8. Climate information, equity and vulnerability reduction

Pablo Suarez, Jesse C. Ribot and Anthony G. Patt

INTRODUCTION

The last few decades have brought about a heightened awareness of the effects of climate change. We now know that climate change can increase the risk of natural disasters. Recent advances in science and technology now provide us with more reliable forecasting tools (Wang et al. 2004). Because these new tools hold great promise for reducing vulnerability, massive financial, technological and human resources are being invested in their development. Possible predictions from these tools range from short-term tropical cyclone tracks to shifts in rainfall patterns due to climate change. Humanity faces two new challenges: not just preparing for the foreseeable climate, but also modifying decision-making processes to incorporate information now available for vulnerability reduction (Brunner 1999).

Researchers and practitioners often disagree on how to define vulnerability (Ionescu et al. 2004) and how climate information can affect it. Vulnerability is broadly defined as the ability to be harmed. There are numerous concepts on vulnerability – depending on *what* people or systems are vulnerable *to* (Patt et al. 2005a). There are two major approaches to addressing this issue: vulnerability to hazard (for example, droughts) and vulnerability to outcomes (for example, famines). This distinction has profound implications regarding the appropriate policy, and resulting strategy, to reduce vulnerability.

Climate information can be used to reduce the negative effects of expected changes (Dilley 2000). However, mere availability is not a sufficient condition to ensure reduction in the vulnerability of all sectors of the population and the economy – particularly in cases where ignorance of future conditions is not the main factor impeding the fulfillment of basic needs. Adequate consideration of the most vulnerable sectors of the population is necessary. Without it, the widespread generation of climatic

forecasts may result in a socially differentiated distribution of benefits. This distribution would increase the gap between those who are relatively safe and those who are most vulnerable and, therefore, need to be given the highest priority for their care (Sperling 2003).

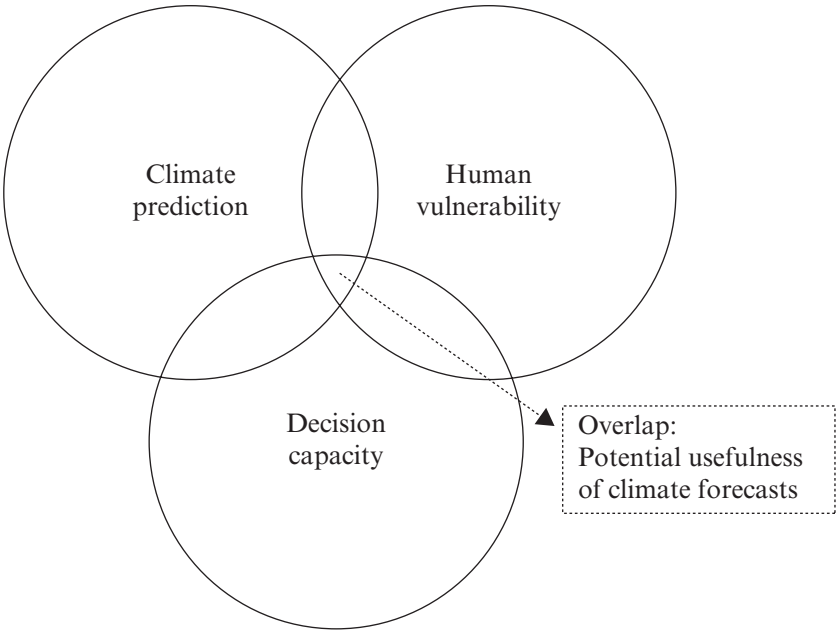
In this chapter we explore the relationship between climate information and vulnerability in the context of competing worldviews. This analysis identifies the most pressing factors limiting the ability to put available information into use. In addition, it suggests innovative ways in which new predictions can help address the causal chain of disasters and related equity issues.

VULNERABILITY AND THE ROLE OF CLIMATE FORECASTS: THREE APPROACHES

Hansen (2002) presents a simple illustration depicting the determinants of the potential for human populations to benefit from climate predictions (Figure 8.1).

In this work, 'human vulnerability' refers to the elements of the human system that are susceptible to harm as a result of climate phenomena. 'Climate prediction' refers to climate phenomena that are predictable (that is, their causal processes are understood to the extent that available information at time t allows us to anticipate their occurrence in place s at time $(t + \tau)$). 'Decision capacity' refers to decisions the human system is capable of actually making to improve its future state (that is, the deliberate interventions that can be chosen by the system and are compatible with the goals, resources and constraints of decision-makers). Forecasts can be useful where these three determinants coexist in space and time – in other words, where the circles in Figure 8.1 overlap.

