Lost Highway: Controversy over the Geology Act in Taiwan[1]

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Abstract

Preventing further life and property losses facing geological hazards, such as landslide and earthquake, is predominant. The change of rainfall patterns and the active plate tectonics impose a high geological risk on highly densely populated Taiwan. The legislation approach (Geology Act) and the liability approach (close to the measure taken prior to the Act) are compared to reach a suitable solution to this problem. Based on the analysis of 6 determinants, this paper concludes that the legislation approach is more appropriate than the liability approach coping with geological hazards.

Keywords

landslide, earthquake, legislation, liability, precautionary approach, risk management

I. Background of the controversy

In a sunny April day in 2010, a landslide occurred on National Highway Number 3 in Taiwan. A huge section of road suddenly gave way, blocking traffic in both directions. Nearly twenty million tonnes of earth and rock slid down the side of the mountain. Three cars and four bodies had been discovered.

Landslides are not new to Taiwan, especially in combination with flood, typhoon, or earthquake. However, in this incidence, the landslide was not preceded by days of heavy rain, neither by an earthquake. It appeared that a

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dip slope and substrata slippage were probably to blame. This section of the highway was located on a dip slope. The substrata consisted of relatively soft sandstone and shale. Years of erosion and days of rainwater infiltration might lead to the landslide.

Similar tragedies include the collapse of Lincoln Mansions condominium in 1997, and Siaolin village buried by a massive landslide in 2009 during Typhoon Morakot's visit. Both caused huge losses of lives. Therefore, not only public infrastructure, but also hillside residence on dip slope merits attention.

The unusual weather events and incidents in 2009 and 2010 make the situation grimmer. Accumulated rainfall in some regions within a few days accounted for about 1,000~2,000 mm, annual amount of rainfall in most populated regions in the island. This phenomenon is unfortunately aligned with the prediction of climate change, even though it appears too soon and too large the magnitude. Further danger lurks beneath the surface regarding active plate tectonics in the Pacific region, most significantly the Indonesia tsunami in October 2010, earthquake in New Zealand in February 2011, and earthquake/tsunami in Chile, south China, and Japan in March 2011.

Whether the society is well-prepared for climate change is one thing, while whether it is prepared to prevent further loss of lives in similar situations is another. Seemingly, the society is well-off and has certain level of related data storage and knowledge. What prevents it from adopting remedies? Is it simply too costly to warn people in the geologically high-risk areas?

The Geology Act was finally enacted on 8 December 2010. However, it had long been controversial in public debates. In fact, the content of the Geology Act itself and the struggles of passing it provide traces of answers. The Act has been under discussion and negotiation within the government since 1996. The Parliament (Legislative Yuan) completed a third reading in 2004. However, special interest groups exerted pressure. Around forty legislators therefore forced reconsideration of the proposal, and eventually eliminated it. The executive branch of the Government (Executive Yuan), for several times, had formally submitted draft bill to the Parliament for consideration. When the Act is passed, the Ministry of Economic Affairs is obliged to designate regions with special geological characteristics or vulnerable to geological disasters as "geologically sensitive areas". It also requires developers to conduct geological survey and safety assessment before

proceeding with construction. Besides, it allows the government to establish a national geological survey mechanism and require the government update relevant information. The government has in fact been working on the latter for several years.

The controversy has evolved along two issues: 1) disclosing or concealing information of geological structure and assessment to the public or not, and 2) identifying clearly developers ' responsibilities. Disclosing "geologically sensitive areas "gives warning to the public as well as signals a plunge of real estate price in these areas. Government could still monitor "geologically sensitive areas " even if the information is concealed. Subsequently, government shoulders responsibility with developers once disaster occurs. The questions are: Should the public be informed of what they cannot see from the surface? Should the developers be forced to take precaution before selling the product to customers?

This paper explores the applications of liability approach and regulation approach to the controversy over of the Geology Act. Section II gives a brief introduction of the case study area highlighting its geological, geographical and economic characteristics; Section III discusses about economics theories and principles regarding the nature of this controversy, the regulation approach, and the liability approach; Section IV compares the regulation approach and the liability approach with regard to reducing the loss incurred by future geological hazards. Section V discusses concerns on its relations with other laws and measures that may be considered by other countries interested in enacting the Geology Act.

