	International conference on **CHALLENGES IN DISASTER MITIGATION &** **MANAGEMENT STRATEGIES** **15-17 FEBRUARY, 2013**
Proccedings as per lecture program	
Message from Director IIT Roorkee	
February 15th Friday (Afternoon Sessions) (Venue: CoEDMM)	
Technical Session I	
2.00-2.30	**Keynote Address by Prof. D.K. Paul**
2.30-2.45	"Compartment Fires An Experimental Study" By Deepak Sahu
2.45-3.00	"FDS simulation of compartment fire and comparison with experimental data" By Bhisham Kumar Dhurandher
3.00-3.15	"A Violent, Episodic Vapour Cloud Explosion In Fuel Storage Area" By Ravi Mohan Sharma
3.15-3.30	"Fault Tree Analysis" By Prashant Srivastava
Technical Session II	
4.00-4.15	"Early warning for natural_hazards_issues_and challenges" By Nikhil Kumar Pant
4.15-4.30	"Delineation Of Seismic Source Zones And Seismicity Parameters For Northwest Himalaya" By Madan Mohan Raut
4.30-4.45	"Integrating Passive Thermal Comfort Features with Seismic Retrofitting Techniques for Non-Engineered Housing in India" By Yasmin Bhattacharya
4.45-5.00	"Meandering Behaviour and Flood Hazard Mapping of Ganges of River Using Remote Sensing and GIS" By Murumkar Asmita Ramkrishna
5.00-5.15	"Optimizing the Emergency Response Activity Planning through GIS based Agent Based Modeling and Simulation Technique" By Mainak Bandyopadhyay
5.15-5.30	"Effects of Deep Soil Deposits on Strong Ground Motion" By Mohd Husain
5.30-5.45	"Evaluation of three Landslide hazard Zonation rating techniques" By Alok Bhardwaj
5.45-6.00	"Paradigm shift in Disaster Management: a special emphasis on Community Based Disaster Management (CDDM) in India" By Mohan Kumar Bera
February 16th Saturday (Venue: CoEDMM)	

Technical Session III	
9.30 – 10.00	**Keynote Address by Prof. Chhetri**
10.00-10.15	"Evaluation Of Nuclear Containment Building Against Crash Of Boeing 767 Aircraft" By Mohd Rehan Sadique
10.15-10.30	"Participation of Youth Councils in Local-Level Implementation of HFA Tasks in Makati and Infanta, Philippines" By Glenn Fernandez
10.30-10.45	"Stability of algorithm for determination of three- dimensional attenuation structures: Case study of Niigata, Japan" By Parveen Kumar and A. Joshi
10.45-11.00	" Korea Disaster Report" By Dr. Inuh Cho
Technical Session IV	
11:30-12:00	**Keynote Address by Prof. Chandan Ghosh**
12.00-12.15	"Development of an Approach for Mitigation of Hazardous Pesticides Using Microbes" By Manasi Gupta
12.15-12.30	"A Biotechnological Approach For Detection Of Synthetic Milk Components; Urea Detection" By Piyush Kumar
12.30-1.15	**Keynote Address by Prof. B.D. Malhotra**
Technical Session V	
2.15-2.30	"Detection of Genotoxic Chemical hazard using Biosensor" By Santosh Kumar Srivastava
2.30-2.45	"Role of bacteria present in extreme environment in mitigation of foul odor from polluted water" By Dr. Ila Dubey
2.45-3.00	"Encountering Marine Environmental Challenges Using Ecofriendly Biosurfactants" By Anshu Singh
3.00-3.15	"In Vitro Bacterial Reduction Of CR(VI) and FE(III)" By Sadhna Tiwari
3.30-3.45	"Simulation and confirmation of directivity effects of Sikkim earthquake of 18th Sep, 2011 using semi empirical approach" By Sandeep Arora
3.45-4.00	"Seismic Retrofitting of School Buildings in Uttarakhand, India" By Girish Joshi
4.00-4.15	"Prediction of Onset of Untenability Conditions in an Assembly Hall using Computational Fluid Dynamics" By Saurabh Jain
4.15-4.30	"Using limited applicability of attenuation relation for simulation of strong motion records of the Uttarkashi Earthquake, India" By Ashwani kumar

February 17th Saturday
(Venue: CoEDMM)

