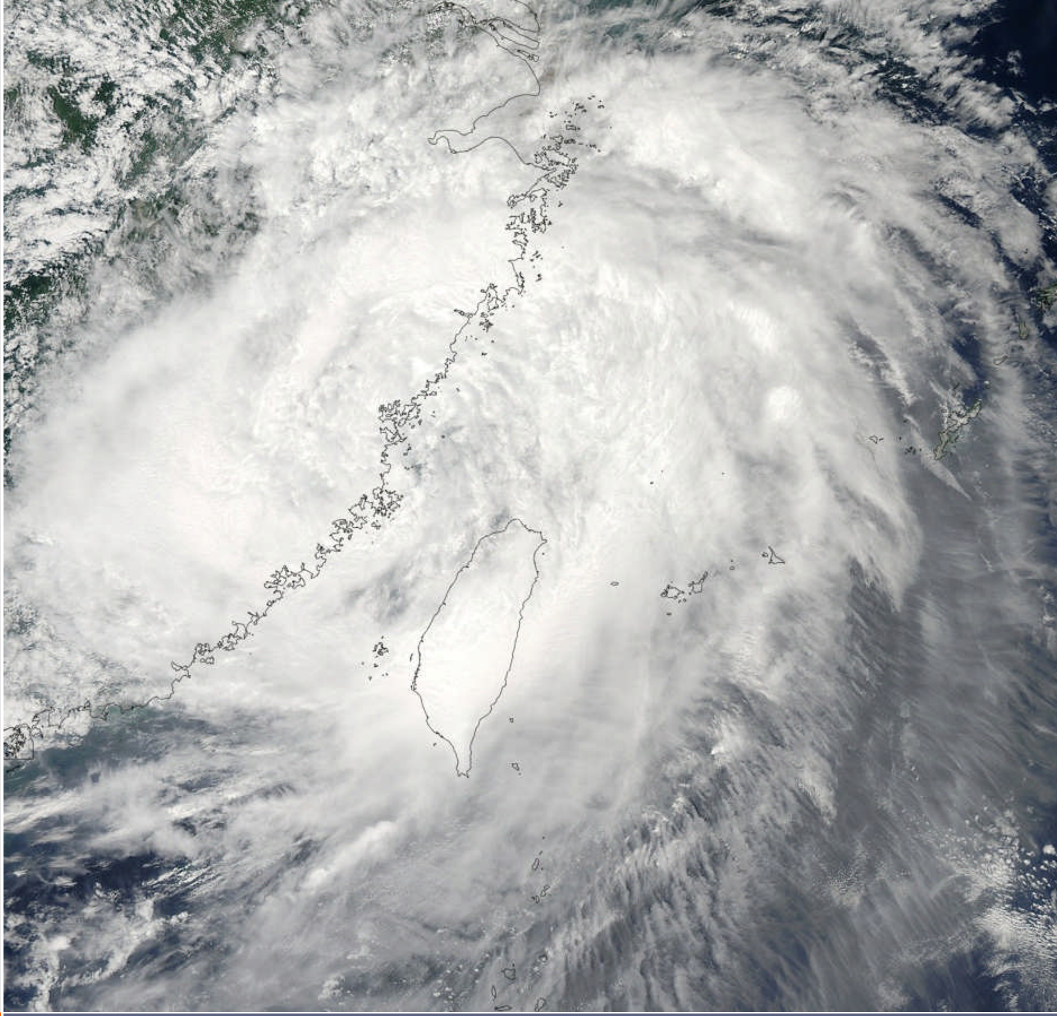

Taiwan, the People's Liberation Army, and the Struggle with Nature

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PROJECT 2049 INSTITUTE

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Mark Stokes and Tiffany Ma

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Cover image: NASA satellite image of Typhoon Morakot above Taiwan and China. Source: NASA.
Image above-left: victims of Typhoon Morakot evacuated aboard a Chinook CH-47 military helicopter in southern Taiwan. Source: sinodefenseforum.com
Image above- right: evacuees on a military vehicle in southern Taiwan during Typhoon Morakot. Source: Boston Globe.

Introduction

At first glance, Taiwan's (Republic of China) vibrant landscape belies its designation as the most vulnerable place on earth to natural hazards. Every year, meteorological and seismic records show that the island is affected by multiple typhoons and earthquakes. The potential of devastation is only matched by the ubiquitous presence of a growing arsenal of increasingly accurate and lethal conventional ballistic missiles opposite the island. The potential for natural and manmade disasters are stark reminders of the diverse range of threats continuously faced by the island's population.

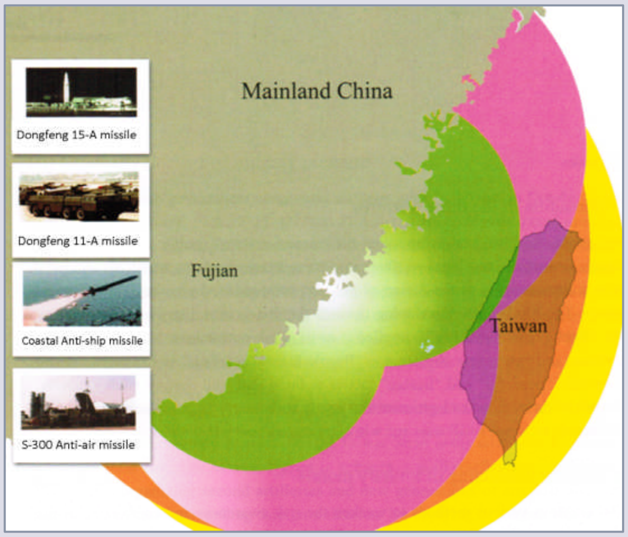
The 2010 typhoon season—which included Typhoon Fanapi in September and Typhoon Megi in October—invoked memories of the human, economic, and political devastation that Typhoon Morakot wreaked upon Taiwan more than a year before. From August 6 to 10, 2009, Morakot unleashed record rainfall and winds of up to 200km/hr, triggering fatal land and mudslides. As the deadliest typhoon in Taiwan's recorded history, Morakot took more than 600 lives and left more than US$3 billion in economic damage—devastating agriculture, livestock, and infrastructure. Morakot also caused significant damage to the island's communications, including loss of 1700 wireless base stations and six undersea cables carrying international traffic.[1] It also inflicted great political costs as criticisms of a slow response sparked a severe decline in President Ma Ying-jeou's approval ratings. Due to its unprecedented severity, Morakot highlighted Taiwan's risk factors for natural disasters. These include a dense population, land use and, most importantly, climate change induced variations in weather patterns.