II. Case study area

Taiwan is situated on the edges of the Philippine Sea plate and Eurasian plate in the Pacific Ocean (See Figure 1). The Philippine Sea plate keeps moving westward. When the Philippine Sea plate hits the Eurasian plate, it goes under the crust and becomes a subduction zone. The rising of Taiwan's Coastal Range is a product of this plate movement.

Taiwan is about 300 km long from north to south and 120 km wide from west to east. About 2/3 of the island consists of steep terrain. The western coastline is the most densely populated. The narrow eastern coastline also

accommodates few residential zones while mountain areas are, to a certain extent, populated and developed. The development in mountain areas often involves tourism, commercial agriculture, and construction of dams. Population density in Taiwan reaches the 16th highest in world rank, around 640 people per km^2.

The island is located in tropical and subtropical climatic zones. The annual precipitation ranges from 4,000-5,000 mm in mountain areas, and 1,500-2,000 mm in the plain and coastal areas. Most rivers flow from the central mountain area into the Taiwan Strait in the west. The rivers are short while the riverbeds are often steep.

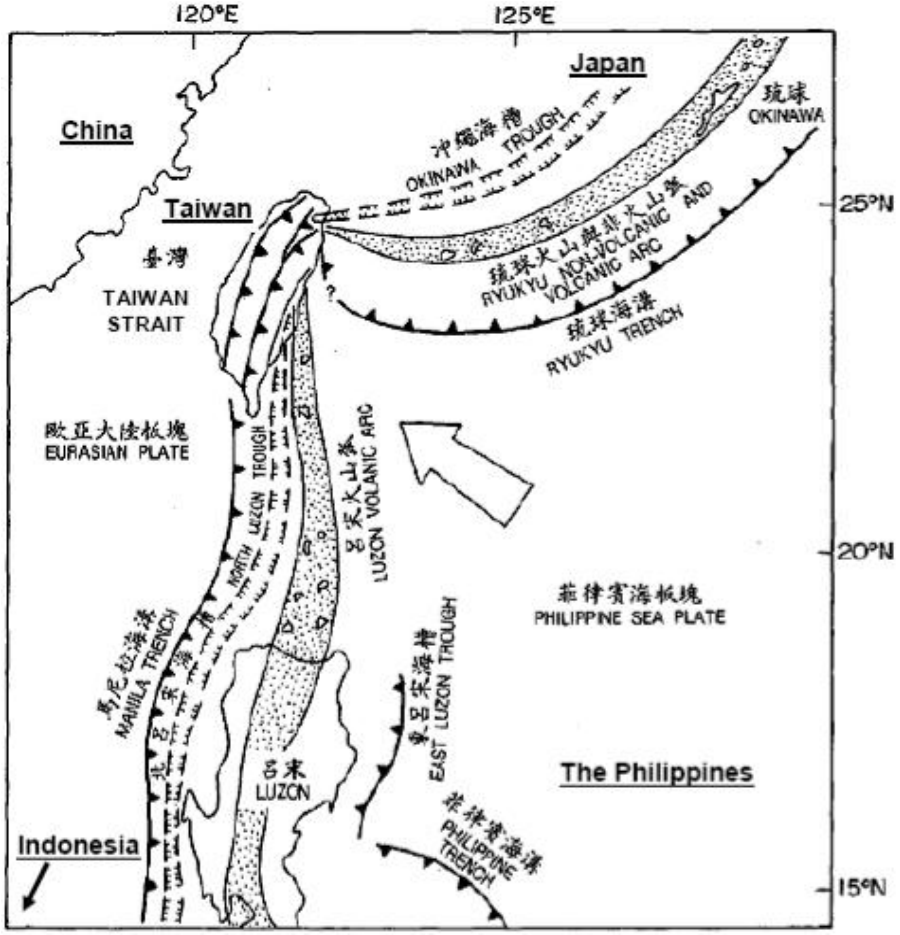

Figure 1. Cenozoic plate tectonic setting of and around Taiwan (adapted from Central Geological Survey at Ministry of Economic Affairs, 2010)

Taiwan's GDP (PPP) per capita is 30,100 US dollars in 2007, ranked the 34th highest in the world. Its GDP (PPP) in 2009 is ranked the 19th highest, according to both World Bank and CIA World Factbook. Agriculture contributes 3% to GDP, manufacture accounts for 24%, and service sector makes up for 73% of the economy.