Technical Session VI	
9.30 – 9.45	“Urban Risk Management” By Neha Bansal
9.45-10.00	“Understanding the Behavior of RCC Structures at Elevated Temperature to Mitigate Fire Hazard” By Mohd Suhaib Ahmad
10.00-10.15	“Assessing The Role Of A Podium Block In Mitigating Adverse Pedestrian Level Winds In The Vicinity Of Tall Buildings” By Prof K Mohan
10.15-10.30	“Disaster Management on Construction of Debris Flow : Lessons from Batang Kuranji River in West Sumatra, Indonesia” By Bambang Istijono
10.30-10.45	“Development of Decision Support System for Flood Disaster Mitigation in part of Mahanadi River Delta Region, India” By Anurag Aeron
10.45-11.00	“Role Of Twitter To Enhance Citizens’ Participation With Decentralised Coordination In Disaster Management” By Ayanti Ghosh
11.00-11.15	“Numerical Modelling of One dimensional Liquefaction Phenomenon” by Pragyan Pradatta Sahu
11:30-11:45	“Recovery Challenges to Disastrous Floods: A Case Study of Yamuna Nagar District in Haryana” By Anil Pundir
11:45-12:00	“Terrain Analysis Using Satellite Imageries & Landslide Hazard Zonation (LHZ) Mapping in Tehri Reservoir Region, Uttarakhand” By Rohan Kumar

DISASTER MANAGEMENT ON CONSTRUCTION OF DEBRIS FLOW: LESSONS FROM BATANG KURANJI RIVER IN WEST SUMATRA, INDONESIA

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ABSTRACT
West Sumatra Province has 4,239,730 hectares area, 87% of the area are mountainous. There are 4 lakes and 606 rivers which flow to their estuaries to the west coast and the east coast of the Sumatra Island. It is located in the tectonic slab between the confluence of two major continental plates, the Eurasian plates and Australian plates, 250 km to the west from the coastline and Great Sumatran fault along Bukit Barisan Mountain range. This province also has four active volcanoes.
Many studies revealed there are 58 rivers; those are very susceptible to debris flow hazards. One of the extraordinary flood had happened in the upstream of Batang Kuranji river.The upstream of the river is in western part of Bukit Barisan. It is a steep river and flows into the west coast of Sumatra (Indian Ocean). In July and September 2012,an extraordinary flood disaster in Kuranji river had destroyed irrigation area around 3,000 hectares and damaged some areas around the river. Moreover, some units settlements and public facilities have damaged by the flood and 4 people died.
Recovery action which included dredging sediment, groundsill and river bank protection is one of the emergency counter measure post disaster of flood. Rehabilitation of public infrastructures i.e. irrigation schemes, bridges has been done to make a sense of security to the community. Management process of debris flow and flood in Batang Kuranji river has been implemented base on the stages of disaster management, i.e. emergency response, recovery (rehabilitation and reconstruction), preparedness and mitigation.

Keywords- *debris flow, disaster, recovery*

1. BACKGROUND

West Sumatra has 4,239,730 hectares area which is 2.17% of Republic of Indonesia's area, and population of 4,845,998 people (West Sumatra in Numbers 2010). The province is flanked by two main epicenters; the seductions zone of the Eurasian Plate and Indo-Australian Plate located around 250 km to the west from the coastline, and Great Sumatran fault extending along Bukit Barisan Mountain range. This province also has four active volcanoes. The province has abundance water resources through 606 rivers, some of those have their estuaries to the east coast and the west coast of Sumatra island and they can be grouped into 5 unit area along with 4 big lakes. West Sumatra has sea territorial around 186,500 km^2 with the coastline length 2,420 km, 375 big and small islands. The geological and geographical condition of this province has made it a potential area for disaster such as earthquake, volcano eruption, flood and debris flow, galodo (landslide), windstorm and tidal waves.
With those conditions, this province can be called as an area of "Natural Disaster Store". It also has other disaster potential aside from natural disaster which can be caused by human such as social

conflicts, epidemics, and technology drawbacks. The potential of this disaster is relatively small based on its occurrence.

