Chapter 15
Post-Morakot Land Use Implications for Taiwan

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Abstract Because of its geographic position and special topography and geological conditions, many disasters have been caused by earthquakes and extreme rainfall in Taiwan in recent years. Especially, climate change brings about extreme rainfall intensity, and typhoons bring extreme torrential rain, which usually causes landslide, debris flow, and flooding in mountain areas and low-lying areas in Taiwan, such as the disaster Morakot that resulted in the greatest casualties to Taiwan in 2009. Based on the results of field surveys, the lack of an integrated plan of land use and extreme rainfall are the causes bringing about these catastrophic disasters. The Government has applicable policies in response on rule-making and policy implementation for avoiding similar problems happening again. For example, in the Typhoon Morakot Reconstruction Special Act, development is prohibited in specific areas and insecure areas to avoid repeated threats to living safety in environmentally sensitive areas and vulnerable areas. In addition, after Morakot many counties reviewed the articles of the regional planning law to enhance the measures of disaster adaptation and disaster mitigation, including the norm of land use on hillside land and governing in coastal flooding areas, intending to reduce casualties and property losses from disasters through applicable land use strategy.

Keywords Disaster Morakot • Land use management • Climate change

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15.1 Introduction

The disaster Morakot was a terrible flood from August 6 through August 10, 2009. The typhoon struck Taiwan for about 96 h, and the torrential rain caused much damage, especially in central and southern Taiwan. The people confronted the most catastrophic flood of the past 50 years. This section analyzes the extent of the damage and its influence on Taiwan.

15.1.1 Damage Extent

Typhoon Morakot made landfall in Hualien, in eastern Taiwan, and remained in Taiwan about 5 days. The greatest rainfall in Taiwan caused by Morakot occurred in Chiayi and Pingtung counties. Typhoon Morakot caused the most catastrophic damage of the past 50 years, including soil loss, driftwood deposits, floods, and flooding. According to statistics of the Typhoon Morakot Central Disaster Emergency Operation Center, Morakot caused 699 deaths and disappearances and 4 injuries; traffic was stopped, and power failures, water outages, agriculture damage, water conservancy facilities damage, serious soil calamities, channel-fill deposits, driftwood deposits, and flooding, etc. occurred (Jenn-Chuan Chern 2010).

When Morakot struck Taiwan, the Siazhu River, next to Siaolin village (Chiahsien township, Kaohsiung county), rose suddenly and sharply; in an undeveloped area named Mountain Xiandu, more than 1000 m in elevation at the northeast side of Siaolin village, a landslide occurred because of the torrential rain, which brought a large amount of sediment flow into the Nanzixian River, causing the river course to become blocked by sediments and form a large dammed lake. The 9th to 18th neighborhoods of Siaolin village, including the Siaolin elementary school, Siaolin Public Health Center, and Siaolin Police Station, were all destroyed by the floods and landslides, and 491 residents disappeared.

15.1.2 Environmental Impacts

The areas suffering the main influence of Morakot are in central and southern Taiwan. Heavily damaged areas are Nantou, Chiayi, Tainan, Kaohsiung, Pingtung, and Taitung (Fig. 15.1); among them the most seriously damaged townships are Chiahsien (Siaolin village), Namasia, Liouguei (Xinkai village) in Kaohsiung county, and Linbian, Jiadong in Pingtung county, and Beinan (Jhihben Hot Spring area), Taimali in Taitung County. The greatest rainfall was in Alishan of Chiayi county; the cumulative rainfall in 3 days of about 2854 mm caused serious flooding in central and southern Taiwan (Fig. 15.2). After Morakot, new added collapses totaled 39,492 ha, and the estimate of mud–sand production was 12,000,000 m^3

