Hazard Mapping Program in Taiwan: Compared to the Experience of Austria and Japan

Su-Chin Chen,[1)] Yung-Chuan Ko[2)] and Ting-Yeh Wu[3)]
1) National Chung-Hsing University, Taichung 402, Taiwan (scchen@nchu.edu.tw)
2) National Chung-Hsing University, Taichung 402, Taiwan (k205@ms6.url.com.tw)
3) National Chung-Hsing University, Taichung 402, Taiwan (tingywu2020@mail.nchu.edu.tw)

Abstract

Hazard mapping program is considered a useful tool of natural hazards mitigation strategy in many countries. The program includes not only series steps of risk assessment and management, but also continuing coordination and communication processes. Following the experiences of other countries Taiwan also lunched the juristic hazard mapping program in 1996, but this policy doesn't show satisfying results so far. However, for the purpose to reveal the feasible methods for hazard mapping program, the similar programs in Austria and Japan were selected for comparison in this paper. Both countries are mountainous in landscapes and have lots of the concentrated settlements on slope areas. The analysis showed that even if the hazard mapping program in Taiwan has legitimate regulations for implementation, but the ambiguous zoning practices lead to the policy failure. The mapped areas should not only delimitate the boundary for certain risk but also should spatially identify the costs, benefits and responsibilities that can be shared properly. Moreover, the hazard mapping program usually equips with series instruments including control measures as well as regulatory taking on property. Unavoidably, regulatory instruments tend to lead the hazard mapping program less incentives than other projects for natural hazards mitigation in Taiwan. The existence of parallel projects indirectly causes the hazard mapping program somehow become a last choice for neither stakeholder nor local authorities. In the past 10 years, only 68 hazard mapping programs were approved in Taiwan and with the budget about 25 millions USD, which is only the 2% compared to other similar projects. Taiwan's experience shows that a comprehensive consideration for all strategies is important for policy designers. Especially, once strategies are legitimatized for enforcement, these strategies may lead to unexpected effect to others. Although hazard mapping program not functions as expected in Taiwan, nevertheless, this paper further illustrates strategies to achieve the same purpose alternatively for implementation.

Keywords: hazard mapping program, control measures, regulatory instruments

Introduction

Taiwan is a subtropical island with an area of nearly 36,000 sq. kilometers; roughly three-fourths of total area is occupied by hill slope and mountains, while not more than 870 thousands hectares are suitable for settlement. In addition, with the frequent earthquake and high precipitation bring the natural hazards continually. However, high development and intensive population on slope areas increase the loss in natural disasters. The authorities had put a lot of resources on disaster mitigation projects since 1965. In the very beginning, most of the programs focused on the physical control measures which were mainly for blocking or detaining the landslide, debris flow, and flood. However, with the increasing events of natural disaster, development control on slope areas by land use regulations was highly emphasized by the authority lately.

There are not short of land-use regulations for preventing natural hazards in Taiwan, such as Regional Planning Act, Water Act, Soil and Water Conservation Act...etc. Some of these regulations are for specific disaster, and some for multiple conservation purposes. However, these kinds of forbiddances on land use somehow involve with the property right's expropriation, which lead to serious conflicts between government and stakeholders. Consequently, land use regulations for preventing natural hazards are not popular for not only authority but publics. For this reason, the first thing that policy maker should take into account is to find proper ways to solve the conflicts or to make these regulations flexible in practice.

For the purpose to understand the problem of the hazard mitigation strategies with land use regulation in Taiwan, we firstly reviewed the "Project of Designated Soil and Water Conservation Zone" which is the only project for dealing with natural hazard by not only structural measures but land-use regulation. In the second part, we pointed out some debates of this project and illustrated the relation between cause and effect of the case. In addition, some valuable experience of hazard mapping programs in Austria and Japan were referred

pp. 821–827

Table 1. Disaster mitigation strategies in Taiwan

Strategies	Hazard reduction	Vulnerability reduction	Capacity advancement
Control measures	V		
Land use regulation	V	V	
Emergent response management			V
Early warning system		V	V
Disaster reduction education			V
Building Codes		V	
Post disaster rescuing system			V
Tax and financial instruments		V	V

to analyze the problem in Taiwan. Finally, we proposed some suggestions to the "Project of Designated Soil and Water Conservation Zone", and directed some alternative ways to enhance the feasibility in the practice.

