

Conceptualizing and Measuring the Economic issues in the Evaluation of Socio-ecological Resilience: A Commentary

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Abstract - Resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a state controlled by a different set of environmental conditions and processes. Despite the growing importance of socioeconomic resilience, this concept has not been yet carefully defined or satisfactorily measured within the more general issue of socio-ecological resilience of both natural (forest) and anthropogenic (agricultural) systems. Investigating socioeconomic resilience in a rapidly changing landscape is important for sustainable land management under intense and increasing human pressure, like observed in the Mediterranean region. This paper presents an overview of definitions and indicators of the socioeconomic resilience and comments on some possible measurements of the concept taken from the parallel ecological literature. The study is intended to contribute to this deserving issue in the light of the (increasingly complex) relationships between the environment, the economic systems, and the social sphere.

Keywords - Desertification risk, Resilience, Forest ecosystems, Human systems, land cover.

Introduction

Despite the growing importance of socioeconomic resilience during the current period of 'economic' and 'social' global crisis, this concept has not been yet carefully defined or satisfactorily measured within the more general issue of socio-ecological resilience. This concept has received increasing interest in Europe, particularly in the

Mediterranean region, whose landscape resulted from the complex interaction between society, economy, and the ecosystem (Lepart and Debussche 1992; Lavorel 1999, Thompson 2005).

The 'resilience' term, as originally illustrated by Elton (1958), refers to the amplitude of changes brought about by disturbance and by dynamics of post-disturbance recovery. Holling (1973) popularized this term within the broader framework of 'ecosystem stability'. He provided a definition of 'resilience' as the amount of disturbance that an ecosystem could withstand without changing self-organized processes and structures, defined as alternative stable states. The 'resilience' concept does not necessarily imply a return to the pre-existing state, but could be referred to as the capacity to respond to opportunities which arise as a result of change (Holling 2001).

In this perspective, Folke (2006) described 'resilience' as the set of opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new paths (Brand and Jax 2007). 'Resilience' hence expresses the adaptive capacity that allows for continuous development like a dynamic interplay between sustaining and developing with change (Carpenter et al. 2001).

This paper presents an overview outlining some possible meanings and measures of socioeconomic resilience by debating the implicit definitions proposed in the (rather) restricted literature that deals

with socioeconomic resilience and commenting on some possible measurements of the concept taken from the parallel ecological literature.

In the first section we present a general definition of the concept from both the ecological and the socioeconomic side. A summary methodological introduction on how to measure socioeconomic resilience of human and natural systems was introduced afterwards. The relationship between ecosystem management and socio-economic resilience was further discussed in the light of complex relationships between the environment, the economic systems, and the social sphere. In the final section we outlined an economically-oriented vision of the 'resilience' concept as an original contribution to the complex research issue of sustainability.

1. Main definitions

In social science literature reviews on resilience, perhaps the most traditional meaning of socioeconomic resilience is the ability of a regional economy to maintain a pre-existing state (typically assumed to be an equilibrium state) in the presence of some kinds of exogenous shocks. Although only a few studies explicitly use the term "resilience" most of the economic literature that deals with the idea of resilience is concerned with the extent to which a regional or national economy that has experienced an external shock is able to return to its previous level and/or growth rate of output, employment, or population (Blanchard and Katz 1992, Rose and Liao 2005, Briguglio et al. 2006, Feyrer, Sacerdote, and Stern 2007).

Another interpretation could be the idea of path-dependence, or historical "lock-in" processes; this concept is based on the assumption that an economy has multiple equilibria, not all of which are efficient (in a static or dynamic sense). This suggests a concept of regional economic resilience in which resilience is the ability of an economy to avoid becoming locked into such a low-level equilibrium or, if in one, to transition quickly to a "better" equilibrium.

A long-term, holistic perspective, in contrast, would emphasize the structure of relationships among macroeconomic variables that persists over a long period of time and the economic, political, and social institutions that condition this structure (Reich 1997). As an example, a social structure is not static; although it persists for a long time, it evolves in ways

that ultimately threaten firms' profitability and long-term macroeconomic growth.

