

The Prevalent Vulnerability Index (PVI)

This index depicts predominant vulnerability conditions by measuring exposure in prone areas, socioeconomic fragility and lack of social resilience. These items provide a measure of direct as well as indirect and intangible impacts of hazard events. The index is a composite indicator that provides a comparative measure of a country's pattern or situation. Inherent⁶ vulnerability conditions underscore the relationship between risk and development (UNDP, 2004). Vulnerability, and therefore risk, are the result of inadequate economic growth, on the one hand, and deficiencies that may be corrected by means of adequate development processes. Although the indicators proposed are recognized as useful for measuring development (Holzmann and Jorgensen, 2000; Holzmann, 2001) their use here is intended to capture favorable conditions for direct physical impacts (exposure and susceptibility), as well as indirect and, at times, intangible impacts (socioeconomic fragility and lack of resilience) of potential physical events (Masure, 2003; Davis, 2003). The PVI is an average of these three types of composite indicators:

$$PVI = (PVI_{Exposure} + PVI_{Fragility} + PVI_{-Resilience}) / 3$$

The indicators used for describing exposure, prevalent socioeconomic conditions and lack of resilience have been estimated in a consistent fashion (directly or in inverse fashion, accordingly), recognizing that their influence explains why adverse economic, social and environmental impacts take place following a dangerous event. Each one is made up of a set of indicators that express situations, causes, susceptibilities, weaknesses or relative absences affecting the country, region or locality under study, and which would benefit from risk reduction

⁶ That is to say, the predominant socioeconomic conditions that favor or facilitate negative effects as a result of adverse physical phenomena (Briguglio, 2003b).

actions. The indicators were identified based on figures, indices, existing rates or proportions derived from reliable databases available worldwide or in each country (see methodology: Cardona *et al.*, 2004a, 2004b, and 2005).

Indicators of Exposure and Susceptibility

The best indicators of exposure and/or physical susceptibility (PVI_{ES}) are the susceptible population, assets, investment, production, livelihoods, historic monuments, and human activities (Masure, 2003; Lavell, 2003b). Other indicators include population growth and density rates, as well as agricultural and urban growth rates. The indicators used are listed below.

- ES1. Population growth, average annual rate.
- ES2. Urban growth, avg. annual rate (%).
- ES3. Population density (people/5 Km²).
- ES4. Poverty, population living on less than US\$1 per day PPP.
- ES5. Capital stock in millions US dollar per thousand square kilometers.
- ES6. Imports and exports of goods and services as a percent of GDP
- ES7. Gross domestic fixed investment as a percent of GDP.
- ES8. Arable land and permanent crops as a percent of land area.

These variables reflect the nation's susceptibility to dangerous events, whatever their nature or severity. Exposure and susceptibility are necessary conditions for the existence of risk. Although, in any strict sense it would be necessary to establish if exposure is relevant for each potential type of event, we may nevertheless assert that certain variables reflect comparatively adverse situations where natural hazards can be deemed to be permanent external factors without needing to establish their exact nature. Figure 8 shows the PVI_{ES} by country and period, weighted using the Analytic Hierarchy Process (AHP).

Indicators of Socioeconomic Fragility

Socioeconomic fragility (PVI_{SF}), may be represented by indicators such as poverty, lack of personal safety, dependency, illiteracy, income inequality, unemployment, inflation, debt and environmental deterioration. These indicators reflect relative weaknesses that increase the direct effects of dangerous phenomena (Cannon, 2003; Davis, 2003; Wisner, 2003). Even though these effects are not necessarily cumulative (and in some cases may be superfluous or correlated), their influence is especially important at the social and economic levels (Benson, 2003b). The indicators are listed below.

- SF1. Human Poverty Index, HPI-1.
- SF2. Dependents as a proportion of the working age population.
- SF3. Inequality as measured by the Gini coefficient.
- SF4. Unemployment as percent of the total labor force.
- SF5. Annual increase in food prices (%).
- SF6. Share of agriculture in total GDP growth (annual %).
- SF7. Debt service burden as a percent of GDP.
- SF8. Soil degradation resulting from human activities (GLASOD).⁷

These indicators show that there exists an intrinsic predisposition for adverse social impacts in the face of a dangerous phenomena regardless of their nature or intensity (Lavell, 2003b; Wisner, 2003). The propensity to suffer negative impacts establishes a vulnerability condition of the population, although it would be necessary to establish the relevance of this propensity in the face of all types of hazard. Nevertheless, as with exposure, it is possible to suggest that certain values of specific variables reflect a relatively unfavorable situation in the eventuality of natural hazard, regardless

⁷ Global Assessment of Human-induced Soil Degradation

of the exact characteristics of those hazards. Figure 9 shows the PVI_{SF} weighted using the AHP.