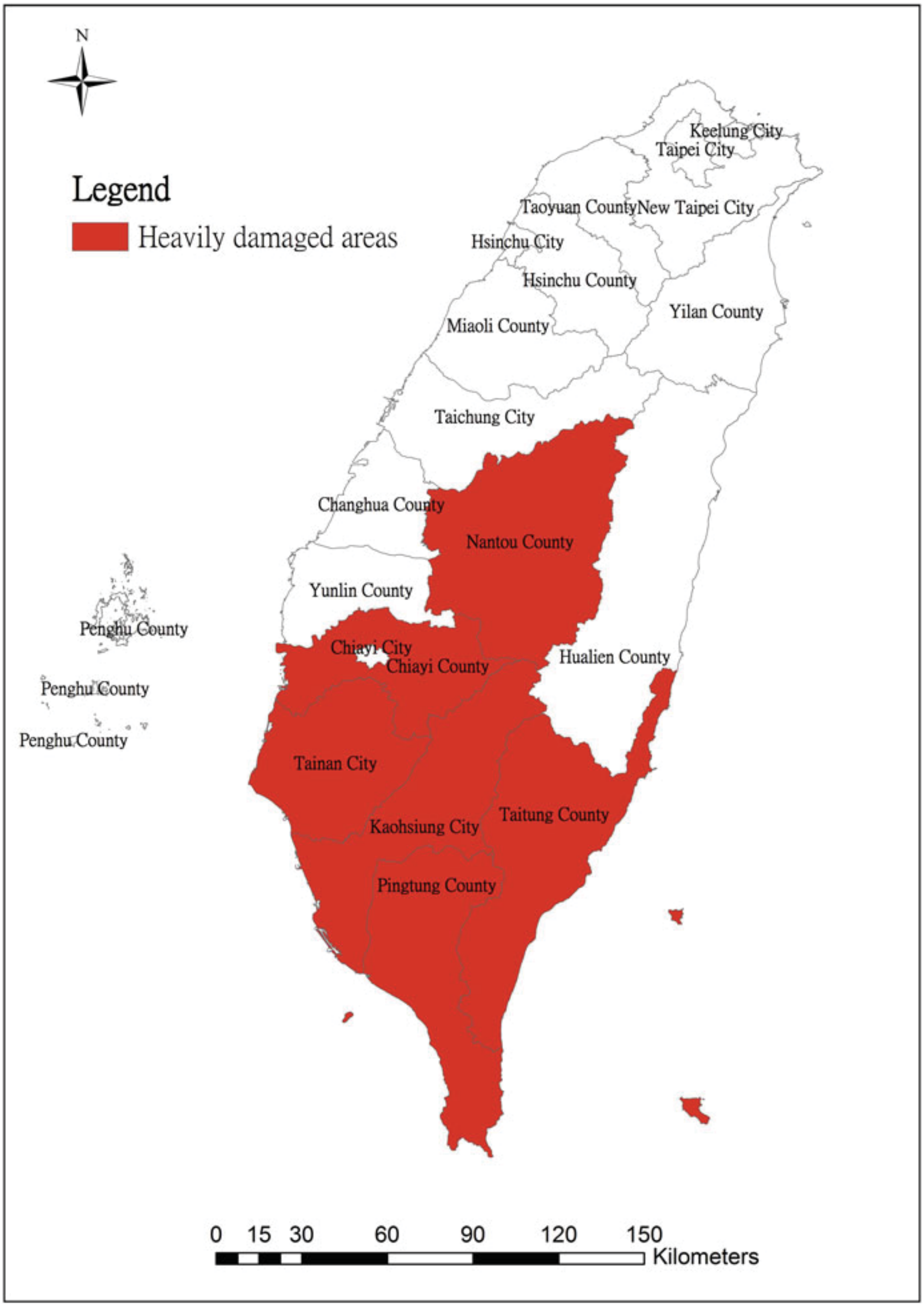

Fig. 15.1 Heavily damaged areas in Taiwan caused by Morakot

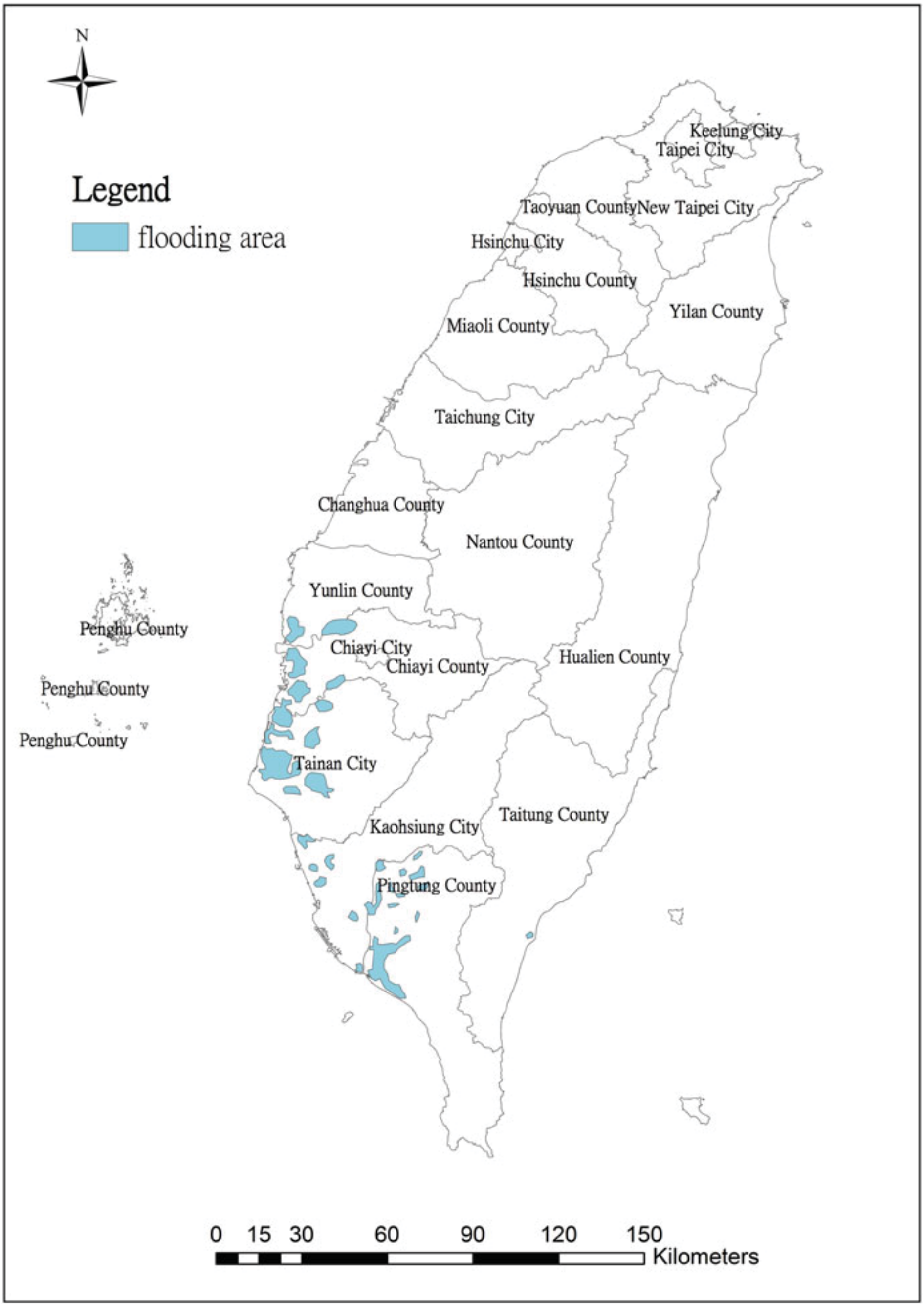

Fig. 15.2 Distribution map of the flooding area

(equivalent to 650 Taipei 101 buildings); among these the amount of residual slopes is 800,000,000 m^3 and the amount of effluent sand is 400,000,000 m^3 (Jenn-Chuan 2010). Seventy-five percent of the collapse was distributed among areas 200 to 2000 m in elevation, especially between 600 and 1600 m, involving about 50 % of the collapse. Grades between 20° and 50° were involved in 80 % of the collapse, especially that of 30°–40°, involving about 35 %. The distribution map of landslide disasters caused by Morakot is shown in Fig. 15.3, from which we can see the main area of landslide disaster is in Chiayi, Tainan, and the mountain areas in Kaohsiung, and these areas are also the locations of hillside development and villages (Landslide Disaster Reduction Team of National Science and Technology Center for Disaster Reduction, and Department of Social and Regional Development, National Taipei University of Education 2010).

15.1.3 Impacts on Victims of Morakot

Typhoon Morakot came in August 2009. In all regions, the high intensity and long duration of the rain caused catastrophic disasters in southern Taiwan and brought large-scale collapse to many places. These natural disasters cannot be controlled by humans, usually because of carelessness or lack of concern, and the consequences are unpredictable and inconceivable. Disaster Morakot inflicted serious damages in Kaohsiung, causing much damage to property, families, life, and the spirits of the victims. The most catastrophic damage occurred in Siaolin village, Chiahsien township, and Nansalu village, Namasia township. Nansalu village experienced a landslide disaster, in which were destroyed people's homes and the city center; many people were forced to move to other towns to restart their lives.

This section is about the impacts on victims of Morakot, involving environment and psychology.

