IRDR
Integrated Research on Disaster Risk

FORIN
Forensic Investigations of Disasters

The FORIN Project




Understanding the Causes of Disasters

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IRDR

The Integrated Research on Disaster Risk (IRDR) programme was established by the International Council for Science (ICSU) in 2010 in cooperation with the International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UNISDR). IRDR's main legacy will be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts. This will include a shift in focus from response-recovery towards prevention-mitigation strategies, and the building of resilience and reduction of risk through learning from experience and the avoidance of past mistakes.

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The FORIN Project
Understanding the Causes of Disasters

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THE DISASTER RISK PROBLEM

Photo: Remains of a house, destroyed by Typhoon Haiyan, on the outskirts of Tacloban City, Eastern Visayas, Philippines. (Trocaire from Ireland via Wikimedia Commons)

Disasters are increasing in number, type and impact; but why? At a time when much more is known about the science of natural events and the technical capacities for warnings have improved, losses continue to rise. Such losses are not only the product of large-scale or large magnitude events, but increasingly smaller and medium-sized events are now also generating significant losses. The damages natural events trigger are largely attributed to choices made by humans. That is to say more and more people and property have been placed in harm's way or in places of higher risk under conditions of increasing and more diverse vulnerability. This growth in losses exceeds what would be expected based solely on population and economic growth patterns. Further, exposure often coincides with vulnerability – reducing the capacity to respond or cope. It is this creation of risk that needs to be controlled. We need to understand the deeply rooted and historical processes, termed root causes, that lead to disaster risk by influencing the ways dynamic processes or risk drivers develop, such as demographic change, poverty and inequality, weak governance structures, inadequate risk policies, poorly managed development, risk perceptions and culture, declining environmental health, conflict, and climate change and variability.

The Forensic Investigations of Disasters (FORIN) project of the Integrated Research on Disaster Risk (IRDR) programme examines these root causes and the dynamic processes of risk drivers through an integrated, interdisciplinary and comprehensive analysis of the causes and consequences of disasters. It is through the identification of the risk drivers that factors, which attenuated or accelerated the impacts, can be identified and then translated into improvements in disaster risk management policies and practices. The analysis of root causes and risk drivers of FORIN research employs a longitudinal perspective with four basic approaches: comparative analysis, retrospective longitudinal analysis, projective longitudinal analysis and meta-analysis.

In the pages that follow, three case studies are presented that illustrate the FORIN perspective and approaches. They each represent a different model of root causes and risk drivers that led to the construction of risk. The policy-relevant findings of the case studies are highlighted.

CASE STUDY 1:
Typhoon Morakot, Taiwan 2009

Photo: Flooding in Tainan County, Taiwan as a result of Typhoon Morakot (Jonathan Chen via Flickr)

Description

Typhoon Morakot hit southern Taiwan in 2009, leaving 677 people dead, 22 missing and 25 unidentified body parts, and causing an estimated USD$5.5 billion (NTD$16.4 billion) in damages. It formed early on 2 August 2009, as an unnamed tropical depression and later developed into the deadliest typhoon ever experienced in Taiwan. During its five-day span, the storm brought more than 2000 mm (78.74 in) of rainfall to most parts of the island. The extreme amount of rainfall triggered enormous mudslides and severe flooding throughout southern Taiwan.

Risk Drivers Affecting Impacts and Outcomes

Extreme amounts of rainfall (both high in intensity and long in duration) triggered the flooding, slope failures and mudslides. The prior occurrence of many shallow earthquakes in central and southern Taiwan led to loosened soil and rocks in the mountains that were eventually washed into the streams and rivers, causing siltation and reducing the effective capacity of the channel to convey all the runoff from the heavy rains. Flood control structures (embankments, reservoirs) were unable to handle the discharge resulting in failures of the structures, overtopping or the need to release water from the reservoir to prevent a dam failure, all of which worsened the downstream flooding. Poor land use plans in the mountainous regions (mainly used for agricultural cultivation and tourism) led to inadequate soil and water conservation, which helped trigger and amplify the likely mudslides. Inland fish farming in the coastal regions over-extracted groundwater causing land subsidence, which further enhanced the flood impacts.

