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Institutional Hierarchy of Flood Mitigation for Settlement Areas in Padang, West Sumatera, Indonesia

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Abstract
Indonesia is a wet tropical climate region and so that it has rainfall intensity almost throughout the year. The consequence is some region in Indonesia have risked of flood disaster. Flood makes huge impacts and damages so the institutional hierarchy of flood disaster mitigation at settlement area turn into an important thing. For defining institutional hierarchy , this research is using Interpretative Structural Modelling (ISM) method. Used element to organize institutional hierarchy of flood disaster mitigation are stakeholders and obstacles. Analysis result on institutional of flood disaster mitigation shows sub elements such as local government, province, and central government have role as key element on stakeholder elements, and a key element of obstacles element is because of the weakness of law enforcement for spatial violation.
Keywords: organize institutional hierarchy, obstacles element , and stakeholder elements.

1. Introduction

Disasters happened in Indonesia in recent decades increase continuously, from quantity perspective, intensity or their spread. During 2015, amount of disasters are 1.229 times and 375 (31,3%) are flood disasters. The impacts are 1.944 houses damage based on BNPB data in 2012 (BNPB 2012). Jha et al. ‘s observation (2011) in some regions in the worlds are vulnerable from flood. The impact level of flood at this time and in the future demand us to make a management for flood risk in urban settlement areas as a high priority in politics and policies making process. Therefor, to figure out the cause of flood and its impact, to arrange a draft, cost and implementation for minimalizing risk is a responsibility of an idea from development and a part of the purpose of development.

According to Kodoatie (2013) land use transformation become built land has effected to flood increasing because less of soil water systems and drainage. Land use transformation happened in natural conservation and preservation area, especially surface water and soil water and now the land is use for develop a new settlement area and infrastructure improvement.

Next, Djakapermana (2010) expresses complex factor that should be considered on space utilization, system approach on area expansion is a method to solve problems in a region. With using system approach implied there were a whole and integrated process that can be describe a problem to be solved, and also can simplify a complex without losing an essential element from the object that being studied.

A method that can be used for analysis is ISM technic which doing a group study through a produced structural model to snapshot a complex thing from a system through designed pattern using graphic and sentences (Eriyanto 2003). This method is pretty effective to structure complex issues because can be used for defining and clarify the problems, evaluate the effects and identify relation between policies.

Based on the background, the purpose of this research is to identify the structure that related to the management settlement area programs at research's area. To achieve that purpose, structure ranking analysis has been done in this settlement management program and can be classified into elements where each element will be explained into some sub elements. Three (3) chosen elements for analyzed are involved stakeholder in settlement management program, obstacles, and expected changes for settlement area management.

2. Research's Method

a. Location and Research schedule

Padang geographically located between 100º05' 05" - 100º 34' 09" BT and 00º44'00" - 01º08'35" LS (Figure 1). Overall research area have 69.496 km^2 wide and divided into 11 districts. The research held from April 2015 until December 2015.

