocks, logs flow downward	
18		14:40	06:00	24	301	Lv5	Lv5	Rain recedes	
19		14:45	07:00	4	305	Lv5	Lv5	Rain recedes	
20		14:50	08:00	0	305	Lv5	Lv5	Rain stops	
21		14:55	09:00	0	305	Lv5	Lv5	Rain stops, survey and emergency actions start	

H.2 Implementing the Focus Group Discussion/FGD Problem Exploration Process and Problem Solutions

Focus group discussion (FGD) is a data-collecting technique that generally used to explore the qualitative information, in order to discover the meaning of a certain theme according to a certain group's perception based on discussion results focused on a certain problem and also used to prevent researchers from having incorrect perceptions of a certain problem.

In a FGD, participants explore the problems until they arrive at a solution. There are two stages, Stage I and Stage II (Figure below).

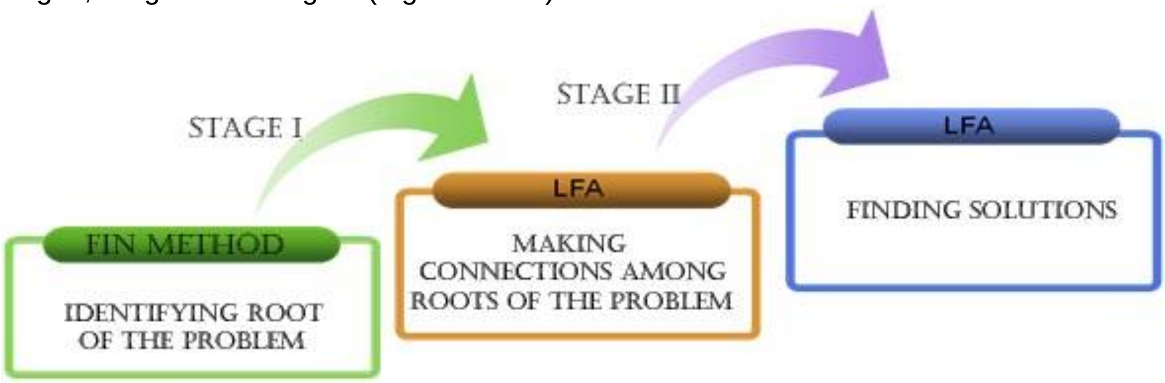


Figure H. 1 - Problem Exploration Process and Problem Solutions

Stage I : Fin Method

- Facilitator explain what the activities are and their purposes, and give technical directions on how to carry out the activities. They ask simple, easy to answer questions, such as, "Has the early warning system met the FGD participants' ideal expectations? If not, what are the reasons?" or other questions relevant to early warning system problems.
- Facilitators hand out cards to FGD participants and ask them to write down the problems on the cards. FGD participants should be given several minutes during which they write down subject-related problems.
- Facilitators must make sure that each card contains only one issue/problem. Key words should be written in capital letters so that other participants can read and understand them easily.
- Facilitators and co-facilitators collect the cards on which the problems and problem causes are written.

Stage II: LFA Technique

- The research team and FGD participants discuss the inter-relatedness of the problems and problem causes using the LFA technique and a piece of cardboard paper.
- All the issues informed by the public are grouped together, so that the real, main problems are identified (these problems are seen during the fin technique).
- Find the logical inter-relatedness among the groups of problems. By discovering the logical inter-relatedness, participants can then determine the real roots of the problem and which issues are important in indicating the reason behind the problems.
- The amount of arrows pointing outward from an opinion box shows the priority levels of the roots of the problems. In other words, the opinion box with the **highest number of outward-pointing arrows** is the most prioritized **root of the problem**.
- The opinion box with **the highest number of inward-pointing arrows** and **only a few or no outward-pointing arrows at all** shows the **main issue**.