Taiwan's frequent experience with natural disasters has established an extensive record of experience. At the same time the government's response is judged according to previous responses, rather than against the actions of other countries confronting natural disasters, thereby compounding the political pressure. Due to its unprecedented severity, Morakot served as a watershed event that sets the bar even higher in managing future natural disasters. Moreover, the disaster underscored the imperatives of mitigating climate change related alterations in weather patterns. Bearing the brunt of global climate change and facing the world's most rapidly modernizing military, is Taiwan prepared for the challenges? While Taiwan's political isolation in the international community limits its opportunity for international exchanges in crisis management, there are also bureaucratic and organizational impediments that prevent Taiwan from reaching its full potential in natural disaster mitigation.

Road damaged by Typhoon Morakot in 2009.
Source: CNN.

Taiwan's Security Challenges

As one of the world's foremost natural disaster hotspots, Taiwan faces serious security challenges with both potential manmade and natural disasters all presenting dangers to life and prosperity. Fortunately, there are opportunities for innovative approaches that meet non-traditional security challenges without coming at a cost to defending against traditional security concerns, specifically maintain military preparedness. Currently, Taiwan's defense transformation is taking place within the broader context of its comprehensive security requirements. The People's Republic of China (PRC) poses a real and growing military challenge, not just to Taiwan but also increasingly within the region as a whole.



China's joint fire power against Taiwan
Source: National Defense Report, 2009, Ministry of National Defense, Republic of China.

There are common features between manmade and natural disaster contingencies; these include a large impact zone with limited access, advantages of early warning, imperative of protecting strategic assets, and coordination of rescue and relief efforts—that will require detailed planning, surveillance and warning, effective and survivable communications systems, and rapid emergency response capabilities. In a resource constrained environment, countries such as Taiwan can improve disaster response capabilities by looking to comprehensive, asymmetric, indirect, and cost-effective solutions. Over time, defense expenditures, as well as spending of other government ministries, may increasingly emphasize dual-use capabilities. In other words, following in the footsteps of many European governments, Taiwan may seek to rationalize its expenditures to cover a broader range of security threats beyond the People's Liberation Army (PLA). Particularly since events such as natural disasters, epidemics, terrorism, and extremism, and border control also pose significant challenges to Taiwan's security.

Taiwan's democratically elected leadership must manage some of the world's most severe and complex security challenges. This brief examines the range of hazards emanating from Taiwan's unique natural environment, the island's record of managing disasters, the effects of Morakot, and outlook for the future given climate change prognoses. It will evaluate the parallels that exist in "all hazards" defense between defense of the nation, disaster management, response to extremism/terrorism, and pandemic outbreaks. This brief concludes that the United States should leverage Taiwan's experience in managing natural disasters, establish climate change as a core component of the unofficial U.S.-Taiwan relationship, and jointly explore technical solutions that could enhance disaster warning, recovery, and response. Ultimately, Taiwan's emergency management challenges may mandate a review, and possible new paradigm, for deepening and broadening the U.S.-ROC security relationship.

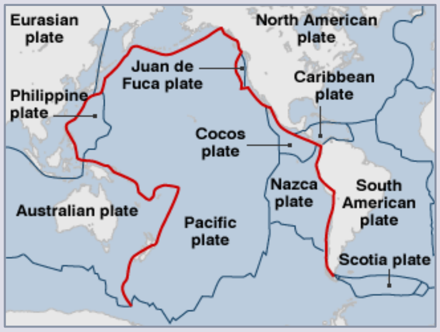
Taiwan and Natural Disasters

While military challenges faced by Taiwan may result in more persistent and protracted crises, non-traditional threats may be more imminent and just as lethal to life and prosperity (see appendix I). When it comes to the forces of nature, a joint World Bank-Columbia University study, *Natural Disaster Hotspots: A Global Risk Analysis*, concluded "Taiwan may be the place on Earth most vulnerable to natural hazards." The island is situated upon a tectonic fault line, at high risk of earthquakes, and in proximity to underwater volcanic activities; in the path of a growing number of typhoons that are increasing in strength due to rising ocean temperatures in the Pacific; and features a landscape contoured by some of the highest mountains in the Asia-Pacific region, creating a sharp drop to the ocean that produces rapid runoffs of rain water that result in floods in the alluvial plains on the western side of the island.

What all disasters and emergencies have in common is a sense of urgency as well as a need for prompt action to prevent a further, often immediate, deterioration of the situation. As an illustration, this brief examines the following and draws links between these non-traditional threats and conventional defense requirements: 1) disaster warning, recovery, and response; 2) terrorism/extremism; 3) border control; and 4) pandemics.

Earthquakes and Tsunamis

Sitting astride the Pacific Ring of Fire, Taiwan experiences up to 18,000 detectable earthquakes each year.[2] Since 1900, there have been 97 major earthquakes with 19 of them classified as disasters, defined as causing 10 or more fatalities.[3] As in a military conflict, earthquakes can cause extensive damage, sensors can help warn of impending danger, and a command and control capability is required for effective response and recovery. However, like military actions, natural disasters can have a significant effect on the operability of critical infrastructure.