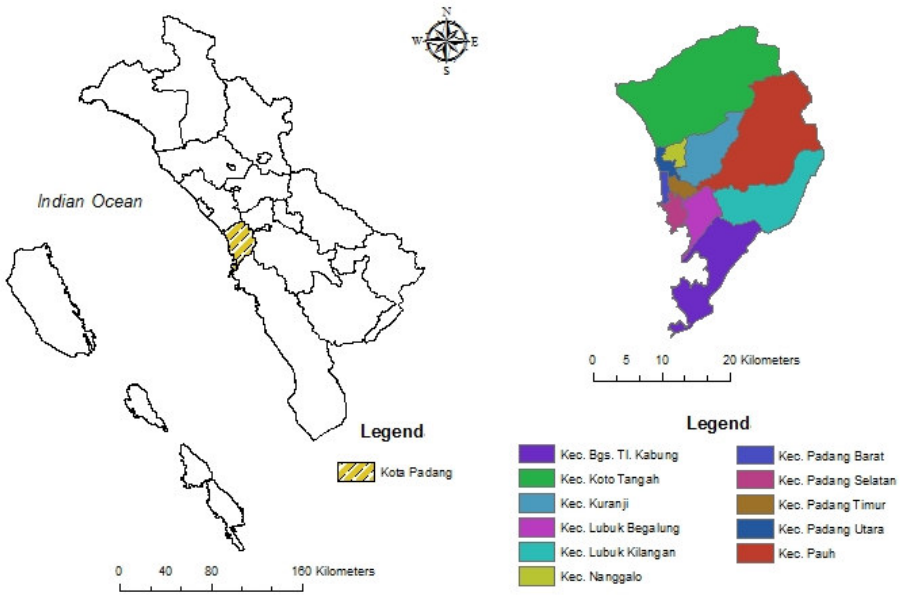

Figure 1. The research location in Padang West Sumatera Indonesia

b. The technic of institutional hierarchy analysis

This analysis is using ISM method. This method is pretty effective to structure complex issues because can be used for defining and clarify the problems, evaluate the effects and identify relation between policies. ISM method divided into 2 parts namely hierarchy management and sub element classification (Eriyanto and Larasati 2013).

The base principal of this methodology is identify from structure in a system that have high benefits for gathering the systems effectively and for a better decision making. The outline of ISM method steps are :

1. Divide every element into some sub elements'
2. Determine contextual relation between sub element on each element that shows paired ratio. Expert's opinion is using to define contextual relation exist or not.
3. Arrange Structural Self Interaction Matrix (SSIM) using V A X and o symbols.
4. Make Reachability Matrix (RM), to substitute V, A, X, and O symbols with 1 or 0.
5. Calculate based on transivity rules where SSIM matrix is corrected until close matrix happen.
6. Make level sub elements on each element according to vertical stage or horizontal stage.
7. Arrange Driver Power Dependence matrix for every sub element. Classify element into 4 parts :
   a) First quadrant: not related (Autonomous) consist of sub element that have driver power value $\leq 0,5$ X and dependence value (D) $\leq 0,5$ X. Where X is sum of sub element on each element. Sub element that exist on first quadrant generally not related or have small relation to the system
   b) Second quadrant: Dependence consist of sub element that have driver power value $\leq 0,5$ X and dependence value (D) $\geq 0,5$ X. Where X is sum of sub element on each element. Sub element that exist on second quadrant is depend on element in third quadrant.
   c) Third quadrant: The hook (linkage) consist of sub element that have driver power value (DP) $\geq 0,5$ X and *dependence* value (D) $\geq 0,5$ X. Where X is sum of sub element on each element. Sub element that exist on third quadrant need to be studied carefully because every action on one sub element will be effected to other sub element on second and fourth quadrant.
   d) Forth quadrant : booster (independent) consist of sub element that have driver power value (DP) $\geq 0,5$ X and *dependence* value (D) $\leq 0,5$ X. Where X is sum of sub element on each element.

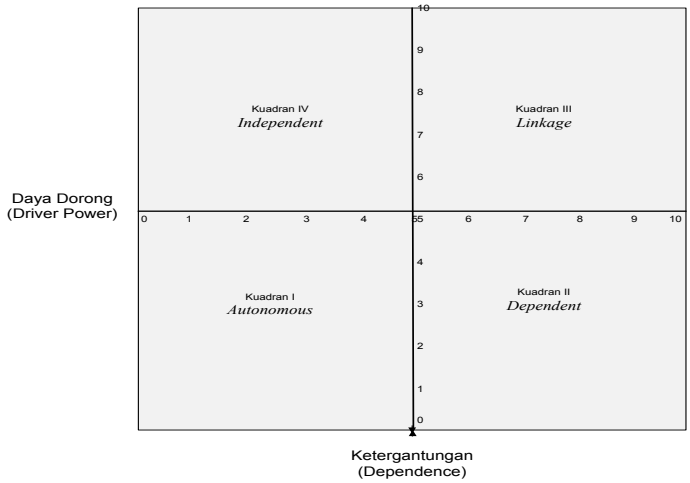

Figure 2. Driver power matrix and dependence for purpose element

3. Research Outcome and Discussion

a. Stakeholder Element

Sub elements have been assigned as stakeholder element that involved with flood risked settlement mitigation in Padang are :

1. Settlement developers
2. Local Neighborhood Association and Citizen Association
3. Local headman and districts
4. Local Bappeda
5. Environmental services
6. Spatial services
7. Local Disaster Countermeasures Institute
8. Cipta Karya Institute
9. Non-governmental organization
10. Universities or College
11. Local , province, and central government.