Below is an example of a FGD that leads to problem clusters:

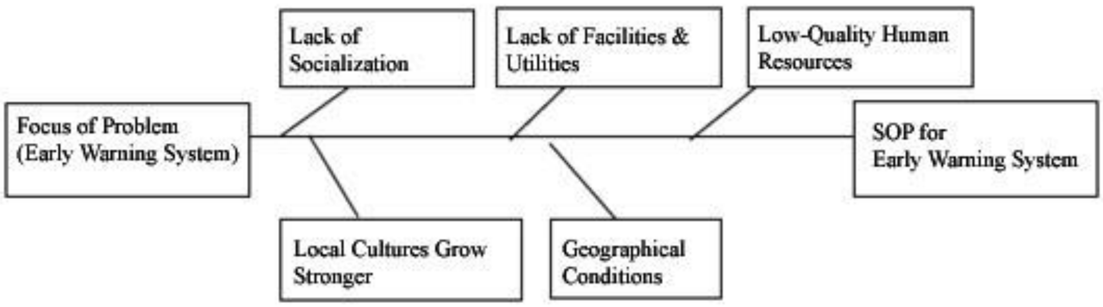


Figure H. 2 - Clustering Problems Using the Fin Method

All FGD participants actively seek the root of the problems until they arrive at solutions for early warning system problems.

Table H. 5 - Problem Clusters in the early warning system for banjir bandang

Cluster	Content
Lack of socialization	a. Familiarization of early warning, including rescue methods, does not reach the targeted audience. b. The public has not been made familiar enough with the early management of flood-prone areas. c. Disaster-related institutions have not conducted enough simulations for residents in flood-prone areas. d. Lack of socialization (only a few residents know about the socialization). e. Institutions and the government must increase public awareness of flood-prone areas. f. Lack of information on early warning. g. Lack of knowledge of early warning signs. h. Lack of motivation on the part of the public. i. Many residents in disaster-prone areas only know a little about early warning, due to lack of socialization. j. Lack of information about early warning. k. Lack of socialization on disaster management for villages. l. The knowledge of residents in disaster-prone areas must be improved, so that they understand what causes a disaster. m. Village command centers should disseminate information on problems that are relevant to public interest. n. Counseling field officers for disaster-prone areas must constantly relay information. o. The public tends to fall into confusion during natural disasters, and this influences the evacuation process. p. Lack of flood warnings, especially from upstream.
Lack of Facilities and Utilities	a. Lack of equipments and information from upstream to downstream. b. Inadequate equipments (early warning becomes inaccurate [e.g. tsunami warnings are incorrect, resulting in misplaced reactions]). c. Flood-prone areas should have more well-manned command centers. d. Inadequate instruments. e. A minimum amount of instruments/inadequate instruments (rubber boats, cars, etc.). f. Inadequate infrastructures. g. The public should be taught to immediately sound the kentongan as a warning. h. Evacuation equipments should be prepared immediately to reduce the number of victims. i. Accessible roads should be built to and from flood-prone areas. j. Lack of means of transportation. k. Logistical aids (food and health facilities) should be delivered immediately. l. Belated relay of information on indicators of disasters. m. Sudden disasters are not handled fast enough.
Low-Quality Human Resources	a. Lack of public concern. b. Lack of understanding of early warning. c. Public self-centeredness. d. Low education level results in lack of understanding of the benefits of early warning. e. Lack of understanding of forestation/logging (lack of human resources). f. Lack of human resources among the public. g. Lack of socialization on natural disasters in villages. h. Lack of public concern about disasters. i. The residents are not responsive enough toward flood early warnings. j. A very low level of public awareness. k. Public management should be improved, e.g. Satlak provides security. l. Lack of public awareness about the dangers in watersheds. m. Lack of alertness on the part of village apparatus (RT/RW (neighborhood councils/associations), heads of communities) in providing facilities to and mobilizing residents.
Geographical Condition	a. Flood-prone areas in Karang Pring, Kalijompo. b. The residents' houses are located in isolated areas.
Social and Cultural Factors	a. Culturally, the public tends not to be aware of the effects of floods. b. The public takes indicators of natural disasters for granted. c. The public tends to accept things as they are, thus they refuse to move to safer locations.