In accordance to the mandate of the Indonesian 1945 Constitution, that every citizen has his rights to get protection for his family and himself, his dignity and honor, and property under his management, and he also has the right to get the secure feeling and protection from fear to do something. Indonesian Government has issued The Law of Republic Indonesian Number 24/2007 about disaster's damage prevention to carry the mandate of the constitution related to disaster threats. It includes some integrated stages such as pre-disaster, emergency responses, and post-disaster which is become an integral part of national development plans, in provincial and regional level. Aside from that law, there are some other supported laws. First, for example The Law of Republic Indonesian number 26/2007 about spatial lay out which requires all of spatial lay out started from its planning, usage, management, and control and supervision must be based on disaster mitigation plan as an effort to increase life safety and security. Second, Republic Indonesian Law number 27/ 2007 about coastal area and small islands management has a special chapter containing disaster mitigation in coastal area and small islands.

Based on the disaster potential of this province has and the mandate of 1945 Constitution and other rules and laws in accordance to the constitution, this province is required to reduce the disaster risks in an integrated and well planned action. Integrated action means that it involves all people who are included in whole process of disaster risk mitigation planning while well planned means that it combines whole strategies of disaster management into regional development planning.

The condition of some rivers in West Sumatra is worsen by their divergence climate and geography and earthquake condition. It also creates high risk of flood and debris flow and galodo (landslide). Those disasters have taken a lot of human and materials casualties.

Batang Kuranji river is one of 23 rivers that flow across Padang City. It has an area of 694,960 hectares which is 1.65% of this province area. The length of this river is 32.50 km and the width at its downstream is 60.00 m and it flows from 1,400 m above sea level to its estuary in Indian Ocean. It is a steep river, where 10.00 km of it is sediment production area, 5.00 km is transportation area and 17.50 km is sedimentation area. The flood and debris flow in July the 24th 2012 and September the 12th 2012 with flood flow of 1,045 m^3 /second as the result of high rainfall, earthquakes some years ago, steep topography with critical land, saturated soils, unstable river banks, and settlement area that reduce the river flow capacity. The flood has resulted some casualties on houses in the upstream of Batang Kuranji river (Gn.Pangilun Housing Complex) at 1,00 m height, damaging 4 irrigation channel with total area 3,000 hectares, and it also caused 95 houses heavily damaged, 172 houses moderately damaged, 271 houses slightly damaged, 2 education facilities and 1 health facilities, 15 mosques are heavily damaged, landslide occurrence which hoarded 6 houses in Batu Busuk village in the upstream of Batang Kuranji river and killed 4 people.

Emergency response actions that have been done included some structural and non-structural aspects but still locally in the sedimentation area and not in the transportation area and the production sediment area, yet.

An immediate comprehensive flood management planning will be done in stages related to government priority scale.

2. ANALYSIS OF DEBRIS FLOW CAUSES AND THEIR IMPACTS

2.1. Satellite Image And Geography Information System Analysis

A condition of 165 mm rainfall for 6 hours had caused the increasing flood flow. The causes of Batang Kuranji debris flow was analyzed by using rainfall data, remote sensing image satellite landsat ETM 7 in 2009, and landsat ETM 7 in 2012 and Geographic Information System (GIS) data.

Remote sensing is a science and art in the acquisition of information about an object or phenomenon without making physical contact with the studied object, area or phenomenon (Lilesand and Kiefer,1997). The remote sensing and GIS are integrated tools that have been used to evaluate natural disaster phenomenon. The function of remote sensing is mainly to map damaging ground coverage like landslides, barren land, and the factors that influencing them. While GIS have functions to create database, data management, presented and analyzing data such as thematic map of land usage plan/land coverage and normalized difference vegetation index (NDVI).

Those data then were analyzed to find out, whether the debris flow occurred because of the heavy rain or caused by the natural dam in the upstream has fallen apart. Remote sensing data is recorded from an interaction between electromagnetic power with the object, recorded by a sensor or sensory tools such as camera, radar and radiometer, each of them was equipped with a detector inside. Remote sensing data can be as digital data or visual data. The visual data contain image or non-image data. Image data is in form of picture that looks like its original or in form of planimetric picture while non-image data is commonly in form of line or graphic (Sutanto, 1986).

By using some data of remote sensing satellite image of landsat ETM 7 in 2009 recorded on March the 1st 2009, and landsat ETM 7 in 2012 recorded on April the 27th 2012 and GIS data, those data then compared, and it was found out that there are some changes in land usage plan/ land coverage and NDVI in the watershed of Batang Kuranji river (Catchment area/ CA). Land usage plan is related to people activity on an area of watershed, while land coverage is related to earth surface performance, and NDVI is an index reflection of vegetation coverage on the earth surface (Jensen R.J, 1988).