From the analysis *Reachability Matrix Final* result towards stakeholder sub element , it can be obtained the highest activator power as 11 (Table 1). In Padang 11th sub element (governments) have role and booster power on flood risked settlement mitigation. 6sth sub element is second highest activator power on flood risked settlement mitigation.

Table 1. *Reachability matrix final* of related stakehokder element on flood mitigation at settlement area in Padang

	Element											Driver	
Element	1	2	3	4	5	6	7	8	9	10	11	Power	Rangking
1	1	0	0	0	0	0	0	0	0	0	0	1	5
2	0	1	0	0	0	0	0	0	0	0	0	1	5
3	0	1	1	0	0	0	0	0	0	0	0	2	4
4	0	1	1	1	1	0	1	1	1	1	0	8	3
5	0	1	1	1	1	0	1	1	1	1	0	8	3
6	0	1	1	1	1	1	1	1	1	1	0	10	2
7	0	1	1	1	1	0	1	1	1	1	0	8	3
8	0	1	1	1	1	0	1	1	1	1	0	8	3
9	0	1	1	1	1	0	1	1	1	1	0	8	3
10	0	1	1	1	1	0	1	1	1	1	0	8	3
11	1	1	1	1	1	1	1	1	1	1	1	11	1
Dependence	2	10	9	8	8	2	8	8	8	8	1		
Level	4	1	2	3	3	4	3	3	3	3	5		

Graphic of relation between driver power and dependence (Figure 3a) shows there are 3 sub elements namely 1st sub element (settlement developers); 2nd sub element (Local Neighborhood Association and Citizen Association); and 3rd sub element (Local headman and districts) are in second quadrant. The 3 of them have high dependencies toward sub element in third quadrant. On third quadrant there are 6 linked sub elements (linkage)

between sub element in 2nd quadrant and 4th quadrant. They are:

a. 4th sub element, Environmental services
b. 5th sub element , Local Bappeda
c. 7th sub element ,Local Disaster Countermeasures Institute
d. 8th sub element ,Cipta Karya Institute
e. 9th sub element ,Non-governmental organization
f. 10th sub element , Universities or College

On the 4th quadrant there are 2 dependent sub elements namely 6th sub element (Spatial service) and 11th sub element (governments). The 2 sub elements on 4th quadrant will effect sub element in 3rd quadrant because they are have high driver power and dependencies to other low sub elements.

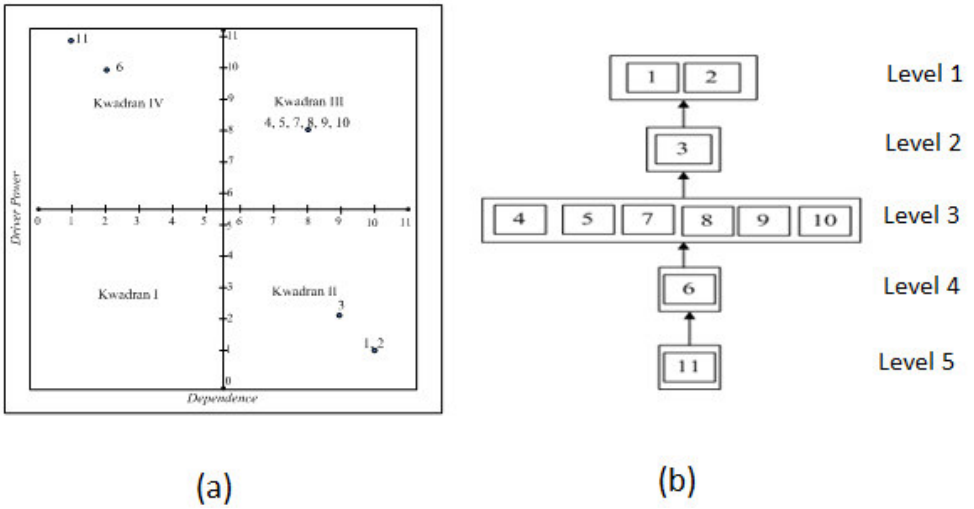

Figure 3. Relation between driver power and dependence (a), hierarchy structural (b) on stakeholder element that involved in settlement mitigation program in Padang

b. Obstacle elements

Identification results towards obstacle elements on flood risked settlement mitigation in Padang there are 10 sub elements :

1. Coordination / corporation between involved institutional
2. Consistency of spatial implementation is still weak
3. Monitoring towards violation is still weak
4. Unavailability of detail spatial planning
5. Unnecessary Local Neighborhood Association and Citizen Association
6. Unplanned Settlement growth
7. The weakness of law enforcement for spatial violation.
8. Low of public awareness on land utilization
9. Unavailability of zoning policy as control tools for spatial utilization and management.
10. Limited ability on management and development infrastructure.