Even though a rather well-off economy in principle has higher capacity to cope with hazards, it also implies a huge economic loss once a disaster strikes. In fact, the densely populated and developed condition corners the society with a high magnitude of life loss and property damage facing disaster.

III. What can the theories offer to resolve the controversy?

Let's start with an economist's line of thought. If a consumer chooses to purchase the product (e.g., house) or service (e.g., using the highway) being aware of the underlying risk, it is an efficient resource allocation, an optimal market equilibrium. However, market can fail due to information asymmetry. Producers of real estate might have more information about the geological risk of the area than the customers might do; however, producers, comparing to the cosumers, are often less motivated to prevent disasters from happening. It is often profit maximisation that producers are after. The deviation of developers' private optimal choice from the public's social optimum is externality. Here we have market failure.

The existence of market failure is often used as a justification for government intervention in a particular market. The situation is slightly more delicate here because the government itself also faces information disclosure concerning public goods. Every day thousands of people drive on the national highways. They are required to pay tolls for these roads. If we take the similar analysis on producers and consumers, they should also have the right to expect that these roads are safe. The government can take measures to impose the cost on producers either beforehand or afterwards. What are the costs and benefits *ex ante* and *ex post*? Precautionary principle and liability principle are applied; regulation approach and liability approach are outlined accordingly.

1. *ex ante*: precautionary principle and regulation approach

The precautionary principle asserts that there is a premium on a cautious and conservative approach to interventions in which our understanding of the likely consequences of the intervention is limited, and there are threats of serious or irreversible damage. In such circumstance, the burden of scientific proof should therefore lie on would-be disrupters to demonstrate that their actions will not result in unacceptable damage (Myers 1993; Pearce and Barbier 2000). Applying to this case, the disrupter refers to developer. The damage is no longer merely the damage to the nature which is indicated above. Rather, the major damage concerned here is mainly the loss of lives (and properties of course).

The regulation approach could be adopted applying precautionary principle. The regulation approach establishes, manages, and enforces standards and procedure in order to prevent and deter behaviour which may lead to losses associated with a specific hazard *ex ante*. Its advantage is to take measures in prevention, to offer opportunity of conducting systematic assessment, and to monitor the targeted hazard. However, it suffers from limitations as most other centralised systems do. That is, the government should possess sufficient information and the system should be flexible enough to adapt to changes and unforeseen circumstances. Furthermore, the government in principle should adequately resist political pressure from interest groups.

2. *ex post*: liability principle and liability approach

Liability principle suggests the party who is liable (defendant) to provide victims (plaintiff) with monetary compensation, after the proof of the fact. The amount of monetary compensation should correspond to the amount of damage inflicted.

Nevertheless, liability is not restricted to the act of negligence. 'Strict liability 'is usually applied in circumstances where the activity in question is inherently hazardous. The plaintiff does not have to prove negligence. The defendant is declared liable as long as the activity cause damage. The activity could be completely legal and the defendant could comply with all relevant laws.

Liability approach allows victims (plaintiff) to file an action claiming a causal link between the defendant's conduct and the plaintiff's loss. Government (or, to be specific, the judicial system) is activated *ex post*. Even

though it is often considered as an *ex post* measure, the potential punishment might stimulate developers to take measures *ex ante*. Therefore, its advantage is providing opportunities of internalising the externality both from incentives (*ex ante*) and compensation (*ex post*) perspectives. However, it is subject to the following disadvantages (Boyer and Porrini 2002): relying on case-specific judgement, challenging in establishing causal link, and costly lawsuit.

Isn't it just convenient to employ this principle? Once something happens, developers, if identified to be responsible, should take the responsibility any how. Nevertheless, the implementation of this principle turns out to be difficult in practice. Whether it is fair to developers or not is also debatable.

IV. Application to this case study

This section compares the application of regulation approach and liability approach considering the reduction of future losses induced by geological hazards. That is, in this case, giving the public and the developers incentives to take precautions towards geological risk such as landslides *ex ante*; or deterring developers *ex ante* to a certain extent and covering the costs and compensating for the damage *ex post*.

In order to correct market failure, government would unavoidably intervene in real estate market, and tourism and commercial farming in the mountain areas. Here it lays the huge controversy over the Act. It involves enormous amount of money and powerful interest groups. How will the regulation approach and liability approach work its way to face the controversy? Revealing or concealing information to the public in combination with other risk prevention or compensation measures? Which approach would be more appropriate in this case?