15.1.3.1 Impacts on Rural Social Life After Morakot

Disaster Morakot brought large-scale flooding to rural homes, farm losses, traffic stoppages, and it threatened the safety of victims' lives and caused total agriculture loss at a record high of about 129 hundred million NTD. Among them, total crop loss was 49.9 hundred million NTD, the total loss of farmland covered up or blown away is 76.5 hundred million NTD, and the total accumulated losses of agriculture facilities are 2.5 hundred million NTD (Council of Agriculture, Executive Yuan 2010).

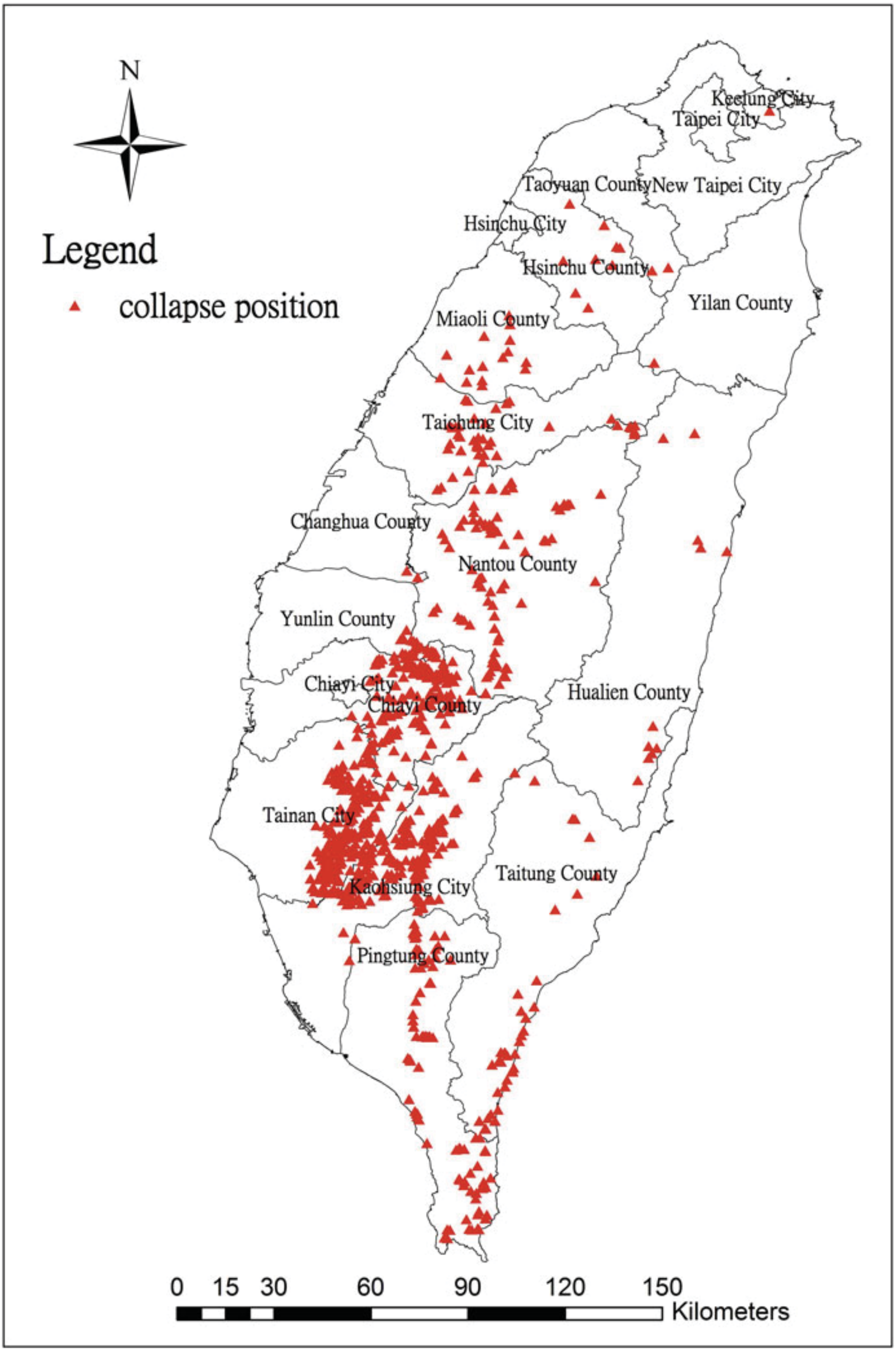

Fig. 15.3 Distribution map of landslide disasters that happened during the Morakot Typhoon

15.1.3.2 Impacts on Public Health After Morakot

The first issue of public health in damaged areas is the garbage left by Morakot, which made the environment dirty and odorous and will foul the water, causing victims to be threatened by communicable diseases. Moreover, if the water supply and power supply cannot be recovered at the first opportunity in damaged areas, some problems might be easily be caused such as keeping food fresh and sanitation. Waterlogging and a dirty environment are present in damaged areas, and when victims clean their homes after a disaster, they usually risk post-disaster communicable diseases and impaired health because of contacting dirty water and mud or because waterlogging results in the multiplication of the vector mosquito fly.

15.1.3.3 Impacts on the Spirits and Mentality of Victims of Morakot

Typhoon Morakot inflicted serious damage in southern Taiwan. When many first-line rescue medical personnel went into the damaged areas, they faced was dead people, destroyed buildings, and crying and shouting everywhere. When people are immersed in fatigue and helplessness for a long time, having uncomfortable mental reactions is difficult to avoid. The most gnawing thing to the victims is that the situation would not be getting better with the passage of time. Moreover, being in touch with the bad news from media reports might have negative influences on their bodies, emotions, and thoughts. Generally speaking, people might have experienced some different kinds of mental reactions after experiencing disasters. Most people will have some symptoms of post-traumatic stress disorder (PTSD), which usually manifests in 3 months, and in some the reaction is delayed to several months or several years later. After a disaster such as Morakot, especially when it threatens life or brings catastrophic damage, the post-disaster emotional and spiritual syndrome is usually one of the effects on victims still living. After the disaster, it is only a start for the recovery of the victims; to help them restore them from PTSD, the most important matter is to introduce and use the power of social support skillfully (NCDR 2010).

Even so, people are still working hard on reconstruction after the disaster; for example, in all townships in mountain areas including Liouguei, Taoyuan, Jiasian, and Namasia, floods and the flow of debris broke down many external access roads. Many villages and famous scenic areas (e.g., Bulao Hot Spring, Maolin National Scenic Area, Baolai Hot Spring, and Liouguei scenic area) were seriously damaged, but reconstructions were started one after another by the cooperation of central and local governments, and NGOs, after the disaster. For more than 1800 people, 756 Yuemei permanent houses were finished so they could start their new life here. The Kaohsiung City Government gave guidance to inhabitants to establish a “Shanlin-Daai Park Management Committee” to help them manage their community and do reconstruction work together. Also, the broken-down Jiasian Bridge was finished 4 months sooner, which improved external access in Jiasian, Namasia, and the connection to Baolai, Taoyuan, etc. The recovery of roads in Jiasian and the tourism industry are expected to revitalize the local economy to assist victims to return to a normal life as soon as possible (research report of the Control Yuan 2010).

