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A Policy Research Challenge towards Governance of Global Critical Infrastructure Systems under Extra-Extra-Ordinary Disaster Risks: Vitae Systems of Systems of Survivability

Abstract:

This paper addresses the need for the problem of governing globally networked infrastructure systems of systems under extra-extra ordinary disaster risk such as the Eastern Japan Great Earthquake Disaster (March 11th, 2011). First the definition of critical infrastructure is reexamined. For the purpose of rigorous examination of how the critical and vital states of networked infrastructures need to be governed, the notion of survivability based on Vitae System is discussed to extend the notion of resilience. For illustration, a case of the Straits of Malacca and Singapore as a global critical marine traffic corridor is presented.

Keywords: global critical infrastructure, survivability, Vitae systems of systems

1. Introduction

Critical Infrastructures, as officially mentioned perhaps for the first time and defined in the US Patriot Act of 2001[1)], are "those systems and assets, whether physical or virtual, so vital […] that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters."

However a question arises: what makes difference between "critical" infrastructure and simply, (non-critical) infrastructure per se? The author makes a point that the term critical infrastructure as originally used and commonly accepted remains yet very confusing and scientifically not rigorous. It is claimed in this paper that critical infrastructure should not be regarded as something that is developed "to exist as an object;" Instead, it should be considered as a "subject" or a "problem/policy issue" which calls for special consideration of "critical characteristics" attached to the infrastructure is polysemous, implying multiple meanings, and thus requires rigorous semantic examination.

2. What is Critical Infrastructure?

2.1 Definitions reexamined

According to the Oxford English Dictionary, the word "critical" is used to mean either of five different senses, among which the following two are considered most relevant to characterizing "critical infrastructure:"

Definition #1 (of a situation or problem) having the potential to become disastrous; at a point of crisis.

Definition #2 Relating to a point of transiting from one state to another (Math. & Physics)

From Definition #1 it is reasonable to list up the following qualifications of the infrastructure being "critical:"

- i. dependent on a situation or problem
- ii. disaster (disastrous) or crisis
- iii. its potential

In this connection it may be reasonable for us to take note of "disasters" or "crises" that are triggered by natural or social hazards (threats.) In fact non-ordinary types of disasters in both frequency (extremely low) and consequence (extraordinary large) have been increasing in Japan, Asia and other regions of the globe. For example, in Japan, the March 11th 2011's Eastern Japan Great Earthquake, an increasing number of huge typhoon disasters and extraordinary heavy rainfall disasters hitting different areas of Japan almost every year, just to name a few. Increasing 'potentials' of such extra-extra ordinary disasters explain well why and how infrastructure (particularly lifelines) should be studied, designed and managed more as a policy issue from the viewpoint of criticality of infrastructure.

From Definition #2 which is used commonly in science and mathematics, the following key items can be listed to relate to the criticality of infrastructure.

- iv. transition
- v. from one state to another

We also note that the Definition #1 of "critical" has two sub-meanings:

- (1) extremely ill and at risk of death
- (2) having a decisive or crucial importance in the success or failure of something

Accordingly the following list of key items is given to characterize the criticality of infrastructure.

- vi. risk of death or crisis of survivability
- vii. decisive or crucial importance
- viii. success or failure of infrastructure management and operation

It is also worth looking into the original meaning of "critic." krinein (Greek) which means

- ix. judge or decide

This is considered quite essential to what is meant by "critical." It implies that one has to judge or decide if it (the infrastructure) is critical or not. In other words "critical infrastructure problems" inevitably involve crucial decision-making to judge if it is critical or not, and if yes, how such decision can be made effectively and timely by whom and how.

2.2 Definition of "vital"

As underlined by the author in the definition of critical infrastructure by US Patriot Act of 2001, we should also pay attention to another word, i.e., "vital," which seems to be used in a tautological definition of "critical."

According to Oxford English Dictionary, the word "vital" has the following meanings.

- a. absolutely necessary; essential: <u>indispensable to the continuance of life</u>
- b. full of energy; <u>lively</u>
- c. fatal (<u>causing death leading to failure or disaster</u>)

It is remarked that the core meaning of

"vital" is "continuance of life" and "liveliness" that might turn to certain death leading to disaster. This implies that in a critical event it could put people or organization at death risk. Notably Okada[2) has made this point and proposed to explicitly model the process of this "narrowly continuing life at risk." He named this process "surviving process" and claimed that it consists of three aspects of "survivability," that is, survivability from certain death, vitality-based survivability, and communication-based survivability. He then proposed to call them, for short, "survivability," "vitality" and " communication" (or "con-vivality"), respectively. Okada's Vitae System Model formulates the prototype model of surviving behaviors of any living body by making use of these three indispensable functions in a critical event.