Indicators of (Lack of) Resilience

Lack of resilience (PVI_{LR}), seen as a vulnerability factor, may be represented by means of the inverse⁸ relationship of a number of variables that measure human development, human capital, economic redistribution, governance, financial protection, community awareness, the degree of preparedness to face crisis situations, and environmental protection. These indicators are useful to identify and guide actions to improve personal safety (Cannon, 2003; Davis, 2003; Lavell, 2003a; Lavell, 2003b; Wisner, 2003).

- LR1. Human Development Index, HDI [Inv]
- LR2. Gender-related Development Index, GDI [Inv]
- LR3. Social expenditures on pensions, health and education as a percent of GDP [Inv]
- LR4. Governance Index (Kaufmann) [Inv]
- LR5. Infrastructure and housing insurance as a percent of GDP [Inv]
- LR6. Television sets per 1000 people [Inv]
- LR7. Hospital beds per 1000 people [Inv]
- LR8. Environmental Sustainability Index, ESI [Inv]

These indicators capture the capacity to recover from or absorb the impact of dangerous phenomena, whatever their nature and severity (Briguglio, 2003b). Not being able to adequately face disasters is a vulnerability condition, although in a strict sense it is necessary to establish this with reference to all potential types of hazard. Nevertheless, as with exposure and socioeconomic fragility, we can posit that some economic and social variables (Benson, 2003b) reflect a comparatively unfavorable position if natural hazards exist. Figure 10 shows the PVI_{LR} weighted using the AHP.

⁸ The symbol [Inv] is used here to indicate an inverse variable ($\neg R = 1 - R$).