The Concept of hazard mapping program

Risk management of natural disasters

There are no such things as natural disasters, but there are natural hazards. A disaster is the result of a hazard's impact on the society. So the effects of a disaster are determined by the extent of a community's vulnerability to the hazard (ISDR, 2002). It's known that risk of natural disaster is the probability of harmful consequences, or expected loss resulting from interactions between natural or human induced hazards and vulnerable/capable conditions. Conventionally risk is expressed by the function,

$$Risk = func.\ (hazard,\ vulnerability/capacity)$$

Therefore, we can recognize that the reduction of the risk of natural disaster is a series of strategies to control the probabilities of hazards, to decrease the extent of vulnerabilities, and to advance the capacities for disaster. These strategies can offer some efforts in mitigating the risk of natural disasters. Obviously, there are several alternatives or combinations in different situation by characteristic of hazards, feasibility of fields, and financial condition of societies. Take the debris flow disaster as an example, control measures, such as check dams or sills, are constructed for controlling the material of debris flow hazard. On the one hand, land use regulation in upper-catchments can avoid the improper activities may lead to collapses that may become the supplement of debris, on the other hand land use regulation in alluvial area may control future vulnerability in advance. In addition, emergent response management, early warning system, disaster reduction education, post disaster rescuing system, all of these strategies can enhance the awareness of people who are threatened by the hazard, and increase the capacity of the public to face the disaster. Table 1 shows common strategies for natural disaster mitigation in Taiwan.

Nevertheless, the projects of natural hazard mitigation mostly were occupied by the structural measures since 1965; non-structure measures were relatively fewer in quantity. In addition, the increasing numbers of different strategies were brought into government's action, but most of strategies were carried out independently. In other words, these strategies somehow go without an integrated mechanism.

Hazard mapping program in Taiwan

"Project of Designated Soil and Water Conservation Zone" was first lunched in 1996, which could be regarded as hazard mapping program in Taiwan. The project is carried out by the Soil and Water Conservation Bureau (SWCB) under the Soil and Water Conservation Act. This project mainly aimed for those areas urgently need the soil and water conservation treatment and maintenance, which includes the following areas,

1. Watersheds of reservoir;
2. Upstream watersheds of main river;
3. Coast, lake area, the bank on river bank of particular protection;

4. Dune land and sandy beach of serious wind erosion;
5. Steep slope land area may threat public safety; and
6. The areas of specific hazard may threat public safety.

The authority should designate the above area as "Designated Soil and Water Conservation Zone" and implement the "Long-term Soil and Water Conservation Plan" with the strict land use regulation. Unlike the other hazard mitigation projects, "Project of Designated Soil and Water Conservation Zone" is a legal based project. In addition, this project is an unprecedented instrument that combines the control measures (structure) and land use regulation (non-structure) for natural hazard mitigation.

According to the Act of Mapping and Repeal Designated Soil and Water Conservation Zone, the local government could submit the proposals of the area of specific hazard may threat public safety to the Council of the Agriculture (COA), authority of the hazard mapping program. The authority should prepare the projects of the Designated Soil and Water Conservation Zone by public communication, field investigation, and technical calculation. The project includes the purpose of the project, location, boundary, geology data, soil data, ecological data, meteorology data, hydrology, administration, and regulations of the Designated Soil and Water Conservation Zone. The draft projects are delivered to the other public organizations for requesting the opinion. Then, the modification of the draft projects are sent back to the local government (municipal government and community) for bulletining to the public. Suggestions are collected for improving the draft projects, but the adverse opinions must proceed with further communication. Sometimes, some insistent opposition makes the communication become a time consuming task, and even may stop the projects. The draft projects have to be submitted to the committee of Designated Soil and water Conservation Zone for approval.

Local governments (municipal government) have to prepare the "Long-term Soil and Water Conservation Plan", as well as to manage the activities according to the project of the Designated Soil and water Conservation Zone. Long-term Soil and Water Conservation Plan includes the matter of the purpose of plan, location data, environment data, land-use condition, analysis of the hazard, comprehensive mitigation measures, schedule, regulated affairs, and expenditure of the plan. The plan has to be submitted to the same committee of the Designated Soil and water Conservation Zone. After the approval of plan, the expenditure of plan also approve by the authority. Although local government has to bear the expense about 5%–15%, nevertheless, most of local government can't afford it because of aggravating finance. In other words, authority has to cover the expense up to 90%. However, the communities or the beneficiary in the project or plan not pay anything all the cases. Implementations of the plans are carried out by the local government and Soil and Water Conservation Bureau respectively depend on the scale.

The most difficult task of Designated Soil and Water Conservation Zone is the prohibition against any development activities inside the zone. However, there are three exceptions of prohibition,

1. The national water resources construction;
2. The recreational areas which have approved by environment impact analysis; and
3. The development under certain scale.