Figures 1 to 3 are shown to illustrate the essential points of Vitae Systems Applied to the Risk Governance of Critical Infrastructure. For details the readers are invited to refer to the

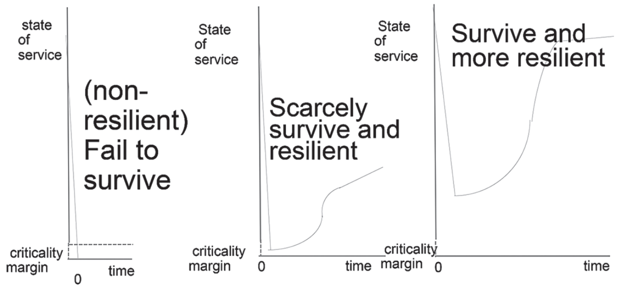

Figure. 1　Processes of Survivability followed by Resiliency

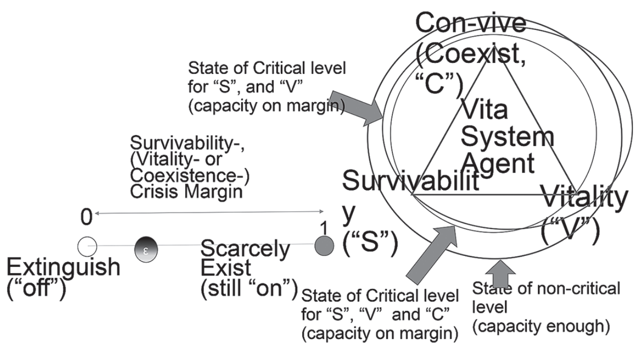

Figure. 2　Vitae System Agent As a Node of Social Networks to Overcome Life-critical Events (by Okada)

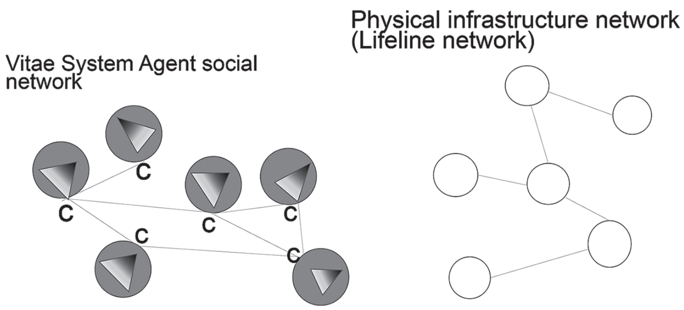

Figure. 3　Physical Infrastructure Network vs. Vitae System Agent Social Network

papers [2] and [3].

2.3 key factors which characterize "criticality" of infrastructure

To sum up the above definitional discussions, the following key factors are listed to characterize "criticality" of infrastructure.

i. dependent on a situation or problem
ii. disaster (disastrous) or crisis
iii. its potential
iv. transition
v. from one state to another
vi. risk of death or crisis of survivability
vii. decisive or crucial importance
viii. success or failure of infrastructure management and operation
ix. judge or decide

In addition it is advised to add the above-stated "vital" factors as follows:

a. indispensable to the continuance of life
b. lively
c. fatal (causing death leading to failure or disaster)

In other words these 12 factors need to be taken into account when we discuss what makes critical infrastructure special about as compared to infrastructure without the adjective of "critical."

3. Policy Study on Maritime Global Critical Infrastructure by IRGC and DPRI, Kyoto University

3.1 The Definition of Maritime Global Critical Infrastructure (MGCI)

By applying the definition of Critical Infrastructures by the US Patriot Act of 2001 [1], Maritime Global Critical Infrastructures (MGCI) are systems and assets as they relate to marine activities specifically and can impact international security, global economic security, public health or safety, or any combination of these. This paper proposes to elaborate on the above definition: We deal with MGCI as a policy issue on the critical/vital risk governance of complex systems which consist of infrastructures (lifelines) of infrastructures (lifelines) networked either interlocally, regionally, globally and cross-sectorally.

The author has served as the principal coordinator of this policy research project. For the sake of space only the summary of this study is given below.

3.2 The Summary of the Report [4)]

The Straits of Malacca and Singapore are one of the most important sea lanes in the world . They are a strategic passage for global trade, a source of oil, mineral and mangrove resources, and a centre for the Earth's marine and coastal biodiversity. Locally, Indonesia, Malaysia and Singapore derive different economic benefits from the Straits, but jointly shoulder the burden of environmental, safety and security risks. Globally, outsiders which depend on passage, especially Japan, China and Korea, would be negatively impacted by disasters that could lead to disruptions in the Straits. As such, the Straits constitute a prime example of a Maritime Global Critical Infrastructure that supports economies and societies locally and worldwide. Global Critical Infrastructure (GCI) offers a new perspective on emerging critical infrastructure systems characterised by globally and internationally connected critical infrastructure networks of a high level of complexity. Responsible risk governance of GCI requires a broadened perspective to creatively manage risks in increasingly complex, stressed systems. It can help improve resilience and the capacity of stakeholders in the Straits to cope with surprises. This may be accomplished *by being proactive in the development of prevention, preparedness, response and recovery strategies to deal with known, uncertain and unknown hazards (adapted from IRGC, 2005).*