In addition, Tai-21st Highway in Kaohsiung from Qishan, Shanlin-Daai village, Yongling organic agriculture farm, Jiasian business district, Wulipu-Siaolin village, an Siaolin village memorial park, etc., will form an embryonic form of gallery with national demonstration significance, including the Yongling organic agriculture farm, which is expected to develop into an organic agriculture distribution center, for supporting victims to obtain employment and continue well; the purpose is positioned with "Living, Producing, Ecology," three kinds of industries, combined with Art, Holiday Farm, and Organic Products sales, providing a diversity of experiences when traveling. This center is expected to create 500 jobs and rebuild artificial scenery provided with ethnic group culture and life educational meanings.

When a typhoon arrives, even though emergency rescue in the early stages is important, applicable reconstruction policies and enforcement plans are also important for the victims' future, not only to mobilize social resources from outside damaged areas but also significantly to encourage the victims themselves to improve their motivations and intentions. The final purpose in reconstruction of a typhoon catastrophe is that victims could recreate new chances and help people in distress, and this can attain the utilities of disaster prevention, disaster rescue, and life reconstruction.

15.2 Review of Causes of Disaster Morakot

Typhoon Morakot resulted in many types of disasters in southern Taiwan in 2009, including landslides and floods. The causes of the disaster are mostly related to the extreme rainfall and poor land use. This section is the analysis of factors related to this issue.

15.2.1 Inadequacy of Land Use

The types of landslide disaster caused by Morakot are collapse and debris flow, also disastrous floods in low-lying lands. The cause of collapse and debris flow in mountainous areas is probably poorly planned land use of hillside lands, and the cause of flooding is probably the long-existing land subsidence problem at shorelines and inadequate land governance along rivers.

According to research, Morakot caused large-sized collapse in several catchment areas of reservoirs: Zengwen reservoir in Dapu, Chiayi is an example, with a collapse area about 1467 ha, and Nanhua reservoir in Nanhua, Tainan, with a collapse area about 810 ha. Most collapse areas occurred upstream and midstream of catchment areas, probably the result of heavy rainfall. But there was only a small area of collapse, about 24 ha, in Mudan reservoir (Mudan, Pingtung), probably because of good vegetation, a better lithological character, and less artificial development in the catchment area of the reservoir (NCDR 2010); this difference suggests that artificial development in the catchment area has a partial effect on the collapse of hillside land.

To understand the relationship between landslide disaster and land use, we can see Namasia in Kaohsiung as another example, based on the survey results of nationwide land use from the National Land Surveying and Mapping Center (Disaster potential maps website of NCDR). The potential debris flow torrent area for a landslide disaster is 65 % in Namasia; if classifying land use in Namasia, we know the largest part of the potential debris flow torrent area is used for agriculture (47 ha), and the next is forest (34 ha). Because the moisture-holding capacity of crops is less, land in agriculture use might be seriously damaged as a debris flow occurs, and for this reason land use in damaged areas shall be adjusted from a landslide disaster region.

Excepting collapses on hillside land, flooding in the plains region is also related to exploitation and management of the lands or channel governance. Morakot caused estuarine expansion in Taimali River, Taitung, and levee failure and inundation in Linbian River, Pingtung, because the original river region was brought into regional development or the levee restricted the flood space. In addition, settlements downstream of Zengwen River had experienced previous flood disasters; although the Zengwen reservoir can provide flood relief upstream, the flood space downstream is too small so that floods can still exceed the levees and cause levee failure (NCDR 2010). So, illegal land use and misuse of land should be modified.

15.2.2 Excessive Rainfall

Morakot had high-intensity rainfall patterns and a high accumulation of rainfall for the long time of 96 h, and heavy rainfall from August 6 to 8 that exceeded the engineered standard of watershed flood control, and the steady accumulation of rainfall on hillside land in catchment areas caused serious disasters. A single episode of maximum rainfall in 24 h or in 48 h both rank in the top 20 events in historical records, so we can see the total accumulated rainfall of Morakot is greater than that of other typhoons with a wider distribution region. The 48-h accumulated rainfall of Morakot is greater than that of Typhoon Herb, becoming No. 1 in Taiwan's typhoon history.

Most disasters of Morakot were compound disasters, including collapse, debris flow, dammed lakes, driftwood, levee failure, traffic obstructions, flooding, and channel-fill deposits, which are related and dynamic, differing from an earthquake, which is short term and concentrated. This section sums up all types of disaster causes related to exaggerated rainfall intensity (NCDR 2010).

15.2.2.1 Flood Disasters

1. The hourly precipitation rainfall intensity in many regions overwhelmed the engineered standard of the rainwater drainage system, delaying drainage of deluges and causing flooding.
2. Extreme rainfall in mountain areas caused many hillside land collapses; a large amount of mud and stones was washed by the deluge to midstream and downstream, resulting in heavy deposits in rivers and reduced water areas that were then inundated.
3. Many levees were broken in this disaster because of flood discharge on rivers that exceeded the engineered protection standard, resulting in flood disasters; for example, the levee was broken and caused a flood that rose higher and higher, flooding over the whole village downstream of the Taimali River in Taitung. Linbian, Jiadong, and Donggang in Pingtung are in land subsidence and flood risk areas, and they also had serious floods caused by levee failure of the Linbian River.
4. Land subsidence areas in Dongshih, Budai in Chiayi, Dacheng in Changhua and Kouhu, and Sihhu in Yunlin also had flood disasters.
5. Water levels on several rivers exceeded Level 1 alert; the high water levels caused failure of the waters to drain away and the occurrence of ponding on both sides along rivers in low-lying areas.

15.2.2.2 Landslide Disaster

1. The main basins of collapse caused by Morakot are Gaoping River, Jhuoshuei River, Zengwen River, the Taitung coastal river system, and Linbian River; the collapse area in all basins after the disaster is as great as 39,492 ha. Only a small number of these basins are agricultural use land; the others are mainly on forested land. Further analyzing land use types in collapsed areas, forested land is the land type in which collapse most easily occurs. The largest collapsed area is also on forested land; forest land collapse midstream and upstream in basins is the major cause for large amounts of soil, stones, and driftwood midstream and downstream. We estimate a large amount of collapse on forested land occurs because of rainfall intensity that exceeds the hillside slope capacity.
2. The geology in southern Taiwan is mostly mudstone, sandstone, shale, and sandshale; very serious weathering occurs in these geologically vulnerable areas. A heavy rain will cause faster collapse and soil erosion, and then disasters can happen.
3. The roads in mountain areas were blocked or failed to drain because of heavy rain, which washed out the roadbeds and resulted in hillside slope collapse up and down from the roadbeds.