Figure 8. PVI for Exposure and Susceptibility

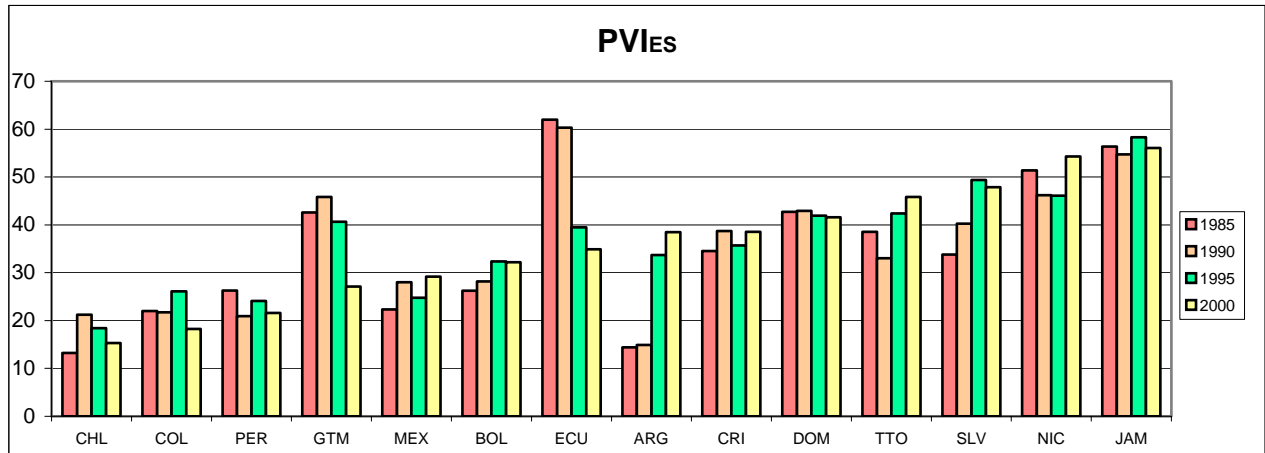


Figure 9. PVI for Socioeconomic Fragility

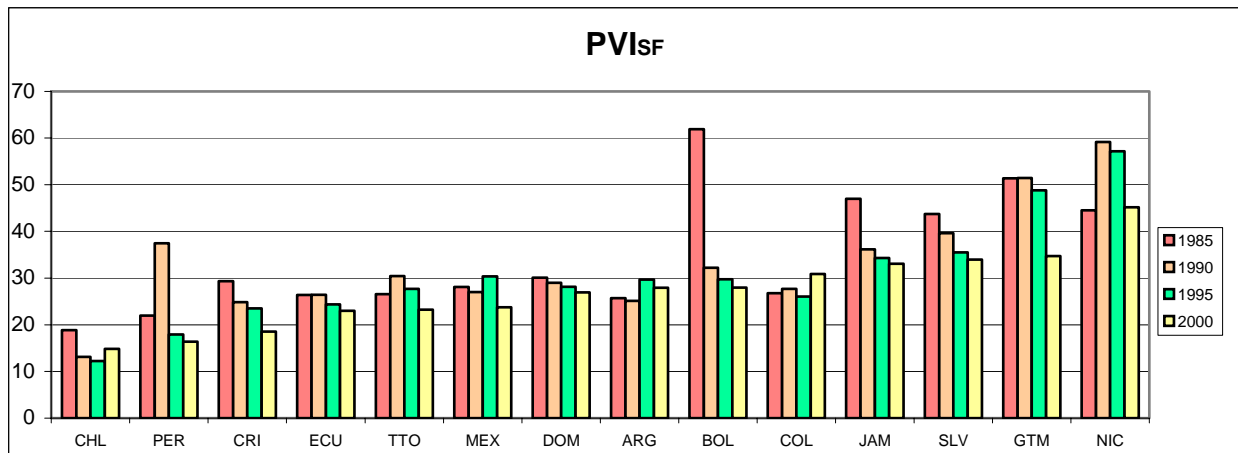
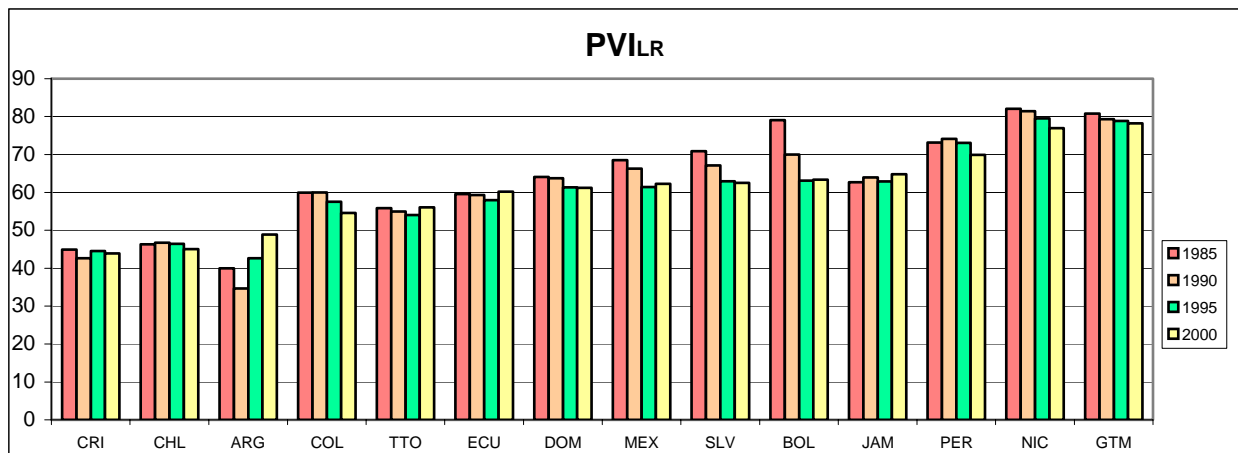


Figure 10. PVI Due to Lack of Resilience



Figures 8 through 10 show that small countries, such as Jamaica (JAM), Nicaragua (NIC), El Salvador, Trinidad and Tobago, the Dominican Republic and Costa Rica, consistently have greater PVI_{ES} . In addition, there has been a relative increase in exposure and susceptibility in Argentina (ARG), Bolivia, Costa Rica, El Salvador, Mexico and Trinidad and Tobago, during the last few years. Ecuador and Guatemala posted significant declines in the index, while Chile and Colombia show only a slight decrease in exposure and susceptibility. The Prevalent Vulnerability Index measuring socioeconomic fragility (PVI_{SF}) for Colombia, El Salvador, Guatemala, Jamaica and Nicaragua is relatively high. However, in most other countries socioeconomic fragility has decreased over time (with exception of Colombia and Chile in the most recent period studied). The values of PVI_{SF} are generally very high; however, a declining trend is apparent during the past few years. The exceptions are Guatemala, Nicaragua and Peru where the index remains high, and Jamaica, Ecuador and Argentina where no recent declines are evident. The countries with the greatest apparent resilience are Costa Rica and Chile.