The Tripartite Technical Experts Group (TTEG) in the Straits deploys and continues to develop technologies and processes to ensure undisrupted navigation, notably through the ship reporting system STRAITREP, the Traffic Separation Scheme and the Marine Electronic Highway. However, due to geographical constraints of the deep sea channels, the proximity to critical hinterland infrastructure, the high concentration of economic activities and the ecological importance, the Straits are vulnerable to hazards of natural, technological, human and malicious origin.

The risk governance of Maritime Global Critical Infrastructures is of interest to the Disaster Prevention Research Institute (DPRI) at Kyoto University and the International Risk Governance Council (IRGC). In this context, two expert workshops and initial scenario-based discussions were held in 2009 and late 2010 to specifically address the case of the Straits of Malacca and Singapore. These workshops and discussions showed that beyond traditional maritime casualties, there are trans-boundary threats and risk cascades that affect both land and sea with regional and global consequences. The Straits can be analysed as a "system of systems" with multiple and overlapping circles of stakeholders from local to regional to global scales, including public, private and non-governmental organisations as well as civil society. The scenarios discussed were: an explosion in an industrial area of refineries and petrochemical facilities, a cyber-attack on marine electronic systems, and ship collisions. These scenarios revealed potential risk governance deficits, including: insufficient awareness to new threats, inadequacy of early warning systems, unequal organisational capacity and burden sharing among littoral and user states, and the difficulty of dealing with dispersed responsibilities among stakeholders with diverging interests. Some of these deficits have already been addressed by the landmark effort known as the Cooperative Mechanism A culture of cooperation among the littoral states has been critical in preventing and mitigating some hazards in the Straits, notably in the cases of piracy and oil spills, but it should be strengthened and expanded to deal with other hazards and to include other stakeholders. In fact, existing mechanisms are not adequate to deal with all identified hazards and emerging risks, leading the authors of this report to propose five major recommendations.

3.3 Policy Recommendations

It is recommended that the littoral states, with user states, the maritime community and other concerned stakeholders: No.1 Harmonise methodologies, tools and procedures for risk assessment of maritime infrastructure and operations that start with the identification of possible triggering events, notably in terms of attacks on cyber-security, based on generally accepted frameworks. No.2 Implement an integrated disaster risk management approach by extending the scope of the existing emergency response system from a specifically oil spill contingency plan to provide an all-hazards plan. This would include the specification and sharing of multi-hazards and risk maps, communication chains, and an appropriate tri-lateral (Indonesia-Malaysia-Singapore) emergency operations system, and regular training exercises.#3 Prepare joint contingency plans in case of a closure of the Straits, involving navies, coast guards, port authorities, shipping companies, communities, among other key players. The plans should include notification, alternative routes, and a tri-lateral

(Indonesia-Malaysia-Singapore) effort to reopen the Straits. No. 4 Conduct comprehensive, joint (Indonesia-Malaysia-Singapore and user countries) risk assessments of the environmental, societal and economic impact of major activities in the Straits. The aim of these assessments would be to verify the appropriateness, consistency and sufficiency of existing policies and their implementation. More broadly, they would contribute to develop long-term cooperation between the littoral states and other stakeholders.#5 Create an observatory or ad hoc expert joint committees, embedded within the TTEG and Cooperative Mechanism, which would act as a representative and neutral platform for collecting and evaluating data to advise key stakeholders.

For illustrations Figures 4 to 6 are shown.