Also, the heavy rain also damaged public buildings or structures, such as the many roads that were seriously damaged mainly because the accumulated rainfall was too great and the duration of the rain too long, exceeding the tolerability of the slope of the roads. In another event, the main structure of a bridge could not resist the instantaneous force and was destroyed because the flood washed it away, or debris flow that occurred upstream and the height of the river's flood stage or its flow exceeded the design peak flow of the bridge. Further, because of the heavy rain the levees were attacked and washed out by flooding, causing levee failure.

15.3 Land Use Management After Morakot

According to the points previously mentioned, a part of the disaster caused by Morakot is land use and management. Thus, this section probes landslide disasters, discusses the relationship between land use and landslide disasters, and discusses how the Government should develop the norm of land use post Morakot.

15.3.1 Geological Disaster Potential in Taiwan

Before interpreting hillside land use in Taiwan, we should know the locations where geology disasters such as collapse or debris flow might occur. If we can categorize land use types in Taiwan and overlap these with sites of potential geological disasters, we can analyze the relationships between all kinds of geological disaster potential and land use. This section can only interpret from the disaster potential data we have collected. Several great typhoons, floods and earthquakes such as the Jiji earthquake occurred in Taiwan; the geological disaster potential is enhanced every year. Four types of geological disaster in Taiwan are slides of debris, rock slides, falling rocks, and dipping slopes (Fig. 15.4a). The Morakot typhoon brought overly abundant rainfall, resulting in complex disasters happening all at one time, such as hillside land collapse in mountain areas, debris flow, flooding, dammed lakes, and dam failure. The heavily damaged areas of landslide disaster are in Nantou, Chiayi, Tainan, Kaohsiung, and Pingtung (Fig. 15.4b). In the disaster site pictures shown in Fig. 15.5, debris flow and collapse in the Chiayi mountain area caused by Morakot are shown. Comparing with Fig. 15.4, we can see the collapse positions caused by Morakot are similar with the results of geological disaster potential predicted from research, which shows that we already can preliminarily control the signs and characteristics of geological disaster caused by natural disaster events, and this will help us to carry out preventive geological disaster work in the future.

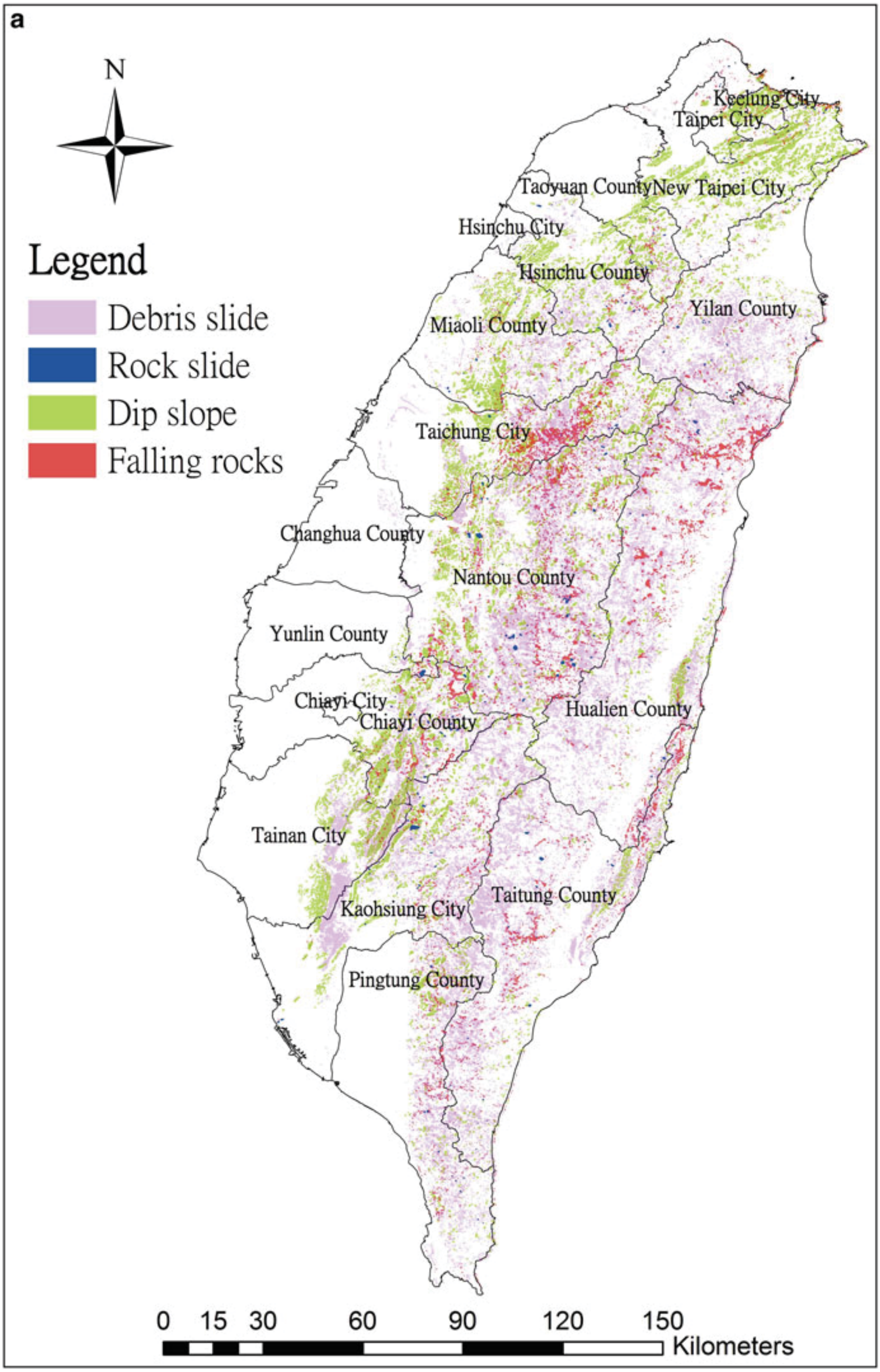

Fig. 15.4 Taiwan geological disaster potential and collapse positions caused by Morakot. (**a**) Taiwan geological disaster potential.