The Pacific Ring of Fire as demarcated in red. *Source: BBC news.*

One of the deadliest earthquakes in record history—the 921 earthquake—occurred on September 21st, 1999. Measuring in at 7.3 on the Richter scale, the earthquake left a toll of over 2,400 dead and caused serious damage to infrastructure. In Taiwan's mountainous areas, the destruction of roads is affecting transportation until today. The loss of power and damage to sensitive equipment in Hsinchu Science Park halted the world's semiconductor supply, sending ripple effects throughout the global technology supply chain. The earthquake also interrupted water supplies to almost 80% of the island's population and caused the collapse of the tower supporting two of Taiwan's four main power lines, cutting off electric power to most of northern Taiwan (the Chungliao power station that directs up to 45% of the power to northern Taiwan was also heavily damaged). In addition, at least 43 schools were destroyed, as well as more than 50 police stations and the same number of bridges.[4] The damage also included a record number of collapsed buildings, which also contributed to the high death toll.

Off the coast of Taiwan, tsunamis can occur when movement is unleashed less than a depth of 50km or by an underwater earthquake measuring at least 6.5 on the Richter scale. Localities in the Asia-Pacific region experience damage from a tsunami every year or two, and region-wide events occur a few times each century. The 2004 Indian Ocean tsunami, which released the energy equivalent to 23,000 Hiroshima-type atomic bombs,[5] demonstrated the potential devastation of this phenomenon. Although these are low-probability disasters, historic records show that Taiwan has been struck by six tsunamis to date. Prior to the 2004 tsunami, Taiwan was often cited as suffering the greatest losses from a tsunami in 1781 that hit the island's south. The Central Weather Bureau (CWB) issues a warning and alerts emergency services when it detects a 7.0 earthquake less than 35km deep.[6] The bureau estimates that Taiwan's northeast and southwest coastlines are the most vulnerable to tsunamis due to the proximity to tectonic movements and underwater volcanic eruptions.[7]

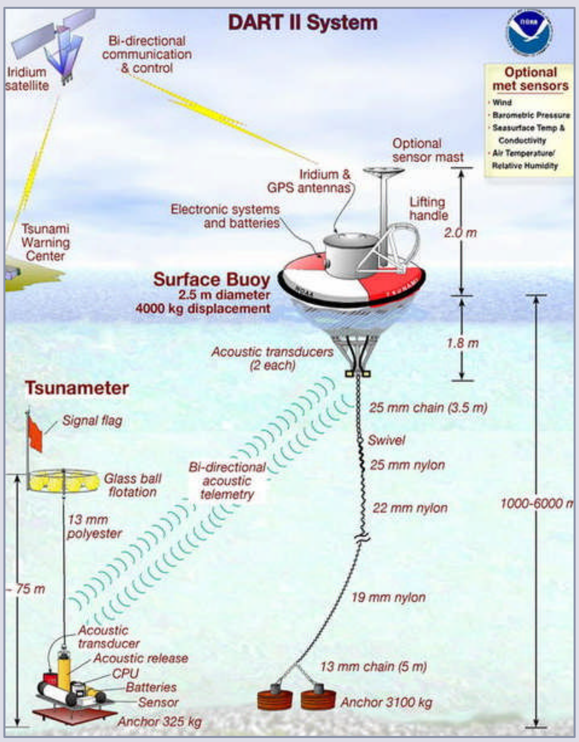


Diagram of the Deep-ocean Assessment and Reporting of Tsunamis (DART) II buoy.

In modeling and simulation studies, engineers believe that the two potential sources could be the Manila Trench, which runs north to south in the Bashi Strait and off the coast of Luzon, and the Ryukyu Trench, which runs up from Hualian and the Ryuku Islands. In one scenario, southern Taiwan could be hit with a wave 11m in height, with flooding reaching 8.5km inland.[8] As the dynamic seismic activity and, to a slightly lesser extent, volcanic activity around Taiwan are extremely difficult to predict with current technology and data resources, this places an impetus on early warning to maximize response time. Currently, the CWB obtains tsunami warnings from the Pacific Tsunami Warning Center (PTWC) and uses the data to evaluate the likely impact on Taiwan before notifying the coast guard, central emergency management authorities, and mass media, pending level of alert.[9]

Deep-ocean Assessment and Reporting of Tsunamis (DART) project is an effort within the Asia-Pacific region to measure tsunami movement towards coastal communities so as to increase the speed and accuracy of tsunami warnings and to reduce costly false alarms that undermine the credibility of the warning system. Dual-use of the U.S. Navy's Sound Surveillance System (SOSUS) has led to fundamental discoveries in seafloor volcanism, oceanic seismicity, the distribution and behavior of large marine mammals, and has led to a vast expansion in the data base on oceanographic research.

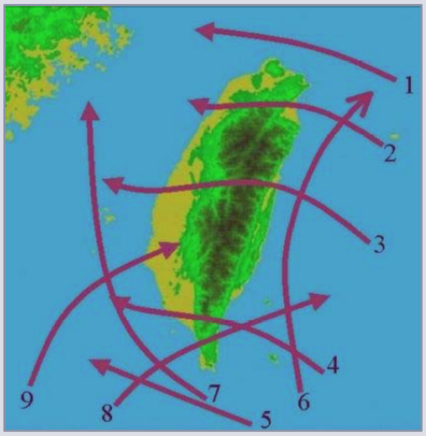
The SOSUS arrays, or integrated undersea surveillance systems (IUSS), would be a dual-use asset that is capable of jointly focusing on a wide variety of underwater requirements. In addition to augmenting existing tsunami warning networks, undersea surveillance assets can help in resource management of marine mammals, the monitoring of natural hazards including earthquakes, volcanoes and slumping, and ocean climate monitoring. Many in Taiwan's scientific community have called for fielding a system capable of providing early warning of off-shore seismic and other events, perhaps linking in to the PTWC.[10]

Typhoons and Extreme Rainfall

Typhoons account for at least 70% of Taiwan's natural disasters and they often cause significant human casualties and economic loss. According to one estimate, typhoons are responsible for an annual economic loss of around NT$20 billion.[11] As a natural hazard, typhoons bring violent winds and extreme rainfall to the island. While the severity of a typhoon is often categorized by wind speed, it is the sudden rainfall that creates the greatest devastation as the deluge bursts upon steep mountainous areas, hovering above an elevation of 1000m, which span 32% of the island.[12]