While population evacuation measures were in place, the lack of proper implementation by local governments led to excess casualties. On the other hand, large-scale population evacuations in the early stages led to secondary public health hazards in shelters and evacuation centres because of overcrowding. In addition, many of the shelters in the rural areas were located in high-risk areas (paths of mudslides), so when community members left their homes for shelter they inadvertently placed themselves at greater risk.

Causal Loop Analysis of Risk Drivers

Three different causal relationships were abstracted from the social causal network analysis that heightened the social impacts of the typhoon (Figure 1). First, the legislative

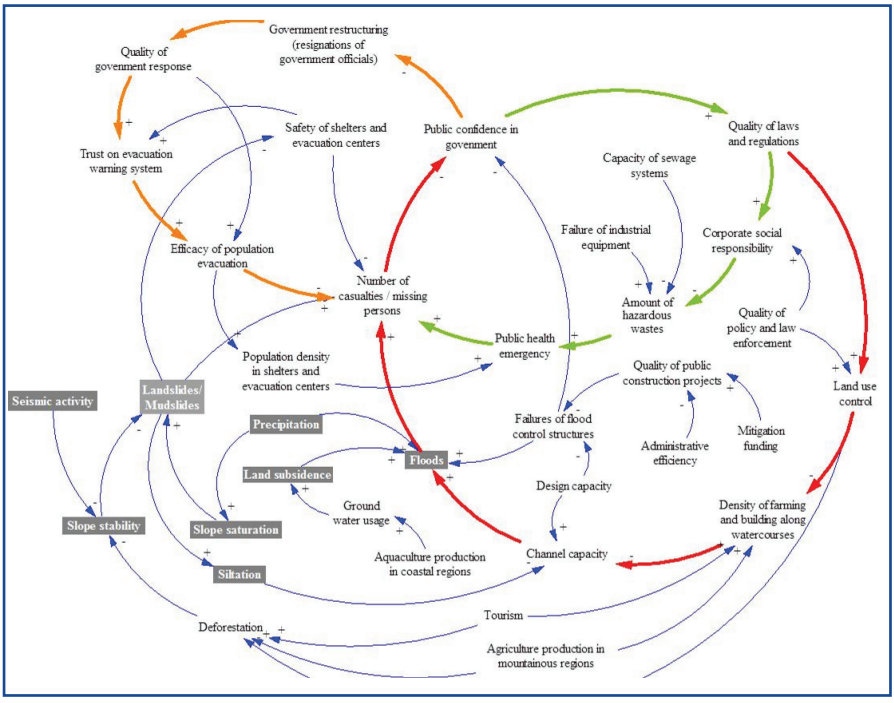

Figure 1: The three intersecting causal loops: legislative (red), governance (orange), and hazardous waste (green) systems. The items shaded (e.g. seismic activity, siltation, etc.) are natural phenomena for which there is little direct human control.

system failed to enforce policies to prevent illegal land usage (red). Over time, the rate of illegal farming and building along watercourses increased significantly, putting more lives and property at risk from potential flooding. The unplanned developments in river basins also made the 2009 floods worse. After Morakot, new legislation was passed and risk zones delineated, but many people still did not move to safe locations. At present, this legislation has had little effect in reducing the overall risk.

A second causal loop (orange) involved the governance system. The number of casualties and missing persons forced authorities to take political responsibility for their failed policies, which led to resignations of central government officials. Administrative inefficiencies on public construction projects led to lower quality construction (materials and practices) that caused casualties or blocked traffic. Lack of confidence in government could hamper the reactions of the public to the alerts from warning systems in the future.

