Toward a theory of resilience for international development applications

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We advance a theory of resilience as it applies to the challenges of international development. The conceptualization we advance for development resilience focuses on the stochastic dynamics of individual and collective human well-being, especially on the avoidance of and escape from chronic poverty over time in the face of myriad stressors and shocks. Development resilience clearly nests within it the related but distinct idea of humanitarian resilience and thereby offers a conceptual apparatus to integrate the humanitarian and development ambitions. We discuss the implications for programming, systems integration, and measurement.

sustainability | vulnerability | poverty traps | risk

As climate change, political instability, and economic volatility appear to many observers to have become more pronounced, the risks faced by many of the world's poor seem to have become more intense and less predictable. In search of a strategic response to such risks, international development and humanitarian organizations have manifested a sharp increase in interest in the concept of "resilience." Given that resilience is fast becoming a distinct policy objective, we need a clear theory of development resilience to guide measurement and programming and to inform evaluation. We offer a theory of resilience as it applies to the challenges of international development. The conceptualization we advance for "development resilience" focuses on the stochastic dynamics of individual and collective human well-being, in particular the capacity to avoid and escape from unacceptable standards of living—"poverty," for short—over time and in the face of myriad stressors and shocks. Our aim here is to lay the groundwork necessary to inform more precise use of the resilience concept, to articulate better theories of change, and to promote more focused measures of resilience for development applications.

The main value of development resilience is that it compels a coherent, multidisciplinary, and rigorous explanation of the interrelated dynamics of risk exposure, multiscalar human standards of living, and broader ecological processes. Resilience draws attention to the analytical benefit of combining ecological concepts—such as critical thresholds (1), regime shifts (2, 3), and cascade effects (4)—with the climate and environmental change literatures' explorations of coupled human and natural systems (5–9) and with established economics work on relationships between risk and poverty (10–16). Viewing poverty dynamics through the lens of resilience enhances the economics and social science literatures on poverty by more explicitly considering issues of risk, dynamics, and ecological feedback, which may reduce specification errors that undermine causal inference. It remains to be seen whether the resilience concept will actually strengthen causal inference related to poverty dynamics and improve associated prescriptions for development interventions. Attempts to assess the usefulness of the resilience concept require an empirically testable theory. This work represents a first step in that direction.

The Need to Adapt and Integrate Existing Applications

Resilience is not a novel concept. It has long been applied, for example, in ecology, engineering, psychology, and other fields. Holling described resilience as the "… persistence of relationships within a system and… the ability of these systems to absorb change of a state variable, driving variables, and parameters, and still persist" (1). Later, Holling distinguished between engineering resilience and ecological resilience, where the former emphasized efficiency, constancy, and predictability—something akin to what many ecologists refer to as "resistance"—and ecological resilience emphasized persistence and recovery in the face of change and unpredictability (17). [Some ecologists see resistance as part of resilience (18), although others consider the former as the ability to remain "essentially unchanged" in the wake of a disturbance (19).]

Just as Holling felt compelled to distinguish resilience as a concept useful in ecology from the preexisting engineering concept of resilience, so is it necessary to differentiate development resilience from other, prior uses of the term. Engineering resilience concerns inanimate objects that exercise no agency and have no aspirations for a standard of existence superior to their initial state. Ecological resilience relates to systems, within which the condition—even the very survival—of individual members is not intrinsically essential, as long as populations of species, and the relationships among them, are maintained. Development, however, concerns individual agents with basic rights as well as aspirations for improved living conditions, which necessitates differentiation from and adaptation of preexisting, systems-oriented uses of the resilience concept in fields like ecology. The fact that aggregates of individuals—households, communities, nations, etc.—are likewise of interest does not obviate the necessity of applying concepts and measures relevant at the microscale.

The preexisting concepts do offer natural entry points for a theory of development resilience. For example, as Holling and others explain, resilience is particularly important when a system approaches a threshold in which critical functions of that system may be subject to sudden, perhaps unpredictable, regime shifts (1–8, 17–19). Thresholds of this kind appear particularly prevalent in low-income countries where high poverty, food insecurity, stressed sociopolitical systems, and inadequate infrastructure may create conditions that expose people to a broad range of stresses and hazards, as the social science literature on poverty traps emphasizes (10–13). We therefore emphasize the integration of fundamental insights from the ecological literature on resilience into the economics literature on poverty traps.

