A New Assessment to Measure the Risk Levels Between Natural Disasters and SocioEconomic-Political Disasters

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A NEW ASSESSMENT TO MEASURE THE RISK LEVELS BETWEEN NATURAL DISASTERS AND SOCIO-ECONOMIC-POLITICAL DISASTERS

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Abstract

In this paper, we attempt to analyse and compare the magnitudes of destruction caused by natural disasters versus socio-economic-political disasters around the world. To do so, we deploy a multi-disciplinary approach that encompasses history, politics, sociology, and economics (Ruiz Estrada, 2011 and 2017). In the methodological discussion, we propose using quantitative and qualitative methods simultaneously to systematically evaluate different type of disasters. In this context, we propose a new analytical tool: "The General Disasters Final Impact Simulator" (GDFI-Simulator). Finally, we apply the GDFI-Simulator to Africa, America, Asia, Europe and Oceania in the 19th and 20th centuries.

Keywords: Natural disasters, socio-economic-political disasters, Econographicology
JEL Classification: B41

1. Introduction

The idea of disasters is synonymous with destruction, damage, and loss. All disasters, from ancient times to the present, are an integral part of human evolution and evolution (Stallings, 2006). Disaster is inherently unpredictable and independent of geographical area and time framework (Schenk, 2007). In this paper, we propose an alternative definition of disaster as any social-economic-political or natural destructive event that can generate significant human causalities and economic damage under different magnitudes of destruction. Furthermore, we argue that any disaster can be classified into one of two groups: socio-economic-political disasters and natural disasters (Cuaresma, 2010).

Socio-economic-political disasters originate from rational or irrational human action (Nel and Righarts, 2008) through war, organized crime, kidnapping and robbery, drugs consumption and trafficking, financial speculation, slave trading, colonization, government repression and corruption, piracy, foreign trade restrictions, political revolution and terrorist action (Berrebi and Ostwald, 2013) as well as civil war, religious conflict, terrorist action, and other violent activity that can generate small or large damage(s) individually or collectively. Any socio-economic-political disaster has special features in terms of predictability, preventability, and negotiations.

On the other hand, a natural disaster consists of any natural destructive force that can generate human casualties and material losses under limited predictability at best. In addition, we distinguish between natural hazard associated with natural physical event such as cyclonic storms, earthquakes, floods, hurricanes, tsunami, typhoons, volcanic eruptions, droughts, and epidemics versus natural disaster, which refers to the final damage resulting from the natural hazard. Natural disasters are chaotic, cyclical, and costly. At the same time, we can observe that both natural and socio-economic-political disasters entail different magnitudes of human causalities and material losses (Narayanan et al., 2016).

In this paper, we propose that the evaluation of any natural disaster or socio-economic-political disaster be quantified by its magnitude of destruction in different historical periods to properly understand the negative impact of disasters on society as a whole (Albala-Bertrand, 2000). We will restrict our evaluation to the 19th and 20th centuries. There are two main reasons for this choice. First, a large database is required to run our simulator. Second, these two convulsed centuries witnessed a large number of both types of disasters.

In addition, we wish to show that the evaluation of any natural disaster or socio-economic-political disaster can show different levels of vulnerability, magnitudes of destruction, and reconstruction time frameworks. Following our evaluation of the two types of disasters, we construct a large database of human causalities - i.e. number of dead, missing, and injured, material losses per km^2, and reconstruction time.

We hope that our research can contribute toward a more systematic and accurate measurement of the final impact of any natural disaster (Hanson, 2005) or socio-economic-political disaster. While most research studies on disasters look primarily at natural disasters (Hayes, 2005), our study also incorporates socio-economic-political disasters and their impact as a point of reference. Finally, we propose a new analytical tool, “The General Disasters Final Impact Simulator” (GDFI-Simulator) to estimate and compare the magnitudes of destruction of natural disasters versus socio-economic-political disasters.

2. An Introduction to The General Disasters Final Impact Simulator (GDFI-Simulator)

In this section, we set forth the General Disasters Final Impact Simulator (GDFI-Simulator). The simulator is is built using nine indicators: (i) Socio-Economic-Political Disaster Vulnerability Rate (α); (ii) Natural Disaster Vulnerability Rate (β); (iii) Total General Disaster Vulnerability Rate (Ψ_t); (iv) Natural Disasters and the Socio-Economic-Political Disasters (β/α) Sensitivity Analysis; (v) Total Full Potential Economic Output Growth Rate (Δ); (vi) Economic Leaking (ε); (vii) Economic Desgrowth ($-\delta$); (viii) Total Poverty Growth Rate (θ_t); (ix) Investment Reconstruction Growth Rate ($+\lambda$); (x) Disasters Damage Recovery Index (ξ); and (xi) General Disasters Impact Graphical Evaluator.

a. Indicator-1: Calculation of the Socio-Economic-Political Disaster Vulnerability Rate (α)

The Socio-Economic-Political Disaster Vulnerability Rate (α) is equal to the sum of Hst and Mst. First, we need to find the value of the marginal rate of human casualties from socio-economic-political disasters (Hs), which is the result of the total sum of fifteen growth rates (i = fifteen socio-economic-political disasters). Basically, each growth rate ($\partial Hs_{i(to)} / \partial Hs_{i(t-1), i = 1, 2, \ldots, 15}$) represents the relative changes between two periods followed by the present year (t_o) and a past year (t_{-1}) respectively. Hence, in our case, each growth rate represents human causalities from fifteen different socio-economic-political disasters, which are war ($\partial Hs_{1(to)} / \partial Hs_{1(t-1)}$), organized crime ($\partial Hs_{2(to)} / \partial Hs_{2(t-1)}$), kidnapping and robbery ($\partial Hs_{3(to)}$

$/\partial Hs_{3(t-1)}$), drugs consumption and trafficking ($\partial Hs_{4(to)} /\partial Hs_{4(t-1)}$), financial speculation ($\partial Hs_{5(to)} /\partial Hs_{5(t-1)}$), slave trading ($\partial Hs_{6(to)} /\partial Hs_{6(t-1)}$), colonization ($\partial Hs_{7(to)} /\partial Hs_{7(t-1)}$), government repression and corruption ($\partial Hs_{8(to)} /\partial Hs_{8(t-1)}$), piracy ($\partial Hs_{9(to)} /\partial Hs_{9(t-1)}$), foreign trade restrictions ($\partial Hs_{10(to)} /\partial Hs_{10(t-1)}$), revolution ($\partial Hs_{11(to)} /\partial Hs_{11(t-1)}$), terrorist action ($\partial Hs_{12(to)} /\partial Hs_{12(t-1)}$), civil war ($\partial Hs_{13(to)} /\partial Hs_{13(t-1)}$), religious conflict ($\partial Hs_{14(to)} /\partial Hs_{14(t-1)}$), terrorist action ($\partial Hs_{15(to)} /\partial Hs_{15(t-1)}$) or any other violent activity that can cause socio-economic-political disaster individually or collectively – see expression 1. If we assume that $Hs \neq 0$, then it is possible to assume that a socio-economic-political disaster is possible anytime, anywhere. Therefore, total human casualties from socio-economic-political disasters (Hst) are stated in expression 2. Total human casualties from socio-economic-political disasters (Hst) is calculated as the differentiation between two periods followed by the Hs from the present year (t_o) and the Hs from the past year (t_{-1}) respectively.

