A CONCEPTUAL FRAMEWORK TO REVIEW THE HAZARD MAPPING PROGRAM IN TAIWAN

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Abstract Taiwan started to delineate hazard zone according to the Soil and Water Conservation Act since 1996, which was in charged by Soil and Water Conservation Bureau (SWCB). During the pass years, SWCB had implemented only 59 projects of hazard zone, relatively a small amount, compared to the great number of endangered villages all around Taiwan. This is because people would like to have the disaster prevention works, but no hazard zone with strict land use regulation. Moreover, the ambiguous standard caused lots of controversy when authority determine where should be or should not be designated as hazard zone. To identify this ambiguity, this research developed a conceptual framework $Rk=(Hr \times Vr/(Ec+Cs))$, which was derived from concept of risk management, where Hr is the probability of specific nature hazard, *Vr* is the vulnerability of endangered resident or public services, *Ec* is the effectiveness of control measures, and *Cs* is the capability of social awareness of disaster. The advantage of this framework is each modularized component can be defined according to quantifiable data or ranking order collectively in Taiwan. It was also applied to check the 41 controversial hazard zone projects and found that only 2 projects should be carried out continually, 13 projects can be substituted by strengthened sediment control works, and 26 projects can be repealed immediately.

Key Words: hazard zone, risk management, nature disaster

I. Introduction

"Soil and Water Conservation Act" has made public of its implementation on May 27, 1994, which is mainly to handle and preserve the implementation of soil and water conservation of Taiwan; to preserve and care for soil and water resource, to eliminate natural disaster, to promote legitimate usage for the land, to enhancing national welfare, and to be a legal based foundation in soil and water conservation system. Among which Chapter Three is "Special Soil and Water Conservation Treatment and Maintenance", which has particularly stressed on area definition, mapping purpose, management, and the buffer zone of Designated Soil and Water Conservation Area. However, relatively to the normal soil and water conservation measures, as for the area that desperately needed soil and water conservation treatment and maintenance that has been mapped as Designated Soil and Water Conservation area together with the strict land use management.

Although according to the Clause 16 of the "Soil and Water Conservation Act" of the time that has regulated those that needed protection on reservoir watersheds, the upstream of main river watersheds, seacoast, lake area, the bank on both sides of waterway that needed particular protection, sand dune land, and sandy beach that has been seriously eroded by wind, the hillside that has steep inclination, and those that have jeopardized the public security, and others that have critically affecting soil and water conservation, which all these will be mapped as soil and water conservation area. But as for the land that has initially been mapped as the designated soil and water conservation area, it has only listed reservoir watershed of control as the item of prohibition,

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the others will be mapped as the region of designated soil and water conservation area, which has not been proclaimed in writing as the restricted developing behavior (Legislator Yuan, 1994). Moreover, as for setting up of the protective zone, it has only ordered to enforce installing the reservoir watershed as the targeted zone, as for the other types of designated soil and water conservation area, it is only order by the main government institute to set up buffer zone according to the need. According to the legislating spirit at that time, it is mainly to control the development on the use of the designated soil and water conservation area of the reservoir watersheds, to levy the full water level above thirty to fifty meter of land; yet the other types of the designated soil and water conservation area has not been restricted on its usage, and it was only on the necessary area of delimited buffer zone that has enforced usage restriction.

On October 21 of the same year, the amendments on “Soil and Water Conservation Act” has been announced on its implementation (Legislator Yuan, 1994), as for the relevant clause of the designated soil and water conservation area to make two major points of amendment, Among which one is to amend “those that must be particularly protected on the watershed of the upstream of river” into “those that need to be particularly protected on the watershed of the river,” as for the second, it is to amend the original Clause Nineteen that aim at the usage restriction regulation of the reservoir watershed, into prohibiting all developing behavior for each type of soil and water conservation area, and to increase listing three unrestricted proviso. For the amendment of this time, although it has loosen three items of unrestricted developing behavior, it has nevertheless, prohibited all types of developing behavior for the designated soil and water conservation area. Because of this, for area mapping as the designated soil and water conservation area, its developing behavior must be restricted, in essence, it has already exceeding the tradition of purely administrating construction, and to lead into the spirit of state planning and risk management.