Image data used in landsat-7 ETM imaging which has 7 band. They are 1,2,3,4,5,7,8 band, and the 6 band is not used because it is a specific band for thermal cover. Landsat image used is in level 1, system corrected (1G). According to Prahasta E (2008) this level is corrected in radiometric, geometric and free from distortion.

GIS is a computerized system to store and manipulate various geography information. GIS is designed to collect, store, and analysis of various object and phenomenon where geography location is a crucial characteristic and critical to analyze (Aronoff, 1989). There are two kinds of data in GIS, spatial data and attribute data (tabulation).

Spatial data is a form of data about an object or geographic characteristic that can be identified and has its location reference based on specific coordinate system.

Graphics data is a form of image data in computer. Maps in computer are graphic data. Based on its structures the data can be vector data or raster data. Vector data are data stated in form of coordinate (x,y). Vector data in map can be dots, lines, and polygon. Digitizer, keyboard and mouse are used to input the data. Raster data are stated in form of line, grid or cell. The image is formed in some cells, which the smallest unit is known as pixel (picture element). Scanner is used to input the data. An image is a data input to the computer in form of raster data that can be converted into a vector data.

Attribute data are usually categorized as non-spatial data, because their roles do not point out the position, but to explain the object and its identity. The attribute data has four kinds; nominal, ordinal, interval and ratio.

2.2. Analysis Of Satellite Landsat-7 ETM In 2009 And In 2012 Image

Vegetation: vegetation in a CA is used as an indicator of the critical level of the CA. The image is made to represent land coverage vegetation density, it is called NDVI image. NDVI is measured by the equation below (Jensen J.R, 1988):

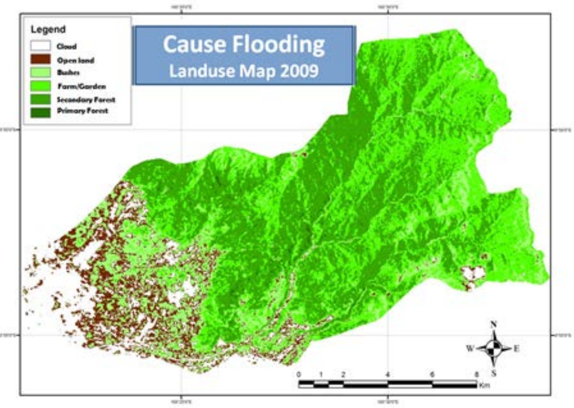
$$NDVI=\frac{\text{Band 4} - \text{Band 3}}{\text{Band 4} + \text{Band 3}}$$

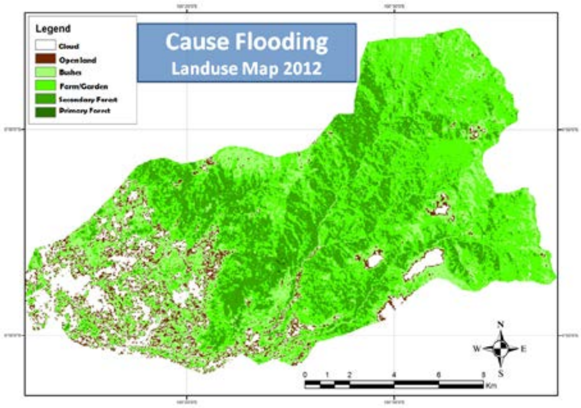
Band 4 refers to band with Near Infra Red Wavelength range, while Band 4 refers to band with Red Wavelength range. Based on the NDVI equation, the greenery level of Batang Kuranji CA region or NDVI image that reflects vegetation coverage on the Earth surface can be calculated, with value starting from -1 to 1. If the value is closer to 1 it means that the vegetation in that CA is in relatively good condition; on the contrary, if it is closer to the value of -1, it means the vegetation is in bad condition. The shift in land coverage value and NDVI value can be found by comparing the thematic map of land coverage and the NDVI in year 2009 and 2010.

River Body: To distinguish between river body and land on landsat-7 satellite image, software Arc GIS 10 can be utilized by comparing band 2 to band 5. If (band 2/ band 5) > 1 therefore that object is river body (black color), and if (band 2 / band 5) < 1 therefore that object is land other than river body (white color), (Smith, R.B, 2006 and Alesheikh A.A et.al, 2007).