The incidence of typhoons in Taiwan has risen from an average of 3.3 times per year in the 20th century to an average of 5.7 times per year after 2000.[13] After 2000, experts also note a trend of greater number of medium-strength typhoons and fewer minor typhoons.[14] The increased frequency, as well as intensity, of typhoons has been associated with warming sea temperatures. Therefore, as the island's senior political leadership has noted, the typhoon prognosis for Taiwan is bleak, with climate change projected to further increase ocean temperatures.[15]

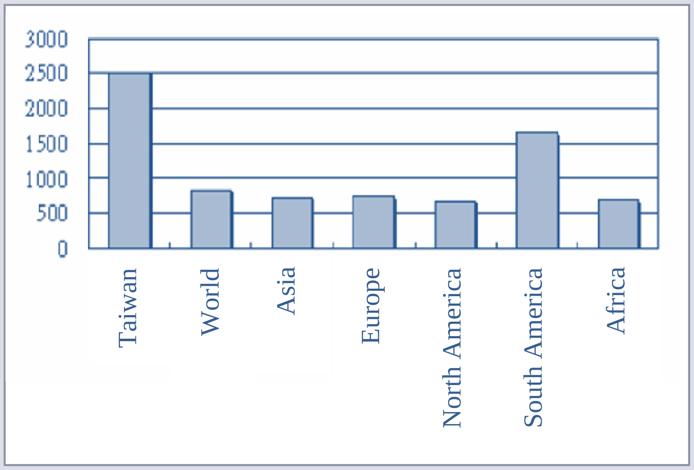
Climate change poses a severe threat to the national security of Taiwan. An accelerated rise in the Earth's surface and atmospheric temperature is contributing toward more frequent and extreme weather events. Even a modest rise in temperature can have significant effects on climate. For Taiwan, a single degree (Celsius) rise in surface temperature can result in a 140 percent increase in extreme precipitation.[16] Faced with some of world's most severe challenges from natural disasters, it is a paradox that Taiwan's primary security partner—the United States and its primary economic partner, the People's Republic of China (PRC)—are the two top emitters of greenhouse gases that contribute to climate change.



Typhoons in Taiwan can be classified by 9 different paths that span across the entire island. Experts have noted that typhoon path 1, originating from a north-westerly direction, often brings rainfall related disasters. Paths 2, 3, 4, and 9 are the most direct lines of impact and present the greatest dangers. Paths 5, 7, and 8 have the greatest impact on southern Taiwan and although path 6 does not pass overhead, it may affect south-westerly pressure systems to create heavy rains that lead to floods or mudslides. *Source: Huang Jin-shan, "Taiwan 2004 Flood Disaster Reflections and Countermeasures," The 8th Cross-Strait Water Technology Symposium.*

Floods

Taiwan is rich in water resources, which are critical to Taiwan economy and society. However, natural conditions and rainfall patterns make management of water resources difficult. Taiwan's average annual precipitation of 2500mm is more than twice the global average, moreover, the island's mountainous regions are prone to more than twice this amount of rain.[17] Rainfall is also not distributed evenly throughout the year. From May to June, Taiwan frequently experiences the 'meiyu' [梅雨] weather pattern that is unique to Northeast Asia, while months from July to September are particularly vulnerable to heavy rains that can result in severe flooding.



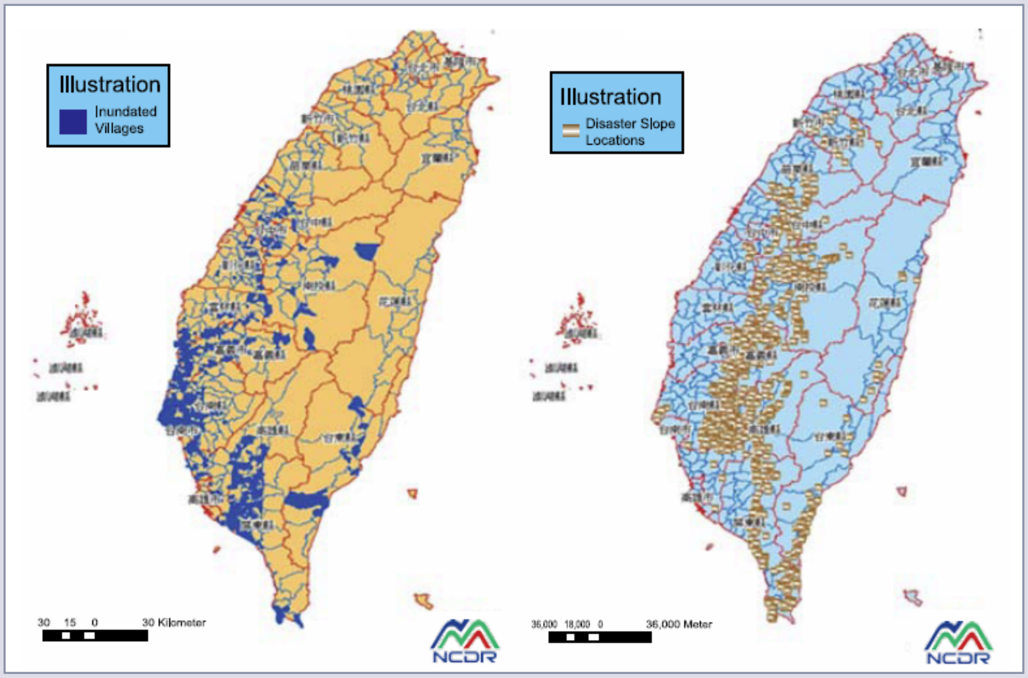
Taiwan's average annual rainfall compared to other regions (in mm).
Source: "Taiwan's Flood Characteristics," Disaster Education website, Ministry of Education, Taiwan.