$$Hs = \sum[\partial Hs_{1(to)} /\partial Hs_{1(t-1)} + \partial Hs_{2(to)} /\partial Hs_{2(t-1)} + \partial Hs_{3(to)} /\partial Hs_{3(t-1)} + \partial Hs_{4(to)} /\partial Hs_{4(t-1)} + \partial Hs_{5(to)} /\partial Hs_{5(t-1)} + \partial Hs_{6(to)} /\partial Hs_{6(t-1)} + \partial Hs_{7(to)} /\partial Hs_{7(t-1)} + \partial Hs_{8(to)} /\partial Hs_{8(t-1)} + \partial Hs_{9(to)} /\partial Hs_{9(t-1)} + \partial Hs_{10(to)} /\partial Hs_{10(t-1)} + \partial Hs_{11(to)} /\partial Hs_{11(t-1)} + \partial Hs_{12(to)} /\partial Hs_{12(t-1)} + \partial Hs_{13(to)} /\partial Hs_{13(t-1)} + \partial Hs_{14(to)} /\partial Hs_{14(t-1)} + \partial Hs_{15(to)} /\partial Hs_{15(t-1)}] \quad (1)$$

$$Hst = \partial Hs(t_o)/\partial Hs(t_{-1}) \quad (2)$$

Second, we need to calculate the marginal rate of material damage from socio-economic-political disasters "Ms". In the calculation of "Ms" it is necessary to find different growth rates. The measurement of each Ms depends on the calculation of fifteen growth rates (i = 15 socio-economic-political disasters) that we can measure using the material damage per km^2 between two periods - i.e. the present year (t_o) and a previous year (t_{-1}) - from different socio-economic-political disasters events following war ($\partial Ms_{1(to)} /\partial Ms_{1(t-1)}$), organized crime ($\partial Ms_{2(to)} /\partial Ms_{2(t-1)}$), kidnapping and robbery ($\partial Ms_{3(to)} /\partial Ms_{3(t-1)}$), drugs consumption and trafficking ($\partial Ms_{4(to)} /\partial Ms_{4(t-1)}$), financial speculation ($\partial Ms_{5(to)} /\partial Ms_{5(t-1)}$), slave trading ($\partial Ms_{6(to)} /\partial Ms_{6(t-1)}$), colonization ($\partial Ms_{7(to)} /\partial Ms_{7(t-1)}$), government repression and corruption ($\partial Ms_{8(to)} /\partial Ms_{8(t-1)}$), piracy ($\partial Ms_{9(to)} /\partial Ms_{9(t-1)}$), foreign trade restrictions ($\partial Ms_{10(to)} /\partial Ms_{10(t-1)}$), revolution ($\partial Ms_{11(to)} /\partial Ms_{11(t-1)}$), terrorist action ($\partial Ms_{12(to)} /\partial Ms_{12(t-1)}$), civil war ($\partial Ms_{13(to)} /\partial Ms_{13(t-1)}$), religious conflict ($\partial Ms_{14(to)} /\partial Ms_{14(t-1)}$) or terrorist action ($\partial Ms_{15(to)} /\partial Ms_{15(t-1)}$). If we find our fifteen growth rates (sub-variables) then we can calculate "Ms" according to expression 3. We assume that $Ms \neq 0$ because we are assuming that any socio-economic-political disaster can cause large material damage to private or public infrastructure anywhere, anytime. Hence, we can calculate the total material damage from socio-economic-political disasters (Mst) according to expression 4. The damage is calculated as the differentiation between the two periods followed by the Ms from the present year (t_o) and the Ms from the past year (t_{-1}) respectively.

$$Ms = \sum[\partial Ms_{1(to)} / \partial Ms_{1(t-1)} + \partial Ms_{2(to)} / \partial Ms_{2(t-1)} + \partial Ms_{3(to)} / \partial Ms_{3(t-1)} + \partial Ms_{4(to)} / \partial Ms_{4(t-1)} + \partial Ms_{5(to)} / \partial Ms_{5(t-1)} + \partial Ms_{6(to)} / \partial Ms_{6(t-1)} + \partial Ms_{7(to)} / \partial Ms_{7(t-1)} + \partial Ms_{8(to)} / \partial Ms_{8(t-1)} + \partial Ms_{9(to)} / \partial Ms_{9(t-1)} + \partial Ms_{10(to)} / \partial Ms_{10(t-1)} + \partial Ms_{11(to)} / \partial Ms_{11(t-1)} + \partial Hs_{12(to)} / \partial Ms_{12(t-1)} + \partial Ms_{13(to)} / \partial Ms_{13(t-1)} + \partial Ms_{14(to)} / \partial Ms_{14(t-1)} + \partial Ms_{9(to)} / \partial Ms_{14(t-1)}] \quad (3)$$

$$Mst = \partial Ms(t_o)/\partial Ms(t_{-1}) \quad (4)$$

Subsequently, the Socio-Economic-Political Damage Vulnerability Rate (α) is equal to the sum of Hst and Mst (See Expression 5).

$$\alpha = Hst + Mst \quad (5)$$

b. Indicator-2: The Calculation of the Natural Disaster Vulnerability Rate (β)

The initial calculation of the natural disaster vulnerability rate (β) starts with the sum of two general variables represented by total human casualties from natural disasters "Hnt" and total material damage from natural disasters "Mnt". First, the calculation of the marginal rate of human casualties from natural disasters "Hn" measures nine growth rates (or sub-variables) represented by ($\partial Hn_{i(to)} / \partial Hn_{i(t-1)},\ _{i=1, 2,\ldots, 9}$) to evaluate the deaths, injuries, and missing growth rate between the present year (t_o) and last year (t_{-1}) from cyclonic storms ($\partial Hn_{1(to)} / \partial Hn_{1(t-1)}$), earthquakes ($\partial Hn_{2(to)} / \partial Hn_{2(t-1)}$), floods ($\partial Hn_{3(to)} / \partial Hn_{3(t-1)}$), hurricanes ($\partial Hn_{4(to)} / \partial Hn_{4(t-1)}$), tsunamis ($\partial Hn_{5(to)} / \partial Hn_{5(t-1)}$), typhoons ($\partial Hn_{6(to)} / \partial Hn_{6(t-1)}$), volcanic eruptions ($\partial Hn_{7(to)} / \partial Hn_{7(t-1)}$), droughts ($\partial Hn_{8(to)} / \partial Hn_{8(t-1)}$), and famines and epidemics ($\partial Hn_{9(to)} / \partial Hn_{9(t-1)}$). We are thus able to calculate total human casualties as a result of natural disasters "Hnt" (See Expression 7). At the same time, we need to assume that $Hnt \neq 0$ because the possibility that a natural hazard may occur anytime, anywhere, is sizable.

$$Hn = \sum[\partial Hn_{1(to)} / \partial Hn_{1(t-1)} + \partial Hn_{2(to)} / \partial Hn_{2(t-1)} + \partial Hn_{3(to)} / \partial Hn_{3(t-1)} + \partial Hn_{4(to)} / \partial Hn_{4(t-1)} + \partial Hn_{5(to)} / \partial Hn_{5(t-1)} + \partial Hn_{6(to)} / \partial Hn_{6(t-1)} + \partial Hn_{7(to)} / \partial Hn_{7(t-1)} + \partial Hn_{8(to)} / \partial Hn_{8(t-1)} + \partial Hn_{9(to)} / \partial Hn_{9(t-1)}] \quad (6)$$

$$Hnt = \partial Hn_{(to)}/\partial Hn_{(t-1)} \quad (7)$$

Second, we can calculate the total material damage from natural disasters "Mnt". To do so, we need to find the marginal rate of material damage from natural disasters "Mn". The measurement of Mn depends on the calculation of nine growth rates (sub-variables) based on the material damage per km^2 between two periods - i.e. the present year (t_o) and past year (t_{-1}). In our case, we focus on the aftermath of nine natural hazard events: cyclonic storms ($\partial M_{1(to)} / \partial M_{1(t-1)}$), earthquakes ($\partial M_{2(to)} / \partial M_{2(t-1)}$), floods ($\partial M_{3(to)} / \partial M_{3(t-1)}$), hurricanes ($\partial M_{4(to)} / \partial M_{4(t-1)}$), tsunamis ($\partial M_{5(to)} / \partial M_{5(t-1)}$), typhoons ($\partial M_{6(to)} / \partial M_{6(t-1)}$), volcanic eruptions ($\partial M_{7(to)} / \partial M_{7(t-1)}$), droughts ($\partial M_{8(to)} / \partial M_{8(t-1)}$), and famines and epidemics ($\partial M_{9(to)} / \partial M_{9(t-1)}$). Next, we first find our nine growth rates (sub-variables) and then we sum all the nine growth rates (sub-variables) to get the final estimate of Mn respectively (See Expression 8). Subsequently, we can proceed to calculate "Mnt" according to expression 9. We assume that Mnt $\neq 0$ because the possibility that any natural disaster can directly harm infrastructure is high.

$$Mn = \sum[\partial M_{1(to)} / \partial M_{1(t-1)} + \partial M_{2(to)} / \partial M_{2(t-1)} + \partial M_{3(to)} / \partial M_{3(t-1)} + \partial M_{4(to)} / \partial M_{4(t-1)} + \partial M_{5(to)} / \partial M_{5(t-1)} + \partial M_{6(to)} / \partial M_{6(t-1)} + \partial M_{7(to)} / \partial M_{7(t-1)} + \partial M_{8(to)} / \partial M_{8(t-1)} + \partial M_{9(to)} / \partial M_{9(t-1)}] \quad (8)$$

$$Mnt = \partial M(t_o)/\partial M(t_{-1}) \quad (9)$$

Finally, the natural disaster vulnerability rate (β) is equal to the sum of Hnt and Mnt (See Expression 10).