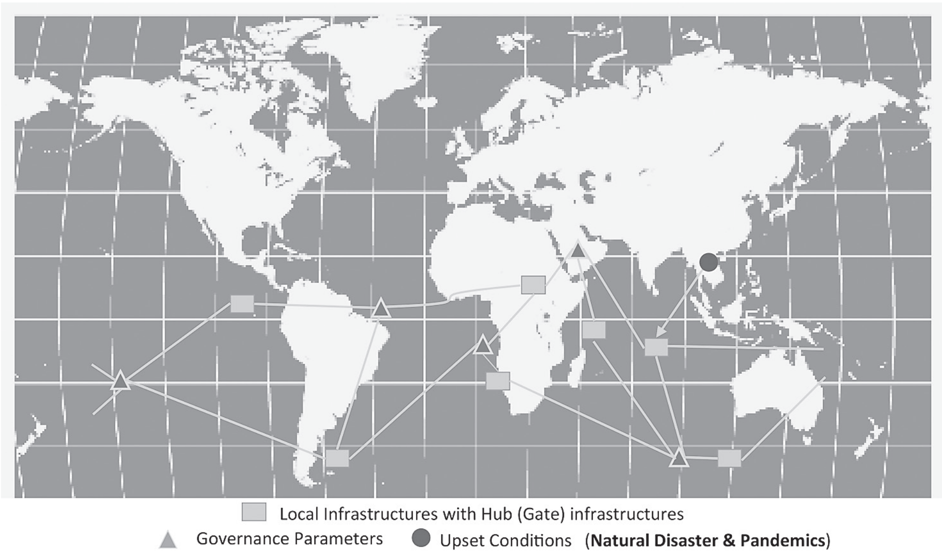

Figure. 4　MGCI as Network of Networks[4)]

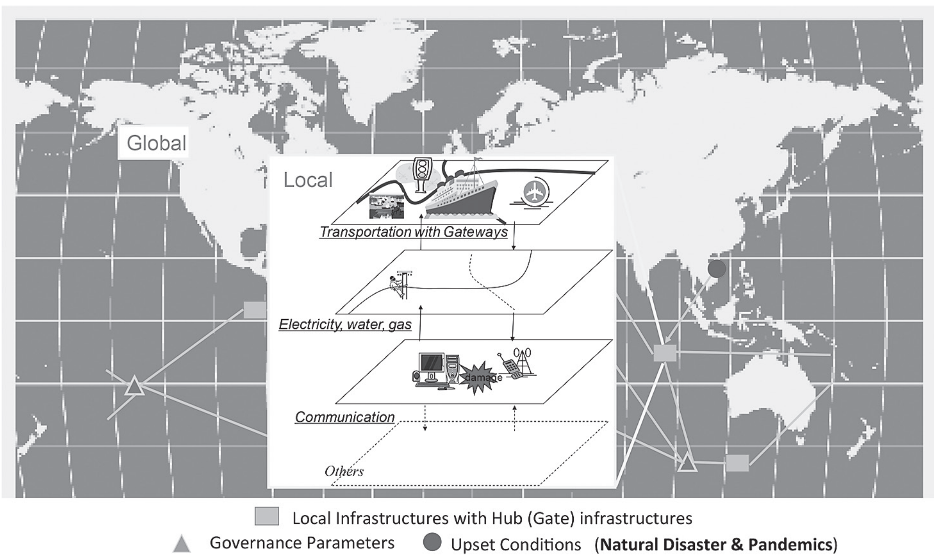

Figure. 5　A Local Network as a Unit of MGCI[4)]

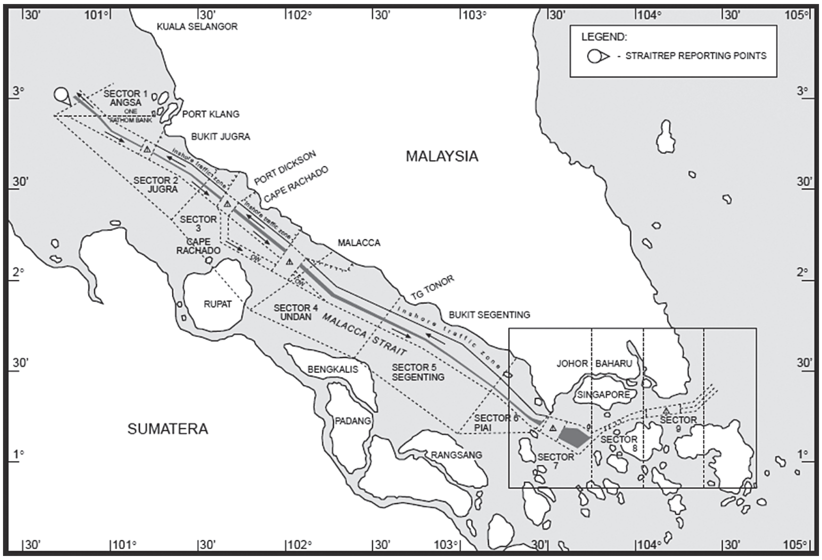

Figure. 6　Case Study Area: Straits of Malacca and Singapore[4)]

4. Conclusion

Instead of discussing how to “build” critical infrastructures per se, we should switch our way of thinking. Let us take it more as a matter of why and how we see the problem “so critical.” If we have a global perspectives and concerns, the problem can be framed and treated as a global issue. Therefore it would be more advisable to study how we formulate the critical infrastructure problem as a perceived policy issue. This requires us to question: how we scope the problem, who are stakeholders, and how we set up a forum where such policy issues can be effectively communicated together so as to come up with workable scenarios and implementable countermeasures for the stakeholders involved.

The presented case study may help us understand and systematically imagine what types of critical infrastructure problems need to be better focussed, discussed and systematically examined.

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