Finally, hazardous waste was produced as the capacity of sewage systems and industrial equipment was not adequate to cope with the storm (green). Under normal circumstances, industries would be responsible for cleaning up their own hazardous waste. However, in the aftermath of Morakot, legislation was amended which recognised the precipitating hazards (mudslides, flooding) as "unintended consequences due to natural disasters," thus absolving the industrial companies of any liability or fines for the release of hazardous materials. This exception to the routine management of hazardous waste concerned the public who saw it as a major flaw of the public health and environmental safety systems.

Lessons Learned

The use of FORIN in the analysis of Typhoon Morakot allowed researchers to demonstrate how the impacts of the storm were linked to social processes taking place before, during and after the typhoon itself, resulting in the disaster. Despite massive funding of mitigation measures, many of the flood-control structures still failed under this extreme weather event. Evacuation plans were in place but were not properly implemented by local governments, which led to more casualties. The analysis shifted the view of disasters as merely a natural event to a perspective that was focused on causes and consequences of the disaster based on the long-standing practices and processes that influenced the political, social and economic dynamics of Taiwanese lifestyle. Using a more detailed case study of two villages, the FORIN analysis showed how the impacts of a disaster are felt and often amplified across scales and domains of government, and how the impacts of the typhoon had cascading effects on industry and health.

The overall risk drivers were failed governance systems. By documenting these shortcomings in disaster risk management and making them known to the responsible authorities and to the public, the forensic analysis creates opportunities for improved disaster risk reduction and the avoidance of new risk creation.

Sources:

Huang Tailin, Hsiang-Chieh Lee, Hui-Hsuan Yang, and Chung-Sheng Lee (2013. ***Towards a Generic Framework for Synthesizing the Societal Disturbance from Typhoon Morakot***. Taipei City, Taiwan: National Science & Technology Center for Disaster Reduction.

Yang, Hui-Hsuan, Su-Ying Chen, Sung-Ying Chien, and Wei-Sen Li (2014). ***Forensic Investigation of Typhoon Morakot Disaster: Nansalu and Daniao Village Case Study***. Taipei City, Taiwan: National Science & Technology Center for Disaster Reduction, Report NCDR 102-T28. Available: http://www.irdrinternational.org/wp-content/uploads/2013/09/Final-Project-Report_NCDR-Team_START-revised_web.pdf.

Photo: The Taimali Stream Railway Bridge in south-eastern Taiwan's Taitung county was destroyed by flooding during Typhoon Morakot. (ellery via Wikimedia Commons)

CASE STUDY 2:
Haiti Earthquake, 2010

Photo: Earthquake damage in Port-au-Prince, 15 January 2010. (Tech. Sgt. James L. Harper Jr., USAF via Wikimedia Commons)

Description

On 12 January 2010 a 7.0 magnitude earthquake struck 15 miles (25 kilometres) southwest of Port-au-Prince, Haiti's capital and largest city. This was the largest earthquake ever recorded in the region. There was catastrophic damage to the city and estimates of deaths ranged from 100,000 (US Geological Survey) to more than 310,000 (Haitian government), with more than 1.3 million displaced. Nearly 180,000 buildings were either completely destroyed or damaged. In the days, weeks and months following, aftershocks, rains, flooding and mudslides added additional urgency to the need for humanitarian assistance as the city and surrounding areas lacked transportation, communications, energy, potable water, food and sewage infrastructure systems. The potential for cholera and other diseases escalated the public health crises as the city began the task of rebuilding.

Risk Drivers Affecting Impacts and Outcomes

Haiti is the poorest nation in the western hemisphere. Its human development index ranks in the bottom 10 per cent of nations, while its risk index is quite high due to tropical cyclones (hurricanes), flooding, mudslides and seismic activity. The physical (proximity to the epicentre, topography) and environmental conditions (deforestation, the onset of hurricanes) clearly influenced the post-event impacts in the weeks, months, and years that followed. The basic infrastructure in Port-au-Prince (logistics, health, water, sanitation, electricity supply) broke down as many public and government buildings collapsed. Government and UN Agency workers also perished in those buildings severely reducing the institutional capacity to coordinate rescue and relief operations. For example, the loss of the city morgue and the inability to remove and bury the dead quickly increased the contamination of the water supply (which itself was damaged), exacerbating the cholera situation and increasing the death toll.

