A Review of the FORIN Methodology and Existing FORIN Case Studies

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Abstract

The paper reviews the FORIN (FORensic INvestigations of disasters) methodology for understanding the root causes of disaster events with the aim of developing its use across scales and types of disaster event. It is based on an assessment of existing case studies that have formally adopted the FORIN framework. The paper highlights how FORIN provides a broad and adaptable framework for the holistic assessment of root causes. It also outlines five key challenges to FORIN: 1. Developing our understanding of the governance context for disaster management, 2. The role of the disasters cycle in perpetuating risk, 3. Integrating backward-looking and forward-looking analysis, 4. Developing methods for analysing causal pathways and 5. Developing FORIN indicators for comparative analysis over time and through which to improve the policy update of FORIN and potentially assess its impact.

1 Introduction

This review of FORIN aims to assess FORIN's utility as a conceptual and methodological framework for analysing disaster root causes. Specifically, the review was undertaken as part of the PEARL (Preparing for extreme and rare events in coastal regions) project, which sets out to include a root cause analysis in its assessment of the formation of risk and vulnerability in particular coastal zones[1]. This review is the first step in this analysis, and will be followed by a draft proposal for a revised FORIN framework, based on testing the proposed framework against 40 peer-reviewed studies of European coastal disasters. The final step will be to propose a methodology to be used in PEARL for this revised framework.

The paper proceeds as follows: The second section sets out the main elements of FORIN. The third section examines in more depth the case studies officially undertaken under the rubric of FORIN so far, analysing the utility and limitations of FORIN in each case. The fourth section reviews the FORIN approach in light of the case study analysis and a review of other root cause analysis frameworks. The fifth section concludes with recommendations for the development of the FORIN methodology.

2 What is FORIN?

2.1 Aim, justification and hypotheses

FORIN (FORensic INvestigations of disasters) is an investigative multi-disciplinary framework that aims to uncover, and then promote learning from, the root causes of disaster losses and risk by examining policy, management, social and cultural, and emergency response decisions made before, during and after disaster events. FORIN aims to deepen the spatial and temporal scales of disaster analysis and integrate a systematic understanding of the links between disasters and development. It does so by promoting independent, scientific investigations of disaster causes which aim to shift

[1] For more details, see http://www.pearl-fp7.eu/

the paradigm of disaster management policies towards more holistic approaches which also address the underlying factors that precipitate disaster losses and damage.

Although the noticeable growth in losses from disaster events is often attributed to increases in human population and material wealth, and their expansion into more hazardous locations, this is not a complete explanation of a now recognisable phenomenon. Since major disasters continue to occur through the developing and developed world, in turn suggests that there must be more to the explanation than access to science and technology, and choice of location, and resource scarcity (Birkmann 2012; Adger et al. 2005). In addition, the vast majority of these studies into the causes and consequence sof a disaster event are conducted in isolation from those most intimately involved and ultimately responsible for disaster risk planning and management. The FORIN methodology has been specially developed to fill the deficit and deficiency in existing research on disasters by reducing these barriers and incorporating a more inclusive approach.

Through the development of a multidisciplinary framework with a common set of fundamental questions explicitly designed and enacted to provide an in-depth investigation of a range of disaster events, FORIN is utilisable at various scales. FORIN studies seek to address four key hypotheses that have been identified as inherent to a reduction in vulnerability to disasters:

1. The risk reduction hypothesis
    - greater accountability, visibility and transparency of risk reduction processes being employed would enable and stimulate improved disaster risk reduction
2. The integration hypothesis
    - integrated and participatory research is required to yield more useful and effective results
3. The responsibility hypothesis
    - precise identification and structuring of responsibilities and accountability both for creation and/or the prevention of the growth disaster risk is key in reduction of that risk
4. The communication hypothesis
    - intended recipients of disaster risk reduction knowledge are unaware of the insights or alternatively are resistant to the knowledge and information and may feel threatened by it

2.2 The FORIN Methodological Framework

The FORIN methodology is based around the development of case studies that answer a set of core questions about responsibility and risk for use with a range of different disaster types. Using the Hyogo Framework for Action (International Strategy for Disaster Reduction 2005) as a foundational reference, FORIN identifies governance as the primary factor in driving disaster risk reduction at multiple scales, and therefore a critical element to address directly (Integrated Research on Disaster Risk 2011). Besides governance, other critical elements (See Figure 1, Source: Integrated Research on Disaster Risk 2011) highlighted by the FORIN framework further reinforce the need to employ a fully integrated research agenda across disciplines in order to maximise the utility of FORIN

generated results across temporal and spatial scales. These addition elements include i) risk assessment, made up of causal agents, social systems and infrastructure, and ii) understanding and awareness of underlying causal processes and outcomes and impacts in terms of sectors, spatial distribution and susceptible populations. Specific research questions that can be investigated across scientific disciplines have been developed for each element of the framework. These include 20 core questions to be directly addressed in each of the case studies according to the specific circumstances and 10 generic questions which can be used to help design a project synthesis report.