The mapping of the designated soil and water conservation area has formally begun after announcement on the implementation of “Designated Soil and Water Conservation Area Mapping and Repeal Act” on March 25, 1996. Initially the mapping project has trial run on the watershed of Ming-Hu and Ming-Tan Reservoir and three debris-flow torrents, until today, there are 59 areas of announcement for the project, mainly divided into three major categories as reservoir watershed, debris-flow torrent, and the landslide.

After 1993, “Soil and Water Conservation Act” has consecutively been amended twice, as for the part on the designated soil and water conservation area, it has not yet made the additional amendment; to survey the past experience, because it has involved with the complicated problem of the accrual basis and management by other organizations, at the same time affecting the rights and interests of the land ownership, which the problem faced during the promotional process may not be called seldom. On top of that, currently our nation has actively promoting debris flow disaster preventive strategy and states planning project, which the “Designated Soil and Water Conservation Area” has played as one of the important role, for this reason, there is a need to cooperate with the adjustment on soil and the water conservation act that involved with this project, in order to actualize and continually promoting this assignment.

II. Challenge on Hazard Mapping Program in Taiwan

2.1 The fear of prohibit on all development

According to the regulation on “Soil and Water Conservation Act” Clause Nineteen, for different type of area that has been mapping as designated soil and water conservation area, any developing behavior was prohibited within the area, although the same act has regulated

concerning the major construction of water resource, not involving the proviso that wasn't restricted by the development on three items in the natural touring and rest area etc., that has been approved by environmental affect evaluation investigation and the change in terrain features that was above a definite scale, but since the beginning of this project, one still has to face the protest by the residents and question by the local government.

Although during the course of promoting the practical, as for the behavior of the present development, it would be for the legal use, in order to ensure the right and interest of the local, and to excluding the agriculture herding usage behavior beyond the developing restriction, but the land owner would often protect on defending the unrealized benefits and interests. Although this situation has been widespread on every area, with regards to peripheral area or the area with the tourism potential of the neighboring metropolitan area, it was even more critical, therefore the local residents generally were expecting development in investment, for this reason, it was not as easy to delimit the boundary. For instance, although the grass hill tourism area of Yunlin often has the occurrence of debris flows and landslides, since the residents have regarded its tourism potential, so even as early as 1999 to delimit as the designated soil and water conservation area, because of opposition by the residents which still has not complete its announcement. But for five years, after going through numerous disasters, it has gradually lost its tourism value.

With regards to local government institute, according to the law, the local government should first request the mapping as designated soil and water conservation area, and after mapping to draft and execute the long term soil and water conservation project, which belonged to one of the important link within the mapping system of the designated soil and water conservation area, since the local government organization must bear the pressure of public opinion, with regards to the protective objective to concentrate on handling and preserving the area that is desperately in need of soil and water conservation, which ought to delimit the most demanding area of protection, but because the lands are mostly private own, so often on, in order to avoid the contention by the resident and the failure to submit a report, on the contrary, the reporting objective of the protection were the area of public infrastructure that has reduced the dispute, causing the regret of not mapping the area that ought to. Based on the past mapping experience, the main protective objective that has been kept in good repair was often the case example of roadway or bridge, which was caused by the above descriptive reason.

2.3 To naturally edge out with many substitution programs

In the past, for promoting the task of this project, initially it is based on the main feature of "Priority mapping, with priority renovation", to mainly look at the positional step of the law, possessed by designated soil and water conservation area, and according to the law to must draft a long term soil and water conservation project, and to base on the handling and preservation of project's implementation. But ever since the 921 earthquake in 1999, government for the sake of solving the related landslides and debris flows caused by earthquake and typhoon, has actively promoting various renovation proposals, under hastening the sufficient fund for disaster rescue method, and various disaster administration and management, even though the designated soil and water conservation area possesses a renovation basis of the law source, since it was burdened by the restricted development, it was often not favored during choosing the policy of handling by the main government organization, and unable to be completely accepted by the residents and the local government institute. Based on Jiufen Ershan as an example, after being through 921 earthquake, different handling projects and the implementing proposals have quickly been checked and ratified, and to immediately proceed with planning and to carry out the with emergency handling, although at that time it has also considered delimit it as designated soil and water conservation area, since the process would require public announcement and deliberation,

then to draft the long term soil and water conservation project, and to also prohibit all the development after consider for mapping, which would affect the development of the local. No matter it is on the time of execution or on the future development, it will not be as good as the other special case project, because of this, even if the area comply with the important condition of mapping as designated soil and water conservation area, in reality, it cannot be implemented because of being edged out by other choices.