Taiwan is receiving greater annual rainfall, but with fewer days of rain, which is resulting in a higher concentration of volume with each downpour and increasing the likelihood of floods.[18] With more than half of Taiwan's annual rainfall sometimes produced in as little as one day, large amounts of water race down the slopes of the highest mountain range in East Asia, sweeping away anything in its path. Taiwan's rivers have some of the steepest grades in the world, which gives Taiwan the dubious distinction of having the fastest discharge per unit drainage area and fastest flood peak time. The intense rainfall and rapid water flow causes erosion, a problem that is compounded by frequent earthquakes that undermine the stability of mountains and hillsides.[19] Flash flooding deposits large amounts of sediment into national water reservoirs which cuts the water available to Taiwan's society by more than half. The downpour overwhelms urban drainage systems in one of the world's most densely populated societies, particularly when exacerbated by damage to river catchments upstream.

Taiwan's natural risk for flooding has been compounded by patterns of land use and urban development. Deforestation and over-development has accelerated the speed of the downstream water flow into city areas by reducing natural brakes such as ground absorption or vegetation on slope lands. Flood mitigation should give greater consideration to flood plain planning and creation of more flow diversion measures to minimize damage caused by flood peak discharge.

Landslides, Mudslides, and Debris Flow

Together, earthquakes and typhoons create secondary disasters that amplify devastation. Frequent and severe earthquakes dramatically exacerbate the effects of typhoons and heavy rainfalls by loosening mountain soil and rocks. For example, the 921 Earthquake undermined the stability of hillsides of the Central Range, leading to 2,365 landslides, and resultant sediments often trigger debris flows in the event of a deluge.[20] This geological instability and erosion also contributes to dangerous mudslides as heavy rain falls on the hilly terrains. During Morakot, landslides and debris flows were major causes of casualty and building damage.[21] The risk of compound disasters brings an additional imperative to disaster response.



Flood (left) and landslide (right) areas caused by Typhoon Morakot.
Source:"Extreme Events and Disasters are the Biggest Threat to Taiwan: Typhoon Morakot," Environmental Protection Administration, Taiwan.

Terrorism/Extremism

Beyond natural disasters, Taiwan also faces hazards associated with proliferation of weapons of mass destruction and terrorism/extremism. While such scenarios are low probability/high impact events, they could have repercussions that resonate beyond the island's territory. For example, an entity seeking to target a critical node in the global information technology supply chain could choose to disrupt Taiwan's manufacturing and innovation centers.[22] Taiwan's growing interdependence with the mainland—and by extension, the PRC's interdependence with the United States especially in international finance—could draw the attention of Chinese terrorists seeking to use Taiwan as the vehicle to affect their own government.[23]

Border Control

The defense of Taiwan, especially in an invasion scenario, is a border control exercise on a massive scale. As an island nation**,** Taiwan's harbor areas, coastlines, airports, and other points of entry require constant vigilance. In the case of peacetime border control, challenges transcend that posed by the PLA as illegal goods and activities, weapons of mass destruction, and people are able to cross borders easier than at any time in history. In particular, illegal migration has posed a problem since the lifting of martial law in 1987. According to official statistics, human smuggling peaked from 1990 to 1993, during which 5,000 mainlanders were smuggled onto the island per year. That number tapered off to about 1,500 between 1994 and 2001, but in 2002, more than 2,000 illegal Chinese immigrants made it to the island. In 2005, at least 2,500 mainlanders crossed the strait into Taiwan illegally. Experts point out that the actual number of illegal Chinese immigrants to Taiwan who have successfully evaded arrest or detention could be three to five times higher than official numbers indicate.[24] An unexpected collapse in social and economic order in China could also result in a mass exodus of asylum seekers to Taiwan.

There are solutions to help control the entry of illegal goods, drugs, terrorists, and immigrants. Sensors needed for the early warning of PLA use of force could be dual-tasked to support border control surveillance. Such sensor technologies would include ground sensors, aerial vehicles, and maritime surveillance. These dual-use sensors should always be energized to gather information on potential border excursion and the data integrated to provide early indications and warning to the national command and control centers. Possible ground sensors include magnetic detectors for metal objects, seismic sensors that detect land movement, infrared and electro-optical sensors, as well as radar systems. Capitalizing on ranges that span from tens of meters to several kilometers, sensors can constantly provide different types of data that could also be integrated for a comprehensive picture. Man-portable, ground surveillance systems can detect and classify moving ground targets up to 48km. New generation radar systems have become multi-purpose sensors that can detect aircraft, vehicles, and pedestrians for both critical infrastructure protection and border control. Passive sensors include triangulating various electronic emissions in a broadband range, including emissions from transponders, radar, jammers, and tactical air navigation system/distance measuring equipment (TACAN/DME) interrogators. Electro-optical, infrared, and radar sensors also could be installed on aerial vehicles that could provide broad area surveillance out to hundreds of kilometers. Mechanically and technically covert, these systems are designed to be unobtrusive and easily camouflaged in any surface environment.

Sensors also could be installed on surface vessels patrolling coastal waters, and undersea multi-purpose vehicles for both overt and covert surveillance as well as monitoring. Bottom-mounted sensors could detect and provide acoustic threat data on surface ships, small boats, submarines, and other submersibles to sophisticated signal processing systems. Similarly, rapidly deployable sonobuoys hold great potential for this application. At airports and other ports of entry, biometrics—such as fingerprint recognition, facial recognition, and iris recognition—hold potential for positive identification of visitors.

Disease Control

While the threat of PLA use of biological weapons may be considered slim, warning and response to the very real threat of epidemics and pandemics shares commonalities with a biological attack. Scientists believe an influenza pandemic, emerging from birds and pigs, is almost unavoidable; with the epicenter most likely to be China or Southeast Asia. As one of the most important transportation hubs in the western Pacific region, Taiwan is particularly susceptible to the avian flu. Moreover, Taiwan has a huge number of people and volume of cargo exchanges with China, where several severe infectious diseases—including SARS (the Severe Acute Respiratory Syndrome)—occurred. Every influenza pandemic since 1850, with the possible exception of the 1918 pandemic, has originated in China.[25] The threat is not limited to mainland China, but includes all of Southeast Asia, which is believed to be the region in which the next pandemic is most likely to begin.