Figure 1. A conceptual framework for key questions.

Due to the diverse range of disasters that can be analysed using the FORIN approach, a series of organisational pathways have been identified in order to categorise studies employing part or all of the suggested framework. Initially, four disaster types have been identified which include:

- Specific events (e.g., the Hanshin earthquake, Japan)
- Recurrent events (e.g., floods in Mozambique)
- Thematically important dimensions (e.g., school and hospital safety, trans-boundary risks)
- Risk drivers (e.g., management, poverty, governance, etc.)

In addition to the types of disasters that each study is concerned with, four methodological pathways have been identified. The use of these pathways are dependent on different contexts or motivating interests involved, but they are all guided by the same overall objectives outlined by the FORIN approach. The selection of the appropriate research methodology for a specific event or set of risk conditions is a function of the expertise of the research groups conducting the studies as well as the nature of the case study itself. These pathways have been identified as:

1. *Critical cause analysis*
    - Analyses that seek to identify the root causes of the disaster events. This approach is based on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms.
    - Multidisciplinary in nature integrating social, environmental and technical assessments.

2. *Meta-analysis*
    - Systematic reviews of the available literature carried out to identify and assess consistent findings across diverse studies for causal linkages as well as the effectiveness of interventions

3. *Longitudinal analysis*
    - Repeated observations of comparable events, either geographically (e.g., two different but essentially comparable places with similar event characteristics where the sequence of actions, decisions, policies, etc. are cross-examined in comparative fashion) or comparative in-situ (same place, two temporally different events, repeat events; or the same place with two different perils).

4. *Scenarios of disaster*
    - Science-based retrospective re-constructions of specific conditions, causes and responses involved in particular destructive events selected on the basis of a known hazard that represents a realistic and possibly inevitable future event.

As one of its aims, FORIN expects to be able to establish a range of case studies across disaster types as well as methodological approaches in order to more fully understand both the risks posed by disasters as well as how to reduce the increases in catastrophic losses which continue to be realised.

3: Review of FORIN Case Studies

This section shifts from a review of FORIN itself to an assessment of the utility of the methodology as deployed. An analysis of each case study was undertaken and the matrix in Table 1 was used to visualise which components of the FORIN conceptual framework and core questions were covered. Each question was colour coded. The results can be assessed in terms of the comprehensiveness of the methodology deployment, but not of the quality of the methodology or data produced, nor of the impact of any study on practice. As can be seen from the tables (displayed in the Annex), no single study has covered the full range of FORIN questions, although the study of the GEJET by Fujiwara, Sagara and the ICHARM studies use all FORIN methods and cover all the framework elements specified by FORIN.

Draft for circulation

Table 1. FORIN visualization matrix

DISASTER: (LOCATION, DATE, TIME)		FORIN Framework element																																			
STUDY SITE, TEAM LEADER		Governance/Priority						Risk Assessment					Understanding/awareness						Outcomes/impacts									Risk reduction						Enhancing resilience					
Methodological pathway																																					
	Disaster typology	*8*	*11*	*11a*	*18*	*19*	*G10*	*1*	*2*	*2a*	*6*	*7*	*3*	*4*	*5*	*6*	*7*	*20*	*12*	*13*	*14*	*15*	*16*	*17*	*G2*	*G6*	*G9*	*9*	*10*	*G1*	*G4*	*G5*	*G8*	*15*	*15a*	*15b*	*15c*	*15d*	*G3*	*G7*
Critical cause analysis	Specific events																																				
	Recurrent events																																				
	Thematically important dimensions																																				
	Risk drivers																																				
Meta-analysis	Specific events																																				
	Recurrent events																																				
	Thematically important dimensions																																				
	Risk drivers																																				
Longitudinal analysis	Specific events																																				
	Recurrent events																																				
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	Risk drivers																																				
Scenarios of disaster	Specific events																																				
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The FORIN case studies were also analysed for what they tell us about the strengths and limits of, and gaps in FORIN as applied to date. As can be seen from the table below, the strengths of the FORIN approach lie in its conception of disasters as inseparable from both development processes and everyday societal processes; comprehensive analysis that learns from the past to ground sustainable disaster management; inter-disciplinarity; the inclusion of multiple stakeholders; the adaptability of FORIN components and the range of methodological pathways, which allows for scenario analysis alongside historical methods. Limits included defining the scope of FORIN and allowing for the analysis of changes in imperceptible 'climate normals' alongside disaster events. Common gaps included methods and concepts for analysing causal relationships.