Analysis result toward 10 elements there is 7th sub element (The weakness of law enforcement for spatial violation) as the highest activator power with 10 marks from obstacle *Reachibility Matrix Final* in settlement mitigation program in Padang (Table 2). 7th sub element is the key sub element faced on in settlement mitigation program in Padang.

Table 2. Obstacle *Reachibility Matrix Final* in settlement mitigation program in Padang

Element	Element										Driver Power	Rangking
	1	2	3	4	5	6	7	8	9	10		
1	1	1	1	1	1	1	0	1	1	1	9	2
2	1	1	1	1	1	1	0	1	1	1	9	2
3	1	1	1	1	1	1	0	1	1	1	9	2
4	1	1	1	1	1	1	0	1	1	1	9	2
5	1	1	1	1	1	1	0	1	1	1	9	2
6	1	1	1	1	1	1	0	1	1	1	9	2
7	1	1	1	1	1	1	1	1	1	1	10	1
8	1	1	1	1	1	1	0	1	1	1	9	2
9	1	1	1	1	1	1	0	1	1	1	9	2
10	0	0	0	0	0	0	0	0	0	1	1	3
Dependence	10	9	9	9	9	9	1	9	9	10		
Level	1	2	2	2	2	2	3	2	2	1		

Graphic of relation between driver power and dependence (Figure 4a) shows 10th sub element is o 2nd quadrant with the highest dependence value. On 3rd quadrant there 8 sub elements :

a. 1st sub element, Coordination / corporation between involved institutional
a. 2nd sub element , Consistency of spatial implementation is still weak
a. 3rd sub element , Monitoring towards violation is still weak
a. 4th sub element , Unavailability of detail spatial planning
a. 5th sub element ,Unnecessary Local Neighborhood Association and Citizen Association
a. 6th sub element , Unplanned Settlement growth
a. 7th sub element , Weak law enforcement for spatial violation.
a. 8th sub element , Low of public awareness on land utilization
a. 9th sub element , Unavailability of zoning policy as control tools for spatial utilization and management.

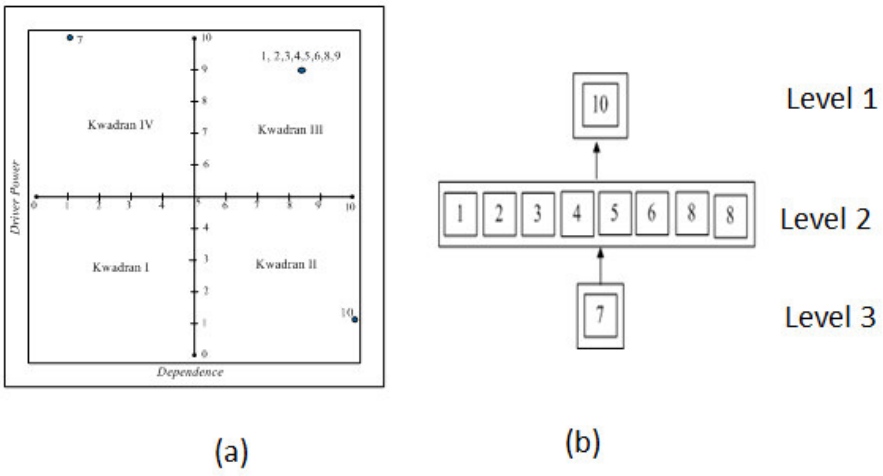

Figure 4. Relation between driver power and dependence (a), hierarchy structural (b) on stakeholder element that involved in settlement mitigation program in Padang

Sub elements on third quadrant has function as linker (linkage) between sub element in 2nd quadrant and 4th quadrant. Treatment and action towards sub element on 3rd quadrant will affect other sub elements in 2nd quadrant and 4th quadrant so sub element that exist on third quadrant need to be studied carefully. There's 7th sub element on 4th quadrant. Sub element on 4th quadrant is low dependent sub element and has large activator power and called sub element independent. There are three level of obstacle hierarchy structure in flood risked settlement mitigation in Padang from 10 sub elements. Higher obstacles on hierarchy level will affect the improvement of other low level obstacles. law enforcement for spatial violation will prevent settlement expansion from impact of flood.

