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# A new resilience rating system for Countries and States

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**Abstract**

This research presents a quantitative method to assess resilience at the state level. The approach introduced in this work is an evolution of the risk assessment concept. Risk is mainly a function of vulnerability, hazard, and exposure; on the other hand, resilience focuses more on the internal characteristics of a system rather than its vulnerability. To tackle this difference, a new formulation has been introduced for the evaluation of resilience. In this formulation, resilience is a function of hazard, exposure, and intrinsic resilience. Generally, intrinsic resilience deals with the internal characteristics of a system, and it differs from the traditional resilience index that takes into account external factors in its assessment, such as the disaster intensity and the level of exposure. The paper also provides a method to compute the intrinsic resilience of countries. This method is based on the data provided by Hyogo Framework for Action (HFA), which is a work developed by the United Nations (UN). HFA evaluates the inherent resilience of countries based on a number of equally weighted indicators. However, further analysis has shown that the contribution made by each of those indicators toward the intrinsic resilience is different. This discrepancy has necessitated weighting the indicators based on their individual contribution towards the intrinsic resilience. To do that, we introduce the Dependence Tree Analysis (DTA). DTA is a method that determines the correlation between a component and its sub-components (i.e., between intrinsic resilience and its indicators), enabling us to orderly allocate new weights to the indicators to obtain a more representative output for the intrinsic resilience. Finally, a case study composed of 37 states has been conducted in order to illustrate the methodology in all details. Both intrinsic resilience and resilience indexes for each of the states were assessed. This was followed by a comparative analysis in order to test the applicability of the methodology, and the results were in line with the predictions.


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*Keywords:* Community resilience; Vulnerability; Risk management; Hyogo Framework for Action

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## 1. Introduction

Over the years, community resilience has attracted tremendous attention due to the increasing number of natural and man-made disasters. The concept of resilience is multi-dimensional, and therefore involves various subjects of different disciplines [1]. In engineering, resilience is the ability to "withstand stress, survive, adapt, and bounce back from a crisis or disaster and rapidly move on" [2]. The term resilience is defined by Bruneau et al. as "the ability of social units (e.g. organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways to minimize social disruption and mitigate the effectors of further earthquakes" [3]. In their own part, Allenby & Fink defined resilience as "the capability of a system to stay in a functional state and to degrade gracefully in the face of internal and external changes" [4]. The concept of resilience has only recently been applicable to the engineering field, which makes it hard to determine a general accepted definition for resilience engineering [5].

The absence of a concise and methodical approach makes it extremely difficult to evaluate resilience. The immense progress in the Hyogo Framework for Action (HFA) — a work developed by the United Nations — has led to the formulation of an international blueprint that is very useful in building the intrinsic resilience of nations and communities. The methodology adopted by the HFA focuses on implementing detailed measures at the governmental and policy levels. The goal was to encourage the countries to implement the HFA in their respective laws. The lifespan for the implementation was from 2005 to 2015, after which each of the participating countries were required to submit a report on their own progress. A score was then given by the UN to each of the submitted reports on the basis of the progress each country had made.

One of the many topics discussed when referring to resilience is its relationship with vulnerability and whether they are similar enough to be considered the same. Although vulnerability is strongly linked to the concept of risk assessment [6], Richard et al. pointed out that the concept of vulnerability had long been associated with resilience under various scientific disciplines [7]. Cardon et al. [8] identified vulnerability as the lack of capacity. Under this context, the vulnerability is reduced by increasing the system's capacity. Moreover, Klein et al. [9] indicated that some literary publications provide the same definitions for resilience and vulnerability, while Gallopin [10] identified some instances where scholars had different views for the two concepts, admitting that they may overlap in some areas. Table 1 shows a comparison between vulnerability and resilience on different scales. The contrast suggests that resilience is more concerned with the human capacity to recover from a disaster within a short time and with no outside assistance, while vulnerability is the property of resisting the stress caused by a natural hazard.

Table 1. Difference between vulnerability and resilience at different levels [11].

| **Vulnerability** | **Resilience** |
|---|---|
| Resistance | Recovery |
| Force bound | Time bound |
| Safety | Bounce back |
| Mitigation | Adaptation |
| Institutional | Community-based |
| System | Network |
| Engineering | Culture |
| Risk assessment | Vulnerability and capacity analysis |
| Outcome | Process |
| Standards | Institution |