Table 2: Summary of the strengths, limits and gaps in FORIN in case study applications of the approach

Study	Strengths of FORIN	Limits of FORIN	Gaps in FORIN
Naruchaikusol, Beckman & Mocjizuki 2013	Allows for investigation inter-play disaster risk and development processes at different scales and effects of cumulative decision-making at these scales Scenario method allows integration of predictive methods		
Huang et al. 2013	Conceptual view of disaster as inseparable from everyday and wider development and societal processes; disasters as result of the outcome of interaction between different systems and different phenomena Inter-disciplinary framework, importance of historical approach for policy learning, allows for synthesis of societal dynamics, pre, during and post disaster, assists comprehensive scenario planning	If disaster is perceived of as societal disturbance, where limits of 'disaster' end, how to define relevant stakeholders, what are the criteria for setting a generic framework across different disaster types, what are the implications for policy from this comprehensive view	Authors turn to systems theory for conceptual and methodological basis for the analysis of causal pathways; use to establish most critical phenomena and main 'storylines' that explain their relationship

Castillo et al. 2013	Use of comprehensive, inter-disciplinary approach that integrates perspectives of different stakeholders Adaptability of hypotheses, objectives and methods of FORIN to context of climate change (Also innovation of the FORIN narrative allowed for preliminary studies to be produced)	Influence of long-run changes in climate 'normals' Practical challenges of inter-sectoral work	Models used to enhance the predictive capacities of the FORIN approach, allowing analysis of common variables affecting risk and resilience to disasters and climate change Objectives modified to include element related to transformational change The original FORIN framework was also modified to include a more explicit characterisation of risk (as the holistic analysis of hazard, exposure and vulnerability in the past, the present and projected into the future), the research cycle itself and capacity building as a core element by which the research results are implemented. The report also included modifications made to the core questions to adapt them for the context of climate change.
Faustino-Eslava et al. 2013	Use of FORIN as a predictive tool even where there is no history of disaster Inclusion of multiple stakeholders in discussions of risk mitigation measures		
Fujiwara, Sagara & ICHARM studies of			Questions around damage to

GEJET			infrastructure networks, and damage propagation between networks

3. Critical Analysis of the FORIN approach

FORIN's overall approach can be described as one aiming at a 'root cause analysis'. Root cause analysis has no generally agreed definition. FORIN makes a key contribution in formalising this analytical space and agenda. Root cause analysis has been described as "a structured investigation that aims to identify the true cause of a problem and the actions necessary to eliminate it" (DKKV 2012). These two components – cause and remedy – are shared by FORIN, as is a claim to analytical acuity. The following section assesses FORIN's success drawing on existing FORIN studies and a wider group of non-FORIN studies that have deployed similar approaches.

3.1 The strengths of FORIN as a disaster root cause analysis approach

Arguably the distinguishing feature and main utility of the broad FORIN framework is that it gives power to analysis that conceptualises disasters as intrinsic to development and societal processes more broadly, based on its inter-disciplinary and comprehensiveness. As seen through the case study analysis, this approach aims to integrate different scales of analysis and is revealing of the interactions between socio-economic and political and risk dynamics (Huang et al. 2013; Naruchaikusol, Beckman, and Mochizuki 2013; Castillo 2013). Its objectives, methods and questions are broad enough to allow for its adaptation to different contexts and forms of risk. FORIN's methodological approach also fosters the inclusion of multiple stakeholders in the research process (Faustino-Eslava 2013), and the innovation of the FORIN narrative allows for rapid studies that can be expanded over time (Castillo 2013).

3.2 An analysis of FORIN's analytical elements

The review of FORIN identified 5 core elements for the development of FORIN as an approach to root cause analysis:

1. Developing our understanding of the governance context for disaster management
2. The role of the disasters cycle in perpetuating risk
3. Integrating backward-looking and forward-looking analysis
4. Developing methods for analysing causal pathways
5. Developing FORIN indicators for comparative analysis over time and through which to assess the impact of FORIN

1. Understanding the governance context for disaster management

The governance component of FORIN is arguably the linchpin of the project. However, could different approaches to understanding governance be utilised to unpack more clearly questions of decision-making and capability? Of the 40 studies of disaster causation reviewed for this paper (see Annex 3), particular studies emphasised elements not yet included in FORIN: the role of performance and interpretation in organisational responses to disaster (Adrot 2013), the role of

institutional culture and beliefs (Constantinides 2013) and the lack of communication and understanding between institutions (Emdad Haque 2000). The existing FORIN approach would seem to emphasise an actor-oriented, top down orientation. Other FORIN-inspired studies, such as the STREVA project to examine the root causes of volcanic risk, for example, explore what defines institutional capacity at different scales and how it is influenced by the relationship between formal and informal institutions, networks between different actors and coherence across those scales (Wilkinson 2013). As well as this vertical, multi-scalar conception of tiers of governance, an institutional political economy approach can help unpack the horizontal relationships between different organisations within a particular institutional configuration.