1. regulation approach

The Geology Act adopts the regulation approach. It allows the Ministry of Economic Affairs to designate and publish "geologically sensitive areas" where special geological characteristics are present or are vulnerable to geological disasters. It also requires all developers to conduct geological survey and safety assessment before proceeding with construction. Apart from

enforcement, the government by law also has the obligation to establish and to update a national geological survey.

The Act identifies responsibilities of the government and of the developers on releasing information and taking precaution in advance. It will hopefully help estate buyers steer away from locations that are susceptible to landslides; it will stimulate enterprises to reconsider their tourism and commercial agriculture in the mountain areas; it will also suggest visitors to think twice about their visits.

However, the regulation approach faces political pressure from developers and estate owners. Also, the government itself might be under pressure by taking measure on infrastructure allocated in geologically sensitive areas.

It is often the users/residents, instead of the developers or the government, who would have more incentives to prevent themselves from stepping into the risk. The regulation approach attempts to ensure that the public is kept well informed. Therefore buyers, residents of the real estate, and visitors and users of designated geologically sensitive areas could make decisions based on relatively sufficient information.

2. liability approach

How does the system look like when we apply the liability rule in this case? It had long been mainly State liability prior to the enactment of the Geology Act. In the case of residential areas, developers are sued and national compensation is offered.

It is also possible to transfer this liability to developers in the case of hillside residence and mountain development according to the liability approach discussed in the previous section. By doing so, a developer is not only obliged to providing compensation *ex post*, s/he is also deterred from taking risky measures *ex ante*.

It is perhaps the strict liability that should be considered here. Developers are engaged in inherently hazardous activities once they choose geologically sensitive areas for development. Developers therefore need to take responsibility for the losses as long as geologically related disaster occurs, even though they do not violate any law in the process of development.

3. regulation approach or liability approach?

Table 1 compares the regulation approach and the liability approach applying in the case of the Geology Act in Taiwan. In order to make a choice between the two approaches, determinants identified in Shavell (1984) and Boyer and Porrini (2002) are employed. In addition to confirming the four determinants suggested by Shavell (1984) and complementing, rather than entirely rejecting, the fifth determinant raised in Boyer and Porrini (2002), this paper adds the sixth determinant.

Shavell (1984) suggests four determinants of the relative desirability of liability and safety regulation. The first determinant is the possibility of a 'difference in knowledge about risky activities as between private parties and a regulatory authority.' As pointed out by Tietenberg (1998), legislative remedies such as the Right-to-Know laws are not sufficient if there is too little information to be shared. In the case of Geology Act, there has been years of monitoring and record-keeping concerning the geological assessment all over the country. Therefore, there is no worry about information availability while one chooses the regulation approach.

The second determinant is that 'private parties might be incapable of paying for the full magnitude of harm done.' The scale of damage caused by landslides by far has been tremendous, mainly resulting in loss of lives and properties on this densely populated island. The price for developers to compensate damage is often too high to pay. In other words, developers might not be able to afford to compensate the damage in the liability approach. The scale of damage in most incidences has proven to be too huge to be recovered. If the liability approach is taken, it may end up with the situation that either the government and tax payers shoulder the responsibility or the victims bear the cost/loss themselves.

The third determinant is that 'parties would not face the threat of suit for harm done.' Even though it is often geographically focused, and the harm done is often instant, it might be difficult to attribute harm to the parties who are in fact responsible for producing it. In the case of landslides, there are two possibilities regarding tracing responsibilities: First, it could be easy to trace which damage occurs on site and no obvious link with activities in the neighbouring areas. Secondly, it could however be difficult to identify the

responsibilities in cases which upstream development takes place. Whether it is on-site developer's or/and off-site (upstream) developer's responsibility becomes difficult to answer.