$$\beta = Hnt + Mnt \quad (10)$$

c. Indicator-3: The Total General Disaster Vulnerability Rate (Ψ_t)

The total general disaster vulnerability rate (Ψ_t) is equal to the sum of Expression 5 and 10.

$$\Psi_t = \alpha + \beta \quad (11)$$

d. Indicator-4: Measurement of the Natural Disasters and the Socio-Economic-Political Disasters Vulnerability Rates (β/α) Sensitivity Analysis

This indicator simultaneously measures the weight (ratio) between the socio-economic-political disasters vulnerability rate and natural disasters vulnerability rate (β) behavior in different periods of time. The main objective is to compare the risk between the natural disasters vulnerability rate (β) and socio-economic-political disasters vulnerability rate (α). Each of the socio-economic-political disasters or natural disasters can occur anytime and anywhere.

$$\beta/\alpha = \beta:\alpha \quad (12)$$

Results of (α:β) Sensitivity Analysis

The (β:α) sensitivity analysis reflects several possible scenarios:

(i) If ▲β:▲α then this continent is highly vulnerable to natural disasters and socio-economic-political disasters simultaneously.

(ii) If ▼β:▼α then this continent shows a lower vulnerability to natural disasters and socio-economic-political disasters simultaneously.

(iii)If ▲β:▼α then this continent is highly vulnerable to natural disasters
(iv) If ▼β:▲α then this continent is highly vulnerable to socio-economic-political disasters
▲: highly
▼: lower

e. Indicator-5: The Total Full Potential Economic Output Growth Rate (ΔGDP)

The total full potential economic output growth rate (Δ) evaluates the expansion or contraction of any economy based on trade volumes and wealth accumulation. We are comparing the growth rates of two full potential economic output growth rates (ΔFPEO) in real prices between the present year (t_o) and a past year (t_{-1}). We are assuming that any economy has limited or finite labour, capital and land outputs.

$$\Delta = \partial\Delta FPEO(t_o)/\partial\Delta GDP(t_{-1}) \quad (13)$$

f. Indicator-6: The Economic Leaking (ε)

The economic leaking (ε) trend is directly connected to the Total General Disaster Vulnerability (Ψ_t) rate. The measurement of economic leaking (ε) is derived by applying a large number of multi-dimensional partial derivatives to find a single value that captures the economic output loss of any economy between the present time (this year) and a previous year [see (11)].

$$\Psi_t = \sum\partial\Psi_t i^n{}_{(t+1)}/\partial\Psi_t i^n{}_{(t)} \geq \mathbb{R}_+ \leq 0 \quad (14)$$

The next step is to convert from $\Delta\Psi_t i^n$ to $\Delta\Psi_t i^{-n}$ [see (15)].

$$[0 \leq 1/\partial\Psi_{ti}^{n} \geq 1] = [0 \leq \partial\Psi_{ti}^{-n} \geq 1] \quad (15)$$

Initial conditions ex-ante [see (16)]

$$\Psi_t \big|_{t=0} = 0 \quad (16)$$

Final conditions ex-post [see (17)]

$$\Psi_t \big|_{t+1=\infty} = \infty \quad (17)$$

The final step is to determine economic leaking (ε) by dividing 1 by the final result from (17) to the power of 2. [See (18)]

$$\varepsilon = \log[1/\sqrt{(\Psi_t)}] \quad (18)$$

g. Indicator-7: Economic Desgrowth (-δ)

We define economic desgrowth ($-\delta$) (Ruiz Estrada, 2011) as a macroeconomic indicator that shows the final impact of any socio-economic-political disaster vulnerability rate (α) or natural disaster vulnerability rate (β) on the total full potential economic output growth rate (Δ) performance. In addition, economic desgrowth ($-\delta$) is directly connected to economic leaking (ε) behaviour (see Expression 19). At the same time, total general disaster vulnerability rate (Ψ_t) is directly connected to the socio-economic-political disaster vulnerability rate (α) and natural disasters vulnerability rate (β) (see Expressions 5 and 10). Hence, the $-\delta$ is in function of Δ and ε. Therefore, economic desgrowth ($-\delta$) is the multiplicative product of of the total full potential economic output growth rate (Δ) and the economic leaking (ε) according to expression 19. Conceptually, the economic desgrowth rate ($-\delta$) can be considered as a discount rate.

$$-\delta = (\Delta)\ (\varepsilon) \qquad (19)$$

In the last instance, economic desgrowth rate ($-\delta$) behaviour is always directly dependent on economic leaking (ε). We can observe that there exists a strong relationship between "Ψ_t" and "ε". Basically, the empirical results show that if the total general disaster vulnerability rate (Ψ_t) and economic leaking (ε) are high, then economic desgrowth ($-\delta$) is also high. The finals results calculated for economic desgrowth rates ($-\delta$) show that when the full potential economic output growth rate (Δ) and economic leaking (ε) are high, the effect on economic desgrowth ($-\delta$) is magnified. Hence, $-\delta$ is directly proportional to the total general disaster vulnerability rate (Ψ_t) and economic leaking (ε) in the long run. Finally, we assume that economic desgrowth ($-\delta$), total general disaster vulnerability rate (Ψ_t), and economic leaking (ε) are intimately connected (see Expression 20 and 21). Economic desgrowth ($-\delta$) always starts from zero and remains negative throughout its entire trajectory according to our simulator.

$$\uparrow -\delta = (\uparrow \Psi_t)\ (\uparrow \varepsilon) \qquad (20)$$

$$\downarrow -\delta = (\downarrow \Psi_t)\ (\downarrow \varepsilon) \qquad (21)$$

h. Indicator-8: The Total Poverty Growth Rate (θ_t)

The total poverty growth rate (θ_t) evaluates the expansion, stagnation, or contraction of poverty. First, we need to find the marginal rate of poverty (Q). The calculation of Q is based on the total sum of seven growth rates: unemployment growth rate ($\partial Q_{1(to)} / \partial Q_{1(t-1)}$), bankrupt firms' growth rate ($\partial Q_{2(to)} / \partial Q_{2(t-1)}$), bankrupt consumers' growth rate ($\partial Q_{3(to)} / \partial Q_{3(t-1)}$), consumption growth rate ($\partial Q_{4(to)} / \partial Q_{4(t-1)}$), savings growth rate ($\partial Q_{5(to)} / \partial Q_{5(t-1)}$), housing demand growth rate ($\partial Q_{6(to)} / \partial Q_{6(t-1)}$), and homelessness growth rate ($\partial Q_{7(to)} / \partial Q_{7(t-1)}$) (See Expression 22). Subsequently, we can build the total poverty growth rate (Q_t) according to expression 23. Therefore, the total poverty growth rate (θ_t) is equal to the evaluation of two different results, the present marginal rate of poverty (t_o) and the past year's the marginal rate of poverty (t_{-1}) (See Expression 23).

$$Q = \sum[\partial Q_{1(to)} / \partial Q_{1(t-1)} + \partial Q_{2(to)} / \partial Q_{2(t-1)} + \partial Q_{3(to)} / \partial Q_{3(t-1)} + \partial Q_{4(to)} / \partial Q_{4(t-1)} + \partial Q_{5(to)} / \partial Q_{5(t-1)} + \partial Q_{6(to)} / \partial Q_{6(t-1)} + \partial Q_{7(to)} / \partial Q_{7(t-1)}] \quad (22)$$

$$Q_t = \partial Q(t_o)/\partial Q(t_{-1}) \ (23)$$

i. Indicator-9: The Investment Reconstruction Growth Rate (+λ)

The investment reconstruction growth rate (+λ) explores how a lower economic desgrowth (-δ) can accelerate the disasters damage recovery in a short period of time. (See Expression 24)

$$+\lambda = \partial{+\lambda} t_o(-\delta_{to})/\partial{+\lambda} t_{-1}(-\delta_{t-1}) \ (24)$$

j. Indicator-10: The Disasters Damage Recovery Index (ξ)

Post-disaster reconstruction and damage recovery index (ξ) are a direct function of the investment reconstruction growth rate (+λ) in the short and long run, according This indicator is a measure of reconstruction, in years. (Edgington, 2011) (See Expression 25).

$$\xi = f(+\lambda) \ (25)$$

k. Indicator-11: The Post-Disasters Impact Graphical Evaluator

The post-disaster impact graphical evaluator is able to evaluate a long series of variables in the same graphical space and at the same time. This new graphical evaluator uses the concept of general spaces, sub-spaces, and windows refraction (see Annex). In fact, we use one general space and five-sub-spaces, namely the continents of Africa, Asia, America, Europe and Oceania. At the same time, each sub-space has seven windows, as seen in Table 1 and Figures 1 and 2.