In Padang 11th sub element (governments) have role and booster power on flood risked settlement mitigation. Figure 5a is on flood risked settlement area. The picture shows there are 53,5% settlement found on high hazard zone in Padang. Because of the high rate, local government in urban planning should be paying attention on the flood risked area. Besides, based on level of vulnerability in Padang, 31,5% from settlement area are high vulnerability area. Therefor, it is necessary to do some capacity improvement to face disasters, especially

flood. Based on flood risk in Padang, there were 34,5% settlement area on high risk of flood. To decrease loss, it's important for governments to do some actions.

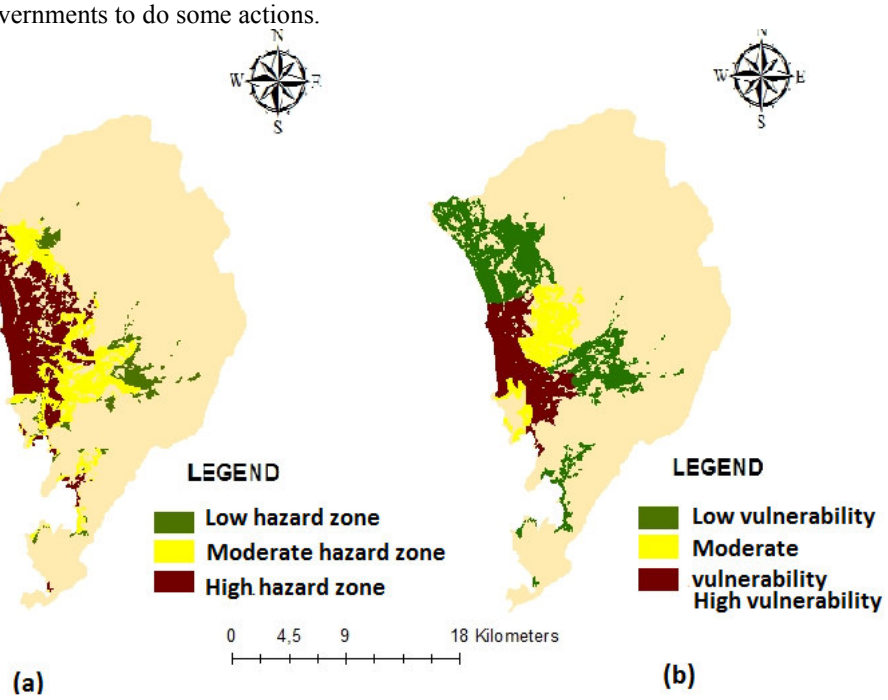

Figure 5. Flood hazard settlement area (a), flood vulnerability area (b) in Padang

Relation graphic of driver power and dependence from stakeholder element shows 3 sub elements, namely 1st sub element (developers); 2nd sub element (neighborhood association and citizen association); 3rd sub element(headman and district) exist on 2nd quadrant. The 3 sub elements have high activator power toward sub elements on 3rd quadrant. On third quadrant there are linked sub elements (linkage) between sub element in 2nd quadrant and 4th quadrant. The 6 linked sub elements on stakeholder elements in Padang. They are : a) 4th sub element (Local Bappeda); b) 5th sub element (Bapedalda); c) 7th sub element (BNPB); d) 8th Cipta Karya (PU); e) 9th sub element (LSM); and ;f) 10th sub element (College). On 2nd quadrant there are 2 dependent sub elements, they are : 6th sub element (spatial service) and 11th sub element (governments). The two of these sub elements on 4th quadrant will affect sub elements on 3rd quadrant.