Significance

This paper lays the theoretical groundwork necessary to inform more precise use of the term "resilience," to articulate better theories of change, and to promote more focused measures of resilience for international development applications. Our work complements a flurry of recent notes, white papers, and policy briefs on resilience, all offering measurement tools, policy and programming prescriptions, etc., but conspicuously without any explicit theory of resilience as might be applied to the lives of the poor.

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Toward a Theory of Development Resilience

As a first step toward a theory, we conceive of development resilience as follows:

> Development resilience is the capacity over time of a person, household or other aggregate unit to avoid poverty in the face of various stressors and in the wake of myriad shocks. If and only if that capacity is and remains high over time, then the unit is resilient.

This conceptualization focuses tightly on human well-being, most simplistically broken into two categories: poor and nonpoor. It recognizes the necessity of a concept that applies to individuals but that is also aggregable into higher-level units of social organization. It recognizes the central role of background risk (stressors) of all sorts and that sometimes risk is realized in the form of adverse events (shocks) that can catastrophically change lives. It emphasizes the time path of standards of living, which may be nonlinear and uncertain. Unlike the term's use in engineering or ecology, where resilience refers to properties of objects or systems and is neither good nor bad, it is merely descriptive; development resilience has clear normative foundations: More is better. Conceptualized in this way, development resilience concerns the stochastic dynamics of human well-being and is a worthy goal for development agencies because it varies inversely with the likelihood of being and remaining poor.

Development resilience is thus closely related to the idea of stochastic poverty traps (10–13). Both ecologists working on resilience and economists studying poverty traps use similar frameworks that draw on the mathematics of dynamical systems (20). In both cases, the evolution of one or more key state variables—e.g., some poverty indicator(s)—follows some stochastic and potentially highly nonlinear law of motion that results in multiple attractors—stable states within distinct regimes—and tipping points that lead to discernible shifts in behavior and performance. A crucial difference is that multiple stable states are not necessary for the existence of poverty traps (13) or to the concept of development resilience, as we explain below.

The state variable of interest in development resilience is a person's—or some aggregate (household, village, nation, etc.) of many people's—well-being, W, perhaps best (abstractly) represented by Amartya Sen's concept of "capabilities" (21–23). Chronic poverty reflects the sustained deprivation of capabilities. The capabilities framework nests within it special cases based on indicators such as income, expenditures, assets, health, nutritional status, or subjective life satisfaction or security and, if desired, can be represented with multidimensional measures (24, 25).

Well-being is intrinsically—and some would argue increasingly—stochastic, affected by a range of exogenous events that we summarize in a disturbance term, ε_t, so that the evolution of well-being over time, from W_t in period t to W_{t+s} in period $t + s$, is subject to random shocks. A compact and quite general way of representing stochastic well-being dynamics is through the moment function for conditional well-being, $m^k(W_{t+s} \mid W_t, \varepsilon_t)$, where m^k represents the k^{th} moment—for example, the mean ($k = 1$), variance ($k = 2$), or skewness ($k = 3$). These moments describe the conditional dynamics of the full distribution of possible well-being outcomes that may be functionally related to resilience capacity.

Fig. 1 offers a heuristic, reduced form representation of one possible conditional expectation function (CEF) of W_{t+s}, $m^1(W_{t+s} \mid W_t, \varepsilon_t)$, where today's well-being appears on the horizontal axis and tomorrow's expected capabilities on the vertical axis. Any of a host of candidate structural mechanisms could give rise to these expected path dynamics (13, 26). The CEF arises from individual and collective choices subject to constraints imposed by human institutions (e.g., laws and norms), resource availability (e.g., money, time), and nature. Choices made by agents successfully maximizing their well-being may be optimal, in the usual economic sense that no greater expected well-being is feasible given the available choices, and nonetheless lead, sooner or later, to an undesirable outcome because no nonpoor outcomes are both feasible and sustainable. People become or remain poor due to binding constraints that make nonpoor outcomes infeasible. The myriad combinations of constraints and incentives that drive these behaviors lead to heterogeneity among well-being CEFs of the sort stylized in Fig. 1.