The questions that arise, then, are how institutional capabilities to assess and manage risk (and the developmental drivers of risk) are shaped across these dimensions in the context of different political regimes (Pelling 2003), with different value orientations and social and cultural foundations, at different points in time (in particular when disasters open up 'windows' of opportunity for change)(Birkmann et al. 2010). Further questions might also address the role of disaster narratives in the process of disaster causation and the influence, for example, of the discursive production of disasters as amenable to technical solutions alone, or the labelling of affected communities as 'responsible' in ways that might be contested (Aragon-Durand 2007; Rebotier 2012). This final sense of how notions of responsibility come to be used within the disaster-related discourses of different actors connects most strongly with a view of governance as a set of everyday practices which also influence how risk and vulnerability are experienced (Zeiderman 2012).

The emphasis on knowledge as a core component of institutional capability also raises the issue of the relationship between risk assessment and governance. Risk assessment exercises do not only occur outside governance structures (as a separate element) but are also embedded in them, raising questions about how different knowledge sources are used as well as communicated. This acknowledgement potentially re-frames the hypothesis that the knowledge that exists about disaster risk reduction has not been communicated effectively. Although this is certainly also the case, it suggests the need to pay attention to how scientific understandings of risk are constructed and deployed in particular contexts in ways that may restrict a holistic understanding of vulnerability and risk (rather than take risk knowledge as a given)(Jasanoff 2004; Lane, Landström, and Whatmore 2011).

2. The role of the disasters cycle in perpetuating risk

The disasters cycle itself – preparedness, mitigation, response, recovery and reconstruction – is a process embedded in the institutions of governance that influences the occurrence of risk. The post-disaster phase is not simply the end point of the disaster event, but a process in its own right that has its own antecedents in the social, economic and institutional context and forms part of how we understand disasters as complex and unfolding phenomena, rather than single points in time(DKKV 2012). These antecedents merit their own forensic analysis: how and why were particular response options chosen, by what actors and with what results? This is often a neglected area of analysis with similarly few studies tracking decision points in the generation of impact, though recent studies (Whittle et al 2012) indicate the reconstruction process can have a considerable impact on human wellbeing and vulnerability (Birkmann 2011). Problems with accessing insurance payments and

secondary economic costs, as well as gains in reconstruction may be more important in some instances than the initial disaster. In addition, disasters might also be intensified and risks continue due to inappropriate disaster response strategies (DKKV 2012).The nature of response and recovery determines how existing vulnerabilities are ameliorated or exacerbated and may preclude as well as enable policy and planning changes for enhanced resilience (IPCC 2012). In addition, FORIN does not identify what sort of recovery or to what scale that recovery should be seen. Here the concepts of resilience and transformation may help measure processes of risk reduction, against the ideal of 'building back better', used but not developed in FORIN documents, and deep structural change that transforms the nature of social relations (Pelling 2011).

3. Integrating backward-looking and forward-looking analysis

The FORIN case studies have already demonstrated how scenario-based analysis can be integrated with historical root cause analysis, with both the Thai and Filipino cases using down-scaled climate change models alongside other FORIN methods. In addition, one FORIN case study (and one ongoing FORIN investigation into volcano risk) focuses on providing a baseline analysis of risk in an area under threat, but with no history of disaster (Faustino-Eslava 2013). The predictive capacity and conceptual focus of FORIN in this regard merits further investigation. A FORIN-like approach could be used in conjunction with other predictive analyses, like the social vulnerability index (Cutter et al. 2003) or the disaster risk index (Peduzzi et al. 2009), to identify vulnerability hotspots and enhance pre-disaster actions. Conceptually, the FORIN emphasis on historical root cause analysis could be developed with an approach that moves to understand how historic drivers connect with contemporary manifestations, and might drive risk into the future.

4. Developing methods for analysing causal pathways

While FORIN talks in general terms about root causes, in analysing the causal processes that lead to disasters, it may be helpful to make further distinctions about causal types and causal processes. For example, the Root Cause Framework suggested in DKKV 2012 keeps a strong distinction between *drivers* and *root causes* (where drivers are the activities and processes that translate root causes into unsafe conditions, while root causes are the structures and processes that go beyond an individual crisis or event (DKKV 2012). Further to both frameworks, however, is a consideration of how actions and decision-making are set within the interaction of social and ecological processes in ways that are dynamic, and potentially non-linear (Miller et al. 2010). The FORIN case studies used systems analysis as a methodological and conceptual guide for analysing causal processes, through the construction of causal loops and analysis of the strength of different causal phenomena.