[INSERT TABLE 1]

[INSERT FIGURE 1 AND 2]

3. The Application of the General Disasters Final Impact Simulator (GDFI-Simulator) to the Continents of Africa, Asia, America, Europe and Oceania in the 19th and 20th Centuries

The general disasters final impact simulator (GDFI-Simulator) was applied to the five continents - Africa, Asia, America, Europe, and Oceania. According to our results, comparing the 19th and 20th centuries, we can clearly observe that the 20th century (Anon., 2002) was more vulnerable century, with a socio-economic-political vulnerability rate (α) of 0.97. On the other hand, the natural disasters vulnerability rate (β) for the 19th and 20th centuries are almost identical at 0.31 and 0.35 respectively. The total general disaster vulnerability rate (Ψt) changes from 0.80 in the 19th century to 1.32 in the 20th century).

Hence, the world has become more vulnerable in the 20th century compared to the 19th century. According to Figures 3 and 4, it is possible to observe that socio-economic-political disasters were growing faster than the natural disasters. In fact, at any time in the 20th century, the world was more likely to suffer a devastating socio-economic-political disaster than a natural disaster. Therefore, the simulations indicate that socio-economic-political disasters are more dangerous and difficult to recover from than natural disasters.

[INSERT FIGURE 3 AND FIGURE 4]

In the case of natural disasters and socio-economic-political disasters (α/β), sensitivity analysis of the GDFI-Simulator finds that in the 20th century out of ten disasters, eight are likely to be socio-economic-political disasters and just two are likely to be natural disasters. Interestingly, in the 19th century, six disasters were likely to be socio-economic-political disasters and four natural disasters. The construction of the total full potential economic output growth rate (Δ) is based on long run changes in international trade volumes and wealth accumulation. The total full potential economic output growth rate (Δ) presents the next results for the 19th century and 20th century, followed by 0.53 and 0.67 respectively.

However, economic leaking in the 20th century ($\varepsilon = -0.68$) is several times higher than in the 19th century. This large economic leaking in the 20th century can be traced to two catastrophic socio-economic-political disasters, namely the First and Second World Wars. At the same time, the large economic leaking from the 20th century caused large economic desgrowth ($-\delta$) of -6.12. The large economic desgrowth ($-\delta$) in the 20th century coincides with a rapid growth of the total poverty growth rate ($\theta t = 0.67$). This means that poverty grew several times faster in the 20th century than in the 19th century ($\theta t = 0.12$).

Simultaneously, the large economic desgrowth ($-\delta$) of the 20th century had a large negative impact on the investment reconstruction growth rate ($+\lambda$) that lasted from the 19th century ($+\lambda = 0.26$) to the 20th century ($+\lambda = 0.89$). In fact, the period of time in the disasters damage recovery index (ξ) rose from three years in the 19th century to nine years in the 20th century. The main reason for the increase is the large number of socio-political-economic disaster events in the 20th century (See table 2).

[INSERT TABLE 2]

The general disasters final impact simulator (GDFI-Simulator) evaluates five continents, namely Africa, Asia, America, Europe, and Oceania). We take as the main reference for our analysis the socio-economic-economic disasters and natural disasters of the 19th and 20th centuries (see Tables 5,6,7, and 8). The parameters for socio-economic-political disasters and natural disasters are based on the magnitude of human casualties - i.e. more than 10,000 dead, missing, and injured - and material infrastructure damage per km^2.

[INSERT TABLE 5, 6, 7, AND 8]

We can observe that the total general disasters vulnerability rate (Ψt) for the 20th century was as follows: Europe (Ψt = 0.87), Asia (Ψt = 0.68), America (Ψt = 0.55), Africa (Ψt = 0.42), and Oceania (Ψt = 0.35). A similar pattern is also observed in the 19th century with Europe at the top of the list. In addition, we can observe that the total general disasters vulnerability rate (Ψt = 0.87) was higher in the 20th century. The main reason is the fast expansion of the socio-economic-political disasters vulnerability rate in Europe (α = 0.91) as well as the other continents (Asia α = 0.59, America α = 0.47, Africa α = 0.41, and Oceania α = 0.31).

The GDFI-Simulator found that the most common social-economic-political disasters in the five continents in the 20th century were wars, financial speculation, colonization, government repression and corruption, foreign trade restrictions, revolutions, and civil wars. Moreover, America (0.59) and Asia (with 0.53) experienced the highest total natural disasters vulnerability rates (See Table 3). According to the GDFI-Simulator, the most common natural hazards in the five continents in the 20th century were earthquakes, tsunami, floods, famines and epidemics, volcanic eruptions, hurricanes, and droughts.

[INSERT TABLE 3]

The natural disasters and the socio-economic-political disasters vulnerability rates (β/α) sensitivity analysis results show that in the 20th century, out of every ten disasters, one is a natural disaster and nine are socio-economic-political disasters. The ratio of natural to socio-economic-political disasters is 1:9 for Europe, 3:7 for Africa, 5:8 for Asia, 4:6 for America, and 6:4 for Oceania.

However, Europe has the highest total full potential economic output growth rate (Δ) of 0.82, followed by America at 0.60. Asia and Oceania share third place (Δ = 0.39), and Africa is last (Δ = 0.29) (See Table 3). The main reason for Europe's leading position in total full potential economic output growth rate (Δ) is the European colonial powers' control of colonies and the main international trade routes, along with accumulation of wealth from slave trading, natural resource extraction, and other economic exploitation of their colonies.

Economic leaking (ε) increased dramatically from -0.37 in the 19th century to -0.75 in the 20th century in Europe. The higher economic leaking (ε) originated in the large expansion of the total general disasters vulnerability rate (Ψt) due to the socio-economic-political disasters of the 20th century. A similar trend was observed in Asia (ε = -0.61), America (ε = -0.35), Oceania (ε = -0.22), and Africa (ε = -0.31). The large amounts of economic leaking (ε) directly influenced economic desgrowth (-δ) in Europe (-δ=-0.75), Asia (-δ= -0.61), America (-δ=-0.35), Africa (-δ=-0.31), and Oceania (-δ=-0.22) respectively. The high levels of economic desgrowth (-δ), in turn, led to rapid expansion of the total poverty growth rate (θt) around the world in the 19th and 20th centuries. More specifically, θt rose from 0.39 to 0.71 in Europe, from 0.35 to 0.63 in Africa, from 0.41 to 0.59 in Asia, and from 0.29 to 0.53 in America.

The global expansion of poverty was faster in the 20th century than in the 19th century. Moreover, the investment reconstruction growth rate (+λ) and the disasters damage recovery index (ξ) experienced a considerable expansion, especially in Europe (+λ = 0.89) and Asia (+λ = 0.53). At the same time, the disasters damage recovery index (ξ) indicates longer reconstruction periods, as evident in Africa (from 5 years to 10 years) and Europe (from 2 years to 5 years) (See Table 4).

[INSERT FIGURE 4]

Finally, the disasters impact graphical evaluator show a significant worsening of vulnerability and risk levels between the 19th century and the 20th century. In particular, the prevalence of socio-economic-political disasters, some of them catastrophic, made the 20th century extremely vulnerable (See Figure 5).

[INSERT FIGURE 5]

4. Conclusion

Most of the existing economic research on disaster looks primarily at natural disasters and their economic ramifications. Yet the world has also experienced plenty of man-made socio-economic-political disasters throughout history, which is why we analyse and compare the two different types of disasters. We find that overall, socio-economic-political disasters cause more damage to humanity than natural disasters. The constant evolution of societies, which are often subject to violent and disruptive social, economic and political shocks, make it imperative for us to gain a solid understanding of man-made disasters. Furthermore, the gap between socio-economic-political disasters and natural disasters is large and growing, according to the GDFI-Simulator results. The best way to address both types of disasters is to for each country to work toward a policy and institutional environment that can deliver economic, social, and environmental sustainability.