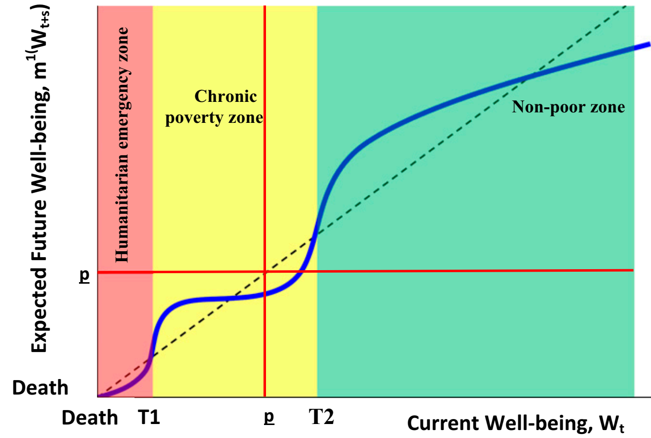

Fig. 1. Nonlinear expected well-being dynamics with multiple stable states.

The dashed diagonal line represents points where standards of living are not expected to change over time (i.e., dynamic equilibria or stable states, a random walk process, $\mathrm{E}[W_{t+s}] = W_t$). The poverty line, $\underline{p}$, appears on both axes [the placement of $\underline{p}$ relative to the dynamic equilibrium within the chronic poverty zone (CPZ) is arbitrary]. Three stable states exist: One is death at the minimum value of the range of feasible well-being; the second is a poor standard of living; and the third is a nonpoor standard of living. There exist some thresholds, T1 and T2, that separate the basins of attraction—defined with reference to initial period standards of living expected to lead toward a dynamic equilibrium in the relevant range due to agents' expected behaviors—for these three distinct regimes: (*i*) a humanitarian emergency zone (HEZ; shaded in red), within which populations are collapsing toward death; (*ii*) a CPZ (shaded in yellow), within which people recover from shocks—either adverse or favorable—to a stable but poor standard of living manifesting capabilities; and (*iii*) a nonpoor zone (NPZ; shaded in green) within which people are likewise expected to recover from noncatastrophic shocks. We can normatively order these regimes: People prefer NPZ over the other two, and CPZ over HEZ. Anyone in either CPZ or HEZ is chronically poor in expectation, as implied by $m^1(W_\infty | W_t \in \{CPZ, HEZ\}, \varepsilon_t) < \underline{p}$. (Note that this statement does not imply they cannot escape poverty—merely that it can only happen through either unusually good luck or direct intervention of the sorts we discuss below.) The poverty line merely offers a normative reference point; it could fall within any of the three basins of attraction, depending on the shape of the well-being CEF.

The exact shape of the CEF need not follow that shown in Fig. 1, of course. The existence of multiple dynamic equilibria is obvious; death is an absorbing state that constitutes the lowest equilibrium, and at least one living equilibrium must exist. Some threshold, T1, must separate a (or multiple) regime(s) with a living stable state from a (perhaps very small) region within which extremely low levels of well-being (e.g., severe acute malnutrition or illness) naturally lead in expectation to death in the absence of intervention so that the path dynamics depicted in Fig. 1 are convex over at least some (perhaps very small) domain. Whether there exists a second threshold, T2, or not is an unresolved empirical question subject to much current research (13). Beyond T1, $m^1(W_{t+s} \mid W_t, \varepsilon_t)$ could be a concave, monotonically increasing function with a single, stable dynamic equilibrium. (If that equilibrium falls below $\underline{p}$, a single equilibrium poverty trap exists.) None of the theory we advance turns on the existence of multiple equilibria beyond T1, although one or more T2 do make the analysis more interesting and accentuate the prospective integration of ecological concepts of resilience into development theory.

