

# *Implementation of Spatial Data Infrastructure in Cianjur District for disaster risk management purposes*

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**Abstract.** According to the Indonesia Disaster Risk Index, one of the most prone districts to disaster in Indonesia is Cianjur District. The district is exposed to floods, landslides, droughts and geological hazards, such as tsunamis, earthquakes and volcanic eruptions. Using the existing data that the district currently has, this study aims to explore more deeply about disaster risk management in Cianjur District, and to know whether Spatial Data Infrastructure (SDI) can be implemented to make disaster risk management better. Commonly used definition of SDI, it is said that SDI is data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way, that is "the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data. Therefore, this study aims to assess to what extent such framework has been used and can be improved given the characteristics of Cianjur District. This study selects flood data in Cianjur as the case study. The methods used are identifying flood vulnerable area in Cianjur by processing data from Development and Planning Agency of West Java Province, then comparing the results with current data of flood vulnerable area owned by BPBD Cianjur, disaster occurrences in the past and the business model of BPBD as well as coordination with other stakeholders, such as Social Agency and Health Agency.

## **1. Introduction**

Most Indonesian cities expanded rapidly compared to other cities in South-East Asia region. The expansion brings problems both for the government and the citizens, especially in terms of management. Moreover, Indonesia is a developing country that is facing many problems, one of them being natural hazard. Based on information from Center for Hazards & Risk Research at Columbia University, between 1907 and 2004 there are 43 volcanic

eruptions, 93 floods, 78 earthquakes, 11 droughts and 10 cyclones (Birowo, 2010).

Cianjur District, West Java Province is prone to natural hazard. Disaster has an enormous impact to Cianjur citizens on a number of issues, such as economy and social. Index (IRBI) 2013 by National Disaster Management Agency (BNPB), Cianjur District is located in the top position with a score of 250 were categorized as high-risk class than 496 cities/districts throughout Indonesia. In the

previous year Cianjur district ranks number 11 national and number 6 in West Java Province as a potential disaster area in Indonesia that can cause loss of life, displacement, loss of property and other losses that are invaluable. Disaster will always happen and it is inevitable to live without it. However, implement some engineered methods are possible to reduce the impact of the natural hazard.

This research concentrates on data processing to determine the Curve Number (CN) using Soil Conservation Service (SCS) method. We cannot use this CN to determine the flood-prone area or created the inundation polygon, however, we can predict the CN value and rainfall within an area and predict whether the areas will be prone to flood. Later, we compared the calculated results with the historical data of disaster occurred in Cianjur District based on recorded by Regional Disaster Management Agency (BPBD) of Cianjur in 2015.

Finally, we verified the results with BPBD of Cianjur determine whether the SDI system is suitable to be implemented in Cianjur—in this case, in disaster risk management. The goal is to find some difficulties and give some recommendations of disaster risk management which utilized the SDI concept.

## 2. Reviewing Spatial Data Infrastructure for Disaster Management

Partnerships, data sharing and data exchange are needed to produce and update information required by emergency situation calls, since the nature of emergency situations are always dynamic. Besides, different organizations become involved in disaster response during emergency situation (Rajabifard et al, 2004). SDI acts as a framework to facilitate decision-making for disaster management following the encapsulated model as illustrated bellow :

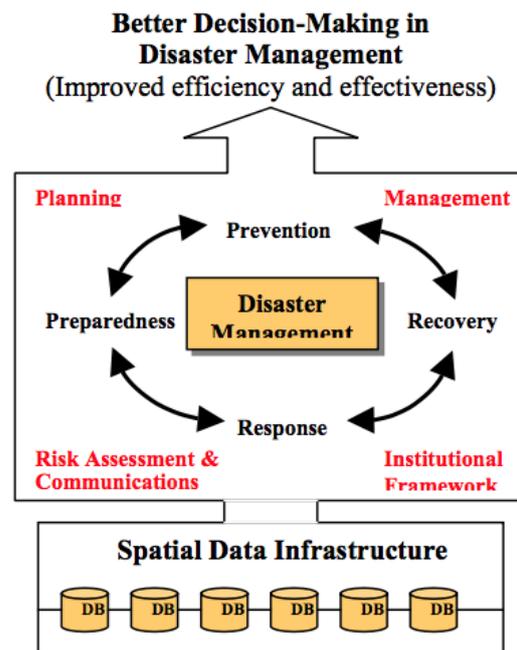


Figure 1. SDI to facilitate disaster management (Rajabifard et al, 2004)

Disaster management is a cycle of activities that begins with *mitigating* the vulnerability and negative impact of disasters, followed by *preparedness* in responding to operations, *responding* and providing relief in emergency situations such as search and rescue, after the disaster struck, *recovery* is in place which can include physical reconstruction and the ability to return quality of life to a community after a disaster, and supported by sets of data stored in databases (Rajabifard et al, 2004).