Tackling socio-economic-political disasters and natural disasters that can prevent both types of disasters as well as mitigate the human and material losses from such disasters requires imaginative, farsighted and sustainable policies and programmes. In addition, they require close and systematic coordination and cooperation at the national, regional and global levels. For example, given the large cross-border spill-over effects of activities that harm the environment and contribute to global climate change, all countries must join forces in the fight to save our planet from irreversible degradation and destruction. Such global cooperation, evident in the Paris Agreement, can lay the basis for institutionalized cooperation among countries, which is indispensable for reducing military conflicts and other socio-economic-political disasters. Finally, given the sheer magnitude of man-made and natural disasters facing mankind in the 21st century, the countries of the world must embark on revolutionary, transformative, fundamental reforms across all spheres of human activity rather than gradual, piecemeal, half-hearted attempts at reform.

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Table 1:

The Disasters Impact Graphical Evaluator: 5-Sub-Space and 35-Windows Refraction

Sub-Space 1: African Continent Windows Refraction: ╬ WR1-1: (ε, Ψt) ╬ WR1-2: (-δ, ε) ╬ WR1-3: (Δ, -δ) ╬ WR1-4: (Ω, Δ) ╬ WR1-5: (θ, -δ) ╬ WR1-6: (+λ, -δ) ╬ WR1-7: (ξ, +λ)	Sub-Space 2: Asian Continent Windows Refraction: ╬ WR2-1: (ε, Ψt) ╬ WR2-2: (-δ, ε) ╬ WR2-3: (Δ, -δ) ╬ WR2-4: (Ω, Δ) ╬ WR2-5: (θ, -δ) ╬ WR2-6: (+λ, -δ) ╬ WR2-7: (ξ, +λ)	Sub-Space 3: American Continent Windows Refraction: ╬ WR3-1: (ε, Ψt) ╬ WR3-2: (-δ, ε) ╬ WR3-3: (Δ, -δ) ╬ WR3-4: (Ω, Δ) ╬ WR3-5: (θ, -δ) ╬ WR3-6: (+λ, -δ) ╬ WR3-7: (ξ, +λ)
Sub-Space 1: European Continent Windows Refraction: ╬ WR4-1: (ε, Ψt) ╬ WR4-2: (-δ, ε) ╬ WR4-3: (Δ, -δ) ╬ WR4-4: (Ω, Δ) ╬ WR4-5: (θ, -δ) ╬ WR4-6: (+λ, -δ) ╬ WR4-7: (ξ, +λ)	Sub-Space 2: Oceania Windows Refraction: ╬ WR5-1: (ε, Ψt) ╬ WR5-2: (-δ, ε) ╬ WR5-3: (Δ, -δ) ╬ WR5-4: (Ω, Δ) ╬ WR5-5: (θ, -δ) ╬ WR5-6: (+λ, -δ) ╬ WR5-7: (ξ, +λ)	

Source: (Ruiz Estrada, 2017)

Table 2:
The General Disasters Final Impact Simulator (GDFI-Simulator)
Final Results: 19th Century and 20th Century

No.	Indicators	19th Century	20th century
1	The Socio-Economic-Political Disaster Vulnerability Rate (**α**)	0.49	0.97
2	The Natural Disasters Vulnerability Rate (**β**)	0.31	0.35
3	The Total General Disaster Vulnerability Rate (Ψ_t)	0.80	1.32
4	The Natural Disasters and the Socio-Economic-Political Disasters (**β/α** Sensitivity Analysis	(5 : 4)	(8 : 2)
5	The Total Full Potential Economic Output Growth Rate (Δ)	0.53	0.67
6	The Economic Leaking (**ε**)	-0.32	-0.68
7	The Economic Desgrowth (**-δ**)	-1.92	-6.12
8	The Total Poverty Growth Rate (θ_t)	0.12	0.67
9	The Investment Reconstruction Growth Rate (+λ)	0.26	0.89
10	The Disasters Damage Recovery Index (ξ)	3	9

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Table 3:

The Total General Disaster Vulnerability Rate (Ψt), the Socio-Economic-Political Disaster Vulnerability Rate (α), the Natural Disasters Vulnerability Rate (β), the Natural Disasters and the Socio-Economic-Political Disasters (α/β) Sensitivity Analysis, and the Total Full Potential Economic Output Growth (Δ) by Continent from 19th Century and 20th Century.

No.	The Total General Disaster Vulnerability Rate (Ψ_t)	19th Century	20th century
1	Africa	0.21	0.42
2	Asia	0.37	0.68
3	America	0.33	0.55
4	Europe	0.61	0.87
5	Oceania	0.15	0.35

No.	The Socio-Economic-Political Disaster Vulnerability Rate (α)	19th Century	20th century
1	Africa	0.35	0.41
2	Asia	0.39	0.59
3	America	0.37	0.47
4	Europe	0.59	0.91
5	Oceania	0.18	0.31

No.	The Natural Disasters Vulnerability Rate (β)	19th Century	20th century
1	Africa	0.17	0.26
2	Asia	0.39	0.53
3	America	0.38	0.59
4	Europe	0.21	0.38
5	Oceania	0.11	0.23

No.	The Natural Disasters and the Socio-Economic-Political Disasters (β/α) Sensitivity Analysis	19th Century	20th century
1	Africa	(2:8)	(3:7)
2	Asia	(6:3)	(5:8)
3	America	(6:4)	(4:6)
4	Europe	(3:7)	(1:9)
5	Oceania	(7:3)	(6:4)

No.	The Total Full Potential Economic Output Growth Rate (Δ)	19th Century	20th century
1	Africa	0.19	0.29
2	Asia	0.32	0.39
3	America	0.33	0.60
4	Europe	0.67	0.82
5	Oceania	0.21	0.39

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Table 4:

The Economic Leaking (ε), Economic Desgrowth (-δ), the Total Poverty Growth Rate (θt), the Investment Reconstruction Growth Rate (+λ), the Disasters Damage Recovery Index (ξ) by Continent from 19th Century and 20th Century.

No.	The Economic Leaking (ε)	19th Century	20th century
1	Africa	-0.11	-0.31
2	Asia	-0.26	-0.61
3	America	-0.27	-0.35
4	Europe	-0.37	-0.75
5	Oceania	-0.07	-0.22

No.	The Economic Desgrowth (-δ)	19th Century	20th century
1	Africa	-0.11	-0.31
2	Asia	-0.26	-0.61
3	America	-0.27	-0.35
4	Europe	-0.37	-0.75
5	Oceania	-0.07	-0.22

No.	The Total Poverty Growth Rate (θ_t)	19th Century	20th century
1	Africa	0.35	0.63
2	Asia	0.41	0.59
3	America	0.29	0.53
4	Europe	0.39	0.71
5	Oceania	0.05	0.09

No.	The Investment Reconstruction Growth Rate (+λ)	19th Century	20th century
1	Africa	0.16	0.27
2	Asia	0.39	0.53
3	America	0.23	0.43
4	Europe	0.31	0.89
5	Oceania	0.03	0.05

No.	The Disasters Damage Recovery Index (ξ)	19th Century	20th century
1	Africa	5	10
2	Asia	5	3
3	America	2	3
4	Europe	2	5
5	Oceania	2	3

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Table 5: List of Largest Natural Disasters in the 20th Century

1.	Eastern United States heat wave	1901 (America)
2.	Mount Pelee Eruption	1902 (America)
3.	Santa María Volcano	1902 (America)
4.	San Francisco Earthquake	1906 (America)
5.	Chinese Famine	1907 (Asia)
6.	Messina earthquake	1908 (Europe)
7.	The Yangtze floods	1911 (Asia)
8.	The Influenza Pandemic (Spanish Flu)	1918-1919 (Worldwide)
9.	Mount Kelud eruption	1919 (Asia)
10.	Haiyuan earthquake	1920 (Asia)
11.	Gansu earthquake	1920 (Asia)
12.	Haiyuan landslide	1920 (Asia)
13.	Russian famine	1921–22 (Russia)
14.	Great Kantō earthquake	1923 (Asia)
15.	Malaria	1925 (Worldwide)
16.	Tri-State Tornado	1925 (America)
17.	Gulang earthquake	1927 (Asia)
18.	The Chinese famine	1928–1930 (Asia)
19.	China Flooding	1931 (Asia)
20.	The Soviet famine	1932–33 (Europe)
21.	The Yangtze foods	1935 (Asia)
22.	Quetta earthquake	1935 (Asia)
23.	Chinese Famine	1936 (Asia)
24.	Agra Famine	1837-1838 (Asia)
25.	Chinese famine	1942–1943 (Asia)
26.	Bengal famine	1943 (Asia)
27.	Ashgabat earthquake (Asia)	1948 Great Chinese Famine1961
28.	Bhola Cyclone	1970 (Asia)
29.	Huascarán Avalanche	1970 (America)
30.	Ancash earthquake	1970 (America)
31.	Red River Delta Floods	1971 (Asia)
32.	Iran Blizzard of February	1972 (Asia)
33.	Tornado Outbreak	1974 (America)
34.	Typhoon Nina	1975 (Asia)
35.	Tangshan earthquake	1976 (Asia)
36.	AIDS	1981 (Worldwide)
37.	El Chichón volcano eruption,	1982 (America)
38.	Armero tragedy	1985 (America)
39.	Lake Nyos eruption,	1986 (Africa)
40.	North American Drought	1988 (America)
41.	Daulatpur–Saturia tornado	1989 (Asia)
42.	Manjil–Rudbar earthquake	1990 (Asia)
43.	1991 Bangladesh cyclone	1991 (Asia)
44.	Hurricane Mitch	1998 (America)
45.	Vargas tragedy	1999 (America)