In addition, the existed buildings, industries, agricultures and settlements are allowed for accomplished use. It means the regulation is added to land use scheme of the area and original scheme doesn't be modified.

The projects of Designated Soil and Water Conservation Zone have to be reviewed at least once in 5 years. Obviously, boundary of the Designated Soil and Water Conservation Zone may change after control of the hazard by implementing the plan, or might expand after another hazard. The local government or the stakeholders can submit the proposals of the repeal Designated Soil and Water Conservation Zone to authority. Of course, the authority must evaluate all the details for modifying the boundary of the Designated Soil and Water Conservation Zone, even cancel the whole project if possible.

Some Debates of hazard mapping program in Taiwan

Sensitive area and hazard zone in hazard mapping program

The projects of Designated Soil and Water Conservation Zone originally designed for conservation on slope land, but in practice the projects mostly focus on mitigation of landslide and debris flow hazards. Therefore, from the viewpoint of the conservation, the area, where the hazard may be induced by physical condition or human activities, should delimitate for extra protection. For example, debris flow hazard may occur in a steep torrent with enough debris materials and water. The debris materials and water might increase dramatically by improper excavations or activities in the upstream watershed; for the purpose to

Table 2. Comparisons between "sensitive area" and "hazard zone" of natural hazards

	Purpose	Instruments	Instruments cost	Beneficiary
Sensitive area	1. To diminish natural hazard induced by human activities. 2. To stabilize the physical phenomena prone to natural hazard.	1. Prohibition of activities and development may induce natural hazard. 2. Implementation of control measures.	1. Land owners in sensitive area pay the opportunity cost of land. 2. Government pays the cost of project	Stakeholders in hazard zone
Hazard zone	1. To prevent the loss in the future. 2. To decrease the loss of the communities threaten by the potential hazard.	1. Prohibition of development or settlements. 2. Implementation of countermeasures.	1. Land owners in hazard zone pay the opportunity cost of land. 2. Government pays the cost of project.	Stakeholders in hazard zone

control causations of the debris flow, the watershed of the torrent should be protected carefully. We can define this area as "sensitive area", it means the area where human activities may lead to or accelerate the negative impact to environment.

On the other hands, from the viewpoint of the hazard mitigation, the area where might be affected by hazard should be protected and give a warming to the public. For example, the alluvial fan is a typical case in debris flow hazard. For the purpose to control vulnerability of the debris flow, the alluvial fan of the torrent should be declared for warning and control future loss. We can define this area as "hazard zone" or "potential hazard area", it means the area may be threaded and destroyed by specific hazards.

Obviously, we may recognize that the purpose of strategies in "sensitive area" and "hazard zone" are different. In another word, the authority must take different mitigation or prevention strategies in two foregoing areas. Of most important, land use regulation usually regards the problem of the compensation. In the case of the "sensitive area", regulations are imposed on the land owner to forbid the improper use may lead to the occurrence of hazards. However, cumulative studies indicate that reasonable regulations for public interests without compensation are tolerable, but sometimes public regulations may "go too far". That means authority should carefully adopt the regulations and avoid to over restraining the property right. If necessary, for public interests, authority has to compensate the loss of landowner. On the contrary, land use regulation in "hazard zone" regards as a concept of "police power" for preventing the obvious danger or threat from natural hazards. It means the land owners should bear the restrain because they could benefit from reducing future vulnerabilities. Of course, authority shouldn't compensate the land owners in "hazard zone". Table 2 shows the comparisons between "sensitive area" and "hazard zone" of natural hazards.

Take the hazard mapping program in Austria for example, the program focuses on the impact of specific hazards, such as avalanche, flood and debris flow. The validity of the criteria for delimitation based on the Forest Act in 1975 on § 8 and § 11. The criteria are foundations for expert opinions of the service in the procedures of authorities (Water Act, Forest Act, Landscape Management and so on) in which dangers caused by debris flows, torrent and other erosive processes (mass movements, landslides, rock falls and so on) have to be assessed. Otherwise also the releasing respectively the disadvantageous influence of such dangers has to be assessed (Fiebiger, 2004). It's clear that the purpose of the hazard mapping program, the planning of dangerous zones, in Austria is the important instrument for the management of disasters. In other words, the program basically deals with the affairs in "hazard zone".