Other than this, the flourishing development in constructing the living quarter of the rural area and the project of natural disaster prevention administration, and also indirectly urging the natural edging out the designated soil and water conservation project, in addition, to base on Huashan Area as example, although in the past, it belongs to the mudflows and landslides disaster area, through the guidance and assistant by the integrated developmental project of the rural area, other than to eliminate the doubts on the danger of the mudflows and landslides while renovate the task on it, moreover, to additionally promoting various countryside tourism and production construction, currently it has developed into an important area of tourism and leisure; if to plan by mapping as the designated soil and water conservation area that is in effect currently, to consider by disaster risk management, it will be in effect after renovation, also it is unlikely to be unrestricted in developing and creating such a flourishing outlooks.

2.4 The perplexity of the mapping object

Although according to “Soil and Water Conservation Act” Clause Sixteen regulated, reservoir watershed, the main rivers watershed that needed to be protected particularly, sea shore, lake area, the bank on both side of waterway that needed to be protected particularly, sand dune and sandy beach etc., with critical wind erosion, hillside with steep inclination, those that concerned for the danger on public safety, and others that critically affect the soil and water conservation to mapping as the object of the project, yet among which it still included the perplexity of mapping the choice of object. In which, the designated soil and water conservation area of the reservoir watershed has already been discussed in previous section; this section will not give any more unnecessary details.

First to aim at the river watershed that needed particular protection, based on the same act Clause Ninth to regulate that each river watershed should through main government organization to join with the relevant organization to proceed with the overall plan of administration, and to aim at soil and water resource conservation, and the need for legitimate use of land; to draft mid and long term plan of administration, through each government organization, institute or obligor of soil and water conservation, to implement by stages and by areas. To show that river should base on act to proceed with overall plan of administration, but based on Soil and Water Conservation Act, Clause Sixteen, it needs to additionally regulate rivers watershed that needs particular protection to delimit as designated soil and water conservation area, which shows other than having the overall plan of administration for this project in mind, to also include the spirit of environmental sensitive area, by the method of land control, to avoid additional human activities as its main objective.

In view of this, to evolve and state the concept that has currently been announced publicly in mapping the designated soil and water conservation area, it’s mainly for the two major categories in debris flows and landslides, similarly to also face the perplexity of which by what point of view to mapping this project. Based on the example on mapping the area with the hazard of debris flows, if by “the need for administration” as the viewpoint of mapping, of course, it must based on the principle that the area has the need to implement soil and water conservation, after mapping then it would be necessary to implement the sediment control construction,

afforestation conservation, or drainage planning etc. But in speaking of the current soil and water conservation task, almost all the debris flows or landslides disaster, as long as there is slight exposing danger of bare land, an emergency administration will be given immediately, it seems as if there's no chance for any debris flows or landslides to endanger the area. According to this reason, almost there's no chance with need to enforce this project; on the other hand, if based on "disaster potential management" as the mapping viewpoint, other than the necessary renovation, to reduce the excessive damage done by man-made activities, which would appear to conform to the spirit of this project, if implemented by this principle, once mapping within the designated soil and water conservation area, it is not like seeing a scene of devastation everywhere with collapse or gully with serious erosion, it may be possible that the area because of topography, geology, and other special circumstance (such as the maintenance object is just on the location within the alluvial fan of the wild stream), which will be mapped as the designated soil and water conservation area, when drafting the long term soil and water conservation project, normally it will construct the sediment control work, which will appear lesser relatively, and management with prohibiting the additional development will be the main objective of this project.

