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## Significance of vulnerability assessment in establishment of Hainan provincial disaster medical system

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### ABSTRACT

Hainan is an island province in south China with a high frequency of unconventional emergencies due to its special geographic location and national military defense role. Given the limited transportation route from Hainan to the outside world, self-rescue is more important to Hainan Province than other provinces in China and it is therefore imperative to establish an independent, scientific as well as efficient provincial disaster medical system in Hainan. The regulatory role for vulnerability analysis/assessment has been demonstrated in establishment of disaster medical system in various countries and or regions. In this paper, we attempt to describe/propose how to adopt vulnerability assessment through mathematical modeling of major biophysical social vulnerability factors to establish an independent, scientific, efficient and comprehensive provincial disaster medical system in Hainan.

## 1. Introduction

Disaster medical response capability has been regarded as one of the most important measures of government functions. Establishment and implementation of a government-led independent, scientific, efficient and comprehensive disaster medical response system in Hainan are a complex and challenging project involving multi-systems and departments. Among the various strategies, vulnerability assessment through mathematical modeling is a key approach in the establishment of Hainan's disaster medical response system.

As defined by the United Union's International Strategy for Disaster Reduction (UN/ISDR) in the disaster reduction context, vulnerability refers to "the conditions determined by physical, social, economic, and environmental factors or

processes, which increase the susceptibility of a community to the impact of hazards". As a relatively new concept, vulnerability has frequently appeared in the literature since 1980s. Vulnerability can be classified as: 1) physical or biophysical vulnerability that refers as to the degree of, and sensitivity to, damage resulted from special climate-related incidents or disasters[1]; 2) social vulnerability that refers to the inability of individuals, organizations, and societies to withstand adverse impacts of multiple stressors, due partially to characteristics inherent in social interactions, institutions[2].

Vulnerability assessment is a process of identifying, quantifying, and prioritizing (or ranking) the vulnerability factors in a system. It has been documented that by reducing human vulnerability to disasters, we can minimize and even eliminate the impact of disasters[3]. Vulnerability is an intrinsic, inner, influencing factor that disturbs the sustainable development of regional system. Optimizing adjustment of vulnerability is favorable for the system to consummate function, mitigate disturbance, adapt environment and develop further[4].

Vulnerability evaluation is playing an important role in prevention & warning and disposal of unconventional emergencies which will carry out fundamental analysis

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and comprehensive judgment on emergencies as well as prevention capability while offering suggestion for prevention & warning plan, treatment, specific action for directing emergency response when confronted with unconventional emergencies, which an important preliminary work in establishment of emergencies response system as well as preliminary reference used by all level government and administrative departments of health in decision-making process. Introduction of vulnerability evaluation in environmental science to prevention & warning of unconventional emergencies has made it possible for evaluation on human health condition and natural environment risk situation based on occurrence of regional unconventional emergencies by establishment of biophysical vulnerability as well as social vulnerability evaluation model.

Hainan is a small island province in the south tip of China. By virtue of its unique geographic location, Hainan is subject to a high frequency of different types of natural disasters including typhoon, flood, earthquake, tsunami and fires. In addition, as one of the Chinese national military frontiers, Hainan is also confronted with potential risk of unnatural disasters. At present, Hainan has no direct high ways and rail road to mainland China, and air planes and sea boats are the primary means of transportation for the island to connect to the outside world, which would be not sufficient to meet the emergency transportation need in the event of natural or unnatural disasters. As a result, self-rescue capacity is more important to Hainan Province than other Chinese provinces<sup>[5]</sup>, and it is imperative to establish a provincial disaster medical system as a comprehensive framework for disaster preparedness, response and recovery within Hainan.

The cause of research on vulnerability is that strength of disasters impact will be influenced by social characteristics has been noted by some scholars, who accordingly carries out analysis as well as confirmation of the social community groups most likely to suffer from natural disasters and pressure as well as the effective prevention measures & alleviation measures confronted with disasters or under other social, economic and political conditions<sup>[6,7]</sup>. The word vulnerable as well as vulnerability has been found popular in document<sup>[8–12]</sup> associated with environmental, ecological, computer network and power systems sectors with extensive development in vulnerability research to describe the vulnerability of relevant system as well as its components to impact and damage as well as their lacking in interference resisting capability as well as capacity of restoring initial state.