Former Taiwanese president Chen Shui-bian during the SARS crisis in 2003.
Source: BBC news.

Just as with other disasters, preparing and responding to an epidemic holds much in common with military defense planning and operations. The ability to monitor patient-loading at medical treatment facilities, medical staffing levels, and medicine inventories are extremely critical in both wartime and civil disasters. Early warning of a pandemic and the ability to closely track the spread of infectious disease is essential to rapid employment of resources to contain its spread. Effective communications are essential to empower the public to respond appropriately, protect themselves and care for each other. Likewise, communications among agencies and organizations will be essential to assure a coordinated and effective response. A pandemic scenario would likely result in high employee absenteeism rates which could disrupt businesses and essential services—such as hospitals, police, fire, utilities (water, electricity, and communications), garbage pickup, and food distribution. In the first four to six months of a global epidemic, there likely would not be a vaccine available, since it can only be made after the newly mutated virus has been identified. A moderate or severe pandemic will severely stress the healthcare system's ability to provide care for victims.[26]

Critical Infrastructure Protection

The requirement to protect critical infrastructure is a shared responsibility between civilian and military agencies that exist for the entire range of threats that Taiwan faces. While damage to critical infrastructure will interrupt virtually all aspects of civilian life, it would also facilitate occupation of Taiwan in the event of PRC use of force. A military or terrorist attack on critical infrastructure could also severely affect the morale of Taiwan's populace in a coercive scenario. Critical national infrastructure would include systems and networks from several major sectors such as:

- Energy, including oil, natural gas, and electric power;
- Banking and finance;
- Transportation (including air, surface, and water transportation);
- Telecommunications and Information Technology (IT);
- Water systems; and
- Government and private emergency services.

In the case of an intentional attack through either PLA use of force or terrorism/extremism, identifying and targeting critical nodes may not be so difficult. A captured Al Qaeda training manual (Department of Justice, 2004) advises: "using public sources openly and without resorting to illegal means, it is possible to gather at least 80% of information about the enemy." In other words, "it is possible to gather, from public sources, at least 80% of the information needed to plan a highly disruptive attack on an infrastructure system." Recent WikiLeaks episodes have observers noting that it is not difficult to find all the information necessary to plan terrorist attacks.[27]

Taiwan's communications network is the backbone of the economy and defense critical infrastructure. *Source: IT news.*

An "All Hazards" Approach to Emergency Response?

The PRC and its ruling Chinese Communist Party present a daunting and growing military threat that is rivaled only by the dizzying array of non-traditional security hazards that often go unheeded. Taiwan's society is one of the world's most vulnerable to natural disasters, and is also challenged by the prospect of pandemics, control of its borders, and terrorism and forms of extremism. Whether military or civilian, responses to all hazards require maximum situational awareness and the means to react efficiently and effectively to prevent a further deterioration of the situation.

Although Taiwan faces a multitude of security challenges, all of the threats examined above share commonalities that would benefit from an integrated "all hazards" approach to threat mitigation. An integrated all hazards approach to emergency management ties together the central government resources to prevent, prepare for, respond to, and recover from the military use of force, major natural disasters, terrorism, and other emergencies. The end result is improved coordination among central, city, and county organizations to help save lives, protect communities, and reduce economic impact.

An "all hazards" command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) system could enhance the effectiveness and efficiency of the national command and control system under stressful conditions. Every threat scenario has elements that are common for effective national response and mitigation:

- Effective primary and back-up communication system;
- Timely and accurate situational awareness to coordinate resources between all agencies, such as first responders, emergency shelters, medical treatment facilities, and earth moving equipment;
- Command and control decision aids and operational planning tools that enable dynamic evaluation based on current and predictive situations; and
- Logistics management to allocate humanitarian assistance resources (food, water, blankets, etc) between civil and military agencies.

Although individual threat scenarios require tailored responses and mission-specific C4ISR systems, all hazards planning and programming would seek universal, interoperable capabilities that could feasibly apply to a full spectrum of emergencies where possible.

Taiwan currently has multiple stovepiped systems for warning, command and control, response, and recovery for each threat. Since 1999, Taiwan has implemented a range of measures to plan for emergency responses, including the establishment of a central disaster prevention and response council, drafting of national and local level contingency plans, and formation of emergency response command centers at both the national and county/city level. The Ministry of Interior holds the responsibility for earthquakes and typhoons, and the Ministry of Economic Affairs is responsible for floods and critical infrastructure protection.

The National Disaster Prevention and Protection Commission is responsible for policy, planning, and oversight of programs intended to mitigate the effects of natural disasters. Under the Executive Yuan and chaired by the Vice Premier, the commission develops emergency management standard operating procedures. It also manages the national warning system and oversees recovery operations.[28] For warning, the National Science and Technology Center for Disaster Reduction (NSTDR) oversees technology programs to mitigate natural disasters, with the most noteworthy being earthquakes and typhoons. The CWB is the organization responsible for forecasting, surveillance and warning of typhoons that could affect Taiwan. The National Science and Technology Center for Disaster Reduction (NCDR) evaluates and estimates the potential rainfall distribution brought by an approaching typhoon, and passes potential maps of flooding and debris flow to the Water Resources Agency and The Soil and Water Conservation Bureau for their reference so that they can issue advance warnings to the appropriate regions. In 2001, Taiwan's Center of Disease Control (CDC) established a comprehensive surveillance system to monitor infectious diseases and take action if needed.

For natural disasters, different agencies are involved at a command and control level. Once the CWB issues a warning, Taiwan's Central Emergency Operational Center (CEOC) is activated and transmits analysis to various government agencies. Representatives from other disaster-related agencies will also staff the CEOC.[29] Taiwan's National Health Command Center, the command post of the CDC, is responsible for preparedness, surveillance, and response to epidemics and pandemics.[30] Responsibilities for rescue and relief operations primarily fall under the National Fire Agency.