For the time being, through the experience of summon numerous discussion on public announcement of this project, the main government organization and the scholar expert that participate in this conference would often argue endlessly over whether the designated soil and water conservation area is in need of administration, mainly is because in mapping this project, there is a different viewpoints on "demand for construction" and "disaster potential management" at the same time, which has consequently led to dispute.

2.5 Social justice and duty

The set up of "restricted development area" is one of the means to control land use, it is mainly to provide disaster prevention, preservation of the historic spot, or environmental protection etc., of the exterior benefit, as for the private land use to proceed with means of restriction on land use control, of course at the same time, it will cause "internal cost" for the landowner and the resident, as for the benefit or loss caused by land control system, should the government compensate or levy a tax, which is a subject of debate for a long time by political economy and the science of law (Council for Economic Planning and Development, 2000). In the past, with regards to the right of the restricted development area user, there was no active defend, causing the management effect generally not clear, which led to malfunction on policy. Executive Yuan on August of 2002, after announcing "The principle on restricting relieve, feedback, and compensation on the developing area", it looks as if to bring up amendment on the loss caused by lacking of economic enticement and the injustice environment under the restricted user control system. Its principle has individually explained the restricted development area of the disaster nature, restricted development area of the public welfare nature, and facilities of aversion nature, or relieve, feedback, and compensation principle on land use affecting area.

"Designated Soil and Water Conservation Area" for a long time, has been seen as a type of restricted development area (Council for Economic Planning and Development, 1996), especially after the handling principle described above has been announced, "Designated Soil and Water Conservation Area" was listed as restricted developing area of public welfare nature, in response particularly to the provider of the public welfare, and according to the loss to grant proper compensation. In actuality, to analyze the object that needs to map within this project, other than the reservoir watershed of this project, the other mapping object would be the area with concern for jeopardizing public security, to contrast the current announcement of this project, it is mainly based on debris flows and landslides as designated soil and water conservation area, which exactly conform to principle of the restricted development area of the disaster nature described

above on the danger area of debris flows and landslides, one ought to base on after disaster relieve as principle. Having appeared with such contradiction and error is because “designated soil and water conservation area” has included diversified objects of mapping, and not to understand the cause on its intension.

In fact, as for whether relieve of the disaster area conform to social justice is still belongs to dispute, since the developing vantage of the deposited area, after the disaster on debris flows and landslides, causing the chance of intrusion by human activities extremely high, which for those who must relatively increase the cost for selecting a safe place for living, the levy tax will be granting to the area of relieve unlimited that is originally unsuitable for living, or to provide disaster preventive measure, whether it conform to fairness, it would be hard to estimate; based on the viewpoint of risk management, as for the resident of the disaster latent area, in facing the risk for disaster to choose compromise and not to avoid right away, but on the mental attitude, to rely or even request government to assist investment on disaster prevention in order to reduce risk on disaster, which has the phenomenon of free rider on the science of economic. Based on the village moving case of Wugong Li of Nantou County or Shenmu Village of Xinyi has been mentioned again and again, still under the anticipation and the work of construction invested by the government, to choose to gamble with risk again and again. Based on the source, to know perfectly that it is an area that will continually having disaster occur, to invest in expense to construct that is far exceeding the cost to purchase all the land, and not to clearly setting the boundary on the duty of its risk, whether it conform to social justice, still would need to wait for consideration.

With regards to the above described problem, the task of designated soil and water conservation area has appeared to be even more important, after mapping as the designated soil and water conservation area of debris flows and landslides, the need is to draft the long term soil and water conservation project, other than letting the nation to assist shouldering the disaster risk of the resident within the area, on the execution, it is to censure the development on the restricted area, in reality, with regards to the main government organization of this project, to base on public authority to reasonably restricted the land use, then let government assist the area to face how to deal with the disaster, which still conform to fairness and justice. However, by the current system design and the misunderstanding on sharing the responsibility, often on when the main government organization or the executing unit is executing this project, to worry about the need to shoulder all the responsibility on the safety of the local after mapping, which results in the difficulty of promoting this assignment.