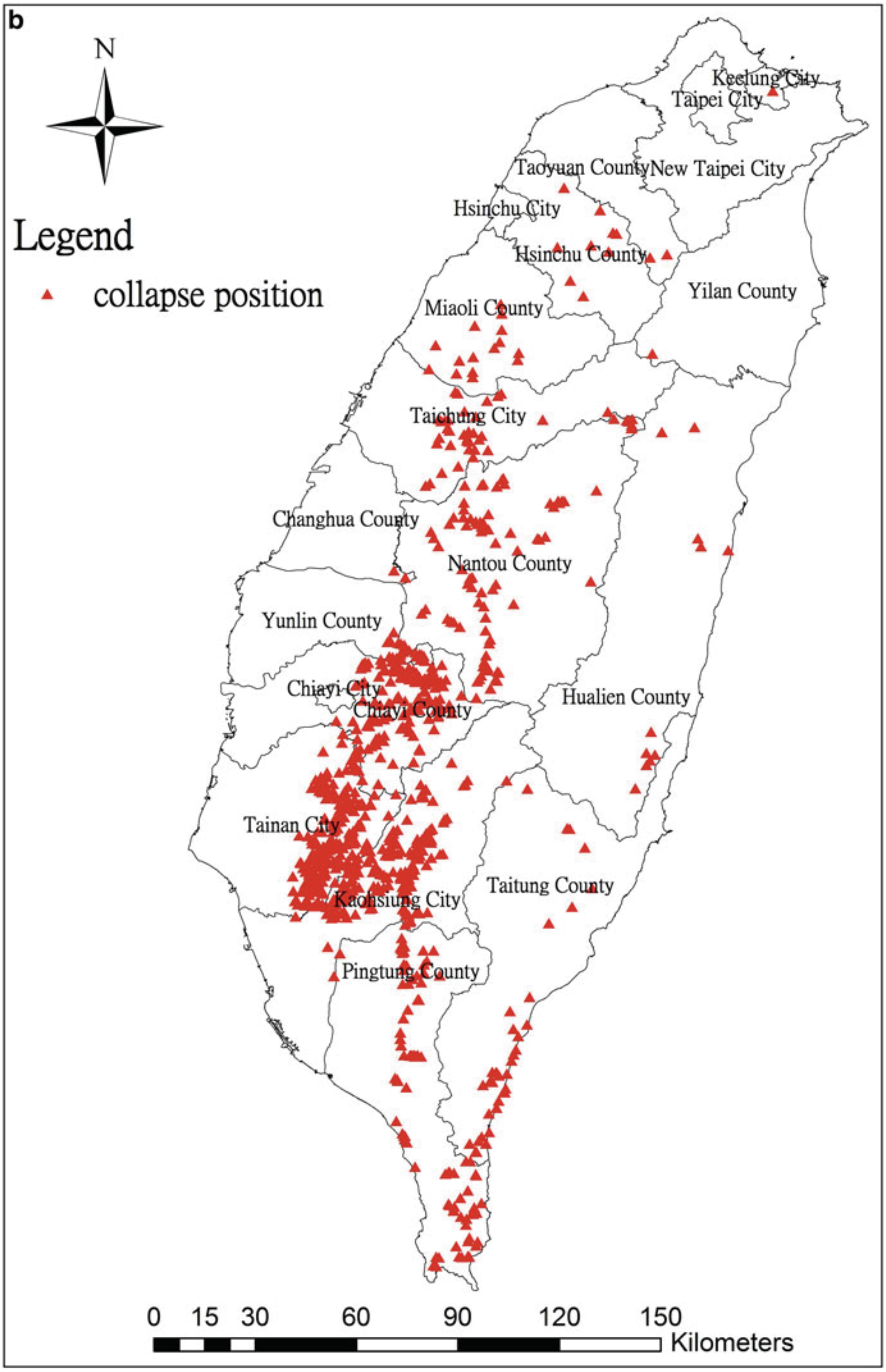

Fig. 15.4 (continued) (**b**) Distribution map of landslide disasters

15.3.2 Pre-disaster and Post-disaster Hillside Land Use

Before Morakot, hillside land use and management in Taiwan incorporated foundation placement, spreading, and hillside conservation and management, and establishing a Soil and Water Conservation Act, but there is no appropriate growth management concept. In the 1970s, Taiwan was just in the economic development period and the punitive provisions of the related legislation were too soft, so people developed hillsides for non-agricultural uses, such as buildings, recreational land use, and developing ore extraction, which caused the geological framework of a hillside to be broken. Also, increasing planted areas of high-value cash crops caused

Fig. 15.5 Disasters caused on hillside land in Taiwan by Morakot. (*Source:* Mu-Fan Tsai, SWAN)

Fig. 15.6 Inappropriate hillside land use in Taiwan (*Source:* Yi-Chun Liu, SWAN)

overuse of hillsides for such crops as tea, betel nut, and high mountain vegetables (Fig. 15.6). These actions have implications for soil and water conservation in Taiwan, because if high-intensity or long-duration rains exceed the slope capacity of a hillside, it will cause landslide disasters such as followed the heavy rain of Morakot, which resulted in catastrophic disasters on hillsides in Taiwan (Research, Development and Evaluation Commission, Executive Yuan 2009).

After Morakot in 2009, to provide an excellent arrangement to the original residents, coherent units of the government and county (city) governments composed a task force giving consideration to several types of environmental disasters, if being considered as unsafe or illegal building through investigation; they consulted with the original residents and obtained a consensus, and thus delimited a special region in the Morakot-damaged area. Principles of special regional delimitation include prohibiting development in areas according to the law, the high potential of debris flow stream-influenced areas, overuse of land, serious land subsidence, degeneration of a river environment, or the probability of endangering the safety of a river. The special regional and unsafe areas were delimited mostly in Kaohsiung, Chiayi, Pingtung, and Yunlin. For comparing land use changes in these areas pre- and post Morakot, relevant studies analyzed the survey results in 2006 and 2011 from the National Land Surveying and Mapping Center: land use in special regional and unsafe areas mostly is in agriculture (41 %), second is forests (30 %), and then buildings (13 %) in 2006. The survey showed that the original land use for public and building uses still remains as it was, but land uses for water, forests, agriculture, and traffic purposes have been mostly changed to a collapsed position as seen from the aerial photograph in 2011 (Construction and Planning Administration 2012).

15.3.3 Research Regulations

According to the relevant acts and regulations, laws and regulations related to land use in Taiwan include the National Land Use Planning Act (Draft), National Land Restoration Regulation (Draft), Regional Plan Act, and Typhoon Morakot Reconstruction Special Act. This section interprets the content of these laws and regulations.

