COSA
Committee On Sustainability Assessment

28 | March 2018

Issue Brief

Resilience Measurement

Differences and Similarities with Sustainability

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One of the key sustainability challenges today lies in establishing precise and practical ways to measure resilience. A better understanding of resilience can help ensure a long-term sustainable development pathway. This issue brief is part of a series of articles from COSA on resilience measurement. In this second brief, we present COSA's resilience measurement system, starting with an analysis of its similarities and differences with common sustainability measurement.

The Issue

The resilience agenda's measurement needs have been compared by Cissé and Barret (2016) to the poverty aggregation needs faced decades ago by Amartya Sen (1979). To guide policy, the concept of resilience, like poverty, needs both to facilitate "identification" (i.e., who is resilient) and "aggregation" (i.e., defining how resiliency's characteristics can be combined in one aggregate indicator).

This Issue Brief provides some of our insights on measuring resilience. We start by discussing conceptual differences in the measurement of resilience and sustainability, and then describe the resilience measurement system adopted by COSA.

Resilience and sustainability measurement

The Sustainable Livelihood Framework (SLF) proposed by DFID (2000), and adopted by the main development practitioners, sees sustainability as a "range of assets" (i.e., capitals) that are essential for any people's desired livelihood outcomes. Sustainability is in this fashion a static concept, since "capital" is explained as a snapshot of assets over which stakeholders have control (e.g., human, social, financial, physical, and natural) that can be measured at any given point in time.

COSA, however, defines resilience as a mix of dynamic and static dimensions, specifically "the capacity of people, communities, or systems to prepare for and to react to stressors and shocks in ways that limit vulnerability and promote sustainability" (Serfilippi and Ramnath, 2017), which implies the passage of time and not a single fixed or arbitrary point.

The difference between the two dimensions, dynamic or static, is linked to the time span and intensity of people's reaction to shocks. Typically, models of resilience consider the capitals owned before a shock as the starting condition, or endowment, of a system's stakeholders. In several models, these starting conditions significantly affect vulnerability to future shocks and the magnitude of the consequences. But those capitals, seen in another light, constitute at the same time the absorptive capacity identified by Béné et al. (2012, 2015). The absorptive capacity is the dual ability to reduce both the risk of exposure to shocks and stressors and to absorb, short-term, the shocks' impact. It includes current measures of risk prevention

and risk mitigation, and all the endowments (i.e., capitals) required to face a shock.[1]

However, when those same absorptive strategies are introduced *after* the shock, they become outcomes of the adaptation process, and therefore components of the adaptive capacity: i.e., the ability to respond to longer-term social, economic, and environmental change. In practice, the adaptive capacity includes all the proactive choices about alternative livelihood strategies in light of changing conditions. It includes variables affecting the farmers' intrinsic ability to adapt[2], and all outcomes of the adaptation process, as shown by diversification of livelihoods and changes in agricultural practices.

Unfortunately, in some cases, the ability to adapt is not enough to overcome the shocks' negative effects; lasting resilience will come only from system-level changes in the sphere of governance, services and infrastructure. This is because weak governance, lack of physical infrastructures (e.g., roads, electricity, water), and basic services (e.g., education, health, and sanitation) limit the households' transformative response and their ability to "bounce back better" from shocks and transform. This third or transformative capacity includes indicators like formal safety nets (from banks, for instance, or NGOs); access to infrastructure and basic services; inclusion, accountability and transparency of the political process; and participation in community activities and deision-making structures.

Returning to the measurement line between resilience and sustainability, the difference between "capitals" and "capacities" is simply a measure of the timespan of a given people's reactions to a particular shock. In the next section, we will show how to translate these theoretical reflections into a resilience conceptual framework and measurement system.

COSA Resilience Conceptual Framework

Inspired by various sources, including UNDP (2013), TANGO (2006, 2012), FAO (2013), DFID (2011) and FSIN (2014), the COSA resilience conceptual framework relates farmers' resilience capacities and levels of well-being (as measured by income, food security and poverty) to disruptive events such as shocks due to flooding.