Negligence or downfalls on the part of the government in terms of knowledge of hazards, preparedness and the overall lack of national disaster risk management structures and capacities, meant that the overall formal government response to the earthquake from those immediately impacted was virtually non-existent. This led to more injuries and deaths as neighbours could only use crude means to search for family and friends among the rubble of the buildings.

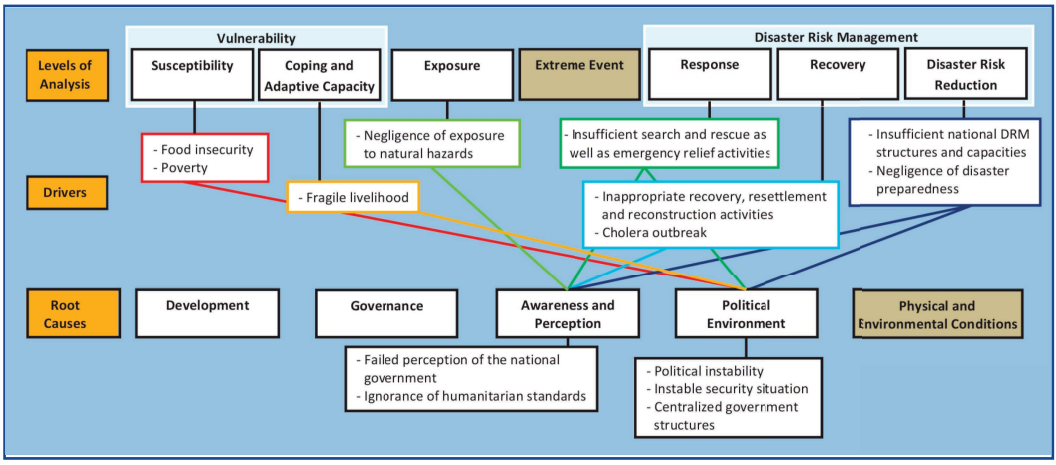

Figure 2: Selected risk drivers and root causes of the Haiti earthquake (Witting et al. 2012:24).

With communication and transportation systems gone, the city was unable to function without outside assistance, which was offered from all over the world.

Root Causes and Risk Drivers

Haiti is a failed state where its national government has not met the basic conditions and responsibilities of a sovereign government to guarantee civil protection to its citizens. The most important risk drivers in Haiti are corruption, lack of governmental leadership and a missing legal framework. The political past with violent conflicts, military coups, corruption and repressive regimes led to an unstable security situation. This contributed to extreme poverty, poor living conditions, fragile livelihoods and food insecurity, hence increasing the vulnerability of the local population to hazards and severely impairing their coping and adaptive capacity in the aftermath of the disaster. The lack of basic governance structures contributed to a failed understanding of the true nature of the disaster risk for the nation. Uncontrolled urbanisation of Port-au-Prince and the lack of urban planning, along with no building codes, resulted in overly crowded and sub-standard construction practices that led to building failures and loss of life during the earthquake.

However, a more detailed root cause analysis shows that external forces adversely affected Haiti's development (Figure 2). The French West India Company established control over the colony from other European powers and, like elsewhere in the Caribbean, African slaves were imported to work the export plantations crops of coffee and sugar. Elite free people of colour (offspring of plantation owners and their slave concubines) initiated slave revolts which culminated in the colony's independence in 1804. France did not recognise the new black republic and demanded a large compensation from Haiti for its lost "property" (slaves) and land before withdrawing its colonial administration. The new country refused and, with the assistance of Great Britain and the US, France maintained an embargo until Haiti agreed (in 1825) to repay the debt (90 million gold francs) to France. The debt was paid off in 1947, with high interest loans. As punishment for seeking independence, Haiti began under crippling debt and an embargo, beginning its sovereign status as one of the most impoverished nations in the world. The Haitian government and the elites brockered the

export of sugar, coffee and indigo with the foreign powers (initially France and then the US), and in the process accumulating power and wealth while draining the country's natural resource base. Particularly in the late 20th century, rural livelihoods were further decimated, trees were cut down to produce charcoal, and trade practices (IMF-imposed tariff reductions on imported and US-subsidised rice) undermined Haiti's rural economy. This led to a spurred massive migration to Port-au-Prince, which was unable to serve current residents much less the expanding population.

