

Establishing Relationships between Disasters and Global Environmental Problems for Sustainable Communities

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Abstract

Many types of disasters are related to environmental problems. Today, frequently occurring disasters and global environmental problems have begun to threaten human life and welfare. Consequently, building sustainable communities requires assessing relationships between environmental problems and disasters using a broad, open approach and with a long-term perspective.

This paper attempts to identify the need for conceptualizing disasters and environmental problems together by comparing mechanisms of both disasters and environmental problems, and attempts to integrate both of these seemingly different types of phenomena as similar types of risk threatening human existence. Based on this work, a chart is proposed for qualitatively organizing disasters, environmental problems and their mutual influences, as well as providing a framework for potential quantitative analysis.

It is hoped this research serves to contribute to effective mitigation to both disasters and environmental problems in today's age of global environmental issues.

Key words : *Disaster, Global Environmental Problems, Human Welfare, Sustainability, GIS*

1. Introduction

Disasters and environmental problems have conventionally been handled as different fields of study. Recently however, the importance of dealing with both issues as related phenomena has been increasingly recognized. This paper attempts to identify the need for conceptualizing disasters and environmental problems together by comparing mechanisms of both disasters and environmental problems, and attempts to integrate both as similar types of risk threatening human life. Based on this work, a chart is proposed for qualitatively organizing disasters, environmental problems and their mutual influences, as well as providing a framework for potential quantitative analysis.

2. The Need for Mutual Assessments of Disasters and Environmental Problems

First of all, fundamental changes in the planet's physical environment can be pointed out. Disasters and environmental problems are occurring more frequently and there are many cases where the two are intricately and mutually related. Consequently, there is greater risk to our living environment and a

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greater need to develop suitable responses to disasters and environmental problems. This is due to the fact that the environmental impact of current global environmental problems exceeds the capacity of the planet. Furthermore, manmade, engineered environments built to support human society are also quite vulnerable to disaster.

Focusing merely on human life and society, both disasters and environmental problems are some form of inconvenience between how human activity interfaces with the physical environment. This not only causes some form of damage for human activity itself, but human activity itself is also a cause of such disasters and environmental problems. In order to properly assess and counter risk, it is natural to treat disasters and environmental problems together from the viewpoint that human beings are both the cause and the victim. Moreover, a shrinking population here in Japan is reducing the amount of urban land-use, providing a unique opportunity to conserve and recover nature by combining mitigation efforts for both disasters and environmental problems. Furthermore, the greater lack of social capital available to invest brought on by the declining population signifies a greater need to reconstruct Japanese urban space more efficiently and selectively.

3. Comparison of Disasters with Environmental Problems

Table 1 shows characteristics of disasters and environmental problems. A common effect is inconvenience, which poses a risk for human sustainability. Disasters occur suddenly on a more localized scale and the situation can change quickly. Environmental problems appear slowly and continuously in comparatively wider areas. In the case of disaster, inconvenience are easily recognized, while in case of environmental problems, it can take time to identify the inconvenience and its cause.

Table 1. Characteristics of disasters and environmental problems

		Disasters	Global Environmental Problems
Results		Inconvenience for human life and welfare Risks that threaten the existence of future generations	
Time scale		Short term, intermittent	Long term, continuous
Spatial scale		Localized scale	Regional or global scale
Occurrence		Easily recognizable	Not easily recognizable
Phenomenon	Biosphere	Degradation of ecosystem services, destruction of forest, loss of biodiversity	
	Atmosphere	tornadoes, high winds	Ozone layer depletion, global warming, Urban heat islands, air pollution
	Hydrosphere	Water contamination wind and flood damage (hurricanes, typhoons)	
	Geosphere	Landslides, earthquakes, volcanic eruptions	

The surrounding natural environment consists of the atmosphere, hydrosphere, geosphere and biosphere. Table 1 organizes disasters and environmental problems according to temporal and spatial scales. The field of human activity is called the human-sphere^[1].