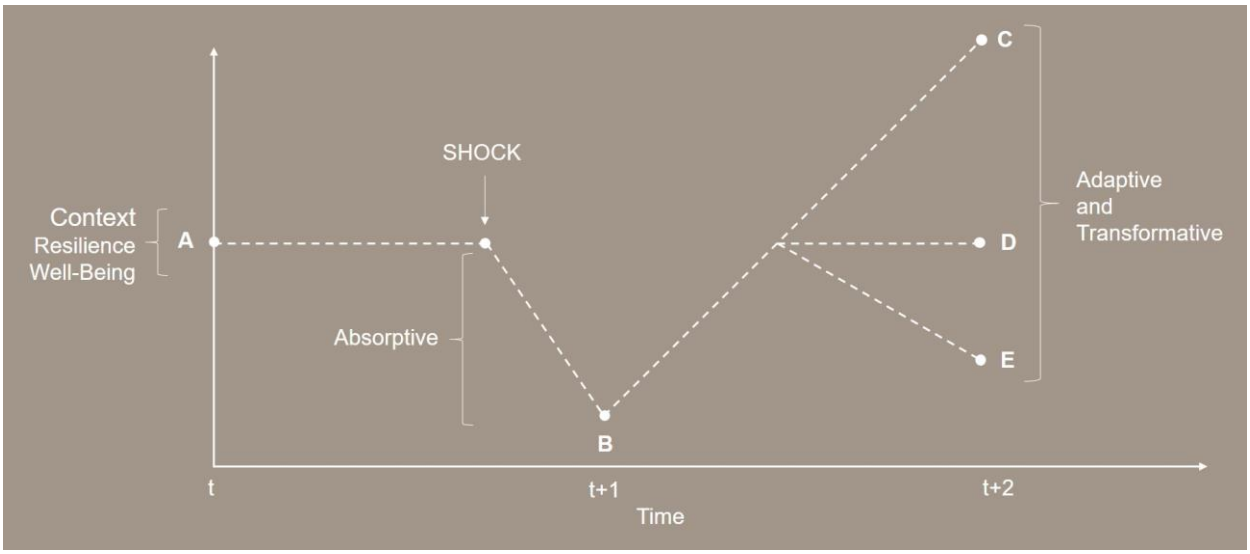
Figure 1[3] represents the farmer's original stable state at a determined level of well-being and resilience at time *t* (A). Assuming that this farmer experiences a shock at time *t+1*, he will reach different levels of well-being at time *t+2* depending on his resilience capacities. In particular, since the absorptive capacity represents the ability to reduce both risk of exposure to shocks and stressors (preparedness) and to absorb the impact of shocks in the short term (mitigation), it will influence the "length of the fall" from the original level of well-being (A) to a lower level of well-being brought about by the shock (B). The adaptive and transformative capacities will play a crucial role after the shock since they reflect the farmer's ability to adapt to the new situation and determine whether the farmer's well-being is better (C), the same (D) or worse (E) than before. In some cases, the adaptation process implies system-level changes resulting in transformation that bring the farmer into a completely new economic or social system. These three capacities can be aggregated in a unique resilience measurement system: a resilience index.

[1] Risk prevention measures are structures (e.g, flood prevention, erosion control, information and early warning systems) and practices (e.g., good agricultural practices, irrigation technologies, adoption of resistant seeds varieties, diversified portfolio of activities) used to prevent a specific risk. The category of risk mitigation includes all the other strategies to reduce the effects of a shock (i.e., coping strategies as external aid, migration, reducing expenses, new sources of income, etc.).

[2] The intrinsic ability to adapt collects variables that, In general, represent human capacities: e.g., a household head's years of education; decision making power; access to information and communication technology; training programs; participation in diverse and equitable social networks (such as self-help groups or savings groups); and food security, a proxy for overall wealth.

[3] The trajectories represented in Figure 1 are assumed to be liner for simplicity of representation.