The simplistic representation in Fig. 1 of the complex behavioral and structural foundations of observed well-being dynamics is the most general reduced form way that we can encompass both shorter-term, life-saving humanitarian goals and longer-term, economic growth and poverty reduction ("development") objectives in a single coherent framework. That is important because reconciliation of humanitarian and development objectives is a central motive behind much current interest in resilience, and many agencies pursue both goals simultaneously. The humanitarian imperative is to intervene quickly and effectively to move people out of the HEZ so as to save lives. The development ambition is that people move to the NPZ and stay there. For the current nonpoor, that implies that resilience against shocks essentially follows the ecological sense of the term: no shift to either of the lower, less desirable zones. Note that people can be nonpoor and yet not resilient in this formulation, as would be true for anyone in the CPZ but above $\underline{p}$ in Fig. 1. However, for the current poor—those presently in CPZ or HEZ—the objective is not maintenance of the present stable state but rather disruption of the relationships that give rise to observed well-being dynamics, to the present state of the individual or group, or both, so as to move people into the NPZ regime, as we describe in *Toward Development Programming to Build Resilience*. [This objective relates loosely to the "transformability" property of ecological resilience thinking (18).] The persistence of relationships within a system that is central to ecological resilience is undesirable in development when those relationships embed the constraints that impose persistently poor standards of living on some persons.

Reconciliation of the poverty-reduction goal that is central to development policy with resilience thus implies a certain asymmetry. We want to guard against downward/leftward slides from one zone to the next but enable upward/rightward adjustments. Ecology-style resilience against shocks—defined as persistence within a single, more desirable basin of attraction (i.e., either of the two preferred zones of Fig. 1)—is crucial to humanitarian response to move people back into their original, non-HEZ zone. However, persistence may be an impediment to longer-term development in which what is needed is permanent disruption of individuals' initial conditions or of the parameters of systems that trap people in chronic poverty.

This asymmetry invites the possibility of two hierarchically orderable forms of resilience. The minimalist form would be humanitarian resilience, defined simply as averting predictable declines toward premature mortality (i.e., steering clear of HEZ in Fig. 1). Adapting our earlier definition of development resilience, humanitarian resilience might be analogously conceptualized as the capacity over time of a person, household, or other aggregate unit to survive in the face of various stressors and in the wake of myriad shocks. If and only if that capacity is and remains high, then the unit is humanitarian resilient. By this standard, an individual who safely remains chronically poor would be humanitarian resilient, in only this lowest-order sense. Development resilience clearly nests within it humanitarian resilience and is, we submit, the more appropriate conceptualization of resilience that truly bridges the humanitarian and development ambitions.

This framing underscores that stability is not equivalent to resilience, although much current discourse suggests such equivalence. [The canonical ecology literature built on Holling expressly differentiates resilience from stability, with the latter related to maintenance of equilibrium (1). Holling and others emphasize the ubiquity of disequilibrium and the inevitability of change so that the objective of resilience is adaptability to change so as to maintain the core relationships among system components, often summarized as maintaining "identity" (18, 27, 28).] Indeed, the possibility of a stable but miserable existence within the CPZ illustrates that stability is not sufficient. The desirability of disruption that necessarily entails instability to shift states demonstrates that stability is not necessary; indeed, in some cases, it may be undesirable.

Of course, Fig. 1 merely represents expected transitions between current and expected future well-being, thereby abstracting from the risk issues that fundamentally motivate interest in development resilience. The more general moment functions approach readily accommodates multivariate stochasticity and the possibility of nonconstant higher-order moments of well-being transitions conditional on current well-being. In Fig. 2, we alter slightly the framework of Fig. 1, plotting realized (rather than expected) future well-being on the vertical axis and supplementing the nonlinear CEF of Fig. 1 with the conditional transition distribution functions associated with $m^k(W_{t+s} \mid W_t, \varepsilon_t)$. These distributions reflect the stochastic transitions from one period to the next due to asset and income risk, prospective illness, productivity shocks, etc., as well as transitions due to human agency, and expressly accommodate possible autoregressive conditional heteroskedasticity or skewness (i.e., persistence in volatility or the likelihood of extreme outcomes) and other nonlinear features of higher-order moments of the well-being function.

Realizations beneath the lower (red) dashed horizontal line—reflecting T1, the unstable dynamic equilibrium value that demarcates the bifurcation in expected path dynamics between the CPZs and HEZs—are expected to drop a person onto a dangerous slide toward death, represented here by the intersection of the axes. Conversely, a positive draw above the upper (green) dashed horizontal line—reflecting T2, the unstable dynamic equilibrium that separates the NPZs and CPZs transitory shocks—either positive, such as due to an asset transfer or windfall gains, or negative, perhaps due to disease or a disaster—can have persistent effects. Even a seemingly short-lived shock that does not change the basic parameters of the underlying well-being dynamics—e.g., from an iid ε_t process—can persistently alter outcomes under the very general assumption that $m^1(W_{t+s} \mid W_t, \varepsilon_t)$ is not a constant. The threshold-sensitive probabilities of falling into worsened states of well-being are typically nonzero for most people, poor or nonpoor, and may change over time.