Table 1. Comparison of regulation approach and liability approach facing uncertainty: in the case of Geology Act in Taiwan

Characteristics	Regulation Approach	Liability Approach
Actors	Ministry of Economic Affairs, local government, developers	Developers, victims, judge
Action	Setting standards, rules and enforcement	Suits
Time of intervention	*Ex ante*	*Ex post*
Principle applied	Precautionary principle	Liability principle
Affecting behaviour of developers	Directly modified by requirement	Indirectly deterred
Information required	Comprehensive, in order to set the regulation properly	Specific, to the targeted case/victim
Facing large scale of damage	More capable to cope with	Less capable to cope with
Accommodating irreversibility of damage	Possible	Less likely
Benefits	Preventing and deterring development activities which may lead to geological hazards (*ex ante*)	Stimulating developers to take measures *ex ante* and demanding developers' compensation *ex post*

Costs	Administrative cost, current loss of property market value, developers ' cost of conducting geological assessment and taking precaution	Potentially high cost regarding loss of lives and property once disaster occurs, and cost of lawsuit
Difficulty or easiness of tracing responsibilities	Relatively easier	Relatively more difficult

The fourth determinant is the 'magnitude of the administrative costs incurred by private parties and by the public in using the tort system or direct regulation. 'Conducting, updating, and monitoring a geological survey system, as well as enforcement of regulation consumes public budget. Also, the production cost of developers increases due to survey, assessment and possible precautions taken. On the other hand, lawsuit is often time-consuming and apparently costly. In this case, both approaches seem to unavoidably employ huge amount of administrative costs.

Boyer and Porrini (2002) add the fifth determinant, 'the possibility of capture and collusion between the enforcers and the parties. 'They interpret it as: if the external pressures in the case considered are likely to be very strong, the liability approach would be better than the regulation approach. This case indeed faces considerable external pressures. However, there is another factor which may influence the possibility of collusion between the enforcers and the parties. That is, the continuity and consistency within geological information. It is not entirely impossible, but it would be rather tricky for developers and government to collude once the geological information is revealed to the public.

However, one crucial determinant is somehow ignored by both Shavell (1984) and Boyer and Porrini (2002). That is, 'the irreversibility of the damage that might occur. 'Life loss is the major concern in this case. Most geological hazards by far unfortunately appear in conjunction with life loss. Besides, change of landscape would be highly costly to recover. The implementation of the Geology Act would indeed very much likely cause a plunge in real estate price in the designated areas, and impose costs on developers to conduct

assessment and to take precaution. However, it is more worthy to prevent loss of lives, rather than providing monetary compensation for the life lost. Taking the liability approach implies geological information is not obliged to be revealed. It might not be able to prevent people from moving into high-risk zones. Since people do not become aware of the risk of the area one resides or travel through/to, and government fail to take action to review existing and planned infrastructure in the high-risk zones, it has potentially high cost regarding life and property losses in the future.

V. Discussion

Sometimes we can detect the change beneath the surface, such as from the gradually mismatching doorframe due to land-subsidence within the reclamation area in the Netherlands. Sometimes, we just can't. The risk lurking underneath the surface may appear in the form of landslides after accumulation of 'sufficient' water, or energy in other forms.

In order to reduce losses from geological hazards, the legislation approach outweighs the liability approach based on the analysis of the 6 determinants. The conclusion supports the enactment of Geology Act. The Act aims at disclosing relevant geological information and imposing responsibility to developers. Hopefully it will steer housing and other development activities away from geologically sensitive areas.

For countries interested in enacting a regulation like the Geology Act, the following discussion prior to the enactment may serve as temporary measures. For instance, some information is made available by the Central Geological Survey at Ministry of Economic Affairs for the public to search, to discuss, and if necessary, to take precaution. After the landslide of National Highway Number 3 in April 2010, the Highway Department indentified 32 locations where dip slope with high risk of landslide in the same highway. Closely monitoring these 32 locations and keeping fingers crossed is what the Department did.

Further work is required in order to properly implement the Geology Act. For instance, the disaster maps completed in recent years are mostly small scale maps at 1:30,000 or 1:50,000 scale. By contrast, urban planning maps or urban land maps are large scale maps at 1:1000 or 1:5000 scale. The two are

simply difficult to compare. There is a need for harmonising development and disaster prevention work.

Harmonisation is also necessary among regulations. For instance, it is likely that all geologically sensitive areas listed in Geology Act are included in land conservation zones covered by the National Land Planning Act, with restrictions on their development.

Lastly, evaluating the employment of both legislation and liability approaches may deserve further study. In some circumstances it might be worthwhile to consider the combination of both regulation and liability approaches. The two advantages of combining liability approach and regulation highlighted by Tietenberg (1998) may worth further consideration: 1) Liability law usually provides the only way the victim of an accident can get compensated; 2) the degree to which they can be tailored to individual circumstances. Taking into account the similarities among the incidences of geological hazard in this case, and room for adjusting Geology Act, regulation alone might be just sufficient at this stage of discussion.

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