Figure 1: COSA Resilience Conceptual Framework



Resilience Measurement

Any "resilience index" must capture the multidimensional nature of resilience (Barrett and Constas 2013, FSIN 2014, USAID 2013). COSA's method involves several composite indices based on indicators that reflect manifestations of resilience's multidimensional construct. In particular, the resilience index measures the rural household's resilience capacities, based on indicators that fall within the three capacities (absorptive, adaptive and transformative) identified by the literature (Béné et al. 2015). Here, the capacity approach accounts both for static resilience components and dynamic ones, allowing development workers to identify whether people require a range of assets for positive livelihood outcomes, or should expand or contract their capital in response to shocks, stresses or changes, relying on skills and linkages to adapt positively.

The resilience index computed through the aggregation of these indicators ranges from 0 (a total lack of resilience capacities) to 1 (maximum resilience), indicating the optimal level of resilience to shocks and stressors.

The estimation procedure is similar to the one followed by Alinovi et al. (2009, 2010) since we use a multi-stage strategy for estimating the resilience latent variable (*R*) adopting multivariate techniques. In particular, in the first stage, we estimate each latent intermediate variable (adaptive, absorptive and transformative capacities) through factor analysis, estimating each capacity as a function of different variables V_{it}:

$$Absorptive_{it} = f^1(V_{it}^1)$$
$$Adaptive_{it} = f^2(V_{it}^2)$$
$$Transformative_{it} = f^3(V_{it}^3)$$

In the second stage, we use the three capacities where the resilience index is a weighted sum of the factors generated using Bartlett's scoring method, and the weights are the proportions of variance explained by each factor. Used by Alinovi et al. (2009, 2010), this is the simplest method to weight each resilience capacity.

$$R_{it} = w_{abs}Absorptive_{it} + w_{adapt}Adaptive_{it} + w_{trans}Transformative_{it}$$

The overall procedure is the same as the one implemented by Alinovi et al. (2008, 2009, 2010) with one difference: instead of re-grouping the variables into five dimensions (namely, access to public services; social safety nets; income and food access; assets; stability; and adaptive capacity), we regroup them using the three resilience capacities. The capacity approach used for constructing the

resilience index has also been implemented by USAID (2013).

As long as there are a reliable number of sampled observations, the procedure used for the households' resilience index can be replicated at higher levels of investigation: e.g., cities, regions, districts, and nations. Since COSA's resilience index was built to investigate household resilience in a rural context, extending the analysis to cities and nations should include other variables that capture characteristics of urban resilience.

Other estimation techniques

COSA uses factor and polychoric factor analysis within a multi-stage estimation strategy to generate resilience capacities and, in turn, the resilience index. Following Alinovi et al. (2009), the main reason for adopting the two-stage factor analysis technique is linked to the fact that measuring the different components separately makes the model more flexible, allowing the inclusion of prior information and thus reducing the parameter identification problem.

In the resilience literature, however, there are other estimation techniques. The main one is proposed by FAO (2016) and it is based on a Multiple Indicators Multiple Causes approach (MIMIC), which is applied in the computation of the resilience index (RIMA II). This computation proposes an indirect measure of resilience that adopts regression analysis and, consequently, allows causal inference; in this approach, the resilience latent variable is jointly estimated by its causes and effects. FAO's technique overcomes two limitations: the endogeneity problems (i.e., the risk of causality between independent and dependent variables); and impracticality in the analysis of shocks since they can be simultaneously included in the estimation procedure. COSA's is actually working to adopt the MIMIC approach in the estimation of the resilience index.

Conclusion

This Issue Brief shows COSA's Resilience Measurement approach and how it builds on both concepts of capitals and capacities. If the capital approach finds its roots in the

sustainability literature, the capacities approach is new, and aims to capture not only the static dimensions associated with resilience, but also its intrinsic dynamism. The information brought by the three resilience capacities is conveyed into a functional resilience index that follows the most common measurement approaches in the literature.

In our third Issue Brief in this series, we will show applications of COSA's resilience measurement approach from various case studies.

For more information on COSA and its resilience measurement system, please send an email to: info@thecosa.org.

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