15.3.3.1 National Land Use Planning Act (Draft)

Climate change has brought about many disasters in recent years, and national land use planning is urgent and necessary; therefore, the Construction and Planning Agency, Ministry of the Interior submitted the National Land Use Planning Act into Legislative Yuan for examination from 1997. National land planning is based on sustainable development; the Act proposed comprehensive planning of Taiwan's national land use and expressly stated land use control. One proposal of this Act is based on land resources properties, environmental carrying capacity, and local development requirements to draw up land use control, ensuring sustainable land development. This Act is planned in accordance with natural resources, wildlife, and nature or landscapes, disaster distribution and its control facilities, and separated by environmental sensitivity classification. Most environmentally sensitive areas having rich natural resources, important ecology, rare landscapes, or vulnerable conditions are defined as national land conservation areas, and others are zoned by function. If conforming to the principles of a national conservation area, it shall be governed in accordance with use doctrine, and rely on resources, ecology, landscape, or disaster properties and degrees of banned or restricted use.

15.3.3.2 National Land Restoration Regulation (Draft)

Executive Yuan submitted the draft of the National Land Restoration Regulation, to review national land restoration and management and draw up its overall policy. This regulation implements control in regions including hillsides, river areas, coastal areas, offshore islands, and serious land subsidence areas (Construction and Planning Agency, Ministry of the Interior 2012). With the expectation of special permission, this regulation provides only aboriginal villages can perform self-sufficient agriculture in high-altitude mountainous areas; in other villages agriculture use and harvesting of forest trees is banned and existing crops shall abandon cultivation within a specified period. New agricultural and other new developments are banned in medium-altitude areas; land use planning and permitted use items shall be reviewed within a specified period on the basis of sustainable development in low-altitude mountain areas. Where delimited as a national conservation area, central and local governments shall draw up the restoration plan to reinstate the ecology system in overexploited areas and reduce development in environmentally sensitive areas.

15.3.3.3 Regional Plan Act and Regulations on Non-urban Land Use Control

The main propose of regional planning of direct-controlled municipalities and counties (cities) is doing a substantial land plan; this plan is at the highest position of statutory planning in the spatial plan system before the National Land Use Planning Act passed. As the National Land Use Planning Act has passed with announcement by direct-controlled municipalities and counties (cities), the Regional Plan Act has ceased functioning.

One main point in the regional plan is to adjust land use strategies to adapt to global climate change, to be an outline of land use strategies to adapt to natural disasters in the future for every region. The government of direct-controlled municipalities and counties (cities) shall transact disaster-related matters in related tasks for reviewing the urban planning district in high mountain areas, to decrease the intensity of land use development. Post Morakot all regional plans in northern, central, southern, and eastern Taiwan were reviewed. As an example, Kaohsiung city, because of loose strata in the debris flow disaster area in mountain areas, with a typhoon or a heavy rain coming landslide disasters easily occurred. The slow repair of roads and bridges influenced external access roads and disaster rescue roads. Some rivers had serious deposits and the levee was repaired slowly, so that a large amount of sediment was deposited or was not dredged in midstream and upstream, and when rain came again the levee might be washed away, causing unsafe living and property conditions for riverside residents. Regarding these problems, the regional plan offers related strategies and policy adjustments as follows.

1. Establish a standard norm of environmentally sensitive areas, controlling land use development, and review the related land use plan, delimiting suitable districts or public facilities to restrict land use.
2. Environmentally sensitive areas of ecological and disaster potential shall be restricted as to development. For example, potential flooding areas, such as Gaoping River and Linbian River, and serious land subsidence areas shall be restricted as to development intensity and density.
3. Building disaster prevention communities to enhance disaster prevention and salvage.

4. Speeding dredging and considering the possibility of a non-dredge reclamation with regard to Gaoping River deposits.

Regulations on non-urban land use control are made on the basis of the Regional Plan Act for protecting the living safety of the residents. The content of the regulations states that if a hillside use is changed, then the land of an established business plan is determined through architecture-related legislations: if there are steep slopes, bed geological structures, broken strata, active faults, or the sliding possibility of a dip slope, or there is a mine, a mound, a tunnel, an apprehension of danger around stream bank erosion or retrogressive erosion, and an apprehension of danger in the base of operations, and if there is an apprehension of danger on collapse or flooding, the land cannot be developed under the law.

15.3.3.4 Typhoon Morakot Reconstruction Special Act

To speeding reconstruction after Morakot, the Government enacted a draft of the "Typhoon Morakot Reconstruction Special Act" to adapt to each matter on September 28, 2009. The main point related to land use of this special act is that the central, directly controlled municipalities and counties (cities) governments must consult with the original residents and obtain a consensus, delimiting a special region, to restrict residence or coercively relocate homes or village within a specified period, and providing an acceptable arrangement; if within the land in disaster areas there is an apprehension of safety or illegal buildings, this is not restricted by other related norms. The land just mentioned might have problems of environmental sensitivity, debris flow disaster potential, hillside environment, flooding potential, etc. Further, to avoid a repeat of inapplicable residence land use, residents of the special region delimited by this act must coercively relocate the home or village within a specified period. Their own land and improvements on the land could be levied; if it is leased public land, the contract could be terminated and compensation obtained by the contract and related legislation. If there is no lease relationship, but the people are actually living or farming on public land, they could receive a relief payment counting land improvements. (This regulation was terminated and expired in 2014.)

Except legislation, there are related projects beginning to research the environmental sensitivity of the land, such as the Central Geological Survey, MOEA. These projects are the synthesis and induction of historic collapses, landslide areas, and dip slopes, zoning to landslide-landslip geologically sensitive area, warning that for development in these areas in the future, a geological survey and geological security evaluation are required before applying for land development, to observe the possibility of collapse and landslide disaster and to estimate the effects on the basis of land development activities caused by collapse or landslide, or the effects on slope stability from development activities. Having an applicable preventive and mitigating measures plan to reduce disaster risk, the Geology Act provides that the regulatory authorities for all relevant sectors shall incorporate data pertaining to geologically sensitive areas for reference in land utilization plans, land development reviews, hazard prevention and mitigation, environmental protection, and resource development. All types of land development activities that fall in a geologically sensitive area shall undergo a geological site investigation and geological security assessment according to "Criteria for a geologically sensitive area undergo a geological site investigation and geological security assessment," and carry out the geological survey system, geological permit system, and geological review system (MOEA 2014).

15.4 Applicable Land Use Management

All human activities are related to land, because all that is needed in our lives is obtained directly or indirectly from the land. Consideration of land use shall include social, economic, or technical purposes, except considering human activities; the situation of natural conditions is also a key point to estimate, such as spatial distribution, topography, and climate.