In the wake of Typhoon Morakot, the Ma administration took a number of steps to shore up Taiwan's bureaucratic capacity for responding to natural disasters. First, a revision to the Disaster Prevention and Rescue Act raised the status of the Disaster Protection and Prevention Commission to a direct reporting office under the Executive Yuan. The organization had previously reported to the Ministry of Interior's National Fire Agency, which is being re-designated as the National Disaster Prevention and Rescue Agency. Subordinate bureaus are to be established under each county and city. The revisions also granted legal authority for the mobilization of military disaster response teams, a procedure that previously required authorization from the President.[31] Media reporting highlighted that Taiwan's disaster response establishment has increased the frequency and intensity of training. The government conducted the largest ever disaster response exercise in April 2010 in conjunction with the Han Kuang military exercise. The Minister of the Interior took charge of the command center and oversaw scenarios based on typhoon and earthquake disasters as well as preparations for the rainy season.[32] More recently, Beijing has expressed interest in working with counterparts on Taiwan in the area of disaster response. More specifically, the two sides agreed to cooperate in the area of forecasting and early warning on natural disasters.[33]

Conclusion

Taiwan's democratically elected leadership must manage some of the world's most severe and complex security challenges. A vision for national security preparedness beyond military contingencies will help direct additional resources towards meeting critical non-traditional security threats, such as natural disasters. Accounting for less than half of Taiwan's public defense budget, the total Ministry of Interior budget for 2011 is US$4.3 billion (NT$129 billion), with disaster response accounting for a fraction. More and increasingly complex interagency training exercises, assured communications and command and control under the most stressing of situations, and greater investment into "all hazards" technologies and systems would further enhance Taiwan's capacity for emergency management. In particular, Taiwan should focus on common and affordable solutions that can be applied toward both traditional and non-traditional security threats.

The key to emergency management is a robust C4ISR capability that can be leveraged by all hazards defense. Facing a diverse set of security challenges, Taiwan has powerful incentives to field one of the most advanced and networked emergency management C4ISR systems in the world. C4ISR systems reduce surprise, increase warning time in emergencies, facilitate information sharing within an emergency response network, and help senior decision makers make better-informed decisions. Such systems also allow Taiwan's national political leadership to communicative effectively with the population and keep them informed of the latest situation, thus empowering them to respond more appropriately.

For example, emergency management centers for disaster warning and response, with fused sources of data and alert systems and command and control systems, could serve as viable back up military command centers at the central and local levels. Satellite remote sensing to support disaster warning and economic development also could support strategic and operational-level early warning operations. Airborne command and control systems could serve as emergency responders. Similarly, speeding to a disaster area at 200km per hour, a heliborne system equipped with an uninterruptible means of communication that could allow emergency responders to reach the scene quickly and effectively. Whether for reasons of economic security, environmental protection, space debris monitoring, island defense, counter-trafficking, or any combination of these or other reasons, maintaining awareness in all domains is a goal desired by most countries in the world. For the U.S., Taiwan may be a valuable partner in monitoring activities in the region in all domains, from deep under the ocean to the outer reaches of space.

Enhancements to its command and control system, especially in the areas of anti-submarine warfare and maritime domain awareness, would better prepare the island's civil and military leadership for emergency situations. Other key investments include advanced voice communication technologies and dual-use space systems, including electro-optical and synthetic aperture radar remote sensing and broadband communication satellites, which could prove invaluable to disaster warning, recovery, and response. These capabilities also may satisfy verification requirements in any future cross-Strait arms control regime.

Furthermore, Taiwan's experiences to date may have much to offer the international community. Taiwan's rapid dispatch of a search and rescue team to New Zealand following the February 2011 earthquake serves as one example of the international respect that Taiwan's disaster response management is earning.[34] Media reporting indicates some dialogue between the U.S. Federal Emergency Management Agency and counterparts in Taiwan. However, much more should be done, including regular dialogue and combined training between U.S. and ROC emergency management establishments. One consideration could be a U.S. initiative to assess Taiwan's current capacity and future requirements for disaster response and emergency management focused in particular on lessons learned that could be applied to the United States. The growing complexity of Taiwan's emergency management challenges may mandate a review and possible new paradigm for deepening and broadening the U.S.-ROC security relationship.

Appendix I: Losses Caused by Natural Disasters (1999-2010)

Source: National Fire Agency and the Ministry of Interior

	Cases	Casualties (death)	Entirely Collapsed Houses	Half Collapsed Houses
1999	**4**	**2,418**	**51,722**	**53,831**
Typhoon	1	1	—	1
Flood	1	2	4	—
Earthquake	2	2,415	51,718	53,830
2000	**11**	**89**	**434**	**1,725**
Typhoon	6	78	434	1,725
Flood	2	6	—	—
Earthquake	2	5	—	—
2001	**9**	**225**	**646**	**1,978**
Typhoon	8	225	646	1,978
Flood	—	—	—	—
Earthquake	1	—	—	—
2002	**4**	**10**	**—**	**160**
Typhoon	3	5	—	—
Flood	—	—	—	—
Earthquake	1	5	—	160
2003	**8**	**6**	**—**	**—**
Typhoon	7	6	—	—
Flood	—	—	—	—
Earthquake	1	—	—	—
2004	**12**	**60**	**376**	**154**
Typhoon	9	27	342	44
Flood	2	31	34	110
Earthquake	1	2	—	—
2005	**6**	**41**	**27**	**143**
Typhoon	4	19	27	142
Flood	2	22	—	1
Earthquake	—	—	—	—
2006	**9**	**9**	**60**	**43**
Typhoon	5	3	2	13
Flood	2	4	41	19
Earthquake	2	2	17	11
2007	**8**	**18**	**54**	**85**
Typhoon	6	13	54	85
Flood	2	5	—	—
Earthquake	—	—	—	—
2008	**12**	**42**	**66**	**17**
Typhoon	6	31	66	17
Flood	6	11	—	—
Earthquake	—	—	—	—
2009	**6**	**644**	**99**	**250**
Typhoon	3	644	99	250
Flood	1	—	—	—
Earthquake	2	—	—	—
2010	**14**	**18**	**233**	**159**
Typhoon	5	2	207	79
Flood	8	16	26	79
Earthquake	1	—	—	1

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[1] See "UN Report on Typhoon Morakot" [联合国公布第一号莫拉克台风情势报告], *United Daily News*, August 20, 2009, at http://udn.com/NEWS/NATIONAL/BREAKINGNEWS1/5089937.shtml. In 2000 seven typhoons (Kaitak, Bilis, Prapiroon, Bopha, Yagi, Xangsane, and Bebinca) ravaged Taiwan, the most severe being Xangsane that resulted in 64 deaths.