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Table 6: List of Largest Natural Disasters in the 19th Century

1.	The Famines in Austrian-Galicia	1804-1813 (Europe)
2.	The Molise earthquake	1805 (Europe)
3.	The Great Coastal hurricane	1806 (America)
4.	Four famines in China	1810-1811 (Asia)
5.	The New Madrid earthquakes	1811-1812 (Europe)
6.	The famines of Madrid	1811-1812 (Europe)
7.	The Crete earthquake	1810 (Europe)
8.	The Guatemala earthquake	1816 (America)
9.	Floods in Saint Petersburg	1824 (Europe)
10.	The Tenpō famine	1833-1837 (Asia)
11.	The Kunming earthquake	1833 (Asia)
12.	The Sumatra earthquake	1833 (Asia)
13.	The Lewes avalanche	1836 (Europe)
14.	The Agra famine	1837–1838 (Asia)
15.	The Galilee earthquake	1837 (Asia)
16.	The 1838 San Andreas earthquake	1838 (America)
17.	The Cap-Haïtien earthquake	1842 (America)
18.	The Highland Potato Famine	1845-1857 (Europe)
19.	The Great Irish Famine	1845-1849 (Europe)
20.	The Nagano earthquake	1847 (Asia)
21.	Four famines in China	1846-1849 (Asia)
22.	The Nankai earthquake	1854 (Asia)
23.	The Tōkai earthquake	1854 (Asia)
24.	The Ansei great earthquakes	1855 (Asia)
25.	The Edo earthquake	1855 (Asia)
26.	The Basilicata earthquake	1857 (Italy)
27.	The Erzurum earthquake	1859 (Europe)
28.	The Doab famine	1860–1861 (Asia)
29.	The Mendoza earthquake	1861 (America)
30.	The Sumatra earthquake	1861 (Asia)
31.	The Great Flood	1862 (America)
32.	The Orissa famine	1866 (Asia)
33.	The Finland Famine	1866–1868 (Europe)
34.	The Swedish Famine	1867–1869 (Europe)
35.	The Arica earthquake	1868 (America)
36.	The Rajputana famine	1869 (Asia)
37.	The Great Persian famine	1870–1872 (Asia)
38.	The Iquique earthquake	1877 (America)
39.	The Gansu earthquake	1879 (Asia)
40.	The volcano eruption of Mount Tarawera	1886 (Oceania)
41.	The Volcano Eruption of Te Wairoa	1886 (Oceania)
42.	The Waimangu Volcanic Rift Valley	1886 (Oceania)
43.	The Volcano eruption of Mount Bandai	1888 (Asia)
44.	The 1891 Mino–Owari earthquake	1891 (Asia)
45.	The Tête Rousse Glacier	1892 (Europe)
46.	The Quchan earthquake	1893 (Asia)
47.	The Istanbul earthquake	1894 (Europe)
48.	The 1896 Sanriku earthquake	1896 (Asia)

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Table 7: The List of Socio-Economic-Political Disasters in the 20th Century

1.	Unification of Saudi Arabia	1902-1932 (Middle East)
2.	Russo Japanese War	1904-1905 (Asia)
3.	Middle Eastern theatre of World War I	1914-1918 (Europe)
4.	Russo-Polish War	1919-1920 (Europe)
5.	Mexican Revolution	1911-1920 (America)
6.	Russian Civilian War	1918-1921 (Europe)
7.	First War world	1914-1918 (Europe)
8.	Riffian War	1921-1926 (Europe)
9.	Spanish Civil War	1936-1939 (Europe)
10.	Chinese Civilian War	1927-1937 (Asia)
11.	Second War World	1937-1945 (Worldwide)
12.	French Indochina War	1945-1954 (Asia)
13.	First Sudanese Civil War	1956-1972 (Africa)
14.	Chinese Civil War	1945-1949 (Asia)
15.	Korean War	1950-1953 (Asia)
16.	French-Algeria War	1954-1962 (Africa)
17.	Six Days War	1967-1967 (Asia)
18.	Biafran War	1967-1970 (Africa)
19.	Vietnam War	1964-1973 (Asia)
20.	Afghanistan War	1980-1989 (Asia)
21.	Iran and Iraq War	1980-1988 (Asia)

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

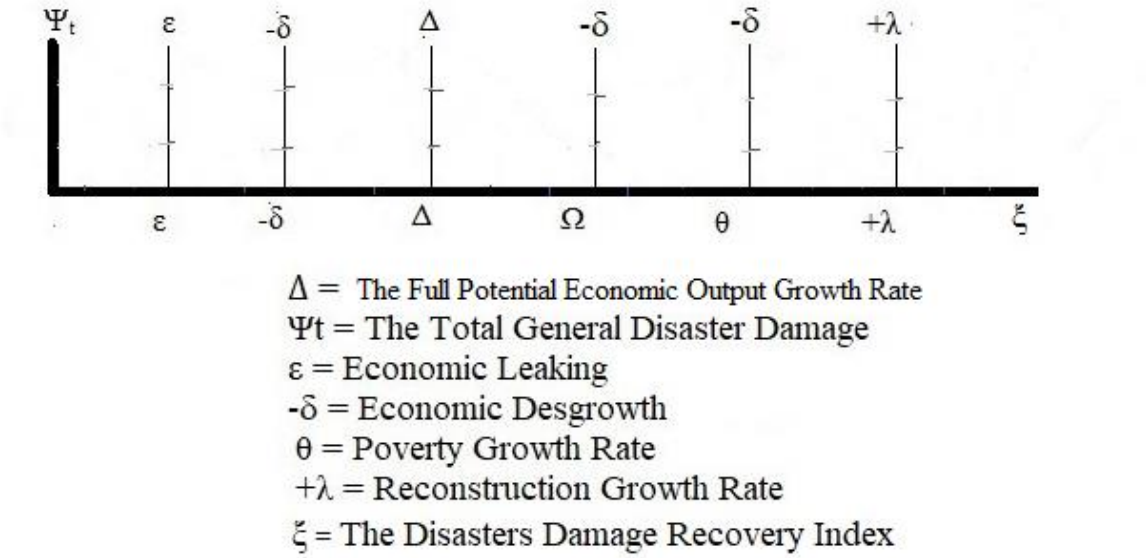
Table 8: The List of Socio-Economic-Political Disasters in the 19th Century

1.	War of the Third Coalition	1803-1806 (Europe)
2.	War of the Fourth Coalition	1806-1807 (Europe)
3.	Anglo-Turkish War	1807-1809 (Europe)
4.	War of the Fifth Coalition	1809-1809 (Europe)
5.	The French invasion of Russia	1812-1812 (Europe)
6.	Russo-Persian War	1804-1813 (Asia)
7.	The War of the Sixth Coalition	1813-1814 (Europe)
8.	The Hundred Days	1815-1815 (Europe)
9.	Russo-Turkish War	1806–1812 (Asia)
10.	Peninsular War	1807-1814 (Europe)
11.	Anglo-Russian War	1807-1812 (Europe)
12.	French Revolution	1830-1830 (Europe)
13.	The Apache War	1849-1886 (America)
14.	The California Indian War	1850-1880 (America)
15.	The Crimean War	1853-1856 (Europe)
16.	The Second Opium War	1856-1860 (Asia)
17.	Second French Intervention in Mexico	1861-1867 (America)
18.	The Austro-Prussian War or Seven Weeks' War	1866-1866 (Europe)
19.	The Franco-Prussian War or Franco-German War	1870-1871 (Europe)
20.	The Japanese punitive expedition to Taiwan	1874-1874 (Asia)
21.	The Russo-Turkish War	1877–1878 (Asia)
22.	The First Sino-Japanese War	1894-1895 (Asia)
23.	The Japanese invasion of Taiwan	1895-1895 (Asia)
24.	The Spanish–American War	1898-1898 (America)

Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Figure 1:

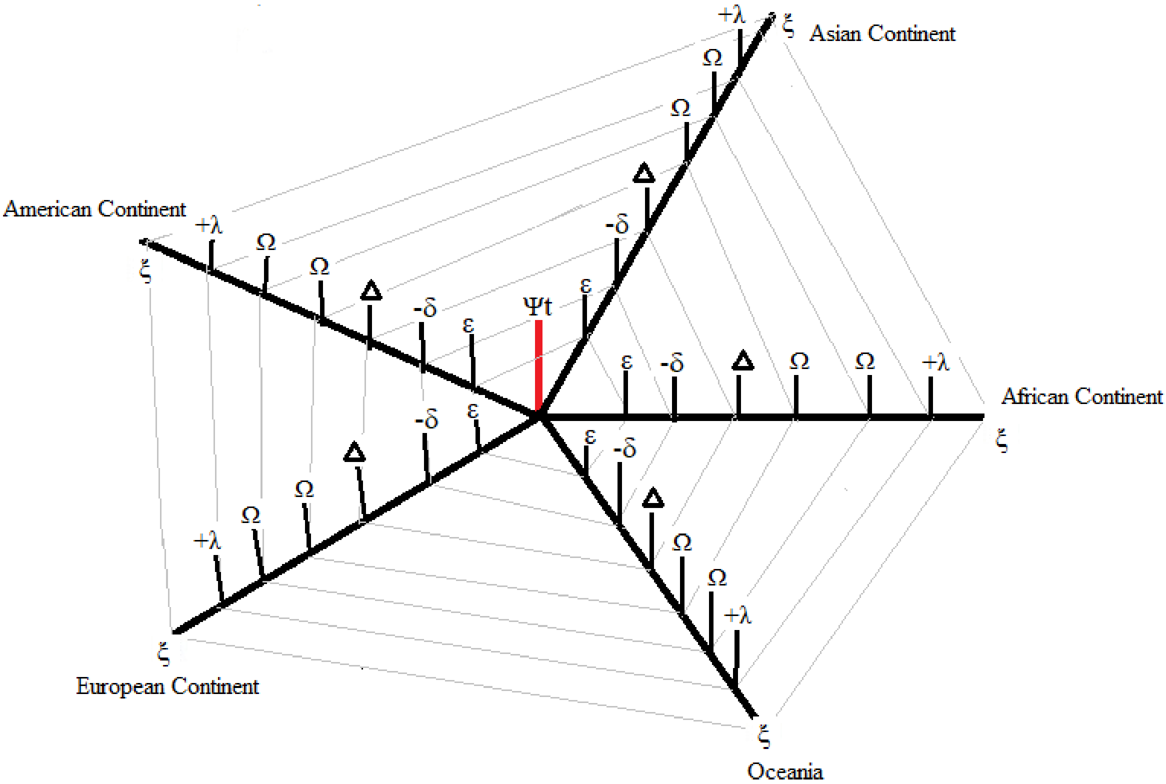
The Disasters Impact Graphical Evaluator: 1-Sub-Space and 7-Windows Refraction



Source: Author

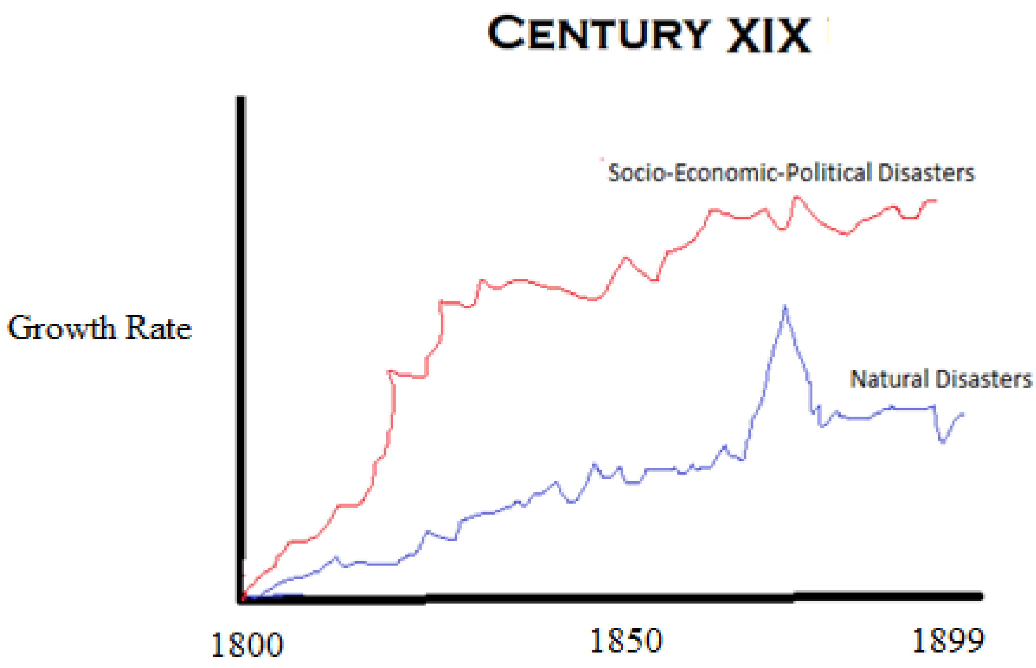
Figure 2:

The Disasters Impact Graphical Evaluator: 5-Sub-Spaces and 35-Windows Refraction



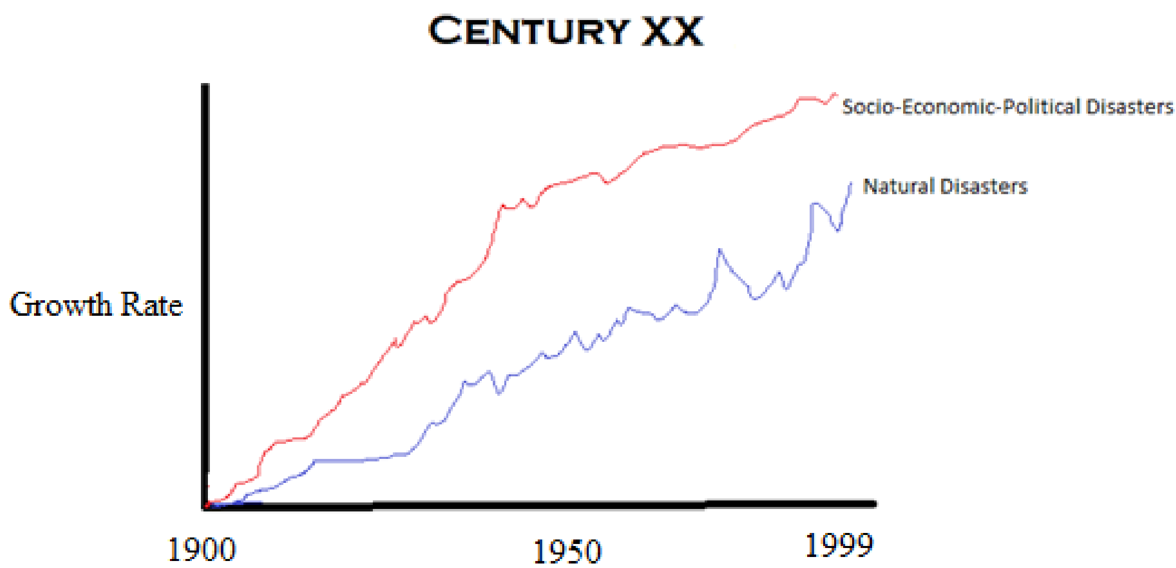
Source: Author

Figure 3: Socio-Economic-Political Disasters vs. Natural Disasters Worldwide in the 19th Century