### 2.1 Current status of SDI in Indonesia

Based on the presidential decree number 27/2014, every ministry, agencies, and local government act as network node in Indonesia SDI (National SDI / NSDI). In order to achieve data sharing purposes, Indonesia has set 17 data custodians (ministries) for 85 thematic geospatial information on 1:50.000 scale based on one base map that is made by Geospatial Information Agency (BIG). This regulation is stated in presidential decree No 9/2016 on Accelerated the Implementation of One Map Policy on 1:50.000 scale geospatial information. (Suprajaka et al, 2016)

### 2.2 Local regulation of SDI

There is specific regulation made by West Java Province about Satu Data (One Data), Local

Regulation no 24/2012 about One Data of Development of West Java.

It dictates that all cities and districts in West Java and various government stakeholders in West Java to support this program.

### 3. Methods and Area of Study

#### 3.1 Methods

There are a few stages that followed in this research, which can be divided into three main

stages, which are literature study and data collecting, data processing and comparison, and conclusions along with recommendations of SDI implementation for disaster risk management, in this case is a flood disaster management.

More detail about this workflow is illustrated in this figure :

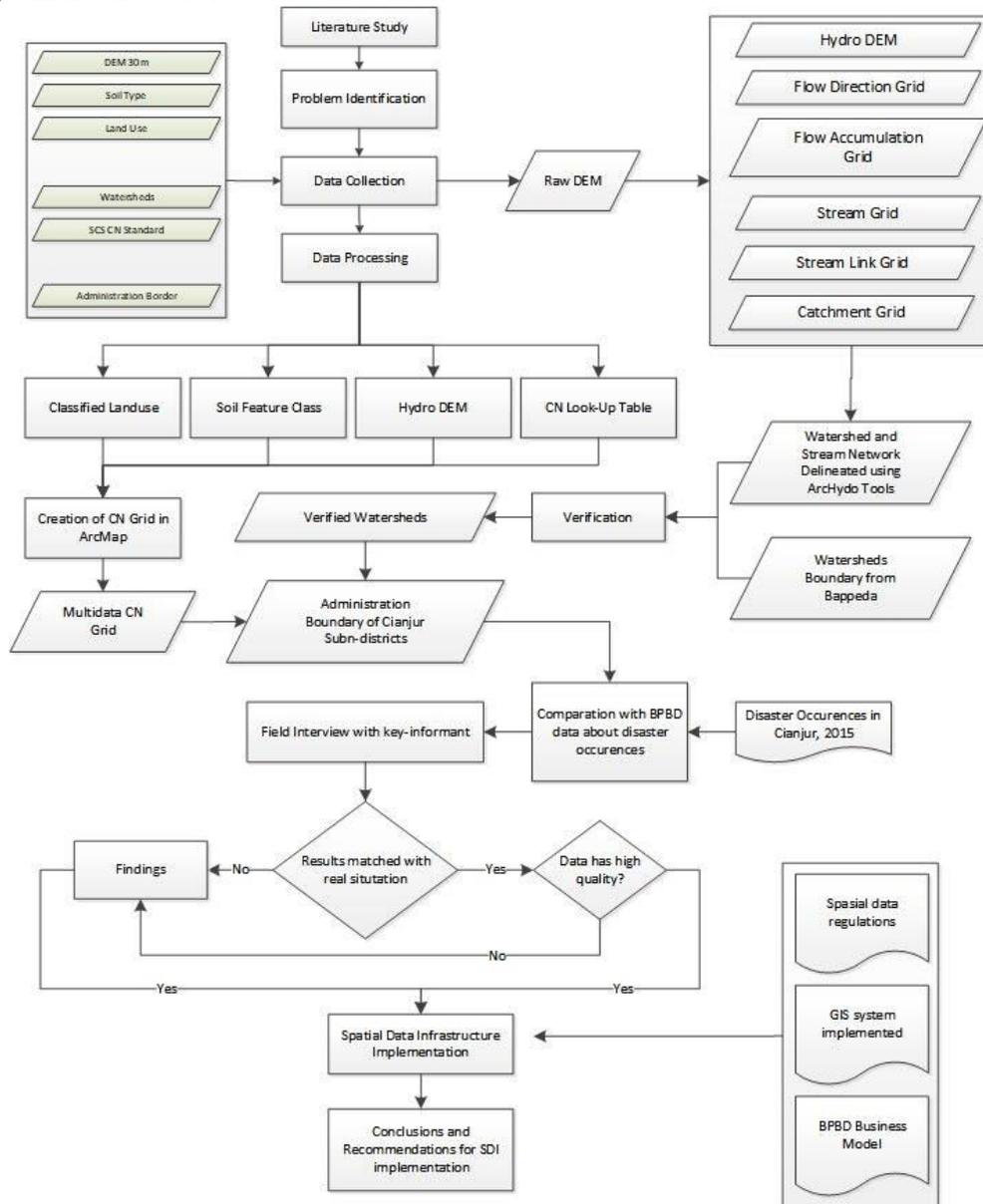


Figure 2. Research workflow and method

#### 3.2 Study area



	(greater than 0.30 in/hr ; more than 8mm/hr).
B	soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15- 0.30 in/hr ; around 4-8mm/hr).
C	soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr ; 1-4mm/hr).
D	soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr ; 0-1 mm/hr).