2.3. Surface Run-off

Part of the rainfall that flows on to land would become surface runoff and the other would seep into the soil, another word for infiltration. This runoff is the largest component that contributes to water production during the flood. According to Horton (1933), the surface runoff occurs when the intensity of rainfall exceeds the soil infiltration capacity, while flood is one of the extreme form of surface runoff in which river surface level or river flow production (water flow) exceeds river capacity.





Classification of Landuse / Coverage Area 2009

No	Landuse/ Landcover	Area (Km²)	Pixel	%
1	2	3	4	5
1	Cloud	22,14	55356	11,01
2	Open Land	17,21	43019	8,55
3	Bushes	29,69	74228	14,76
4	Farm/Garden	*62,98*	157445	*31,30*
5	Secondary Forest	67,88	169771	33,74
6	Primary Forest	1,28	204	0,64
		201,18	502963	100

Classification of Landuse / Coverage Area 2012

No	Landuse/ Landcover	Area (Km²)	Pixel	%
1	2	3	4	5
1	Cloud	19,94	49836	9,93
2	Open Land	12,66	31651	6,29
3	Bushes	39,54	98849	19,65
4	Farm/Garden	*82,55*	206130	*40,98*
5	Secondary Forest	46,27	115675	23,00
6	Primary Forest	0,22	539	0,11
		201,18		100

Flood and drought are natural phenomenon in which river flow system is unable to absorb, retain, and distribute the change in rainfall, causing rise of peak flow and shortening the time toward peak flow (flood), and the further effect is increase of groundwater reservoir during rainy season decreases, therefore decreasing the water production supply during dry season. The rainfall data used is retrieved from Batu Busuk rain station, Gunung Nago and Ladang Padi rain station which are located in CA of Batang Kuranji. Soil texture on watershed based on geo-morphological map of Padang, Sumatera sheet (Karnawan, dkk., 2004) is generally in the form of sandy clay.

2.4. Measuring The Waterflow Based On Rainfall Data

One way to determine the cause of debris flow is by premising the occurrence of the water flow. A method that is mostly used is Japan Rational Method. This method is very simple, easy and well-known among other empiric formulas. The mathematical equation is as follows: $Q = 0{,}278\ C\ I\ A$; in which Q is peak discharge in m^3/second; C is runoff coefficient ($0 \leq C \leq 1$); I is rainfall intensity in mm/hour, and A is drainage area (km^2). C coefficient is defined as a comparison between runoff and rainfall intensity. This factor is the most crucial variable in measuring flood flow. The main factors that influence C coefficient is infiltration rate, the slope of land, land coverage vegetation, rainfall intensity, soil condition and characteristics, ground water, degree of soil density, and soil porosity. The infiltration rate will decreases if rain falls for a long period of time and it is also influenced by the previous rainfall condition. Based on the measurement, the flood flow caused by rainfall is 319.37 m^3/second.

2.5 Measuring Flood Flow Based On Waterflow Data

Data of water flow in Gunung Nago weir (in Batang Kuranji) on July 24th 2012 when the debris flow occurred can be utilized as a comparative data toward water flow that is measured based on rainfall data. The formula used is: $Q = Cd\ 2/3\ \sqrt{2/3}\ g\ b\ H^{3/2}$; where Q = water flow (m^3/second); Cd = waterflow coefficient (Cd= CoC1C2); g = gravitational acceleration (9.81 m/s^2); b = peak width (m); H = height over the peak (m).
Based on the equation, the waterflow data on Gunung Nago weir is 1,045 m^3/s.

2.6. The Cause Of Debris Flows

Debris flows can be caused by heavy rainfall in a CA that is in a saturated condition from the previous rainfall, or the CA has poor absorption capacity and the runoff rapidly concentrates into the river groove. Due to the rapid water flow and runoff flow, debris flows are able carry stones, mud from the erosion of river bank or sediment on brook, and tree stumps uprooted from its place will sweep all area they pass that could destroy land, farming areas, bridge and houses within range and eventually have taken some casualties.
Debris flows can also be caused by the breakdown of water saturated hills crack and natural dam that dam up river flow, followed by water pours into downstream that is previously dam up by the natural dam. This natural dam is formed because the river flow is clogged up by debris flow materials coming from the sloping riverbank that fall at the same time with logs and tree stumps to the bottleneck of a river. Due to the breakdown of this natural dam the materials retained in the upstream, such as logs, mud, and stones will be carried by this debris flow. As a result, all debris flows usually contain logs and tree stumps.