Building on Hansen's diagram, this section identifies categories with which to approach dealing with the threats of the climate phenomena depending on which of the three realms is the focus of the proposed action. We label these three approaches as 'perfect information', 'vulnerability to hazard', and 'vulnerability to outcome'. The perfect information approach emphasizes the decision-maker's need to improve knowledge of future conditions, and assumes that once that information is available the system will optimally adapt. The vulnerability to hazards approach recognizes existing limitations in response capacity, focuses on the multiple effects of a single cause (the predictable hazard), and allows for a conceptual means of prioritizing ways to address that causal vector. Finally, the vulnerability to outcome perspective identifies the multiple causes of each undesired outcome. This allows those interested in reducing vulnerability to that



Note: This figure should not be interpreted strictly as a Venn diagram: the three sets exist in different realms (that is, they have different kinds of elements) and therefore from the perspective of set theory they do not intersect.

Figure 8.1 Hansen's (2002) diagram relating predictions, decisions and vulnerability

outcome to target their investments in order to reduce the most salient set of socio-political causes.

Perfect Information and the Expansion of Climate Prediction

One approach for addressing the risks posed by climate change focuses on expanding climate prediction capabilities. For example, it looks to increasing investments in the monitoring and modeling of atmospheric and oceanic processes, and impact assessments, in order to improve our understanding of the potential consequences of changes in future climate conditions. In Figure 8.1, this implies expanding climate prediction and, thereby, increasing the area of overlap. Once a new prediction is made, the assumption is that this information will flow towards the relevant actors, who should properly weigh risks and uncertainties, and make rational decisions so that the system adapts to expected conditions. This approach

resonates strongly with the quest for information, predictability and rationality embraced both by the scientific community and by proponents of perfect-market economic models (Jaeger et al. 2001).

The expansion of knowledge about future conditions is an essential element of the perfect-market economic paradigm. This paradigm is based on Adam Smith's postulation that the common good is reached most efficiently when each person seeks to maximize utility in a perfectly competitive market. The ability to foresee the near future has been a central topic in the history of economic theory (Coddington 1982). In the 1930s, Hayek (1935) maintained that the assumptions implied in the concept of market equilibrium 'are essentially that everybody foresees the future correctly' (pp. 139–40).

In theory, the Pareto-efficiency of market economies is obtained under a peculiar set of assumed circumstances defined initially by the Arrow–Debreu model of general equilibrium (Debreu, 1959). A fundamental assumption is that of perfect information. The concept of perfect foresight captures the assumption that individuals with perfect access to information can modify their behavior in order to adapt to expected market conditions and maximize utility. Information is a key tool for production in a market economy, both in terms of connecting demand with supply, and in terms of increasing the productivity of labor, land and capital. Market forces require information. In Hayek's (1945) 'The use of knowledge in society', he refers to equilibrium prices in a decentralized market system as aggregators and conveyors of disperse information.

From the perspective of the perfect information model, markets are analogous to the luminiferous ether of physics: a medium which can be effective for transmitting all the types of physical action known to us. Just as 'substanceless' light waves were assumed to travel through the perfect substance of luminiferous ether, so the conceptualization of traditional economics sees the perfect market as the medium through which information is optimally transmitted to enable macroeconomic change (Hayward and Broady 1994).

Like other forms of information, weather and climate forecasts have economic impact insofar as they affect the decisions of individuals engaged in economic activities (Stewart 1997). The emphasis in improving climatic forecasts is a positive step forward as it allows land, labor and capital to adjust optimally to expected conditions. Whatever vulnerability is left in the system, it would be 'the right amount of vulnerability' as dictated by market forces. The assumption that the mere availability of information about the future will lead to the adoption of necessary action is still at the core of many initiatives involving the production of climate forecasts (Stern and Easterling 1999).

More than two decades ago, Lamb (1981) stated that achieving the ultimate goal of climate prediction (that is, the reduction of the negative consequences of climate variability) has two prerequisites. First, the activities and regions most affected by climate variability require identification. Second, the affected regional economies must have the flexibility to adjust to, and capitalize on, the availability of skillful forecasts. He argued that it is only after these two prerequisites are met that we can develop truly useful climate prediction systems. These requirements imply that the most vulnerable regions, sectors and individuals (for example, those unable to adjust and capitalize on the availability of forecasts) will be marginalized from the benefits of climatic information. Accordingly, this chapter chiefly argues that if the development of climate forecasts remains embedded in (and directed by) the perfect-market paradigm, those with the most pronounced need are unlikely to reap the benefits of improved climate predictability.

Imperfect Information Flow and the 'Vulnerability to Hazard' Model

Stiglitz (1986) points out that the assumption of perfect information, if questionable in more developed economies, is clearly irrelevant in less developed countries. Stiglitz's 'imperfect information model' views people as rational individuals operating in environments where information is imperfect, scarce and costly.

Johnson and Holt (1997) note that the existing system for sensing, recording and reporting weather conditions and producing forecasts has been developed primarily in response to the demands of specific market needs, such as airline navigation and agribusiness. The result is that the system for producing, storing and disseminating weather and climate information has strong linkages to the demands of major clients. There are growing discussions about the possibility of treating some meteorological services as private goods (Freebairn and Zillman 2002). Johnson and Holt suggest that discussions will continue to focus on the appropriate division between private and public responsibility.