Soil data obtained has no information about soil group and infiltration rate, therefore,

information from many sources were used to assist soil grouping.

From various sources of soil texture and characteristic, it is determined :

**Table 3.** Hydrologic Soil Group in watersheds around Cianjur.

No	Soil Type	HSG
1	Alluvial	A
2	Andosol	B
3	Brown Forest	B
4	Glei	D
5	Grumusol	D
6	Latosol	A
7	Mediteran	D
8	Red-Yellow Podzolic	A
9	Regosol	A

Soil data obtained, was a digital file which has no information about soil group and infiltration rate. Therefore, information from many sources are used to assist soil grouping.

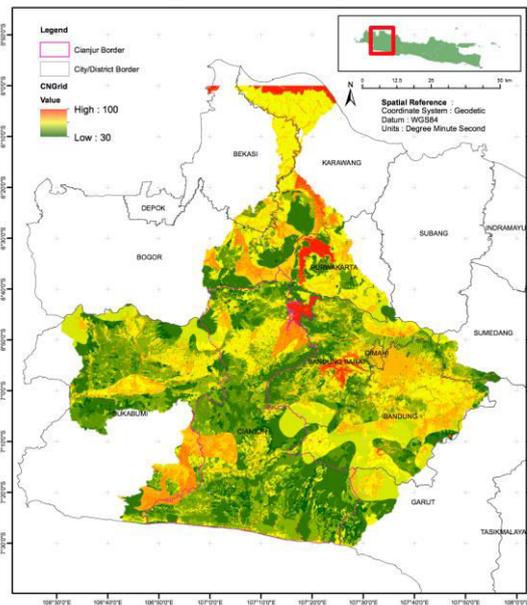
**Table 4.** Curve Number in various type of land cover

No	Area	Hydrologic Condition	A	B	C	D
1	Developed Area (newly graded areas)	Pervious area, no vegetation	77	86	91	94
2	Industrial Area (urban districts)	Industrial	81	88	91	93
3	Embankment (impervious)	Openwater	100	100	100	100
4	River/Lake/ (impervious)	Openwater	100	100	100	100
5	Swam (impervious)		100	100	100	100
6	Paddy field (row crops : Straight Row + Crop Residue cover)	Good	64	75	82	85
7	Meadow	Fair	30	58	71	78
8	Pasture	Fair	49	69	79	84

9	Mixed garden (mixed)	Fair	43	65	76	82
10	Plantation (woods-grass combination/tree farm)	Fair	43	65	76	82
11	Secondary Forest (woods)	Fair	36	60	73	79
12	Primary Forest (woods)	Fair	36	60	73	79

Even though the classification of HSG using secondary data is not entirely accurate, common condition is adequate to be used in the data processing with an extra attention for extreme results.

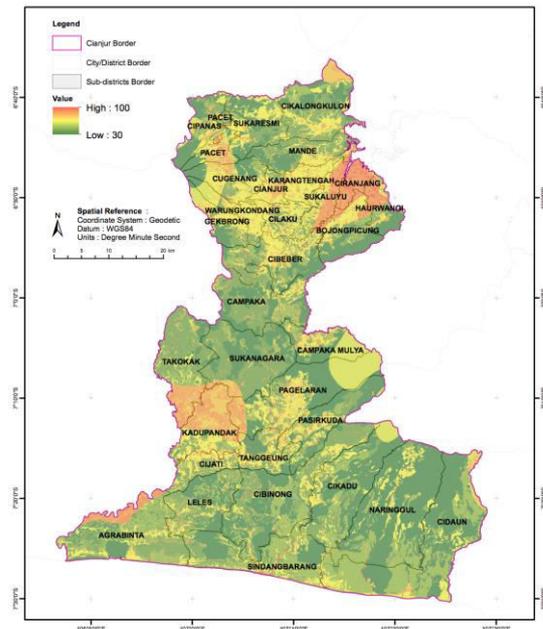
Using HEC-GeoHMS and ArcHydro tools in ArcGIS Desktop, CNGrid is generated :