Development resilience is thus closely related to the similarly appealing-but-elusive social science concept of "vulnerability" (6, 9, 14–16). [A variety of different concepts of vulnerability exist across the social sciences, focusing to varying degrees on welfare outcomes, risk exposure, and behavioral responses (16).] However, a few key distinctions exist, paralleling the distinctions within ecology between resistance and resilience. Vulnerability, as the term is typically used in this context, refers to the prospective immediate impact of (i.e., sensitivity to) a shock, reflecting the likelihood that some disturbance leads to a change of state to an undesirable position, given one's capacity to mitigate or cope with the shock. Development resilience concerns the longer time path of well-being in the face of both stressors and shocks and,

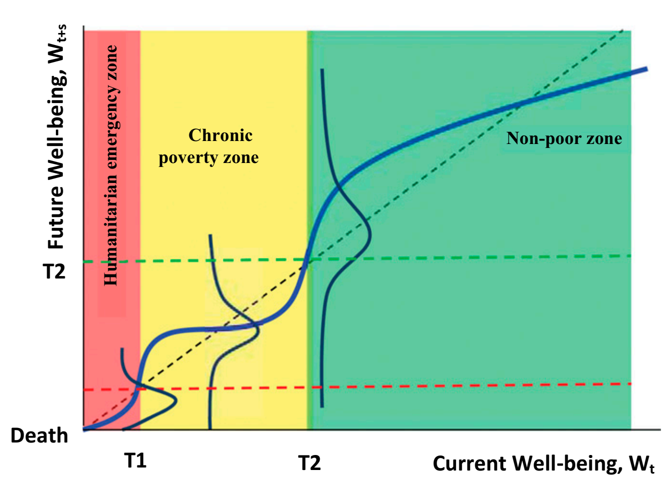

Fig. 2. Nonlinear expected well-being dynamics with conditional transition distributions.

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especially, the likelihood that any adverse outcomes of either risk avoidance or a realized shock not persist for an extended period. For example, a nonpoor household may be vulnerable to becoming poor due to job loss yet be quite resilient if the prospects for finding follow-on employment offering similar compensation are high and/or formal or informal safety-net programs reliably provide adequate support reasonably promptly. In statistical terms, a nonpoor household with high conditional variance of income might be both vulnerable (to becoming poor) and resilient (because the poverty is sufficiently low in duration, intensity, and/or likelihood).

Toward Development Programming to Build Resilience

Several programming implications emerge from this framing of the dynamics of well-being. If one's objective is to minimize the likelihood of people falling into either of the less desirable zones—i.e., avoid chronic poverty, much less premature death—then three general options for disruptive intervention exist.

i) Shift people's current state—i.e., increase W_t—through, for example, cash transfers, education, health care, or other means that increase the recipient's capabilities. This option will typically be the most desired form of intervention in systems where the HEZ and CPZ domains are small, so that modest transfers can achieve dramatic results, or in systems where $m^k(W_{t+s} \mid W_t, \varepsilon_t)$ is such that the probability of $W_{t+s} <$ T2 is low for those in the NPZ, so that it is less the structure of the system than the initial conditions of the currently poor that gives rise to persistent poverty.

ii) Alter the conditional transition distributions by reducing risk exposure—i.e., truncate ε_t from below—through, for example, improved police protection or via the introduction of drought- or disease-resistant seeds or animal breeds; or by transferring risk, such as with an employment guarantee scheme or insurance program that limits losses. In the case of risk transfer, this method can be thought of as (adverse) state-conditional transfers per option 1. However, the big difference from option 1 is that changing uninsured risk exposure endogenously changes behaviors—and thus the conditional expected dynamics as well—if people's subjective perceptions of the uninsured risks they face influence the behaviors summarized in well-being dynamics (12, 13, 29–31).