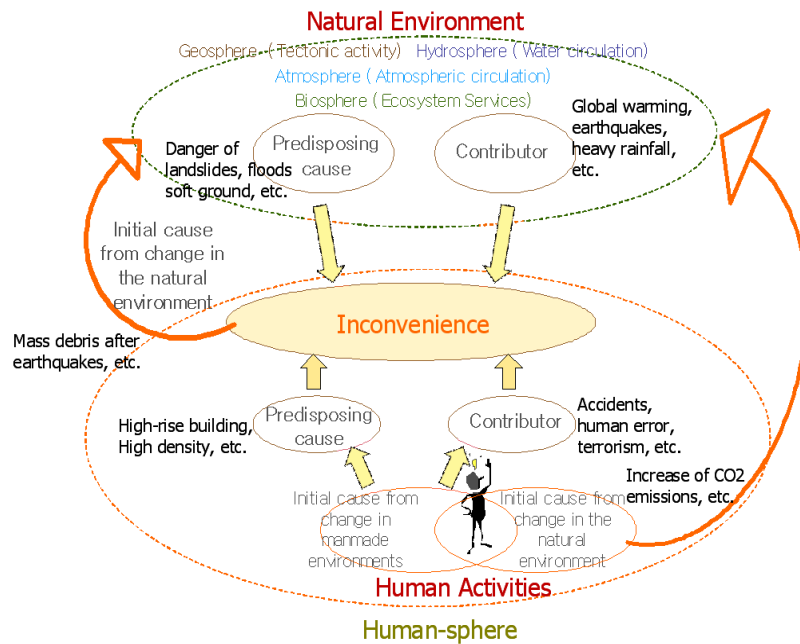


Fig. 1 Mechanisms of Disasters and Environmental Problems

Figure 1 shows the mechanisms of disasters and environmental problems. A particular inconvenience is caused by a predisposing cause and contributor occurring in the human-sphere and nature^[2]. A predisposing cause refers to a certain vulnerability that can lead to a regional disaster or environmental problem, and a contributor refers to the direct triggering factor. In the case of environmental problems, human activity affects natural mechanisms which in turn generate both predisposing causes and contributors of inconvenience. Disasters however also include certain inconveniences caused by contributors in the natural environment that have nothing to do with human activity. Finally, a particular inconvenience can itself initiate more natural change, which can then result in additional predisposing causes and contributors.

As stated above, it is possible to distinguish disasters from environmental problems to some extent. Whether the phenomenon is a disaster or environmental problem also depends on the scale of time and space of the phenomenon compared to those of human beings. Also the predisposing causes and contributors of human activities and nature are intricately and mutually related in the mechanisms of the event, and it is difficult to distinguish them.

4. Integrated Risk Assessments for Predisposing Causes, Contributors and their Causes

4.1 Predisposing Causes and Contributors in Natural Environments

Assessing risk related to disaster or environmental problems requires categorizing the natural environment into several categories, and looking at the various natural systems at work in different types of natural environments. Examples of atmospheric phenomena include atmospheric circulation and other meteorological phenomenon. Human induced influences on the atmosphere include air pollution, global warming from CO₂. Phenomena in the hydrosphere include rainfall, evaporation from the surface of the ground and water flow from higher to lower elevations, and eventually to the sea. The negative

effects and inconveniences brought about by human activity on the hydrosphere are concentrated heavy rains, drought caused by climate change (contributor), and floods in urban areas caused by land-cover changes brought on by urbanization (predisposing causes). Phenomena in the geosphere include tectonic activity. As a result of tectonic activity, earthquakes, volcanic eruptions and landslides occur which become contributors to human inconveniences.

As for the biosphere, 'Eco-system services' are important. Obviously, the human-sphere can not exist without the biosphere. In the United Nations' MA^[3], many benefits human beings obtain from the biosphere are organized according to several categories of eco-system services. Such categories include 'Supporting' services such as soil formation, and primary biological production 'Provisioning' services such as providing food, fresh water, wood, and fuel; 'Regulating' services such as regulating climate, flood and disease, and purifying water; and 'Cultural' services such as serving spiritual, educational, and recreational needs. Cessation of these services poses a significant risk to human life and the preservation of biodiversity, which provides an indispensable foundation of eco-system services listed above.

4.2 Predisposing Causes, Contributors and Initial Causes in the Human-sphere

The majority of modern human society concentrates its population in urban areas, where highly efficient socioeconomic integration delivers economic prosperity. To achieve these ends, the ground is largely developed and altered to provide extra living space. By constructing higher buildings and underground spaces, high density is realized and the infrastructure for supplying energy, water, resources and transportation and information services are constructed. Such activity allows the population to increase. In contrast to the greater population growth and economic prosperity however, such urban development increases the risk of inconvenience to human life. Urban energy and civil infrastructure is not permitted to stop even for a very short time. Once a disaster happens, the influences are extreme because of higher degrees of both predisposing causes and contributors like accidents, human error and the danger of terrorism. Human activity also acts as an initial cause of change or destruction of nature which results in the predisposing causes and contributors

4.3 Integrated Risk Assessment Indicator

Human inconvenience can occur with a degree of severity. The situation to avoid the most is a direct threat of human life and the obstruction of stable water, energy and food supplies that might result in injury, disease or death. Looking at this fact from a global viewpoint, threats to humankind must be avoided at all costs. It is necessary to assess types and sources of inconvenience from both local and global viewpoints, where it may be necessary to give priority to risk avoidance at the global level over the local human level.