**Figure 4.** CN grid map

#### 4.4 Data Process Results

To determine which area that has high CN value, map generated earlier is overlaid with administration border of Sub-district of Cianjur as illustrated in the following image:



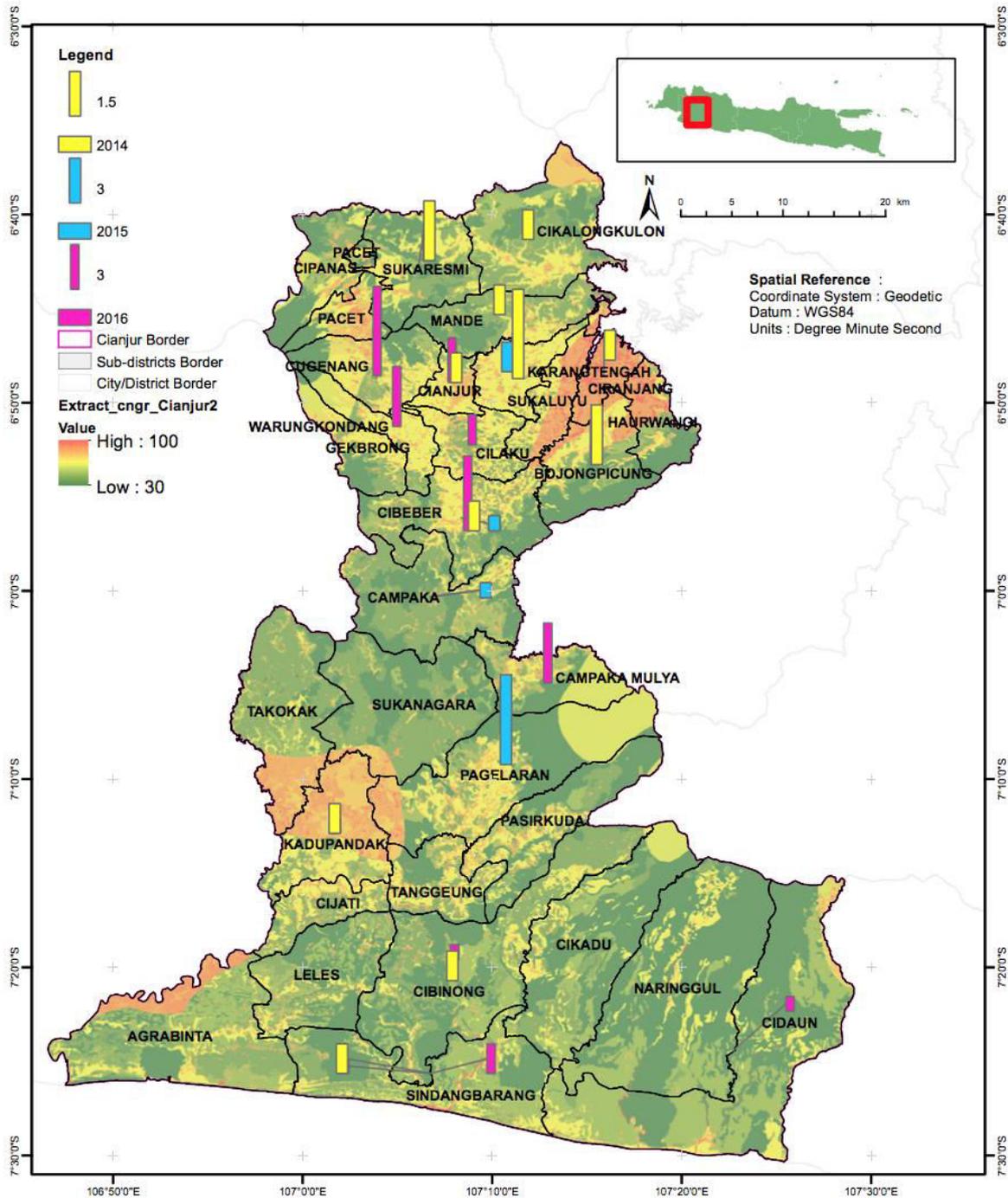
**Figure 5.** Overlaid map of CN grid and Sub-districts border