The study of resilience would then be the study of the rise, stability, and eventual decay of the institutions that underlie long-term regional economic growth. An economy would be resilient to the extent that its social structure was stable or to the extent that it was able to make a rapid transition from one structure to another. So, in general, socioeconomic resilience is defined as the ability of a nation or a region to recover successfully from shocks to its economy that either throw it off its growth path or have the potential to throw it off its growth path but do not actually do so.

Economic systems that experience negative shocks may exhibit three different kinds of responses. Some of these may have returned to or exceeded their previous growth within a relatively short period of time (definition concerns dealt with below); these regions might be called economically resilient. Some may not have been thrown off their growth path at all; these regions might be called shock-resistant. Finally, some regions may have been unable to rebound and return to or exceed their previous path; these might be called non-resilient.

2. General methodologies

Economically resilient and non-resilient economies can be identified using data on aggregate economic performance, while shock-resistant countries can be identified using data on industry performance or other information on non-industry shocks. Human skill may also be regarded as an important factor here but is rather difficult to calculate in a way comparable with the other factors.

Economically resilient and non-resilient economies can in principle be identified by examining their economic performance over a period of time. Criteria for a negative economic shock can be defined and pre- and post-shock growth rates and levels of economic performance can be measured. A region which post-shock growth rate is at least as high as its pre-shock growth rate and that achieves its pre-shock level of economic performance within a specified time period can be considered resilient, while a region that experiences a negative shock and does not meet these criteria can be considered non-resilient.

A continuous variable can be developed to measure socioeconomic resilience, e.g. the number of years (or quarters if the data permit) it takes to return to the previous growth path, percentage of lost employment (or other relevant measure) replaced within a standard period of time, or some other measure that takes into account the relationship between post-shock performance and the size of the shock (Hill. et al. 2008). To implement a socioeconomic resilience measure is necessary to address a series of measurement issues, such as the following:

- What measure(s) of economic performance should be used, e.g. gross domestic product, employment, earnings, income (and for all of these, total or per worker or per capita)?
- Should the growth rate for a region be measured in absolute terms, relative to the national average, or relative to the average in the relevant economic zoning, census region, or administrative division (or all of these)?
- How far back in time should growth paths be traced?
- For how many years should growth paths and shock periods be measured? Should the same number of years be used to define pre-shock, shock, and post-shock periods, or should the lengths of these periods be allowed to differ?
- How should growth paths and shocks be measured (e.g., average annual growth or the slope of a regression line through all observations during a time period)?
- How large does a negative deviation have to be (relative to the region's previous performance and/or national average performance) to count as a negative shock?
- How should a region's pre-shock level of economic performance be defined (e.g., peak or average performance during the pre-shock period)?

3. Measuring socioeconomic resilience in natural and anthropogenic systems

The first challenge faced in measuring socioeconomic resilience is to define spatial areas that reflect patterns of human activity. Areas defined according to ecological criteria (such as hydrological basins or bio-geographical regions) do not effectively capture these patterns. Any spatial definition of

socioeconomic systems is to some degree subjective; these are open systems in which people, money, goods, and services continually cross any boundary adopted. Further, if socioeconomic systems are defined in a spatial hierarchy (international, national, regional, and local), interactions occur among all levels. The theoretical basis for socioeconomic resiliency rests on the concept of social well-being, which is defined as a composition of three factors: economic resiliency, social and cultural diversity (e.g. population size, human skill mix) and civic infrastructure (McCool et al. 1997).

A provisional index of economic resiliency could be thus developed directly from measures of diversity in employment or income among economic sectors. Social and cultural diversity can be measured by using data on lifestyle diversity. Because there was no direct way to measure civic infrastructure, in this analysis the population density is used as a proxy, according to Barkley et al. (1996). The socioeconomic resilience index is developed mixing three factors: economic resiliency, population density, and lifestyle diversity. In this context the measures for both economic resiliency and lifestyle diversity are calculated using a diversity index (Shannon and Weaver 1949):

$$D = - \sum_{i=1}^n (E_i * \log E_i)$$

where, D is the diversity index of an area; i is the i-th industry; n is the number of industries; E_i is the proportion of total employment in the area located in the ith industry; $\log E_i$ is the logarithm (base 10) of E_i . The indices are normalized so that all numbers ranged between 0 (no diversity) and 1 (perfect diversity). The composite rating of socioeconomic resiliency is determined by combining the results of economic resiliency, population density, and lifestyle diversity. the socioeconomic resiliency rating based is assigned on the sum of the ratings for the three factors; that is, the three factors are equally weighted (Horne and Haynes 1999).