Further research on general concept of vulnerability has been conducted by scholars recently for promotion of exchange and communication of this concept in different research fields<sup>[13–15]</sup>, it has been considered by Adger<sup>[1]</sup> that “the vulnerability of one system, community or individual to threat is closely related with relevant threat degree”; vulnerability can be broadly defined as the potential damage of one specific system, subsystem or system component

when exposed to disasters, stress or disturbance<sup>[2]</sup>, whereas the associated specific system and subsystem may refer to regional, community, district as well as ecological system, economic department or an individual.

Biophysical vulnerability and social vulnerability shall be included in evaluation methods in that biophysical vulnerability will provide variable basis for natural environmental while social vulnerability will offer variable basis for human characteristic, making environmental impact research rather integral.

Establishment of vulnerability evaluation mode is currently conducted internationally and those index for evaluating human and environmental security as well as their vulnerability to disasters and threat developed recent years include the following: the Environmental Vulnerability Index composed of 50 index projects with 32 project for risk, 8 for intrinsic resilience and the rest 10 for perfection or deterioration of environment proposed by South Pacific Applied Geosciences Commission which is used for evaluation on vulnerability of island nations to serial natural disasters and man-made disasters; another prevailing accepted evaluation system refers to Environmental Sustainability Index using 21 indicators each equipped with 2 to 8 variable with 76 group data developed by Yale and Columbia university in collaboration which is used to evaluate per national performance in environmental system, pressure reduction, vulnerability reduction, social and institutional capacity as well as global stewardship; whereas Division of Early Warning and Assessment of United Nations Environment Programme has developed the Disasters Risk Index in their collaborative plan “Global Risk and Vulnerability Trends per Year (GRAVITY)” with GRID-Geneva. The vulnerability evaluation framework developed by John F Kennedy School of Government of Harvard University has involved human learning ability and adaptability when confronted with disasters or impact into evaluation framework.

Major international vulnerability evaluation model as well as its indicators can be seen as below<sup>[1, 16–19]</sup>:

1. The Security Diagram from Germany which combines environmental pressure, sensitivity and crisis in single mode to evaluate vulnerability due to climate change as per social & economic index;
2. The Fuzzy Set Theory from Germany has integrated political, economic as well as psychological indicators for systematic quantitative sensitivity mode;
3. The Comparative Vulnerability Assessment from Stanford University of US has utilized three types of vulnerability-sensitivity, exposure and adaptability in one single matrix which is not only applicable for regional scale reference but also for comparison between different systems to confirm the assumption of the associated cause of vulnerability;
4. The Advanced Terrestrial Ecosystem Assessment and Modeling from EU which is a large multi-national program in EU adopting ecological system mode together with social & economic variable to reveal the vulnerability

of European people against climate change, land use and atmospheric pollution;

5. The Vulnerability Analysis of the Coupled Human environment System from Harvard University of Us which utilizes concept of exposure, sensitivity and resilience for analysis framework to discuss the influence of social& biophysical process on vulnerability formation when confronted with environmental disasters. Research has detected that any external political, economic as well as environmental change will remodel regional environmental utilization capability and disaster-resisting capability.

Current emergencies management research against unconventional emergencies has evolved from qualitative management phase to quantitative management phase as well as from disaster rescue& disposal to disaster prevention, emergencies preparedness, monitoring and early warning, during which period biophysical and social vulnerability analysis is considered of great use. Vulnerability research has gradually shifted its previous focus on natural environmental vulnerability to research on humanistic system vulnerability as well as human–environment coupled vulnerability, showing the multidisciplinary trend in vulnerability research<sup>[20]</sup>. The most important implication for vulnerability research against unconventional emergencies is for the expression of the impact to human being caused by biophysical and social factors as well as unconventional emergencies with evaluation results not only appropriate for the reference for disasters prevention decision but also for methods for vulnerability reduction through vulnerability factors. Since the significance of vulnerability analysis in pre–disasters prevention, emergencies preparedness, disasters disposal as well as post– disasters reconstruction has been recognized by us, it is high time for further exploration on application of vulnerability analysis theory in Hainan provincial unconventional emergencies.

### Conflict of interest statement

We declare that we have no conflict of interest.

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