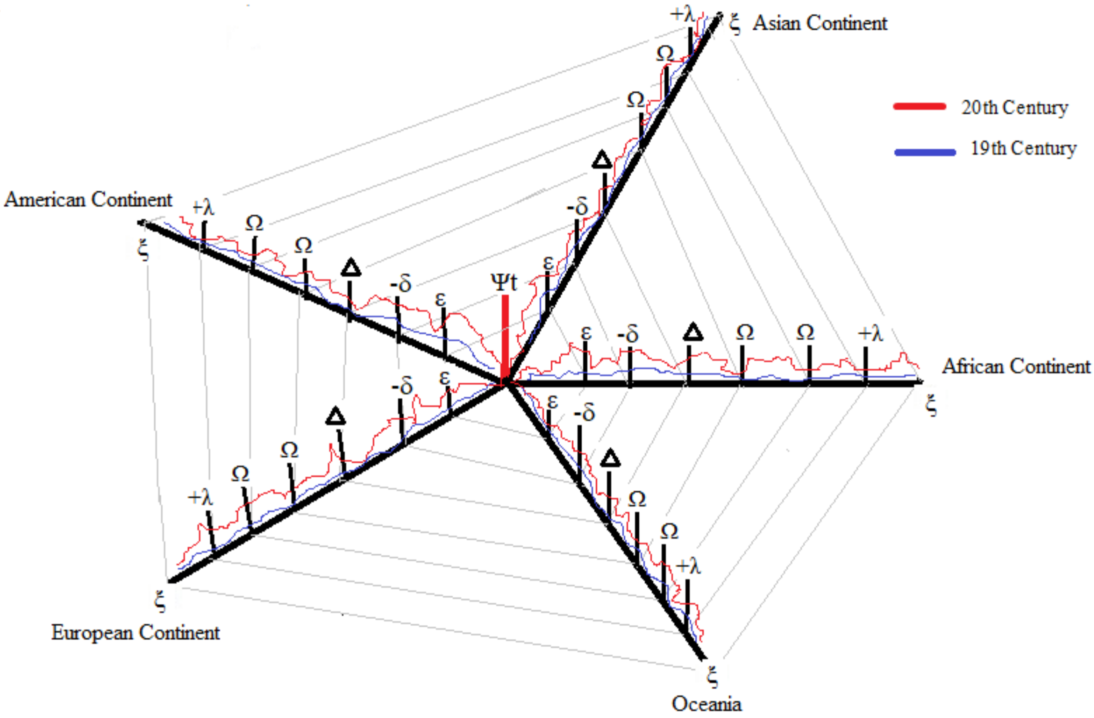
Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Figure 4: Socio-Economic-Political Disasters vs. Natural Disasters Worldwide in the 20th Century



Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

Figure 5: The Application of the Disasters Impact Graphical Evaluator in Five Continents from 19th Century to 20th Century



Source: (CCAPS Research – Strauss Center, 2018), (Mitchell, B.R., 1998), (The International Disasters Database, 2018), (Tufts University Libraries, 2018).

ANNEX:

i. An Introduction to the Inter-Linkage Coordinate Space

The inter-linkage coordinate space (Ruiz Estrada, 2017) is formed by infinite number of general axes (A0, A1 ,…, An …), perimeter levels (L0, L1 ,…, Ln …) and windows refraction (W0, W1,…,Wn…) (See Table 9 and Figure 6). Each window refraction is based on join its sub-x axis (XA-L) with its sub-y axis (YA-L) respectively. Therefore, the window refraction (W0, W1…Wn…) is follow by the coordinate Space (XA-L,YA-L). All windows refraction on the same general axis (A0, A1 ,…, An …) will be joined together under the application of the inter-linkage connectivity of windows refraction represented by "®". The inter-linkage connectivity of windows refraction is represented by the symbol "®". The inter-linkage connectivity of windows refraction "®" will inter-connect all windows refraction (W0, W1 ,…, Wn …) on the same general axis (A0, A1 ,…, An …) but in different perimeter levels (L0, L1 ,…, Ln …). Moreover, the inter-linkage coordinate system is represented by (see Expression 1):

Perimeter level P0 ® Perimeter level P1 ® … ® Perimeter level Pn
General Axis 0 (A0): W0-0 = (x0-0,y0-0) ® W0-1 = (x0-1,,y0-1) ®…® W0-∞ = (x0-∞, y0-∞)
General Axis 1 (A1): W1-0 = (x1-0,,y1-0) ® W1-1 = (x1-1,,y1-1) ®…® W1-∞ = (x1-∞, y1-∞)
General Axis 2 (A2): W2-0 = (x2-0,,y2-0) ® W2-1 = (x2-1,,y2-1) ®…® W2-∞ = (x2-∞, y2-∞)
General Axis 3 (A3): W3-0 = (x3-0,,y3-0) ® W3-1= (x3-1,,y3-1) ®…® W3-∞ = (x3-∞, y3-∞)
General Axis 4 (A4): W4-0 = (x4-0,,y4-0) ® W4-1= (x4-1,,y4-1) ®… ® W4-∞ = (x4-∞,y4-∞)
General Axis 5 (A5): W5-0 = (x5-0,,y5-0) ® W5-1 = (x5-1,,y5-1)®… ® W5-∞ = (x5-∞ , y5-∞)
. . . .
General Axis n (A∞): W∞-0 = (x∞-0, y∞-0) ® …………………………..® W∞-∞ = (x∞-∞, y∞-∞)

Finally, the inter-linkage coordinate space is available to fix a large number of different functions located in different windows refraction (W0, W1 ,…, Wn …), perimeter levels (L1, L2 ,…, Ln …) and general axes (A1, A2 ,…, An …) (see Expression 2):

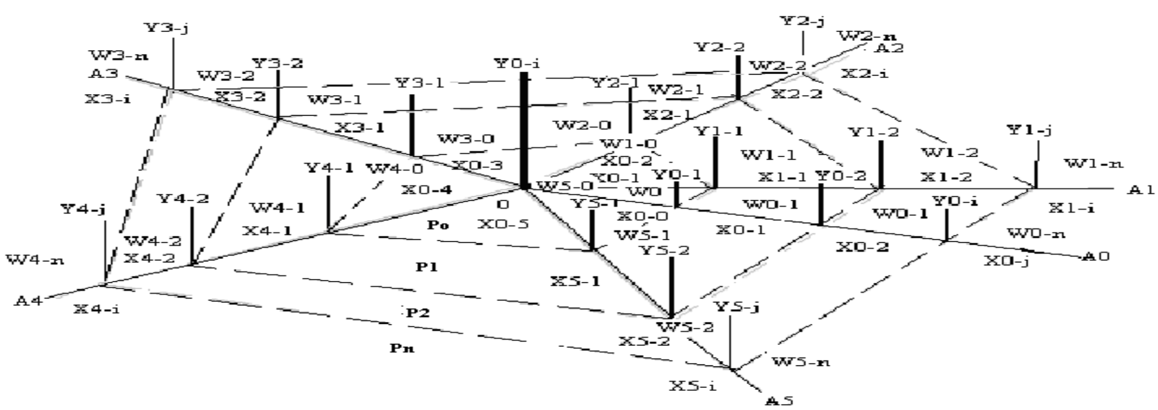
Perimeter level P0 ® Perimeter level P1 ® … ® Perimeter level Pn
General Axis 0 (A0): y0-0 = ƒ(x0-0) ® y0-1 = ƒ(x0-1) ®…….® y0-∞= ƒ(x0-∞)
General Axis 1 (A1): y1-0 = ƒ(x1-0) ® y1-1 = ƒ(x1-1) ®…….® y1-∞ = ƒ(x1-∞)
General Axis 2 (A2): y2-0 = ƒ(x2-0) ® y2-1 = ƒ(x2-1) ®……...® y2-∞ = ƒ(x2- ∞)
General Axis 3 (A3): y3-0 = ƒ(x3-0) ® y3-1 = ƒ(x3-1) ®…….® y3-∞ = ƒ(x3-∞)
General Axis 4 (A4): y4-0 = ƒ(x4-0) ® y4-1 = ƒ(x4-1) ®…….. ® y4-∞ = ƒ(x4-∞)
General Axis 5 (A5): y5-0 = ƒ(x5-0) ® y5-1 = ƒ(x5-1)®……….® y5-∞ = ƒ(x5-∞)
. . . .
General Axis n (A∞): y∞-0 = ƒ(x∞-0) ® ………………………® y∞-∞= ƒ(x∞-∞)

Table 9: Windows Refraction

Space 1: Windows Refraction: Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ . . . Windows Refraction ∞…	Space 2: Windows Refraction: Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	Space 3: Windows Refraction: Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ … Windows Refraction ∞…
Space 4: Windows Refraction: Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	Space 5: Windows Refraction: Windows Refraction 1╬ Windows Refraction 2 ╬ Windows Refraction 3 ╬ ... Windows Refraction ∞…	

Source: Ruiz Estrada (2017)

Figure 6: The Inter-Linkage Coordinate Space



Source: Ruiz Estrada (2017)