III. Conceptual Framework to Interpret the Risk for Hazard Zone

To interpret the risk of nature hazard, this research started from the conceptual framework of risk management Risk =Hazard(H)ㄨVulnerability(V)/Capacity(C), or Risk=function of (H and V/C), where Hazard is the probability of specific nature hazard, V is the vulnerability of endangered resident or public services, C is the capacity of disaster.

Therefore, the research proposes a method for government officer or coordinator for assisting decision-making and communication with the locals. First, the idea was finding out which data can be used in this model, and it’s easily can be found that the debris potential torrent investigation was possible. It covered the data of the ranking of the dangerous torrent and the possible boundary of the hazard. We can use it for the factor of the probability and vulnerability of the specific hazard. In addition, we can get the investigation data from government which contain the general condition of the endanger communities. Since this paper developed the framework as follow,

$$Rk = Hr \times Vr / (Ec + Cs) \qquad (1)$$

Where Rk is the risk of the specific nature hazard, Hr is the probability of the specific hazard, Vr is the vulnerability of endangered resident or public services, Ec is the effectiveness of control measures, and Cs is the capability of social awareness of disaster

1. Probability of the specific hazard（Hr）

(1). Debris flow

The occurrence of debris flow needs enough rock and gravel together with the water. We can ranking the probability according to the investigation in the past few years, where,

a. Normal torrents, *Hr=1.*
b. Low potential torrents, *Hr=2.*
c. Moderate potential torrents, *Hr=3*
d. High potential torrents, *Hr=4.*

(2). Landslide

The Logistic Regression is one of the best fitting model to describe the relationship between the presence and absence of landslides and a set of independent parameters. This research uses the landslide influencing parameters, geological parameter, geomorphologic parameters, proximity to roads, and proximity to river systems, to calculate the landslide areas susceptibility. Where,

a. Very Low susceptibility, *Hr=1.*
b. Low susceptibility, *Hr=2.*
c. Moderate susceptibility, *Hr=3.*
d. High susceptibility, *Hr=4.*

2. Vulnerability of endangered resident or public services（Vr）

Vulnerability can be calculate from the houses, public services, transportation services inside the hazard zone, and Vr can consist with three parts $Vr = Vr_1 + Vr_2 + Vr_3$,

(1). Houses building（Vr_1）：

e. No house, $Vr_1 = 0$.
f. Under 5 houses, $Vr_1 = 0.4$.
g. 5 20 houses, $Vr_1 = 0.7$.
h. Over 20 houses, $Vr_1 = 1$.

(2). Public services (Vr_2):

i. None of public services in area, $Vr_2 = 0$.
j. Facility of which are seldom use such as park or public building, $Vr_2 = 0.4$.
k. Facility of which are regular use such as school or hospital, $Vr_2 = 0.7$.
l. Facility of which are affected living condition such as power or water line, $Vr_2 = 1$.

(3). Transportation services Vr_3

m. None of the transportation services in area, $Vr_3 = 0$.
n. Regular level trans. or bridge, $Vr_3 = 0.4$.
o. County level trans. or bridge, $Vr_3 = 0.7$.
p. Province level trans. or bridge, $Vr_3 = 1$.

3. Effectiveness of control measures (Ec)

Most of the hazard zone can be used the hard mitigation construction to prevent the obvious hazard, but some area have no possible to place any countermeasures in it. However, we can also take the sediment-control rate into consideration,

(1). There aren't any control measures for hazard and Impossible to put one, $Ec = 0$.

(2). There are control measures which sediment control rate under 30%, $Ec = 1$.
(3). There are control measures which sediment control rate between 30-60%, $Ec = 2$.
(4). There are control measures which sediment control rate between 60-90%, $Ec = 3$.
(5). There are control measures which sediment control rate over 90%, $Ec = 4$.

4. Capability of social awareness of disaster（Cs）

Consider the risk awareness of the locals playing more and more important role in risk prevention; especially the evacuation plan became the most effective strategy before the hazard. AHP is a decision-aiding method quantifying relative priorities for a given set of alternatives on a ratio scale, based on the judgment of the decision-maker. This paper applied the AHP on measuring the preparedness to nature hazard of the locals, where

(1). IF the preparedness% for the communities is weak (0-40%), *Cs=1*.
(2). IF the preparedness% for the communities is moderate (41-60%), *Cs=2*.
(3). IF the preparedness% for the communities is good (61-80%), *Cs=3*.
(4). IF the preparedness% for the communities is well (81-100%), *CS=4*.