H.3 Site watching

Site watching is a field activity to inspect the existing instruments which used to banjir bandang early detection.
The purpose of site watching is to learn about the actual conditions in the areas and the instruments already installed. In the case of activities in the Jember Regency, JICA has already installed the following in the model area: the rainfall gauge and water level gauge. Participants are also taken to see watersheds in Kali Jompo, which flow from the Kali Jompo Plantation (upstream) to the Gebang/Slawu Subdistrict (downstream).

H.4 Table Top Exercise

Table top exercise (TTE) is an indoor simulation activities which designed to test the theoretical ability of a group to managing banjir bandang.
Table Top Exercise activities mean stakeholders are practicing their disaster management abilities. The practice concept is based on actual conditions and a previously made concept, namely the standard operating procedure.
One of the major advantages of TTE is that stakeholders are able to test a hypothetical situation without disturbing the residents. TTE for the early warning system is a practice session intended to improve the public and stakeholders' abilities in implementing the early warning system.

1) Preparation
   The Table Top Exercise is led by facilitators who will write a complete practice scenario, using facilities to support the scenario. The scenario is made for rainfall and landslide situations.
   The preparation for the activities is focused on the position arrangement for the participants, dividing the scenario into four screens, and composing the scenario as shown below:
   - Position arrangement for the participants
     To achieve maximum results, the participants are positioned in such a way so that the coordinator can see and hear them clearly.
   - Scenario display
     To improve the participants' understanding and make it easier for them to implement the scenario, the scenario is divided into four screens:
     1. First screen: maps of disaster-prone areas, rainfall, water level, and some of their inherent conditions.
     2. Second screen: rainfall conditions and accumulation.
     3. Third screen: signs of rainfall and natural conditions under certain conditions.
     4. Fourth screen: records of discussions during the composition of the SOP.

Figure H. 3 – Sample of scenario display

   - Scenario Plans
     The scenario is based on actual conditions, signs of rainfall, and signs of landslides. However, due to the time limit in simulations, the scenario is based on the assumption

that one hour in the scenario equals five minutes in the simulation or we can use the other assumption.

Table H. 6 – Sample of TTE Scenario for the early warning system for banjir bandang in Kalijompo

No	Date	Hour	Hour in scenario	Rainfall	Accumulated Rainfall	Rainfall sensor	Water level sensor	Actual conditions
1	Oct 17, 2010	13:15	13:00	0	0	Lv0	Lv0	Cloudy
2		13:20	14:00	0	0	Lv0	Lv0	Cloudy
3		13:25	15:00	0	0	Lv0	Lv0	Cloudy
4		13:30	16:00	0	0	Lv0	Lv0	Start of drizzle
5		13:35	17:00	5	5	Lv0	Lv0	Start of drizzle
6		13:40	18:00	0	5	Lv0	Lv0	Drizzle turns into heavier rain
7		13:45	19:00	23	28	Lv0	Lv0	Drizzle turns into heavier rain
8		13:50	20:00	5	33	Lv1	Lv0	Drizzle turns into heavier rain
9		13:55	21:00	0	33	Lv1	Lv0	Drizzle turns into heavier rain
10		14:00	22:00	15	48	Lv1	Lv0	Heavy rain
11		14:05	23:00	30	78	Lv2	Lv1	Heavy rain
12		14:10	24:00	22	100	Lv3	Lv1	Heavy rain
13		14:15	01:00	9	109	Lv3	Lv2	Heavy rain, fissure gauge shows fissure increases by 2 mm/hr
14		14:20	02:00	14	123	Lv4	Lv2	Heavy rain, fissure gauge shows fissure increases by 4 mm/hr
15		14:25	03:00	20	143	Lv4	Lv3	Heavy rain, fissure gauge shows fissure increases by 9 mm/hr
16		14:30	04:00	82	225	Lv5	Lv4	Heavy rain, small-scale landslide
17		14:35	05:00	52	277	Lv5	LV5	Heavy rain, sand, rocks, logs flow downward
18		14:40	06:00	24	301	Lv5	LV5	Rain recedes
19		14:45	07:00	4	305	Lv5	LV5	Rain recedes
20		14:50	08:00	0	305	Lv5	LV5	Rain stops
21		14:55	09:00	0	305	Lv5	LV5	Rain stops, survey and emergency actions start