5. Developing FORIN indicators for comparative analysis over time and through which to assess the impact of FORIN

While the FORIN framework incorporates a number of thematic areas which map onto specific research questions, developing indicators on the basis of these would facilitate analysis of risk over time and across different cases. The development of consistent and useful sets of indicators of both social and natural dimensions of disaster risk poses two distinctly inherent problems with respect to a complexity of the research parameters: (1) keeping the number of indicators manageable and (2) resolving differences in perspectives and terminology between social and natural system scientists

(Loomis et al. 2014). These issues would have to be overcome before a comprehensive methodology could be developed. However, such a methodology could also facilitate both the measurement of the impact of FORIN (assuming that FORIN's impact can be attributed from changes in risk processes). It might also assist in translating the findings of FORIN studies into tractable frameworks that can be utilised by decision-makers to improve disaster management processes (akin to the 'check list' used in the DKKV methodology).

5 Conclusions

This paper suggests that FORIN has provided a broad and adaptable approach for the study of disaster root causes, with FORIN's hypotheses, objectives and framework resonating well across a wide range of studies of disaster causation. Studies that have used the FORIN framework have been guided by its principles of holism and multi-disciplinarity and the inclusion of a wide range of stakeholders in the analysis process. Undertaking a 'full' FORIN, however, requires time and resources that have been beyond the scope of most existing studies, although the FORIN narrative approach has been used successfully as a starting point for inter-sectoral analysis.

The paper has also suggested avenues for the development of FORIN in a number of key areas. The implications for FORIN's main components are summarised in the table below:

Framework	Inclusion of the different governance elements that drive disaster reduction, including institutional dynamics across scales Incorporation of the disaster management cycle, including response and recovery, as a driver of disaster and disaster recurrence Incorporation of the idea of transformation, not just 'bouncing back'
Approaches	Discussion of ways in which 'predictive' FORINs could employ predictive tools from the social sciences, such as social vulnerability indices Development of a set of comparison indicators for studies Methods for causal analysis (and possible causal loops and feedbacks) underpinning the framework
Examples of possible additional questions (dependent on context)	How have institutional capabilities across different scales and levels of government influenced disaster risk management? What narratives of disaster have been used by different governance actors and how has the use of these narratives affected actions to mitigate disaster risk? How are risk, hazard and vulnerability defined and used when risk assessments are applied and how does this affect actions to mitigate root causes of disaster?

Annex 1: Summaries of FORIN Case Studies

Authors	Naruchaikusol, Beckman & Mocjizuki 2013
Reference	Disaster response and adaptive capacity of upland communities in the face of increasing climate risk. A discussion of changing livelihoods, land use, and natural-resources management in Northern Thailand.
FORIN Study Type	Critical cause analysis and Scenarios of disasters
Disaster Typology	Recurrent events

This study investigated the inter-relationships between land-use changes and adaptive capacity to climate risk in Northern Thailand focusing on how these relationships were influenced by policy-related and economic activities at national, provincial and local levels. The study highlighted numerous climate risks facing marginalized, primarily agricultural communities, including flash floods, heavy rainfall, temperature extremes, and prolonged drought. Extensive details of climatic and environmental conditions, as well as management regimes were discussed. Adaptive management of land-use also formed a key component of this study, and was investigated through extensive stake-holder engagement. A legal and political framework discussion was provided for each study site to provide context for decisions and potential adaptation changes. Policy recommendations for increased disaster risk reduction were made, including the need to establish a comprehensive disaster warning system to improve local emergency-management capacity, especially in the face of the continued risk of landslides post heavy rainfall. Other recommendations into how to improve localised social resilience, including economic and agricultural diversification, and incentives for that practice, were also made.

Methodology Used

This study employed expert interviews and community focus groups. Interviews were conducted with farmers and village leaders, both individually and in small groups, using semi-structured interviewing, timelines, and participatory maps of village land use. Group interviews with key informants were also held. Climate change scenarios were discussed as part of the participatory exercises.

Utility to FORIN

This is a good example of how to use FORIN as a predictive tool for improvement in long-term disaster management to a recurring threat. The economic structure of these communities was extensively discussed but there was less emphasis on the social structure. Further elucidation of the social values of the communities may have provided more information on potential barriers to disaster risk reduction from a more local scale perspective. Since no one disaster event was being described some of the FORIN questions were not relevant, especially in terms of the outcomes/impacts component of the FORIN framework.