The historic extraction and misappropriation of economic capital in Haiti led to a dependent economy; one reliant on international donor agencies for economic aid and development assistance. The dependency perceptions are deeply rooted within Haitian history and its political system. Recent internationally driven economic policy interventions further exacerbated the vulnerability of local people as well. The result was little local capacity or understanding to guide response and recovery, including resettlement, nor was their oversight on the foreign humanitarian efforts, which led to poor communications between the capital and other regions in the country; inadequate shelter planning, land ownership and resettlement camps; provision of potable water; and, ironically enough, the introduction of the cholera virus (which was brought into the country from a foreign aid worker). Although massive foreign assistance from all over the world poured in, it was poorly coordinated and carried out almost entirely without Haitian cooperation or involvement. Instead of using the opportunity to strengthen Haitian capacities and institutions it bypassed them and rendered them even more impotent than before the earthquake.

Lessons Learned

These examples show that various risk drivers and root causes initially identified in the Haiti case are highly interwoven and interdependent (Figure 2). Most of the root causes of the Haiti disaster cannot be addressed sufficiently by conventional disaster risk management approaches and present agencies and international response mechanisms, because the response operates with rather a short time-frame, for example one to two years, and with a local focus, leaving external risk drivers and root causes unaddressed. Inflexible internal donor mechanisms can also be a major driver of instability as well as the insufficient consideration of disaster risk drivers and root causes within post-disaster and recovery strategies. Some donor mechanisms lead to short-term actions and un-sustainable and ineffective disaster relief processes. Although identified risk drivers, such as a weak or even hindering political context, could be articulated through such donor mechanisms (e.g. funding for anti-corruption programmes, institution building, etc.), they are often only addressed in a limited fashion within disaster and post-disaster contexts. The forensic analysis shows how the historical and contemporary capital extraction led to livelihood destruction, development failures and increasing poverty in the nation—antecedent conditions that increased the impact of the earthquake. When coupled with internal corruption, itself a legacy of failed development going back over a century, the ability of Haiti to respond and recover from disasters is severely limited.

Sources:

M. Witting, Zentel, K-O., and J. Birkmann (2012). ***Detecting Disaster Root Causes. A Framework and an Analytic Tool for Practitioners***. DKKV [German Committee for Disaster Reduction]. Bonn: DKKV [German Committee for Disaster Reduction] (DKKV publication series, 48).

Oliver-Smith, Anthony (2012). Haiti's Five Hundred Year Earthquake, in M. Schuller and P. Morales (eds.), ***Tectonic Shifts: Haiti Since the Earthquake***. Sterling, VA: Kumarian Press, pp. 18-23.

CASE STUDY 3:
Hurricane Katrina and Mississippi's Gulf Coast

Photo: Damage and destruction to houses in Biloxi, Mississippi by Hurricane Katrina (FEMA/Mark Wolfe via Wikimedia Commons)

Description

On 28 August 2005 Hurricane Katrina made its second landfall along Mississippi's Gulf Coast with 192 km/h wind speeds, storm surges ranging six to nine meters, and waves more than 10 meters above high tide, all along the coast of Mississippi. While most of the residents safely evacuated, there were more than 230 lives lost. Residences, businesses and infrastructure such as the Port of Gulfport, and roads and bridges connecting the communities along the coast were damaged or destroyed to the tune of USD$26 billion in Mississippi alone. When combined with losses from New Orleans and elsewhere, Hurricane Katrina remains the costliest hurricane in US history.