3.1. Economic-oriented resilience

We said that socioeconomic resilience refers to the policy-induced ability of an economy to recover from or adjust to the negative impacts of adverse exogenous shocks and to benefit from positive shocks. In the study from Briguglio (2007), economic resilience is associated with actions undertaken by

policy-makers and private agents which enable a region to withstand or recover from the negative effects of shocks. Actions which enable a region to better benefit from positive shocks are also considered to lead to economic resilience. The term is used in two senses in this analysis, respectively related to the ability to recover quickly from a shock and to withstand the effect of a shock. The ability of a regional economic system to recover from the effects of adverse shocks is associated with the flexibility of an economy, enabling it to bounce back after being adversely affected by a shock. On the other hand, this ability will be enhanced when the economy possesses discretionary policy tools which it can utilize to counteract the effects of negative shocks.

The ability to withstand shocks relates to the capability to absorb shocks, so that the end effect of a shock is neutered or rendered negligible. This type of resilience occurs when the economy has in place mechanisms to reduce the effects of shocks. For example, the existence of a flexible, multi-skilled labour force could act as an instrument of shock absorption, as negative external demand shocks affecting a particular sector of economic activity can be relatively easily met by shifting resources to another sector enjoying stronger demand.

3.2. *Constructing a measure of resilience*

This section illustrates an attempt to construct a composite index of economic resilience. However care was taken to base the choice on a set of desirable criteria related to appropriate coverage, simplicity and ease of comprehension, affordability, suitability for international comparisons and transparency. The compilation of the index encountered a number of problems with regard to data collection, the most important of which were associated with shortage of data and non-homogenous definitions across countries. A resilience index should be aimed at measuring the effect of shock-absorption or shock counteraction policies across countries. It is hypothesised that the variables that capture these effects are the following:

- macroeconomic stability;
- microeconomic market efficiency;
- good governance;
- social development.

Macroeconomic stability relates to the interaction between an economy's aggregate demand and aggregate supply. If aggregate expenditure in an economy moves in equilibrium with aggregate supply, the economy would be characterised by internal balance, as manifested in a sustainable fiscal position, low price inflation and an unemployment rate close to the natural rate, as well as by external balance, as reflected in the international current account position or by the level of external debt. These can be all considered to be variables which are highly influenced by economic policy and which could act as good indicators of an economy's resilience in facing adverse shocks.

In this study the macroeconomic stability aspect of the resilience index proposed is constructed on the basis of three variables:

- the fiscal deficit to GDP ratio: the government budget position is suitable for inclusion in the resilience index because a healthy fiscal position would allow adjustments to taxation and expenditure policies in the face of adverse shocks.
- the sum of the unemployment and inflation rates: those indicators are also considered to be suitable indicators of resilience. This is because price inflation and unemployment are strongly influenced by other types of economic policy, including monetary and supply-side policies. They are associated with resilience because if an economy already has high levels of unemployment and inflation, it is likely that adverse shocks would impose significant costs on it.
- the external debt to GDP ratio: the adequacy of external policy may be gauged through the inclusion of this indicator. This is considered to be a good measure of resilience, because a country with a high level of external debt may find it more difficult to mobilize resources in order to offset the effects of external shocks.

Microeconomic market efficiency is constructed on the variables that composing the Economic Freedom of the World Index (Gwartney and Lawson 2005), entitled "regulation of credit, labour and business" which is aimed at measuring the extent to which markets operate freely, competitively and efficiently across countries. In the financial market this index assesses the extent to which the banking industry is dominated by private firms; foreign banks are permitted to compete in the market; credit is supplied to the private sector; and controls on interest

rates interfere with the market in credit. All these relate to the degree of interference by government in the financial market, which could preclude the economy from reacting flexibly to shocks.