iii) Change the underlying system structure—for example, through changes in cultural, economic, or sociopolitical institutions or the introduction of new technologies or markets—to induce behavioral change and thereby change the $m^k(W_{t+s} \mid W_t, \varepsilon_t)$ functions. This option underscores the "black box" nature of the reduced form univariate relationships depicted in Figs. 1 and 2. These relationships reflect only how well-being evolves over time stochastically within the system as it presently exists. It would be desirable to embed this relationship in a system that helps explain the causal structure(s) of the observed dynamics and that more explicitly recognizes human agency. Of course, the system and its agents are typically multiscalar, with bidirectional feedback across distinct scales of aggregation across space, time, and other forms of identity, all of which considerably complicates transparent and tractable modeling as well as causal identification (32)—hence, the appeal of the reduced form representation we use.

When key parameters or variables within the broader system change—for example, rainfall patterns, the security of the poor's access to land or employment, disease exposure, the price of fertilizer, etc.—so can the partitioning of the system's phase space and thus its underlying dynamics. The phase space diagram of Fig. 2 can shift discontinuously, for example, from that depicted, with three basins of attraction, to one with just two stable states: death and a nonpoor capabilities set. Such shifts can result from human agency (e.g., a permanent change in legal institutions, the discovery and diffusion of a new technology readily accessible to the poor) or from natural processes (e.g., climate change) that change people's behaviors by altering the constraints and incentives they face (20).

Among the least well understood features of system structure are the nonmaterial relations of solidarity, social exclusion, power, and other sociocultural phenomena that cause or overcome the exclusionary mechanisms that underpin poverty traps (26, 33, 34). Social networks can provide either a bridge that surmounts market failures (e.g., for credit or land) that might otherwise ensnare a household in chronic poverty, or they can become instruments that reinforce suboptimal behaviors and obstruct needy individuals' access to scarce capital, improved technologies, state support to which they have a right, etc. (34, 35).

Consider, for example, the contrasting cases of two initially nonpoor women in poor rural communities whose husbands each died suddenly—one from cholera and the other from a traffic accident. The loss of an able-bodied adult worker would certainly have set the widow and her children back anywhere. However, the contrast in their stories reveals much about how the stochastic path dynamics of capabilities are shaped by more than just the biophysical laws of nature and the economic productivity cost of a loss of some portion of "comprehensive wealth." [We use the term following Arrow et al. (36) to encompass all the productive assets required for sustainable development, human capital included.] In one woman's case, her extended family stepped in and sent a teenage male cousin to live with her and help out with farmwork, while congregants from her church and neighbors made extraordinarily generous donations to cover the costs of a funeral and the fatherless children's school fees. She was traumatized but able to adapt to her new circumstances, supported by a social network that helped her and her children remain nonpoor. In terms of Fig. 2, social institutions truncate the downside tail of her conditional transition distribution functions so that a shock does not thrust her beneath either threshold, T1 or T2.

The other woman was not so lucky. By custom, she had to slaughter the family's only cow to feed mourners at her husband's funeral. Her brothers-in-law took possession of the farmland and home and, when she protested, turned her and her children out. Moreover, because one of her brothers-in-law was quite prominent in their village, her neighbors were reluctant to host her and the children. Alone and suddenly destitute, the widow withdrew the children from school, moved to a slum in the nearest big city, and turned to begging and informal street trade to try to make ends meet. The customs and power relations prevailing in the system of which she was a part greatly magnified the injury of her husband's untimely death, casting her deep into a poverty trap she had not anticipated confronting. In terms of Fig. 2, cultural norms and sociopolitical power conspired to add mass to and elongate the downside tail of her conditional transition distribution functions, magnifying the adverse effect of the natural adverse shock.

Such anecdotes highlight a few points that merit mention. First, the institutional structures of solidarity, power, and exclusion can be as central to understanding system dynamics as are the biology of disease and agriculture or the economics of exchange and finance. Second, not all risks are exogenous to the system. Some of the risks most salient to the prospect of collapsing into chronic poverty are intrinsic to the structure of a community, especially to the institutions that confer differential power among people and enable some to benefit from others' misfortune. Third, and relatedly, we must guard against overromanticized notions of social solidarity networks, community, etc. Although interpersonal relationships and community-level institutions can certainly help reduce or transfer risk, it is equally true that they can be a source of catastrophic shocks (33, 34). It is especially important to look carefully at the social relations that underpin production and exchange in any economy before diagnostic, evaluative or prescriptive analysis.