Another example is the Sabo Act, 1897 and Sediment-related Disaster Prevention Act, 2000 in Japan. The sediment disaster prevention systems established under the provisions of the Sabo (Erosion and Sediment Control) Act are categorized as two types of system: those that regulate harmful actions that may lead to sediment disasters and those that directly mitigate or prevent harmful sediment with control measures (check dam or sabo facilities). In addition, another two laws, Landslides Prevention Act and Prevention of Disasters Due to Collapse of Steep Slopes Act, have similar concept with Sabo Act but different hazards (Sabo Technical Center, 2001). We can identify that these laws spatially aim for "sensitive area". On the other hand, the Sediment-related Disaster Prevention Act was promoted in 2000 because of awareness of increasing vulnerabilities in disaster-susceptible areas. The purpose of the Act is to promote measures for

preventing sediment-related disaster, with the aim of protecting people from death and injury, through measures such as arranging warning and evacuation systems in disaster-susceptible areas, regulating specific types of development, and taking necessary measures for controlling the structures of buildings (T. Ishizuka, etc. 2004; S. Okubo, 2004). Again, we can identify that this law spatially aims for "hazard zone" particularly.

However, in the early stage, foregoing concept was not as clear idea as now, authority in Taiwan delineates the boundary of the Designated Soil and Water Conservation Zone including the area not only "sensitive area" but "hazard zone". Moreover, there are only one control system (prohibition against any development activities) in the Designated Soil and Water Conservation Zone. We can imagine that perplexed debates on management, regulation, and compensation might never stop.

Responsibility distribution

Who should take the responsibility to reduce the risk from accident in general? We can indicate that those who are threatened by risk should bear the responsibility certainly. Nevertheless, regarding the risk of natural hazards, because individual can't afford the enormous loss caused by natural hazards, the Government sometime should step in for the public safety and interests. That is the principle idea of the hazard mitigation programs, relief funds, or hazard mitigation grant and so on. However, much evidence shows that excessive incentive projects from the Government may lead to over dependence as well as "moral risk". Therefore, how to distribute the responsibility between stakeholders and the Government and to encourage individuals to invest in mitigation or preparedness is of important in designing natural hazard mitigation system.

The Government bears the great part of the expenses in not only the projects of Designated Soil and Water Conservation Zone but other natural mitigation projects in Taiwan. Nearly 95% of the expenses of the structural measures are come from Council of Agriculture, and the rests of expenses are come from local government. Therefore, the communities shouldn't pay anything for their own risk. We can observe the fact that people who live in hazard zone claim for mitigation measures for their safety insatiably. Although some voices encourage only individuals, not government, being held responsible for their decision regarding occupancy or use hazard areas and lack of action to reduce their existing exposure ore potential economic loss (D. R. Godschalk, et al, 1999), this idea somehow seems impossible in Taiwan. The reason is the people who live in dangerous areas are relatively disadvantaged group to urban communities. Similar to the other public policies, hazard mitigation program should deal with the problem of efficiency and distribution. In other words, an idea hazard mitigation program may as well to offer the at least protection and to encourage the greater personal responsibility.

Water Construction Financing Act in Austria is a good example for illustrating the responsibility distribution. In the hazard mapping program, the federal government bears 60% of expenses of mitigation measures at most, the federal provinces pay about 23%, and rest of 17% of expenses were pay by beneficiary or communities. The stakeholders on the one hand are regulated by hazard mapping program, they are encouraged to pay some prices for reducing the risk and earning developing right back. On the other hand, stakeholders should consider if the threats from natural hazards still exist, moving away might be an economic strategy.

Impact of rival projects

The projects related to natural hazard mitigation have been lunched since 1965. In the early stage, structural measures, such as check dam, sills, detention area, permeable barrier, and so on, are the main strategy by means of preventing and mitigating hazards. Although several non-structure measures were brought into government's action recently, the public is used to aware that structural measures are the only trustworthy strategy. Moreover, mitigation projects of natural hazards are funded by the Council of the Agriculture in the past years. Nevertheless, such incentive projects occupy a large number of public expenditures to the Government, but cost almost nothing to the stakeholders in the hazard area.

On the contrary, the project of Designated Soil and Water Conservation Zone includes not only the incentive structural measures but also additional regulation. It means stakeholders under the project of the Designated Soil and Water Conservation Zone have to pay more price than those under incentive projects (Table 3). Consequently, we can expect that people prefer the simple incentive projects than the hazard mapping programs (Y.C. Ko and S.C. Chen, 2004).

Moreover, from the viewpoint of the officials of the local government (municipal government or communities), to conduct the project of Designated Soil and Water Conservation Zone are much complicated than to implement the simple incentive projects. Because of the negotiation before reaching the consensus on the project of Designated Soil and Water Conservation Zone is a terrible time consuming task. Obviously, government officers would rather take the easier project than hazard mapping program.