Authors	Huang et al. 2013
Reference	Towards a Generis Framework for Synthesizing the Societal Disturbance from Typhoon Marokot
FORIN Study Type	Meta-analysis
Disaster Typology	Specific event

This study focused on causes of social disturbance after Typhoon Morakot hit southern Taiwan in 2009 leaving 461 people dead, 192 missing and an estimated $3 billion (USD) in damages. Research initially focused on establishing a disaster event database based on a range of news and information sources, and then classified reported social disturbances in order to categorize cause and effect. Investigation topics emphasized societal issues, social structure, especially government management and administration, and human behaviour. Specific causal loops were generated to demonstrate feedback circulation. The results suggest that disasters are not independent events but an outcome of interactions between different systems (e.g., people, organization, and infrastructure) and between different phenomena (e.g., hazardous waste and household damages).

Methodology Used

This study used a meta-analysis approach, specifically the archival literature approach, assisted by textual analysis and methods of induction and deduction, to find phenomena associated with Typhoon Morakot as well as relationships among these phenomena. Documents used included newspaper articles, online new media, academic papers and government publications. Vensim software was then used to develop cause and effect diagrams and describe complex relationships.

Utility to FORIN

This study reinforces the flexibility of a FORIN and demonstrates the wide range of investigative studies that can be designed around the framework as it stands. Although many of the core questions are answered during this report, the authors take a more indirect approach in general, so it was difficult to link the material with a specific core question or framework element in the visualisation table. The FORIN approach was used along with a systems theory perspective, which informed the causal analysis.

Authors	Castillo et al. 2013
Reference	Harmonizing FORIN for Climate Change Adaptation and Disaster Risk Management to Develop Multi-sectoral Narratives for Metro Manila.
FORIN Study Type	Longitudinal analysis
Disaster Typology	Recurrent events

This project aimed

1. to adapt the FORIN framework for disaster analyses into a comprehensive climate change action planning and disaster risk management framework,
2. to operationalize the framework by developing FORIN narratives focused on Metro Manila,
3. to attempt to connect key variables, processes and trends into a systems model structure.

This investigation produced discrete FORIN narratives encompassing the physical, social, economic and health sectors in addition to developing sectoral casual loop diagrams and preliminary system model structures. This approach generated extremely comprehensive documentation of existing threats to each sector as well as detailed recommendations for climate change action planning.

Methodology Used

An initial literature review was performed to determine how FORIN and climate change action planning could be integrated. The expert consultation process utilising the combined framework involved 2-3 experts each from 4 sectors (physical, social, economic and health) to develop a FORIN narrative for each of their sectors for Metro Manila. The social sector report used primarily secondary sources of information including the Disaster and Climate Change Study (2008-2009) conducted in three flood basins of Metro Manila. This study utilized household and community profiling surveys, key informant interviews, and focus group discussion. Orientation meetings and monthly inter-sectoral workshops were held throughout the project lifespan. Dissemination of results to the university community of the Manila Observatory and other interested groups was conducted. Vensim software was used to develop the casual loop diagrams and preliminary system model structures.

Utility to FORIN

This investigation uses FORIN as a part of a larger, integrated disaster risk management and climate change action planning model to maximise the predictive capabilities of the FORIN approach. This combined integrated model allows analysis of common variables that affect risk and resilience to both climate change and disaster impacts. The new framework preserves the original FORIN principles, such as the need for a comprehensive approach that engages researchers from different fields and stakeholders from different sectors. The case study authors also found the hypotheses, objectives and methods of FORIN to be adaptable to a DRM / CCA framework. The objectives were modified, however, to include an element referring to transformative change. The original FORIN framework was also modified to include a more explicit characterisation of risk (as the holistic analysis of hazard, exposure and vulnerability in the past, the present and projected into the future), the research cycle itself and capacity building as a core element by which the research results are implemented. The report also included modifications made to the core questions to adapt them for the context of climate change. However, due to these modifications, it becomes difficult to assess the report using the visualisation assessment matrix.

As in the case study of Typhoon Marokot, this study used systems analysis to deepen the assessment of the underlying feedbacks and processes between different variables that underpin risk. Several additional challenges were reported by the authors, especially when creating the system models after the FORIN framework had been applied. These included issues with 1) unavailable data on sectoral overlaps after the FORIN narratives were constructed creating the potential for duplication in the models, and 2) data availability for several variables have not been documented or have not been disaggregated at the level

required for the model to truly track changes in impacts and in the associated risks due to climate change and extreme weather events. The authors also discuss the challenges to FORIN in analysing changes in 'climate normals' rather than discrete disaster, events and the challenges to inter-sectoral work.

Authors	Faustino-Eslava et al. 2013
Reference	Predictive Forensics for Averting Possible Disasters: A FORIN Template for Tackling Issues Related to the Valley Fault System and the Angat Dam in Luzon, Philippines.
FORIN Study Type	Scenarios of disasters
Disaster Typology	Specific event and Recurrent event

This report provides extensive background on geohazard risk associated with the Valley Fault System on the Island of Luzon and potential risk associated with any damage to the Angat Dam in the face of repeated geohazard episodes. This study uses the FORIN framework as a predictive set of indicators to enhance disaster risk reduction by investigating the geophysical, social and economic drivers of risk in this region. The biggest challenge identified by the research team is that scientific information currently available at the national agency level is not filtering down to the local communities where that information could be critical to local planning efforts.