Similar considerations apply in the case of the labour market. Here interference relates to unduly high unemployment benefits (which could undermine the incentive to accept employment), dismissal regulations, minimum wage impositions, centralised wage setting, extensions of union contracts to non-participating parties and conscription. All these are viewed as possibly precluding work effort, thereby limiting the ability of a country to recover from adverse shocks. Bureaucratic control of business activities are also thought to inhibit market efficiency.

Good governance is essential for an economic system to function properly and hence to be resilient. Governance relates to issues such as rule of law and property rights. This is considered to be useful in the context of the present exercise in deriving an index of good governance. This concept covers five components: judicial independence; impartiality of courts; the protection of intellectual property rights; military interference in the rule of law; and political system and the integrity of the legal system.

A composite index was computed by taking a simple average of the four components previously described: macroeconomic stability, microeconomic market efficiency, good governance and social development. All observations of the components of the index were standardised using a linear transformation. This transforms the values of observations in a particular variable array so that they take a range of values from 0 to 1 (Briguglio 2006).

4. Ecological resilience, ecosystem management and socioeconomic resilience

One of the objectives for the ecosystem management is to encourage socioeconomic resilience defined as the ability of human institutions to adapt to change (Haynes et al. 1996). These institutions include both communities and economies. A community is defined as a sense of place, organization, or structure (e.g. Galston and Baehler 1995). An economy is defined by transactions among people that allocate scarce resources among alternative uses, and may exhibit different spatial configurations than communities. With the concept of socioeconomic resilience, this vision recognize that

change is inherent in human systems. Social and economic factors are continuously changing - population grows, people migrate, social values evolve, and new technologies and knowledge are created.

In the study from Horne and Haynes (1999) the challenge is how to develop a measure of socioeconomic resilience that is useful for understanding the extent to which changes in policies for land management may affect the human systems coincident with those lands (Quigley et al. 1996). The interest of this analysis stems from a long-held concern about the relation between ecosystem management practices and the economic well-being of nearby residents.

In this analysis it is assumed that the relation between diversity and resilience in social and economic systems is similar to that in the ecological literature (e.g. Moffat 1996); that is, a system with higher diversity is less affected by change than a system with lower diversity and the former therefore has higher resilience. Socioeconomic systems with high resiliency are defined as those that adapt quickly as indicated by rebounding measures of socioeconomic well-being. People living in areas characterized by high resilience have a wide range of skills and access to diverse employment opportunities.

Thus if specific firms or business sectors experience downturns, unemployment rates rise only briefly until displaced people find other employment. Systems with low resilience have more lingering negative impacts, such as unemployment or out-migration rates that remain high for several years. The terms "high" and "low" should not be thought of as "good" or "bad," but simply as a reflection of the ability of a socioeconomic system to respond to changes in social or economic factors. Note that having greater diversity (and higher resilience) does not eliminate the possibility of wide fluctuations for single economic entities or sectors.

5. Concluding remarks

The approach previously described is potentially interesting but rather narrow in scope and very difficult to measure across countries. Other components of the 'resilience' dimension can be mentioned at this point. We made just two examples in the follows.

Social development is an essential component of economic resilience. Social development in a country can be measured in a number of ways. Variables relating to income such as its dispersion and the proportion of the population living in poverty, the long-term unemployment rate — indicating the proportion of the population with low skills and inadequate employment prospects — and the proportion of the population with low level of education could be useful, additional indicators to the illustrated evaluation system.

Economic resilience can also be viewed to be determined by a series of other (non-social, non-institutional) factors apart from those mentioned above. It may be argued, for example, that it could be useful to consider the effects of environmental management in this regard (see also paragr. 5). The environment can be an important source of vulnerability by giving rise to shocks of an adverse nature, principally by rapid events, such as earthquakes and floods. In turn, these would have important repercussions on the economy and society.

In conclusion, only a thorough analysis involving multiple research dimensions from environmental, economic, social, and political studies and also multiple assessment scales (from local to supra-national) may assure a conceptual definition and a reliable operational description of the socioeconomic resilience.