5. Chart of Relationships between Phenomena and Outcomes

Table 2 presents a chart that demonstrates relationships between human activity and natural phenomena that cause disasters and environmental problems, as well as several countermeasures. In the table, causes and outcomes are organized according to primary, secondary and tertiary phenomenon. The right side

columns express the outcomes of each phenomenon with upward-facing white triangle (which means improving) and downward-facing black triangle (which means getting worse) symbols (‘△’ and ‘▼’).

Table 2 demonstrates how certain phenomena occurring in the natural environment or as part of human activity can have both positive and negative consequences for the predisposing causes or contributors to a disaster event or environmental problem. In the case of higher urban densities for example, the table indicates how dense cities have positive implications for human life and welfare as well as for energy consumption (due to lower travel times, and less carbon intensive modes of transportation). However, the table demonstrates how dense urban development also has negative implications across a series of ecospheres, such as making humans more susceptible to disaster, increasing the propensity for urban flooding, and exacerbating urban thermal environments. This table provides a starting point for conceptualizing the various cause and effect relationships between disaster events and environmental problems.

Table 2. Chart of Relationships between Phenomena and Outcomes

Phenomenon Category	Phenomenon type (primary, secondary, etc.)		Ecosphere Category								
	(Primary)	(Secondary)	Human sphere	Bio sphere	Geo sphere	Hydro sphere	Atmosphere				
		(Tertiary)	Human Welfare	PC	PC	PC	CON	PC	CON	CON	CON
Natural Environment	Disaster Contributor	Ground Motion by Earthquake					○				
		Destruction of the Ecosystem			▼						
		Flood						▼			
Human Activity	Human Welfare (Original Cause)	Urban High Density	△								
		Vulnerability to Disaster		▼							
		Reduction of CO2 Emissions									△
		Heat Island								▼	
		Flood in the City							▼		
Human Activity	Human Welfare (Original Cause)	Energy Consumption	△								
		Increase of CO2 Emissions									▼
		Frequent Typhoons							▼		
Human Activity	Environmental Countermeasure	Preservation of Forest Ecosystems			△						
		Protection of Landslides by Vegetation				△					
		Danger of Landslides by Higher Sediment Levels				▼					
		Riverbank Overflow						▼			
Human Activity	Environmental Countermeasure	Utilization of Solar Energy				△				△	
Human Activity	Disaster Mitigation	Riverbank Reinforcement (Flood Protection)						△			
		Destruction of River Ecosystem			▼						
Human Activity	Disaster Mitigation	High Quality of Urban Stock and Infrastructure				△					
		Reduction of Waste			△						△
Human Activity	Disaster Mitigation	Repair of Buildings Damaged by Earthquake				△				△	
Human Activity	Environmental, Disaster and Landscape Countermeasure	Facade Engineering	△			△					△

PC: Predisposing cause CON: Contributor

△ : Improving ▼ : Getting Worse ○ : PC itself or CON itself

6. Developing Quantitative Assessments and Management Techniques for Regional Risk

Developing methods to quantify the risk of disasters and environmental problems at the regional level is a necessary step to developing effective risk management. GIS is expected to be an effective tool to achieve this. GIS holds huge potential for constructing informational infrastructure and accumulating spatial scientific data across both time and space. Such informational infrastructure can be combined with simulators to analyze and make predictions according across various scenarios, and can serve as a common platform for researchers to do interdisciplinary works, as well as for stakeholders to share intelligence and build consensus.

Reference

- [1] Takanori Matsui: How to Live as Space People, Iwanami-shinsho, (in Japanese), (2005)
- [2] Yoshiaki Kawata: 4. Future Disasters by the Environmental Change and Development: Hydrologic Circulation and Watershed Environment, Iwanami-kouza Global Environment Studies 7, Iwanami-shoten, (in Japanese), (1998)
- [3] Millennium Ecosystem Assessment 2005, Ecosystems and Human Well-Being (Synthesis), Island Press