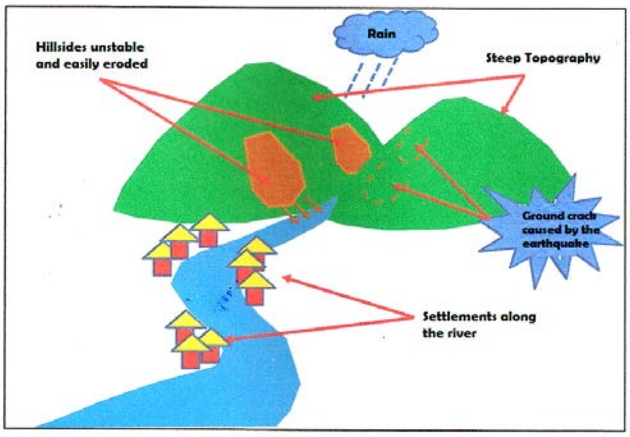
2.7. The Formation of Natural Dam

Debris flow materials in the form of mud, stones or logs can fall into the river flow and immediately form a dam, or, the materials are carried by the water flow and settle in the bottleneck, therefore gradually creating a dam.

2.8. The Cause of the Collapse of Natural Dam

a. Overflow (overtopping): Water in the river which is restrained by natural dam, its surface level will gradually increased, when the surface level has achieved the top level of the dam, water will spill out and simultaneously eroded the forming material of the natural dam and the dam finally collapse, then the restrained flows flowing rapidly and swept away the material that inhibiting it flows.

b. Permeation (piping): Due to the frequent occurrence of earthquake event in this area, it causes some ground fissures which in high rainfall situation the water leaks into the ground could cause underground erosion. If this leak has reach its critical flow rate, it would brought the soil granules along, creating cavities inside the ground under this natural dam, which leads to the collapse of the natural dam and directs the water to the downstream with high velocity rate 40 km/hour and high volume.



Factor Triggering Debris Flow

2.9. The Mechanism And The Triggering Factor Of Debris Flow Flood Runoff

Flood with velocity rate of 40 km/hour could be grouped into three schemes; the runoff which cause by blockage in the bridge zone, the leap /overtopping in the turned groove, and the runoff which is caused by decreasing groove capacity produced by sediment deposition.

a. The runoff is caused by blockage on the bridge area. It commonly occurs in the bridge area, where a blockage is caused by the pillars of the bridge and the head of the bridge, and during the flood, the bridge width will clogged by some material, so the flow will shift to the left and the right of the bridge or out of the river groove. This also occurs in some bridges over Batang Kuranji river.
b. The leap / overtopping of the flow is on the turned area. The leap of the water flows out of the groove which usually occurs on outside area of the turned. One of this phenomenon was occurred in upstream area of Batang Kuranji river
c. The decrement of groove capacity causes the water runoff out of the river groove. This condition occurs in the sediments area with < 3% slope.

3. THE DISASTER MANAGEMENT

1. Non-structural action of disaster management conducted primarily are: mobilizing personnel from many various elements to rescue and evacuated the 500 survivor; fulfilling their basic needs in temporary shelter (relatives / neighbor houses); providing clean water and sanitation facility; and providing health service and nursing for the injured and unhealthy, especially for children under five and elderly. During the emergency response phase is established by City Major of Padang for one month.
2. Structural action of disaster management is conducted to protect the people around the river and to prevent the building over the river, through rehabilitation of some of damaged irrigation system as 3,000 hectares, clean water facilities, bridge rehabilitation, normalization of Batang Kuranji river in form of dredging, river bank reinforcement with wired stone, establishing groundsill with wired stone over some critical place and public facilities.
3. Conducting a comprehensive and integrated planning for the upstream to the downstream of Batang Kuranji river is a must