IV. Future Direction

The task of mapping designated soil and water conservation area is the same as many nations of the world in implementing land management or restriction on its usage, the problem has always circle around the interests and the loss of the land owner, very often the short term profit expectation has often exceeding the anticipated benefit on the future safety, these problems often must reach an unanimous consensus on the risk by the government organization and the land owner in order to be successful. Since it involved the problems on land, economy and risk responsibility, there are still many problems that need to face in the future. Facing different level of financial unit of government, and the condition of having lesser man power by days, the following two directions are the task of mapping designated soil and water conservation area for the future, the active direction of promotion, is explained as followed:

4.1 United efforts by public and private sector

Public and private sector (government and civil unit), by the united efforts structure to commonly promoting public policy and public affair, which is the interactive trend by the public and private sector of the twenty-one century; therefore, under promoting the task of mapping designated soil and water conservation area, at the same time, to consider through the united efforts by public and private sector in the networking relationship, to obtain cooperation by the civil spontaneity, to further achieve the effect of essence development.

Based on the current popular turnkey and the PCM work model, which is to delegate design, supervision and construction over to civil unit, to consider promoting the task of “community disaster prevention” under this project, even the resident explanation meeting or education training, must go deep into community for long term investment. In speaking of the man power of the current government organization, in deed there is a need to aim at designated soil and water conservation area to design and create method of cooperation by public sector, civil unit, and the local resident, such as actualized resident participation on monitoring activities, educational training by professional disaster prevention group, and agreement by community management, which will be an important point of development on the future of this project.

4.2 Develop nature disaster insurance system

Based on the excessive economic cost and social cost brought on by the repeated disaster, to develop finance and economic means of risk share and risk transfer will be the world trend (Li, Zhen-ying, 2002), there is no nations in the world that isn't in the conventional disaster mitigation policy, to actively research and advocating, if one can properly plan insurance, and reinsurance system to scatter the disaster risk, it can reduce the financial burden of the government and society brought on by debris flows and landslides and other nature disaster, to further ensure the economic stability and a peaceful mind by those undergo disaster.

In speaking of the task of the current soil and water conservation, as for the long term investment on the community build on slopeland, and the area that is easy to induce disaster, it has often exceeding the cost effect of the total value for protecting that area, as for the assistance on moving the village on the location unsuitable for human activities, based on the special land circumstance of Taiwan, often it cannot be promoted smoothly, causing the government must indirectly shoulder the disaster risk of the local, and to be burden by the tax of the entire people. Therefore, to base on designated soil and water conservation area as the foundation of developing natural disaster insurance system, other than to have the skill in appraisal natural disaster insurance hazard area, through the setting of the insurance system, to stimulate resident to participate in the investment on disaster prevention.

V. Conclusion

The advocating of the Disaster Prevention and Response Act, has enable the designated soil and water conservation area that has the spirit of disaster potential area to combine with task of disaster prevention, to assist by the wave of unrest for the current state rebuild and state planning, the spirit of state planning is consistent with the spirit of land management for designated soil and water conservation area. In speaking of the current promotion of this project, the government has gradually turn from the past prospects of passivity, to the present initiative and active standpoint, especially currently within the 59 areas of this project that have been announced, all have continually drafting long term soil and water conservation project, which there are over 20 areas of long term plan that has started the overall task of administration, it has shown that the promotion of this assignment has kept up on track, of course, just like what this article has mentioned, there are even more system and policy that need to speed up in its promotion. This article has aimed at the entire mapping problem on the designated soil and water conservation area, to propose innovation and the future direction of promotion, to be the important referencing objective for all circles and policy implementation.

The advantage of this framework is each modularized component can be defined according to quantifiable data or ranking order collectively in Taiwan. It was also applied to check the 41 controversial hazard zone projects and found that only 2 projects should be carried out continually, 13 projects can be substituted by strengthened sediment control works, and 26 projects can be repealed immediately.

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