Areas which has probability to have high runoff value based on calculation are:

- Kadupandak.
- Takokak
- Cijati
- Tanggeung
- Pasirkuda
- Pagelaran
- Cibeber
- Bojongpicung
- Ciranjang
- Haurwangi
- Sukaluyu
- Karantengah
- Cilaku
- Warungkondang
- Cianjur
- Gekbrong
- Cugenang
- Pacet

- Cipanas

Those list then compared to the historical data recorded by BPBD of Cianjur and visualised in the following figure :



**Figure 6.** Disaster Occurrences in Cianjur District

## 5. Findings and Analysis

### 5.1 Findings

According to Dede Hernawan, one of the BPBD officer in Cianjur, flood does not directly affect human activities and never hits

area with high population. Heavy rain only caused the river to be flooded, the real threat cause by natural phenomenon is landslide, many houses were damaged, people injured and died because of landslide in Cianjur.

#### *5.1.1 Data availability*

Most data collected were downloaded or copied from respected custodians or some government institutions which also has data required. Some data like soil type has low classifications and it is really challenging and need extra attentions when grouping it into Hydrological Soil Group developed by SCS. Infiltration rate data which already measured by particular institutions is really hard to find or it can be say that those data doesn't exist. Most research about hydrological analysis done before conducted a field survey to measure this infiltration rate and some of them also sampling the soil type.

#### *5.1.2 Data quality*

Data collected for this research mostly has a scale 1:250.000 which not recommended for city-scaled area of study. Even though data is still coarse, CN value can still be generated. The results should be treated carefully since the accuracy is not high.

Flood disaster occurrences is non-spatial—it has no coordinate be overlaid with CN grid map. Moreover, there are differences of data between local government, BPBD, and Central Bureau of Statistics (BPS). Hence, further spatial analysis also challenging, yet still possible.

#### *5.1.2 Business model of BPBD*

Field survey was also conducted to collect qualitative data about mitigation plan, disaster response, and recovery process in Cianjur District handled by local agency. It is found that this institution still uses traditional methods for those three operations mentioned. BPBD uses text messages, phone, and radio to control field conditions and give commands. And still uses paper map to do analysis. It is really doesn't have digital spatial data.

#### *5.1.3 Regulation which support the implementation of SDI*

There are several initiatives to develop spatial data especially in a centralised data centre. For

local regulation, the only thing Cianjur has is regulation of One Data for Development of West Java issued by province government. However, all discussion and meetings didn't have any conclusion about how Cianjur should has spatial data for developing the city especially for disaster risk management.

#### *5.2 Analysis*

Availability and quality of data collected has main influence to CN value determination since tools which used required highly accurate DEM data, even though DEM has 30m resolution, stream data (river data) to make DEM smooth is also needed. Actually, not only DEM data, but also soil type and land cover as well to generate better results.

Predicting the flood-vulnerable area using generated CN without rainfall data is possible, but not accurate. While qualitative data conducted to get better calculation, numbers still matter. Increasing the resolution of map, soil type, and land cover also including the infiltration rate data is required.

So far, by comparing data from BPBD, most disaster occurred naturally, such as landslide and flood. BPBD performs very well using real time monitoring by contacting field officers and also has a cooperation with local government with intensive communication to make disaster response better.

Spatial data analysis proven in various area to be the system for decision-making more accurate, because it is supported by real-world data and standard.

## **6. Conclusions and Recommendations**

Northern side of Cianjur mostly are developed area and have higher value of CN compared to area in the southern part. Predicting flood-vulnerable area using CN calculation is possible, however it is requires special attention.

Not only Cianjur has a large area, it is also prone to other natural hazard which calls for improvement of disaster risk management in general—since local institution to handle that matter, BPBD, still using traditional ways. BPBD performed good with that way, but increasing the effectiveness and efficiency using spatial data for managing disaster risk

would make it has a better decision making processes and operations.

The implementation of SDI in Cianjur is possible and government also supporting it by regulating in One Data of Development of West Java and the most important thing is the president also asks it to be as quick as possible to be ready to join the NSDI system.

It is recommended to build small-scale system of SDI using flood as a sector to be implemented is a good start to initiate the SDI system in a local government, especially location that prone di natural hazard.

Developed areas are prone to flood, even though residential area didn't flooded directly, most flood occurred cause bridge damage, therefore transportation sector also affected by it.

Making river data more accurate and any hydrological stream network better, is the first stage to build spatial data for the later small-scaled SDI system.

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