- Rehearsal
  The rehearsal takes place before the table top exercise begins. In the rehearsal, participants are conditioned to face the actual simulations. The rehearsal begins with an explanation from the rehearsal coordinator on what participants would need to do. The explanation covers:
  a. The content of each screen.
  b. The level of the early warning parameter in instruments already inspected during site watching.
  c. The procedure of the Table Top Exercise, whose implementation will be guided by the moderator. The rehearsal details for the TTE for banjir bandang early warning system can be found in the Attachment.

2) Implementation
The implementation of the TTE is based on simulation plans that are composed in accordance with actual-time scenarios. Guided by the moderator, participants provide information on what each stakeholder should do. Each stakeholder will have an opportunity to present their activities in each phase in a clear and concise manner.

Figure H. 4 - Example of Table Top Simulation for Early Warning Observational Instruments Under Certain Conditions

The scenario also demonstrates the use of several instruments, such as the rainfall record sensor, complete with that display. TTE participants also can demonstrate the use of early warning system instruments, such as megaphones and walkie-talkies.

H.5 Information Processing and Analysis for the SOP Composition

Data and information from FGD and TTE is collected and categorized, to become materials for the SOP composition. There are also crosschecks with various sources for data validation.

The collected data is analyzed and become part of the materials for composing the SOP. SOP sections are composed based on a framework that makes reading and comprehension easier.

After the SOP is composed, it continues to be evaluated in various ways, such as with FGD and socialization, in order for it to be perfected.

Appendix I
(informative)
Abbreviations

Here is a translation of abbreviations used in these manual.

- BNPB
  Badan Nasional Penanggulangan Bencana (National Agency for Disaster Management)
- BMKG
  Badan Meteorologi, Klimatologi, dan Geofisika (Meteorology, Climatology, and Geophysics Agency)
- BPBD
  Badan Penanggulangan Bencana Daerah (Regional Disaster Management Agency)
- BPPT
  Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment and Application of Technology)
- DAS
  Daerah Aliran Sungai (Watershed)
- ISO/IEC
  International Organization for Standardization / International Electrotechnical Commission
- JICA
  Japan International Cooperation Agency
- KTP
  Kartu Tanda Penduduk (Identity card)
- LAPAN
  Lembaga Penerbangan dan Antariksa Nasional (National Aeronautics and Space Agency)
- LSM
  Lembaga Swadaya Masyarakat (Non-governmental Organization)
- Pemda
  Pemerintah Daerah (Local Government)
- PSN
  Pedoman Standardisasi Nasional (Guidelines for National Standardization)
- PU
  Kementerian Pekerjaan Umum (Ministry of Public Works)
- PVMB
  Pusat Vulkanologi dan Mitigasi Bencana (Center for Vulcanology and Disaster Management)
- SAR
  Search and Rescue
- SNI
  Standar Nasional Indonesia (Indonesian National Standard)
- SOP
  Standard Operating Procedure
- UU
  Undang-Undang (Act)

Bibliography

National Agency for Disaster Management, *National Action Plan for Reduce the Risk of Disaster 2006-2009*, Jakarta, 2006.

National Agency for Disaster Management, *National Action Plan for Reduce the Risk of Disaster 2010-2012*, Jakarta, 2010.

Agency for the Assessment and Application of Technology (http://www.bppt.go.id)

National Standardization Agency (BSN), *Development of Indonesia National Standard*, 2007.