Risk Drivers Affecting Impact and Outcomes

The risk drivers influencing the impacts of Hurricane Katrina were the accumulation of disaster risk through government and private sector investments in the region; the recent reliance on tourist-dependent infrastructure for economic development; and the physical properties of the storm, especially the large storm surge. Another significant risk driver was the social structure of the region that influenced the disparities in impacts, and temporarily or permanently displaced many of the most vulnerable after their homes were destroyed. Nearly 10 years after Hurricane Katrina, the Mississippi coast is less developed with a patchwork quilt appearance of rebuilt homes and businesses interspersed with vacant properties. Some neighbourhoods and communities have recovered, while others are struggling to come back. The social fabric of the coast has been eroded with many former residents not returning. The slow rebound is a function of the root causes, which have dominated the growth and development along Mississippi's coast.

Root Causes

Southern Mississippi's economic base was always precarious and dependent on natural resources, starting with fishing, then timber, and finally agriculture (especially cotton). Cheap labour in the form of imported slaves from West Africa enabled the plantation economy of the coast where the slaves were either employed in the cotton fields or as domestic servants. The social and economic segregation that was a product of this economic model set the stage for the social stratification of the region for the next century and beyond. The "separate but equal" doctrine of the Jim Crow South led to the development of two separate societies in the same physical space, where the abandonment of slavery and reconstruction after the Civil War were fiction rather than fact. The root causes of deprivation for some of the state's population continues

today, as Mississippi continues to rank last or nearly last on most social indicators of all US states, a position it has held for decades.

Concurrent with these social processes, the physical landscape has been shaped by hurricanes with their periodic clearing of properties and infrastructure, only to then be rebuilt. The sturdy plantation owner houses remained unscathed through the years, while the slave cottages were completely destroyed by each storm and then rebuilt with the debris—that is until Hurricane Katrina.

Given the lagging social development of Mississippi, the federal government invested heavily along the coast. For example, the early ship-building industry centred in Pascagoula was enhanced through federal government contracts to build new ships for the US Navy and Coast Guard. Similarly, the development of the Keesler Air Force Base provided the economic engine for the central coast, especially after World War II. Along with the Seabees and Hurricane Hunters who were stationed at Keesler, good paying jobs were available, regardless of skin colour (as the military had long been integrated). In the 1960s, the powerful Senator, John Stennis, managed to locate a Saturn rocket manufacturing facility along the coast as part of the USA space programme. In total, the defense industry transformed the agrarian coast to a more diversified economic base, with skilled labour. However, with the decline in defense spending in the 1980s, the state looked for other economic engines to compensate and found it in the tourist sector.

The Mississippi Gulf Coast had always been a respite for wealthy New Orleanians, who sought escape from the urban heat and humidity of the city and the historical mosquito-induced yellow fever outbreaks that accompanied the summer season. The onshore breezes coming from the Gulf of Mexico waters were sufficient to keep the mosquitos at bay. The seasonal homes dotted the coastal landscape, some larger mansions and smaller bungalows. Domestic help was available to care for the needs of wealthy vacationers. Soon, the Mississippi Gulf Coast became a tourist destination for many southerners, drawn by the gentle breezes, wide sandy white beaches, and laid back atmosphere. However, segregation remained in effect with both "white" and "black" beaches.

The tourism economy was further solidified in 1990, when the Mississippi state legislature allowed casino gambling for the coast. This effort was designed to stimulate the economy of the region (as well as the state). By the time of Hurricane Katrina's landfall, gambling revenues made up nearly 20 percent of the state's economic base. To appease opposition, the casinos were located on barges, not on dry land. The hotels that serviced the casinos were on land. As the casinos and hotels flourished, skilled labour jobs were replaced with low wage jobs and became more plentiful. Minority residents in low-income neighbourhoods generally held most of these jobs. During Hurricane Katrina, the casino barges broke free of their moorings and were pushed inland by the storm surge, crushing everything in their way including the housing of many casino workers (Figure 3).