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References

- [1] Adger, WN (2000). Social and ecological resilience: are they related? *Progress in Human Geography* 24: 347-364.
- [2] Horne AL, Haynes RW (1999). Developing Measures of Socioeconomic Resiliency in the Interior Columbia Basin. General Technical Report PNW-GTR-453, USDA FS, Pacific Northwest Research Station, Portland, OR.
- [3] Barkley, DL, Henry, MS, Bao, S (1996). Identifying “spread” versus “backwash” effects in regional economic areas: a density functions approach. *Land Economics* 72(3): 336-357.
- [4] Berkes. F, Colding, J, Folke, C (2003). *Navigating social–ecological systems: building resilience for complexity and change*. Cambridge, UK. Cambridge University Press.
- [5] Blanchard, O, and Lawrence FK (1992). *Regional Evolutions*, Brookings Papers on Economic Activity 1992, no. 1, pp. 1-75. Washington: Brookings Institution.
- [6] Brand FX, Jax K (2007). Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object. *Ecology and Society* 12(1): 23.
- [7] Briguglio, L (2007). *Economic Vulnerability and Resilience Concept and measurements*. Working paper, Economics Department, University of Malta.
- [8] Briguglio, L (2006). *Conceptualizing and Measuring Economic Resilience*. Working paper, Economics Department, University of Malta.
- [9] Carpenter S, Walker B, Anderies J, Abel N (2001). From metaphor to measurement: resilience of what to what? *Ecosystems* 4: 765-781.
- [10] Chapin, FSIII, Kofinas, GP and Folke C. (2009). *Principles of Ecosystem Stewardship: Resilience-Based Natural Resource Management in a Changing World*. New York, Springer.
- [11] Dell, B, Hopkins, AJM, Lamont, BB (1986). *Resilience in Mediterranean-type ecosystems*. Dordrecht. Dr W Junk Publishers.
- [12] Folke, C (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global environmental Change* 16: 253-267.
- [13] Folke, C, Carpenter, S, Walker, B, Scheffer, M, Elmqvist, T, Gunderson, L, Holling, CS (2005). Regime shifts, resilience and biodiversity in ecosystem management. *Annual Review of Ecology Evolution and Systematics* 35: 557-581.

- [14] Folke, C, Carpenter, SR, Walker, B, Scheffer, M, Chapin, T, Rockström, J (2010). Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society* 15: 20.
- [15] Gwartney, J, Lawson, R (2005). *Economic Freedom of the World 2005 Annual Report*. Vancouver: Fraser Institute.
- [16] Holling, CS (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4: 1-23.
- [17] Holling, CS (2001) Understanding the complexity of economic, ecological and social systems. *Ecosystems* 4: 390-405.
- [18] Lavorel, S (1999). Ecological diversity and resilience of Mediterranean vegetation to disturbance. *Diversity and distributions* 5: 3–13.
- [19] Lepart J, Debussche, M (1992) Human impact on landscape patterning: Mediterranean examples. In: Hansen, AJ, di Castri, F (Eds.), *Landscape Boundaries for Biotic Diversity and Ecological Flows*. Springer, New York, pp 76–106.
- [20] Perrings CA (2006) Resilience and stability of ecological systems. *Ann Rev Ecol System* 4: 1-23.
- [21] Reich, M (1997). Social Structure of Accumulation Theory: Retrospect and Prospect. *Review of Radical Political Economics* 29: 1-10.
- [22] Rose, A, Shu-Yi L (2005). Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions. *Journal of Regional Science* 45: 75-112.
- [23] Shannon, CE, Weaver, W (1949). *The mathematical theory of communication*. Urbana, IL: The University of Illinois Press. 125 p.
- [24] Walker, B, Gunderson, L, Kinzig, A, Folke, C, Carpenter, S, Schult, L (2006). A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. *Ecology and Society* 11: 13.
- [25] Westley, F (2002). The devil is in the dynamics. In: Gunderson, L.H. and Holling, C.S. (Eds). *Panarchy: understanding transformation in human and natural systems*. Washington, D.C., USA. Island Press. 333-360.