National Standardization Agency (BSN), *Adopsi Standar Internasional dan Publikasi Internasional lainnya Bagian 1: Adopsi Standar Internasional menjadi SNI (ISO/IEC Guide 21-1:2005, Regional or national adoption of International Standards and other International Deliverables – Part 1: Adoption of International Standards, MOD)*, 2007.

Sabo Hall Center for research and development of water resources, *Guide the operation of early warning systems of community-based flood debris in the river Jeneberang*, Yogyakarta, 2010.

Department of Energy and Mineral Resources, Vulcanological Survey of Indonesia, *Introducing the movement of land*. (www.esdm.go.id)

Ministry of Land, Infrastructure and Transport, *Guidelines for Development of Warning and Evacuation System Against Sediment Disaster in Developing Countries (Draft)*, Japan, 2004.

Ministry of Land, Infrastructure and Transport, *Procedure and examples of setting standard for critical rainfall for warning and evacuation from sediment-related disasters, National Institute for Land and Infrastructure Management*, Japan, 2005.

Ministry of Public Works (PU) / JICA, *Guidelines for the Setting of Rainfall for Warning Issuance and Evacuation Instruction against Debris Flow Disaster (Tentative Draft)*, Japan, 1984.

Ministry of Public Works (PU) / JICA, *Guideline for Overall Planning of Integrated Sediment-related Disaster Management (Tentative Draft)*, Japan, 2006.

Ministry of Public Works (PU) / JICA, *Flash Flood and Debris Flow Disaster Prevention Manual*, Philippines, 2004.

SABO Department (Erosion and Sediment Control), *Sediment-related Disaster Warning and Evacuation Guidelines*, Japan, 2007.

Government of Germany / International Strategy for Disaster Reduction (ISDR), *Developing early warning systems : A Checklist the results of the Third International Conference on Early Warning (EWC III)*, Bonn, Germany, March 2006.

Haryono Kusumosubroto, *Seminar Dissemination of Sabo Technology*, Semarang, Indonesia, 2006.

Haryono Putro, *Hydrological Simulation Model Paper on Settlement Development Area as a Water Conservation Efforts*, Gunadarma University, Jakarta.

Indonesia Language Dictionary Website (KamusBahasaIndonesia.org).

Dictionary of Public Works Terms, 2008.

Ministry of Public Works (PU), *The introduction of Buildings Directive Sabo Works Sediment Control (SABO Introduction)*, KemenPU, Yogyakarta, 2010.

Ministry of Public Works, *Planning work instructions Sabo building sediment control,* KemenPU, Yogyakarta, 2010.

Indonesian Institute of Sciences (http://www.geotek.lipi.go.id/?p=57)

East Java Province Government, *Mitigasi Bencana Alam Banjir Bandang di Kabupaten Jember*, Jember, 2006.

Regulation of the Head of BNPB Number 4 of 2008, *Guidelines for for Disaster Management Planning*.

Regulation of the Government of the Republic of Indonesia Number 21 of 2008, *Implementation of Disaster Management*.

Regulation of the Government of the Republic of Indonesia Number 42 Year 2008, *Water Resources Management*.

Regulation of the Government of the Republic of Indonesia Number 37 Year 2010, *the Dam*.

Regulation of the Government of the Republic of Indonesia Number 38 Year 2011, *the River*.

PROMISE Indonesia (Program for Hydro-Meteorological Risk Disaster Mitigation in Secondary Cities in Asia), *Banjir dan Upaya Penanggulangannya,* 2009.

Sea defense consultants / Royal Netherland Embassy, *The procedure remains for flood disaster risk reduction community based in Aceh*, Aceh, November 2009.

Law of the Republic of Indonesia Number 7 of 2004, *Water Resources*.

Law of the Republic of Indonesia Number 24 of 2007, *Disaster Management*.

Law of the Republic of Indonesia Number 26 Year 2007, *Spatial Planning*.

Public Servant Foundation (YPM) / JICA, *Manual of Banjir Bandang Disaster Emergency Evacuation,* Jember, 2011.