Methodology Used

A range of geophysical research was conducted using several key methods including: geologic mapping, magnetic surveys, and ground penetrating radar. Focus groups were conducted with local communities to determine risk awareness. Participants included the Municipal Mayors from three communities as well as their Municipal Planning and Development Office as well as 71 residents from the municipalities. Integrated economic analyses were conducted to determine potential economic impacts of flooding scenarios if the Angat Dam was damaged.

Utility to FORIN

This study describes how to use FORIN as a predictive tool for improvement in long-term disaster management to a recurring threat. It supplies a highly detailed physical baseline with extensive information regarding the tectonic setting and regional geology of the area that could be vital to a FORIN study in the event of a disaster. The study refers to FORIN's use in relation to the design of the focus groups, and the inclusion of multiple stakeholders in the discussion of possible risk mitigation measures.

Authors	Fujiwara	Sagara 2011	ICHARM
Reference	Scenario Analysis of Mega Earthquake and Tsunami in Central Japan	Critical Cause Analysis of Delayed Evacuation in the Great East Japan Earthquake and Tsunami	Meta and Longitudinal Analyses of High Death Rates of Some Particular Municipalities in GEJET
FORIN Study Type	Scenarios of Disasters	Critical Cause Analysis	Meta-Analysis / Longitudinal
Disaster Typology	Specific event	Specific event	Specific event

*Review produced from 3 separate power point presentations from the IRDR 2011 conference

These three studies combine to form a FORIN analysis of the Great East Japan Earthquake and Tsunami (GEJET). Each study covered a slightly different aspect of the disaster with components looking at the emergency response and evacuation whilst other components focused on more of a critical cause analysis. A large amount of information describing the events of the GEJET has been generated by these studies including modelling of the impacts on infrastructure and attempting to understand why those impacts were so great in terms of death rate. There is also information generated about why some areas were more impacted than other ones in the form of specific case studies. Large emphasis was placed on understanding failures in evacuation procedure that lead to high numbers of deceased. Although risk-reduction avenues were not specifically presented, much of the information generated can be used to create a lessons learned profile.

Methodology Used

Each study used a range of methods including archival analysis of multiple sources, interviews, and GIS modelling. These methods all contribute to the fact that these studies cover all four methodological pathways associated with FORIN. Many of the detailed methods used are hard to assess due to the fact that they are not included in the presentations. This section can be greatly improved once access to reports and papers is established.

Utility to FORIN

The combination of these three studies provides the best example of a 'complete' FORIN to date with a range of core questions being covered using multiple methods. The visual matrix highlights overlaps between methods employed. This redundancy provides key comparative possibilities that allow a more comprehensive picture to be formed. It also highlights the difficulty of covering the full range of questions posed by a FORIN study, with legal frameworks and social and power structures seemly the most difficult to cover using the FORIN framework. The identification of specific critical action points (linked specifically to evacuation but relevant on a broader scale) highlight a major avenue of investigation that may be relevant to FORIN. Sagara also suggests the addition of questions around damage to infrastructure networks, and damage propagation between networks.

Annex 2: Visualisation tables for FORIN Case Studies

Table 2.1 Visual assessment of FORIN framework areas covered by Naruchaikusol et al.

DISASTER: Continual Flooding		FORIN Framework element																																							
Thailand, Sopon Naruchaikusol		**Governance/Priority**						**Risk Assessment**					**Understanding/awareness**						**Outcomes/impacts**									**Risk reduction**						**Enhancing resilience**							
Methodological pathway	Disaster typoology	*8*	*11*	*11a*	*18*	*19*	*G10*	*1*	*2*	*2a*	*6*	*7*	*3*	*4*	*5*	*6*	*7*	*20*	*12*	*13*	*14*	*15*	*16*	*17*	*G2*	*G6*	*G9*	*9*	*10*	*G1*	*G4*	*G5*	*G8*	*15*	*15a*	*15b*	*15c*	*15d*	*G3*	*G7*	*G11*
Critical cause analysis	Specific events																																								
	Recurrent events	x	x		x	x		x	x		x	x													x																
	Thematically important dimensions																																								
	Risk drivers																																								
Meta-analysis	Specific events																																								
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								
Longitudinal analysis	Specific events																																								
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								
Scenarios of disaster	Specific events																																								
	Recurrent events												x			x	x	x										x	x	x					x			x			x
	Thematically important dimensions																																								
	Risk drivers																																								

Table 2.2 Visual assessment of FORIN framework areas covered by Huang et al.