Under the interaction of several factors, different utilization plans might be required because of time and changes in the natural environment, even in the same land region (Kuang-Yi 2010). Land use refers to human activities that are directly related to the land. The four factors that influence land use are socioeconomics, nature, policy, and location (Tsou and Chang 2004), meaning that land use relates to economic development, suitability of environmental development, policy and system orientation, geographic location, etc. The legislation system of land use in Taiwan shall be considered and based on the foregoing four factors.

In terms of legislation, related legislation of land management in Taiwan shall be improved.

1. A detailed plan classification shall be enhanced, including population allocation, industry allocation, the traffic and communication network, water resources management, disaster prevention, important goods, and protection of sites (Lin 2012).
2. All types of regional environment delimited by the draft of National Land Use Planning Act shall provide a disaster mitigation purpose, draw up a grade of disaster risk regions, and rely on it to provide disaster prevention regulations (Chen et al. 2010).
3. Legislate the National Land Use Planning Act as soon as possible.
4. The substance of regional planning shall be enhanced, informing the public of danger areas, education, epidemiology, and disaster prevention drill, and maintenance management measures of meteorology, river stages, bridge security; debris flow monitoring and a warning system shall be implemented to reduce the extent of damage.

Disaster mitigation is the first step in disaster management tasks. Therefore, an integrated and rational management of land use is the key point to reduce the occurrence of disasters. Areas environmentally sensitive to a high degree shall be delimited to priority national land restoration areas, giving impetus to national land conservation and restoration, these areas being banned for development and use. The security of existing villages or tribes shall be reviewed, and villages may be relocated to reduce casualties and property losses and to decrease the large social costs of rescue and reconstruction. Further, in terms of disaster mitigation in the face of rapid changes in the environment, we shall use remote sensing technology on all types of land use, to enhance monitoring to control waste from all new developments in the land environment around basins, in environmentally sensitive areas, and in low-lying areas, and shall enhance reporting and crackdown on illegal land use. The next step in terms of disaster mitigation is to advise on several tasks of land use and management.

1. Overall governance of river basins

   Impetus must be given to comprehensive river basin governance tasks of water resources, water conservation and forestry, overall planning upstream, midstream, and downstream, and incorporating factors of disaster mitigation while governing and planning, such as estimating vulnerability, decreasing development density in low-lying areas and river reservations, and increasing permeable areas.
2. Reviewing the disaster resilience of existing villages

   Land use patterns combined with the industry of environmental ecology and the characteristics of our culture, and accepting increased security, also can ensure the sustenance of residents by guiding them to participate with public discussion, assuming responsibility and the results of improving their environment together. An applicable compensating mechanism can be provided to encourage private lands to have functions of flood detention and conservation. The Government shall develop residence restrictions or a coercive plan of village relocation for existing villages or houses where there are the greatest disaster threats.
3. Development activities banned in environmentally sensitive areas

   Environmentally sensitive areas in the jurisdiction shall be investigated and made public as soon as possible to increase restricted or banned development. Carrying out priority restoration in areas where serious disasters have occurred previously to enhance the control of all development activities, and reporting and cracking down on violating is certainly required; the Government shall enhance patrolling and controlling from the perspective of disaster mitigation.
4. Land protection and ecological environment restoration tasks

   The Government can improve and intensify the ecological protection of land in vulnerable areas through environmental conservation or restoration measures. Recovering land to its original state as much as possible, especially national land and arable and grazing land that is used or built on illegally, shall be a top priority for restoration and conservation. This approach will reduce pollution and soil erosion in catchment areas and conserve the storage capacity of reservoirs to increase a steady water supply.

5. Use and management of water resources

   Control of land development activities and over-abstraction of groundwater shall be increased in catchment areas, and advanced development and the raising of crops and livestock shall be banned in catchment areas to decrease ruining the environment, which is a threat to reservoir security. In serious land subsidence areas, establishing a new well shall be banned, and new water resources shall be developed instead to stop worsening environmental deterioration.

6. Enterprise transformation promotion

   There are tea gardens, betel nut gardens, fruit farms, and other related arable and grazing uses everywhere on hillsides today, and there are a large number of public and private wells in land subsidence areas. The Government shall provide guidance on enterprise transformation to ecotourism and the low water use industry to reduce environmental loss.

15.5 Conclusions

When a typhoon and heavy rain comes, or an earthquake occurs, it always causes serious disasters in Taiwan because of its geographic position and topography. Ensuring the safety of the lives and property of the people, with effective and applicable national land use, is the most important task for the Government. Facing the challenges of climate change, all compartments of the Government and People must face the increase of extreme weather events and review land use policies for effective management; furthermore, they shall undergo overall self-criticism of the benefits and security created from economic development.

The fundamental policies of hillside land use and management after Morakot in Taiwan are zoning environmentally sensitive areas and building up a control system of resources and land use performance, to implement national land use control, to protect fine arable land in balance with overall economic development, to enhance water resources conservation and manage the types and scale of land use in water source areas, to improve the permission system of land use changes by a fair mechanism, to implement growing management measures, to enhance coordination and integration of land use and government plans to implement sustainable development on off-shore islands, and to assign priorities of city and urban and rural development, etc. For adapting to high-intensity natural disaster events in the future, we shall investigate and plan ahead applicable short-term, mid-term, and long-term strategies to avoid large losses of life and property. Several proposals about land use and management are summarized following (National Science and Technology Center for Disaster Reduction 2010).

1. The short-term proposal

   - Check thoroughly the positions of communities and villages on hillsides in national lands and proceed with a security check, comparing their positions with historical collapse, and estimate possible disaster types and affected areas.

2. Mid-term proposals

   - Set different levels and purposes for protection or conservation areas in every basin, and investigate and plan ahead for different regulations of land use.
   - Fill low-lying areas and flood potential areas with sediment by grading, or move the sediments to costal land subsidence areas.
   - Widen channels or define floodway districts to give way to river reservation and keep the channels active.

3. Long-term proposals

   - To ensure carrying out the national land conservation plan, zone potential high-disaster areas and geological structures belonging to vulnerability areas, restrict development activities that might damage the structure of the hillside, and decrease the density of hillside land use.
   - Consider other traffic management measures such as cable cars or small to mid-size shuttle buses to reduce road development in mountain areas.
   - Review the afforestation strategy of forest lands upstream from reservoirs to enhance soil and water conservation in catchment areas.
   - Decrease runoff caused by hillside development, and hold the runoff water in flood detention pools if necessary.
   - Choose low-risk areas such as parks, a car park, school playgrounds, or swimming pools in which to save excessive floodwater to decrease the load on the rivers.
   - Enhance governance in land subsidence areas.
   - Restrict cutting and development activities in environmentally sensitive areas, such as ecologically protected areas, potential debris flow streams, and a protective forest belt of 50 m along both sides of rivers.

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