Toward Systems Integration

Ecologists concerned about resilience have long emphasized the interrelationship between socioeconomic and ecological variables

(5–7, 18, 27, 37–39). Most of the world's extreme poor live in rural areas and practice livelihoods that depend overwhelmingly on biophysical systems associated with agriculture, fishing, forestry, and hunting. A natural next step in theorizing about development resilience is to link the stochastic dynamics of human well-being to those of the underlying natural resource base.

This extension is most simply made by recognizing that resource state—here simplified as a scalar, R_t—conditions well-being dynamics, reflected in a generalization of the moment functions to $m^k(W_{t+s} \mid W_t, R_t, \varepsilon_t)$. Parallel dynamics exist for the biophysical resource, as reflected in an analogous moment function for the resource base, $rm^k(R_{t+s} \mid R_t, W_t, \varepsilon_t)$. This compact framework introduces the potential for reciprocal causality between human and nonhuman stochastic well-being dynamics and thus for complex socioecological systems with multiscalar feedback (27, 32, 37–39). For example, when poor farmers find it optimal to deplete soil nutrients without investing in replenishing them through inorganic or organic fertilizer application, the resulting decline of the soil state reinforces farmer behaviors, thereby exacerbating inequality by differentiating poorer farmers who eschew modern inputs from their better-off neighbors who find it feasible and profitable to invest in maintaining their soils (40).

Fig. 3 offers a simple, stylized representation of why such reciprocal causality between well-being dynamics and the dynamics of the underlying natural resource base is both important and complex. The upper right quadrant merely reproduces the nonlinear expected well-being dynamics depicted in Fig. 1, mapping the right horizontal axis, current well-being, onto the upper vertical axis, expected future well-being. The lower left quadrant adds nonlinear expected dynamics of the supporting natural resource state, $rm^1(R_{t+s} \mid R_t, W_t, \varepsilon_t)$, mapping the lower vertical axis, current resource state, onto the left horizontal axis, expected future resource state. Measures increase with distance from the origin in each dimension. The resource CEF need not mirror the capabilities dynamics. As drawn, those resource dynamics suggest two stable states, following the dominant model in the ecological resilience literature (1). The gray hashed area is the basin of attraction of the degraded stable state.

The lower right quadrant depicts two candidate relationships showing the reciprocal causality between current human well-being and the current state of the natural resource base. The inverted-U dashed brown curve represents the much-discussed environmental Kuznets curve (EKC), whereby improving human well-being (rightward movements along the horizontal axis) initially degrades the natural resource stock as people exploit the environment, and then beyond some tipping point, further improvements begin to restore and improve the supporting natural environment (41, 42). This curve reflects a hypothesized causal effect of human well-being on the natural resource base. (In the EKC literature, this result is typically the effect of per capita income on the stock of pollutants in the environment. Here we generalize—not as an assertion of the veracity of the EKC hypothesis, much less its broader applicability to all human–environment interactions—but merely to illustrate one such candidate relationship.) Alternatively, the backward-S–shaped blue dotted line reflects that improvements in soil quality—downward movements along the lower vertical axis—are associated with improvements in small farmer well-being—rightward movements along the horizontal axis—initially quite slowly, then accelerating, before plateauing (43). Depending on which human-resource relationship dominates in a given place and time, the dynamics of the underlying coupled human–natural system can differ markedly. The uncertainty of the net relationship between current well-being and resource state only multiplies when trying to map the relationship among future well-being and future resource states, as reflected in the upper left quadrant by a humbling question mark.

The dynamics depicted in Figs. 1–3, much less the broader systems dynamics that give rise to those patterns, are terribly difficult to estimate in observational data (13) and commonly do not lend themselves to experimental identification (44, 45).