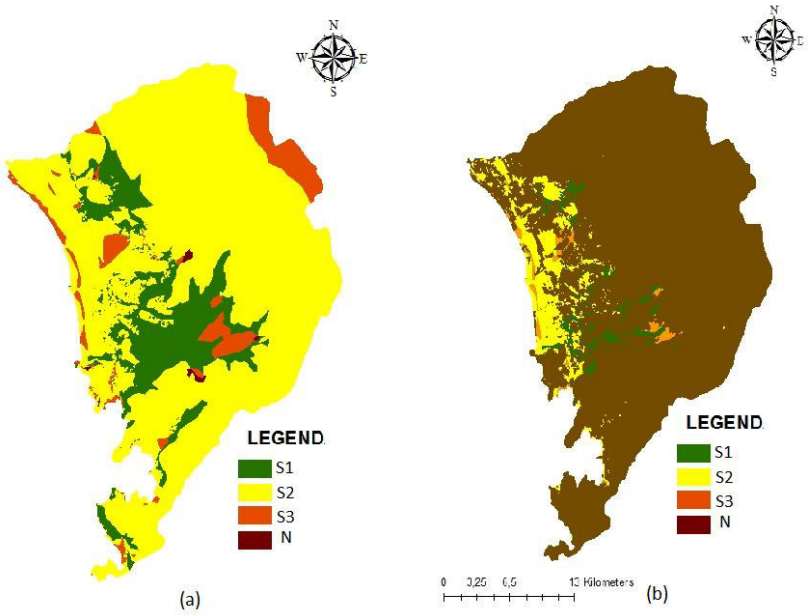

Figure 6. Land suitability zones for settlement (a), land suitability for settlement (b) in Padang

Result of analysis of land suitability for settlement in Padang shows 18% zones are very suitable for settlement; 75,4% zones are suitable for settlement; 6,2% zones are same with marginal for settlement; and 0,8%

zones are not suitable for settlement. Result of obstacles analysis there's 7th sub element (the weakness of law enforcement) has high activator power. In 2014 at Padang, settlement area are 11.477 ha. If it compared with space pattern, there were 21,1% settlement that unsuitable with space pattern. That was the proof of the weakness of law enforcement for spatial violation.

Rustiadi et al. (2011) told that program arrangement of land use has damaged other regions, without realizing it. That's because bad coordination between central and local decisions maker. Arifin et al. (2009) explained landscape conditions and people activities on upper course will affect lower course, and so on the other hand. Hence, it necessary having integration from beginning to ending of land use planning to make continues development.

Suripin (2004) revealed beside the weakness of synchronization and coordination between related component, the low of law awareness and incosistentcy of law implementation also become a problem in spatial issue. According to Iwan et al. (1999) the best effort in disaster mitigation was together with citizens in planning on land use through citizens participation to know and to acomodate local development that has risked of disasters. This way can decrease conflict in development so people feel to be a part of development.

4. Summary

a) On stakeholder element, 11th sub element (goverments) is a key sub element and has high power value (11). In Padang 11th sub element (governments) have role and activator power on flood risked settlement mitigation. 6th sub element is second highest activator power on flood risked settlement mitigation. Based on graphic of relation between driver power and dependence (Picture 3a) shows there are 3 sub elements namely 1st sub element (settlement developers); 2nd sub element (Local Neighborhood Association and Citizen Association); and 3rd sub element (Local headman and districts) are in second quadrant. The 3 of them have high dependencies toward sub element in third quadrant. On third quadrant there are 6 linked sub elements (linkage), they are : a) 4th sub element, Environmental services; b) 5th sub element , Local Bappeda; c) 7th sub element ,Local Disaster Countermeasures Institute; d) 8th sub element ,Cipta Karya Institute; e) 9th sub element ,Non-governmental organization; f) 10th sub element , Universities or College. Beside ,there are 2 dependent sub elements namely 6th sub element (Spatial service) and 11th sub element (governments).

b) Analysis result of obstacle element toward 10 elements there is 7th sub element (the weakness of law enforcement for spatial violation) as the highest activator power with 10 marks from obstacle *Reachibility Matrix Final*. Graphic of relation between driver power and dependence shows 10th sub element is o 2nd quadrant with the highest dependence value. On 3rd quadrant there 8 sub elements: a) 1st sub element, coordination/corporation between involved institutional; b) 2nd sub element, consistency of spatial implementation is still weak; c) 3rd sub element , monitoring towards violation is still weak; d) 4th sub element, unavailability of detail spatial planning; e) 5th sub element, unnecessary local neighborhood association and citizen association; f) 6th sub element, unplanned settlement growth ; g) 7th sub element , the weakness of law enforcement for spatial violation.; h) 8th sub element, low of public awareness on land utilization; i) 9th sub element, unavailability of zoning policy as control tools for spatial utilization and management. Next, There's 7th sub element (The weakness of law enforcement for spatial violation) on 4th quadrant. It means that sub element has high acivator power in flood mitigation on settlement areas.

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