4. DISCUSSION

1. Classification of Land Usage Plan / Coverage Area
   Base on the image of Landsat -7 ETM on year of 2009 and 2012, there are classification of land usage plan / coverage area. In 2009: open land 17.21 km^2; bush 29.69 km^2 (14.76%); farm fields 62.98 km^2 (31.30%); secondary forest 67.88 km^2 (33.74%); and old-growth forest 1.28 km^2 (0.64 %).
   In 2012: Open land 12.66 km^2; bush 39.54 km^2 (6.29%); farm fields 82.55 km^2 (40.98%); secondary forest 46.27 km^2 (23.00%); old-growth forest 0.22 km^2 (0.11%). Base on the data of this land usage plan / coverage area, there was a decrement of secondary forest coverage from 67.88 km^2 in the 2009 to 46.27 km^2 in 2012, the old-growth forest from 1.28 km^2 in 2009 to 0.22 km^2 in 2012, and the increase number of farm fields from 62.98 km^2 to 82.55 km^2 and also the bush from 29.69 km^2 to 39.54 km^2. With the decrement of the number of old-growth forest and secondary forest shift into farm fields and bush, have caused the increase of flow coefficient (C) and finally will increase the flood flow.
2. In 2009 NVDI : -1 to 0.2 (very low) 48.95 km^2; 0.2 to 0.4 (low) 59.68km^2; 0.4 to 0.6 (medium) 92.55 km^2; 0.6 to 0.8 (high) 0 km^2 ; and 0.8 to 1 (very high) 0 km^2. In 2012 : -1 to 0.2 (very low) 42.21 km^2; 0.2 to 0.4 (low) 85.29 km^2; 0.4 to 0.6 (medium) 73.68 km^2; 0.6 to 0.8 (high) 0 km^2 ; and 0.8 to 1 (very high) 0 km^2. Analysis result of greenery vegetation level (NDVI) showed that there are depreciation of greenery level of CA Batang Kuranji . This was presented with decrement of NDVI value of medium quality which in 2009 was 92.55 km^2 to 73.68 km^2 in 2012. The depreciation of the NDVI value shows that the vegetation in CA Batang Kuranji has significantly depreciated.
3. Water-body

Water-body analysis showed that many water puddles were occurred on CA Batang Kuranji. In 2009, water body area was 14 km^2, and in 2012 increased to 20 km^2, which could be in form of puddle in the rice-fields or natural puddle in the upstream of CA. Since the location of this water-body is far in the upstream of Batang Kuranji, the most probable water-body is in natural dam.

Flood flow in July 24th, 2012: Based on the rainfall rate, the calculation results of flood flow was 319.37 m^3/ second, while the water flow in Gunung Nago weir on the Debris Flood event was 1,045 m^3 / second, showed the difference of 725.63 m^3/second. This 725.63 m^3/second flow mostly came from the puddle in the upstream area which was caused by the collapse of the dam. Since the materials that form natural dam come from deposits of land avalanche, this is one of the causes of murky and brownish flood water which contained mud sediments.

Flood flow in September 12nd, 2012: Based on the rainfall rate, the calculation results of flood flow was 675 m^3/ second, while the water flowing flow in Gunung Nago weir on the Debris Flood event was 631 m^3 / second, (almost the same with the previous flood flow in July 2012). Based on the analysis above it can be concluded that the debris flow on that date can be caused by several factors:

a. There are some function shifts of primary and secondary forest into farm land and bushes
b. The condition of the land is rugged and shallow, unstable and easily causes land slide.
c. The high rate of rainfall in the CA that reached 165 mm (Batu Busuk station) during 6 hour.
d. The formation of natural dam that caused puddle in the upstream of Batang Kuranji
e. The optimal saturation rate of the soil is relatively sensitive to erosion after the rain happened the previous day.
f. Earthquake events which produce hill fissures in the upstream CA
g. The collapse of natural dam is caused by inability of the water to block the water flow.
h. The settlements on the river side cause groove to narrow and decrease reservation capacity

4. Policy and Strategy

a. Debris flow disaster management that has been done includes emergency measure and rehabilitation. Emergency measure is temporary and it is done in the respective area to protect the people from the direct impact of the disaster. This measure includes river morphology channel change management that could endanger people around the river, including: local scouring around the bridge, the change in river flow form, the change in river width due to errosion; bridge construction, irrigation and other public infrastructures repairs.
b. A comprehensive sediment disaster management should be applied from the upstream down to the downstream of Batang Kuranji, either structurally or non-structural. Debris flow control in structure can be in form of Sabo series construction with the following criteria:

1. Slite type dam is the most suitable dam in the sediment production area with river flow slope higher than 6% .
2. Check dam or consolidation dam is the best dam in the sediment transportation area with river flow slope between 3-6 %.
3. Channelworks and flow control is the best choice to maintain the river flow stability in deposition area with river flow slope lower than 3%.

c. Evaluation result on emergency response during one month is as follows:

1. Disaster management system does not function properly yet, this condition can be seen from the fact that not all areas have standard procedure for disaster management, due to lack of competent disaster management officers and incomplete equipments.
2. The people do not receive adequate information about the potential danger, such as risk map, evacuation signs, books, posters, and leaflets. Padang municipality has already had evacuation management plan, but some improvements are needed to implement this plan.
3. Critical facilities such as electricity, clean water and communication network are not adequate to fulfill basic needs during disaster management
4. Although emergency disaster command system has been implemented, disaster warning system is still inadequate, in the form of equipments, information to the people, and the participation of related disaster management officials
5. Disaster management network mobilization on one area does not function properly; this is due to lack of communication mechanism and coordination between the government and non-government institution.

6. Lack of materials and preparation equipments affect the evacuation process, eventhough several disasters has happened on the same area.

d. Using analysis on capability, opportunity, and threat possibilities toward the aforementioned disaster, there are four strategies that could become key solutions to handle Batang Kuranji debris flow disaster:

1. The disaster management capacity should be strengthened by composing laws and rules on a comprehensive disaster management.
2. It is necessary to build a strong, structured and standardized disaster management institution.
3. Strengthening the bond among goverment institutions is compulsory in order to cope with disaster management and land-usage supervision by giving information to the surrounding inhabitants.
4. Facilities for disaster mitigation should be provided.

5. RECOMMENDATION

1. It is necessary to conduct integrated debris flow control (starting from planning) from the upstream level to downstream level of Batang Kuranji. It is fully advised to plan the upstream structure on sediment production area (i > 6%) using slite check dam type; for transportation of sediment area (i between 3-6%) using consolidation check dam type, and for deposition area using crib/channel works to keep the river flow stability.
2. The construction of sabo dam / check dam, groundsill, river normalization, canalization and repair work around the hillside are urgent. The construction is done by priority through national, provincial and district government.
3. A comprehensive forestry management is needed through illegal logging prohibition that could decrease the natural function of the forest, and vegetation preservation according to its environmental support.
4. Spatial control and building construction permit need to be implemented since there is housing complex built on flood potential area.
5. Watershed management is necessary by conducting reforestation on critical/ dry land and by implementing soil and water conservation techniques.
6. It is also a must to strengthen the function of disaster management institution and to implement a more effective socialization.

REFERENCES

[1] Alesheikh, et al. 2007. Coastline Change Detection Using Remote Sensing
[2] Aronoff, Stanley. 1984. Geographic Information System: A Management perspective. Canada: WDL Publications.
[3] Horto, R.E. 1940. An Approach toward a Physical Interpretation of Infiltration Capacity
[4] Jensen, J.R. 2007. Remote sensing of the Environment: an Earth Resources Perspective. New York: Prentice Hall
[5] Karnawan, et al. 2004. Geomorphological Map of Padang Sheet
[6] Laporan Advis Teknis Pusat Penelitian dan Pengembangan Sumber Daya Air, September 2012
[7] Lillesand TM, Keifer RW. 1999. Remote Sensing and Image Interpretation. New York: Wiley
[8] West Sumatera in Number, 2010
[9] Pedoman Penanggulangan Bencana Banjir Tahun 2007/2008, Pelaksana Harian Bakornas PB.
[10] Prahasta E. 2008. Remote Sensing: Praktis Penginderaan jauh & Pengolahan Citra Digital dengan Perangkat Lunak ER Mapper. Bandung: Informatika
[11] Smith, R.B., 2006. Remote Sensing of Environment
[12] Sutanto. 1987. Penginderaan Jarak Jauh. Yogyakarta: Gajah Mada University Press
[13] Republic of Indonesia 1945 Constitution
[14] Republic of Indonesia Law Number 24/2007 on Disaster Management
[15] Republic of Indonesia Law Number 26/2007 on Spatial Planning
[16] Republic of Indonesia Law Number 27/2007 on Coastal Area and Small Islands Management