DISASTER: (Typhoon Morakot, 2009)

FORIN Framework element

Taiwan, Tailin Huang		**Governance/Priority**						**Risk Assessment**					**Understanding/awareness**						**Outcomes/impacts**									**Risk reduction**						**Enhancing resilience**						
Methodological pathway	Disaster typoology	8	11	11a	18	19	G10	1	2	2a	6	7	3	4	5	6	7	20	12	13	14	15	16	17	G2	G6	G9	9	10	G1	G4	G5	G8	15	15a	15b	15c	15d	G3	G7
Critical cause analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Meta-analysis	Specific events							x	x	x		x	x	x			x						x		x	x	x					x	x			x				
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Longitudinal analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Scenarios of disaster	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							

Table 2.3 Visual assessment of FORIN framework areas covered by Castillo et al.

DISASTER: Risk reduction planning		FORIN Framework element																																						
Manila, Castillo		**Governance/Priority**						**Risk Assessment**					**Understanding/awareness**						**Outcomes/impacts**									**Risk reduction**						**Enhancing resilience**						
Methodological pathway	Disaster typoology	*8*	*11*	*11a*	*18*	*19*	*G10*	*1*	*2*	*2a*	*6*	*7*	*3*	*4*	*5*	*6*	*7*	*20*	*12*	*13*	*14*	*15*	*16*	*17*	*G2*	*G6*	*G9*	*9*	*10*	*G1*	*G4*	*G5*	*G8*	*15*	*15a*	*15b*	*15c*	*15d*	*G3*	*G7*
Critical cause analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Meta-analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Longitudinal analysis	Specific events	x			x			x	x	x	x	x	x	x					x				x		x				x	x			x		x				x	
	Recurrent events	x			x			x	x	x	x	x	x	x					x				x		x				x	x			x		x				x	
	Thematically important dimensions	x			x			x	x	x	x	x	x	x					x				x		x				x	x			x		x				x	
	Risk drivers	x			x			x	x	x	x	x	x	x					x				x		x				x	x			x		x				x	
Scenarios of disaster	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							

Table 2.4 Visual assessment of FORIN framework areas covered by Faustino-Eslava et al.

DISASTER: Geohazards		FORIN Framework element																																				
Luzon, Philippines, Faustine-Eslava		**Governance/Priority**						**Risk Assessment**					**Understanding/awareness**						**Outcomes/impacts**									**Risk reduction**						**Enhancing resilience**						
Methodological pathway	Disaster typoology	*8*	*11*	*11a*	*18*	*19*	*G10*	*1*	*2*	*2a*	*6*	*7*	*3*	*4*	*5*	*6*	*7*	*20*	*12*	*13*	*14*	*15*	*16*	*17*	*G2*	*G6*	*G9*	*9*	*10*	*G1*	*G4*	*G5*	*G8*	*15*	*15a*	*15b*	*15c*	*15d*	*G3*	*G7*
Critical cause analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Meta-analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Longitudinal analysis	Specific events																																							
	Recurrent events																																							
	Thematically important dimensions																																							
	Risk drivers																																							
Scenarios of disaster	Specific events	x						x	x				x	x	x		x		x		x							x	x	x									x	x
	Recurrent events	x						x	x				x	x	x		x		x		x							x	x	x									x	x
	Thematically important dimensions																																							
	Risk drivers																																							

Table 2.5 Visual assessment of FORIN framework areas covered by Fujiwara, Sagara and ICHARM studies (GEJET)

DISASTER: Great East Japan Earthquake and Tsunami 2011

FORIN Framework element

Japan *Methodological pathway*	Disaster typoology	Governance/Priority						Risk Assessment					Understanding/awareness						Outcomes/impacts									Risk reduction						Enhancing resilience							
		8	*11*	*11a*	*18*	*19*	*G10*	*1*	*2*	*2a*	*6*	*7*	*3*	*4*	*5*	*6*	*7*	*20*	*12*	*13*	*14*	*15*	*16*	*17*	*G2*	*G6*	*G9*	*9*	*10*	*G1*	*G4*	*G5*	*G8*	*15*	*15a*	*15b*	*15c*	*15d*	*G3*	*G7*	*G11*
Critical cause analysis	Specific events	x	x					x	x	x	x	x	x	x					x	x			x		x	x			x												
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								
Meta-analysis	Specific events						x											x	x	x			x						x					x	x	x			x	x	x
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								
Longitudinal analysis	Specific events																	x	x	x			x						x				x	x	x	x			x	x	x
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								
Scenarios of disaster	Specific events							x	x	x	x								x						x	x				x											x
	Recurrent events																																								
	Thematically important dimensions																																								
	Risk drivers																																								

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