[2] A 7.6-magnitude earthquake in central Taiwan in September 1999 killed more than 2,400 people, injured more than 11,000, left up to 100,000 homeless, and resulted in at least U.S. $10 billion in economic damage. The seismic event, known as the 921 Earthquake, was the most devastating one to hit the island since 1935, when tremors in the Hsinchu/Taichung area resulted in the loss of at least 3500 lives. See Lin Hsueh-Mei, "The Spatiotemporal Characteristics on the Nature Disasters in the Past Thirty Years in Taiwan," *Geographical Research*, No. 41, November, 2004, at http://www1.geo.ntnu.edu.tw/files/publish/347_f38f9a0b.pdf and "What is the frequency of earthquake occurrence in Taiwan?," Central Weather Bureau website, Taiwan, at http://www.cwb.gov.tw/eng/education/encyclopedia/eq015.html.

[3] The number of earthquakes over 5.0 on a Richter scale has been climbing, as measured by decade from 1971 to 2000, see Hsueh-Mei Lin, "The Spatiotemporal Characteristics on the Nature Disasters in the Past Thirty Years in Taiwan," *Geographical Research*, No. 41, November, 2004, at http://www1.geo.ntnu.edu.tw/files/publish/347_f38f9a0b.pdf. It has been estimated that for every degree increment on the Richter scale, the force and range of impact multiplies by 27-times. For example, a 5.0 earthquake releases comparable energy as the 1945 atomic bomb test in New Mexico. Cheng Shi-Nan and Yeh Yong-Tian, "Taiwan Earthquakes over the Past One Hundred Years [台灣百年來的大地震]," *Scientific Development [科學發展]*, Iss. 373, 2004 at http://203.145.193.110/NSC_INDEX/Journal/EJ0001/9301/9301-11.pdf.

[4] "Number Of Occurrences of Perceptible Earthquakes," *Statistical Yearbook Of The Republic Of China*, 2005 (edited in 2006); and *Event Report: Taiwan Chi-Chi Earthquake*, Risk Management Solutions (RMS), October 10, 1999. The epicenter was in the mountainous and relatively lightly populated area of central Taiwan. If it had been on the densely populated coastal plain to the west, the disaster would have been even worse. In 2005, Taiwan disaster relief authorities detected 1084 seismic events, with more than half –609 – occurring on the east coast (only five were detected in the Taipei area). Taiwan's peak year for number of earthquakes was 1999, when 2945 earthquakes were detected.

[5] This assertion is based on US Geological Survey estimates.

[6] Ministry of Economic Affair (ROC), Central Geological Survey [經濟部中央地質調查所], "Does Taiwan Face Dangers from Tsunamis? [台灣會受到海嘯的威脅嗎?]," January 7, 2005, at http://www.moeacgs.gov.tw/upload/info/ATT32018.pdf.

[7] According to the U.S. Geological Survey, most of Taiwan sits on top of a collision zone between the Philippine Sea and Eurasian plates. In the north, there is the northward subduction of the Philippine Sea plate beneath the Ryukyu arc. In the south, there is the eastwards movement towards the Manila trench. See "Preliminary Earthquake Report," September 20, 1999, at http://neic.usgs.gov/neis/eq_depot/1999/eq_990920/setting.html.

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[12] Teng Wei-Hsien, Hsu Ming-Hsi, Wu Chung-Hsing & Albert Chen, "Impact of Flood Disasters on Taiwan in the Last Quarter Century," *Natural Hazards*, vol. 37, no. 1-2, February, 2006.

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[14] Chen Liang-Chun, "Adapting to Climate Change Impacts on Disaster Risk Reduction," *Cross-Strait Interflow Prospect Foundation*, November 1, 2010, at http://www.pf.org.tw:8080/FCKM/DownloadFileService?file_id=1274&user_id=hyweb&passwd=Qe567tB9&STATUS=0&ERRCODE=00.

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[22] See, for example, Bruce Einhorn, "Why Taiwan Matters," *Business Week*, May 16, 2005; and Craig Addison, *Silicon Shield: Taiwan's Protection Against Chinese Attack*, (Irving, Texas: Fusion Press, 2001).

[23] The Executive Yuan develops Taiwan's counter-terrorism policy. The Ministry of Interior's National Police Agency (NPA) is responsible for counter-terrorism, senior leadership protection, and critical infrastructure protection (CIP). The NPS's Special Security Service Forces (*wei'an*) have three corps (1st, 4th, and 5th) to cover the island. The NPA's 2nd Corps handles CIP duties for facilities, including nuclear power plants, under the National Science Council and Ministry of Economic Affairs. The NPA's 3rd Corps is responsible for border control and its 6th Corps for senior leadership protection. The military also has specialized counter-terrorism units under the Military Police, Army, and Marines.

[24] Responsibility for monitoring and controlling Taiwan's borders lies with the Coast Guard Administration and NPA. The Coast Guard monitors Taiwan's coastal waters, while the NPA oversees access.

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[26] Utah Department of Health, *Governor's Taskforce on Pandemic Influenza Preparedness: Final Report to Governor*, Salt Lake City, Utah, April 2007.

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[29] At lower echelons, county and city governments with disaster management units form their own command center to coordinate emergency responses. The CEOC, however, remains the central coordinator and serves to communicate significant disaster information to the local command centers in order to achieve minimal loss and rapid response to the disaster.

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