Figure 11 shows the Prevalent Vulnerability Index for each country studied for the period 1985 through 2000. The Prevalent Vulnerability Index increased between 1985 and 2000 for every country except Peru and Guatemala (where it declined), and Jamaica (where it remained unchanged). The countries with the highest PVI are Jamaica, El Salvador and Guatemala; however, each paints a different picture of vulnerability. The PVI for Nicaragua is not only one of the highest, it also increased steadily during the period studied. The index for Guatemala, Bolivia, Ecuador and Jamaica have been higher than that of any of the other countries, however they posted a significant decline since 1985. Finally, while Jamaica has the highest Prevalent Vulnerability Index, it has remained relatively unchanged since 1985.

The situation between 1995 and 2000 changed significantly. Most countries show a declining trend in vulnerability from 1995 to 2000. The exceptions are Costa Rica, the Dominican Republic, El Salvador, and Ecuador where vulnerability increased slightly, and Argentina, which posted a significant increase in vulnerability. The case of Argentina is particularly noteworthy because, in 1985 and 1990, it had the lowest PVI of any of the countries studied. However, vulnerability had increased markedly by 1995 and posted another increase in 2000. The countries with the lowest relative PVI are Chile, Costa Rica and Colombia.

Figure 12 shows the aggregated Prevalent Vulnerability Index for all the countries in 2000. The values in this graph are obtained by adding the three components: exposure and susceptibility, social fragility and lack of resilience. This aggregate value takes into account the physical exposure of infrastructure and persons (direct impact), as well as social and economic fragility (indirect and intangible impact). In addition, it reflects a country's inability to deal with the consequences of a disaster, responding efficiently to it, and recovering from it. In order to reduce these factors of vulnerability, countries need to embark in a sustainable development process and enact explicit policies to reduce risk.

The Prevalent Vulnerability Index should form part of a system of indicators that allows the implementation of effective prevention, mitigation, preparedness and risk transfer measures to reduce risk. The information provided by an index such as the PVI should prove useful to ministries of housing and urban development, environment, agriculture, health and social welfare, economy and planning. Although the relationship between risk and development should be emphasized, it must be noted that activities to promote development do not, in and of themselves, automatically reduce vulnerability.

Figure 11. PVI for Countries Studied

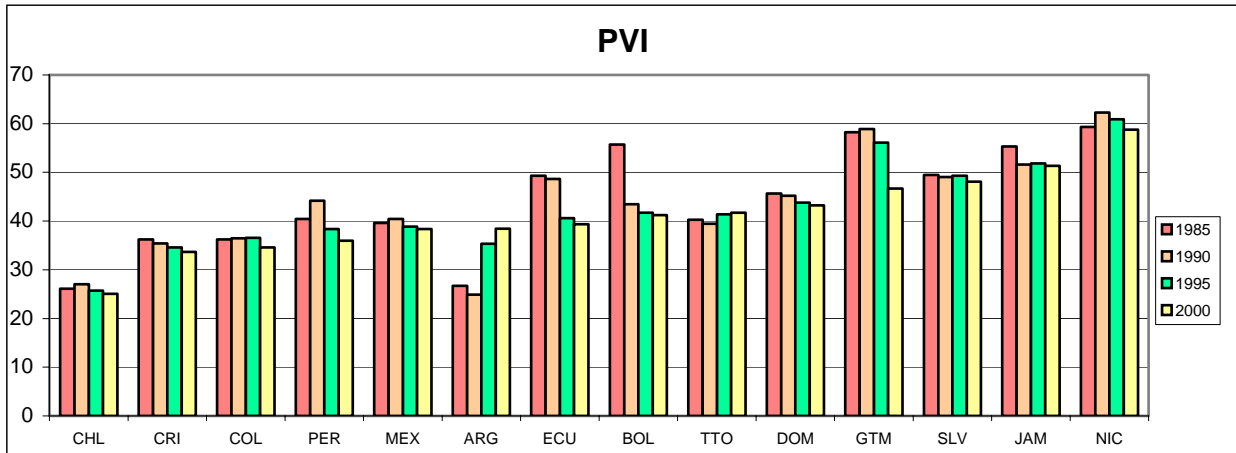


Figure 12. Aggregate PVI