The system of hazard mapping programs in Austria is a good lesson for Taiwan. All the hazard

Table 3. Cost and Benefit of hazard mitigation strategies to the Government and Stakeholder in Taiwan

Strategies		Government	Stakeholders
Cost	Regulation instrument	Regulation cost, negotiate cost (low)	Opportunity cost of land properties (high)
	Incentive structural measures	Control measure cost, land cost, maintenance cost (very high)	None (very low)
Benefit	Regulation instrument	Political reputation, More allocation of budget (moderate)	Property and life (high)
	Incentive structural measures	Political reputation (moderate)	Property and life (high)

prevention and mitigation projects have to follow the hazard mapping program and coordinate with the land use planning. The system of hazard mapping program functions without rival projects. Back to Taiwan's system, however, it's easy to know to stop the other similar projects, but in fact it's not an easy task. Compare to the total annual budget in hazard mitigation projects, the project of Designated Soil and Water Conservation Zone is only 4% of the other similar projects. Obviously, no one would suffer a big loss for a little gain.

Conclusions

The projects of Designated Soil and Water Conservation Zone had lunched for 10 years; only 68 hazard mapping programs were approved in Taiwan. Our research indicated that the mixed area of "sensitive area" and "hazard zone" confuses the purpose of projects, especially in regarding regulation of activities and identification of beneficiary. We believe that the boundary of the Designated Soil and Water Conservation Zone must be modified to either a "sensitive area" or "hazard zone" spatially.

Since the project of Designated Soil and Water Conservation Zone is a legal based project, the amendment of the Soil and Water Conservation Act are necessary. One possible way is to divide the Designated Soil and Water Conservation Zone into sensitive zone and hazard zone, and each zone can be functioned by their own purpose respectively. However, it's not easy to amend the clauses in law because the politician and legislator are sensitive to the laws which concern about the regulation to the publics.

The alternative way is to revise the criterion of delimitation in practice without amending the act. From the viewpoint of the conservation, we can technically delimit the boundary of Designated Soil and Water Conservation Zone as area where should be protected from activities harmful to sediment disasters (sensitive area). Otherwise, from the view of preventing the increasing vulnerabilities (hazard zone), authority could achieve the same purpose by substitute ways, such as publishing the hazards information, and land use planning. However, the result of the modification somehow is similar to the Designated Sabo Region (Sabo Act). Therefore, following the experience of legislation of Sediment-related Disaster Prevention Act in Japan, it means a legal based program for hazard zone is necessary. This is a good direction for the authority working for.

Finally, we can regard the personal responsibility in risk and impact of rival projects as one issue. How to distribute the responsibility reasonably to stakeholders and the Government is the key point in redesigning the system. Although several approaches can be addressed, such as enforcing the communities or beneficiary pay some part for incentive projects, as well as insurance of natural hazard, the main barrier of the new approach might be stopped by political reasons. That is because any new policy might increase the expense of the publics always sensitive to the legislator and politician. However, this study indicates the causal relationship for several controversial debates to the authority in Taiwan. The study is also valuable for those countries that are trying to transform the traditional incentive projects to hazard mapping programs, our experience might be a good lesson for them.

Reference

ISDR (2002) *Living with Risk: A global review of disaster reduction initiatives*, United nation, p.41.

G. Fiebiger (2004) Hazard mapping in Austria — the state of the art, *International Workshop on Hazard Zone Mapping of Hillslope*, p.5–1 – 5–9.

Sabo Technical Center (2001) Legal system and project administration organization for erosion and sediment

control works in Japan, p.1–12.

S. Okubo (2004) Policies, specifically announcement to the inhabitants in the hazard area to be designated base on "Sediment-Related Disaster Prevention Law" enacted in 2000, *2004 International conference on slopeland disaster mitigation*, p.17–28.

D. R. Godschalk, T. Beatley, P. Berke, D. J. Brower, E. J. Kaiser, C. C. Bohl, R. M. Goebel, (1999) *Natural Hazard Mitigation: Recasting Disaster Policy and Planning*, Island Press, p.69.

T. Ishizuka, K. Takanashi, and S. Kusano (2004) Sediment-related Disaster Prevention Law in Japan, *Journal of Chinese Soil and Water Conservation*, **35**(4): 295–308.

Y.C. Ko and S.C. Chen (2004) "Designated Soil and Water Conservation Area": past research, present strategies and future direction, *Journal of Chinese Soil and Water Conservation*, **35**(2):165–175.