Lessons Learned

The differences in the impact of Hurricane Katrina were a product of the storm surge, the rapid redevelopment of the coast after Hurricane Camille's devastation, which increased disaster risk, as well as the existing vulnerability in the region, a social vulnerability produced and maintained by segregation. The loss of gaming revenues post-Katrina took a toll on the local (and state) economy, so much so that the state legislature voted to allow casinos on land. The first casino opened its doors four months later in the newly permitted

Figure 3: Casino barge washed onshore in Biloxi, Mississippi, by the storm surge during Hurricane Katrina (Photo: S.L. Cutter).

hotel-casino complexes. Disaster recovery money was initially spent on rebuilding the Port of Gulfport, a political decision that privileged economic development over low to moderate-income housing for the mostly African American population.

The reliance on quick solutions to economic development and redevelopment provides one of the primary root causes for enhancing disaster risk. Rather than providing a sustainable approach to coastal development, such as a retreat from the highest risk areas, infrastructure (bridges, sewer, and water systems) is being reconstructed with more capacity, implicitly designed to stimulate more growth. However, countervailing events such as the recession and mortgage and lending crises, coupled with a major oil spill (Deepwater Horizon), and additional hurricanes/tropical storms have slowed the recovery and reconstruction along Mississippi's coast. The primary lesson learned from the root cause analysis is that history matters and to encourage communities to plan for recovery in the same manner that they plan for disasters. This can help decision-makers resist the pressures to build back quickly, and instead make informed choices to rebuild smartly with disaster resilience and sustainability principles in mind. The forensic approach highlights the historic social oppression and the misinformed coastal development, which acted in concert to produce the disaster risk.

Source:

Cutter, S.L., C.T. Emrich, J. T. Mitchell, W. W. Piegorsch, M. M. Smith, and L. Weber (2014). ***Hurricane Katrina and the Forgotten Coast of Mississippi.*** Cambridge and New York: Cambridge University Press.

Postscript

These three case studies show that disasters are not entirely unique place-based events, but occur in different contexts that can, in part, be explained by some common underlying causes and processes. The governance-based comparative analysis of Morakot and the retrospective longitudinal analyses of the Haiti earthquake and Hurricane Katrina on the Mississippi coast illustrated two of FORIN's methodological approaches. The expansion of the number of comparable studies in the FORIN project in such a way as to provide for cross-cutting meta-analyses can help to identify the common root causes and risk drivers more precisely. This in turn can lead to improved international cooperation in disaster risk management.

About IRDR

The Integrated Research on Disaster Risk (IRDR) programme is a decade-long integrated research initiative co-sponsored by the International Council for Science (ICSU), the International Social Science Council (ISSC), and the United Nations International Strategy for Disaster Reduction (UNISDR) – the Co-Sponsors. It is a global, trans-disciplinary and intersectoral research programme to address the major challenges of natural and human-induced environmental hazards. The complexity of the task is such that it requires the full integration of research expertise from the natural, socio-economic, health and engineering sciences, legal practices, and cultural studies, encompassing also areas of inquiry and practice such as policy-making, the role of communications, and public and political perceptions of and responses to risk.

The programme is guided by three research objectives:

1. Characterising hazards, vulnerability and risk.
2. Understanding decision-making in complex and changing risk contexts.
3. Reducing risk and curbing losses through knowledge-based actions.

Three cross-cutting themes support IRDR's work towards these objectives:

1. Building capacity, including mapping capacity distribution, for disaster risk reduction at different levels and across multiple hazards.
2. Development and compilation of case studies and demonstration projects.
3. Advancing assessment, data, and monitoring tools of hazards, risks and disasters.

Attainment of these objectives through successful projects will lead to a better understanding of hazards, vulnerability and risk; an enhanced capacity to interpret and manage disaster risk; improved insights into decision-making that may increase risk exposure, as well as how such choices may be influenced; and proposals for how new this knowledge can more effectively guide disaster risk reduction efforts at all levels. The IRDR research programme is conducted through its project working groups FORIN, DATA, RIA, and AIRDR, as well as through its national committees and International Centres of Excellence (ICoE). See www.irdrinternational.org for more information.

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