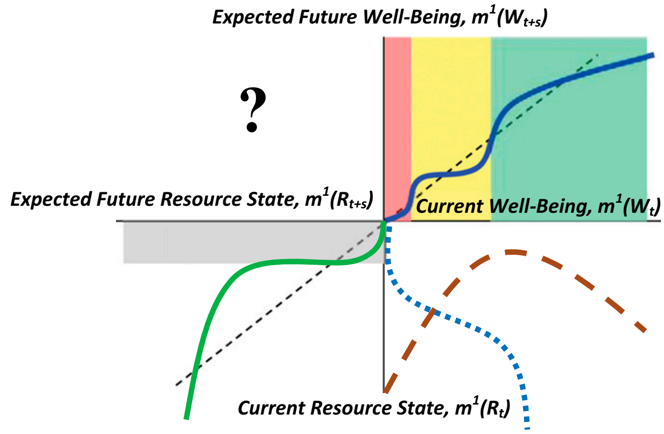

Fig. 3. Coupled human and natural systems dynamics.

Inadequate empirical understanding of coupled dynamical systems is predictably manifest in projects and policies that have short-lived effects but do not fundamentally change the underlying structure of the socioecological systems that too often trap people in chronic poverty. We need an enhanced understanding of the deep interlinkages among ecological and socioeconomic processes to better grasp systems' key parameters and behaviors, which result from the confluence of natural processes and individual and collective human agency. Our collective ignorance about that complexity should serve as a caution against hubris in programming and foster humility about the likelihood of fully and accurately grasping system structure so as to enable productive intervention without adverse unintended consequences.

Toward Measurement and Evaluation

The prior absence of a coherent theory of development resilience has impeded measurement. Although the complexity of nonmaterial variables and of nonlinear feedback with supporting biophysical systems poses serious challenges for operationalizing a theory of development resilience, our conceptualization points in a few key directions for measurement.

One obvious implication of this framing of development resilience is the desirability of working toward reliable quantitative and qualitative estimates of the conditional moment functions for well-being, $m^k(\cdot)$, and the supporting natural resource base, $rm^k(\cdot)$, however measured. Such estimates require a solid understanding of the underlying relationships to avoid specious, and likely misspecified, precision. Once estimated, those conditional moments can then be used to estimate the probability of poverty in each of a sequence of time periods. (One might account for the potentially autoregressive moving average properties of the conditional moments to project the current estimated moments into the future and thereby estimate the path dynamics of the likelihood of being poor. This approach necessarily assumes past relationships continue into the future.) Then, based on a normative assessment of an appropriate tolerance level for the likelihood of being poor over time, one can classify individuals, households, communities, etc. as resilient or not. Such an approach would represent an intertemporal and probabilistic extension of the workhorse Foster–Greer–Thorbecke (12, 46) poverty measure to take into account the predictable path dynamics of well-being. Qualitative measurement could proceed in a conceptually similar fashion, trading off the (perhaps specious) precision of quantitative measures for the enhanced breadth from accommodating difficult-to-quantify factors crucial to well-being dynamics, such as power and community solidarity. In our view, qualitative work to more clearly specify the underlying relationships is essential to inform the quantitative work commonly required by donors for impact evaluation purposes.

With theory-based measures in hand, rigorous evaluation of interventions aimed at building resilience should be reasonably straightforward. One seeks to measure induced changes in the conditional well-being and/or resource moments—that thereby reduce the probability, intensity, and/or duration of poverty spells—that can be causally attributed to the intervention of interest. In the absence of a foundational theory of the phenomenon under study, measurement, inference, and evaluation commonly result in inferential errors. The measurement and evaluation challenge remains formidable, even with a coherent theory in place, but there is at least a clearer path to follow.

Conclusion

As an overarching concept, resilience can bring coherence and a propoor focus to the set of analytical concepts and policy or programmatic initiatives that deal with risk and vulnerability in international development and humanitarian response. A theory of development resilience, differentiated from longstanding literature on resilience in other fields, offers a first step toward producing an empirically credible and logically consistent story that connects causes to effects so that we can reliably measure and evaluate the effectiveness of development and humanitarian interventions in sustainably improving the human condition.

The theory of development resilience we outline builds on existing literature that remains insufficiently integrated, drawing out and building upon the close connections between economic theories of poverty traps and ecological work on resilience. This theory not only provides broad guidance as to what interventions might be considered in an effort to enhance resilience to avoid and escape chronic poverty, it also leads directly to a number of ways to begin thinking about broader systems integration, as well as the measurement of development resilience and the evaluation of development-resilience–oriented interventions, themselves important topics for follow-on research.

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