Buckland (1991) distinguishes between the following three meanings: (1) 'information-as-process'; (2) 'information-as-knowledge'; and (3) 'information-as-thing'. While it is natural to view items that embody information as commodities, information itself is increasingly commodified (Baron 2001; Malone and Elichirigoity 2003). There is a tension between perspectives of information as a commodity with compelling 'public good' characteristics, and information as inherently a value-added product (Koenig 1995). This tension grows with increasing tensions in information technology. Several commentators have highlighted the

social implications of a differentiated production of, and access to, the commodity of information (Baron 2001; Doctor 1991; Lievrouw and Farb 2003). For example, like any other commodity, the value of information is often greater from the perspective of an individual who owns it when it is not widely disseminated. For example, if only a small group of individuals know that a drought is expected, they can profit from that information. Such commodification of forecasts, however, can be very damaging.

A natural consequence of the 'information as commodity' paradigm is that the ability to acquire valuable information is determined by the consumer's assets. When climatic information is relegated as a private good it can be subject to the exclusion principle. Under this principle, those unable or unwilling to pay are excluded from the product's benefits. For example, even the cost of batteries for listening to radio programs communicating seasonal forecasts, or agricultural extension advice, may be prohibitive for some subsistence farmers who are excluded from markets that affect climate information policies.

The recognition of market imperfections in dealing with the threats of climate variability highlights an alternative means of viewing the relationship between predictions, decisions and vulnerability. Dilley and Boudreau (2001) argue that the 'vulnerability to hazard' framework – embraced by the disaster risk community since 1979 (United Nations Disaster Relief Coordinator 1979) – provides a useful theoretical structure for an easy, transparent translation of concepts into practice. In essence, the disaster risk literature delineates the following key terminology: 'hazard' (event that causes harm), 'vulnerability' (susceptibility of a certain unit to a specific event) and 'risk' (likelihood of an undesirable outcome, based on the potential occurrence of harmful events and of the susceptibility to them among those likely to be exposed). In this context, 'vulnerability is contingent on the specification of hazards or shocks' (Dilley and Boudreau 2001). By identifying the specific causal risk factors and relative degree of risk, this approach informs relative to the types of interventions, locations, timing, target population and level of effort necessary to avoid the undesired outcome. This formulation assumes exogenous causal factors. In other words, 'one key conceptual element required is a clear separation between selected causal *events* and outcomes' (p. 235, emphasis added).

For this approach, the essence of vulnerability reduction is to rearrange intrinsic characteristics of exposure units (ranging from households to regional economies) with respect to exogenous climatic factors that put them at risk. In this context, climatic information is essential for reducing vulnerability. For example, if a seasonal precipitation forecast indicates that a drought is likely to strike a certain area, this information

can facilitate the process of getting food aid in time, or helping farmers to anticipate the changes and choose a type of seed that might reduce the magnitude of the anticipated food shortage.

The 'vulnerability to hazard' model argues that the key policy intervention is to expand decision capacity through preparedness and response. In this context, targeted delivery of forecasts is essential. Given the existence of information about expected extreme events, this model suggests that it is necessary to increase the ability to take action in response to the predicted climatic conditions. In the case of climate change and agriculture, examples may range from promoting and enabling the planting of appropriate seed varieties, to setting food aid distribution systems in motion. A key challenge emerging from this framework is that new climatic predictions imply the need to adapt to the potential availability of new forecasts. Thus, people and institutions need to learn about changes in climate predictability, as well as how to respond to newly available information.

A good example is provided by the Regional Climate Outlook Forum. This annual event brings together climate scientists – those who develop regional climate forecasts – and representatives from the user community. These community representatives can include disaster managers, health officials, water managers, agricultural extension agents and the media. Initiatives of this type need to be strengthened, expanded and articulated in order to ensure that the management of forecast information becomes embedded in the institutional decision-making processes of relevant actors. In addition, efforts should be made at promoting dialogue across a variety of boundaries such as those separating administrative jurisdictions, academic disciplines, economic sectors, institutional frameworks and geographic scales.

Expanding the Understanding of Causality: The 'Vulnerability to Outcome' Model

Ribot (1995) views the issue of vulnerability from a different perspective (see also Downing 1991). He begins by stating that it is misleading to designate undesired outcomes as 'impacts' of external hazards such as climate variability or change. Further, he explains that there is an initial need to explain why households came to be vulnerable in the first place. Being more concerned with social and political-economic relations and processes, Ribot embraces a 'vulnerability to outcome' approach. This approach builds on Sen's (1981) work on entitlements. Entitlements are the bundle of goods and services that a particular unit can obtain through production, exchange or extra-legal legitimate conventions. Extreme events become disasters only when entitlement systems fail. From each

instance of entitlement failure, chains of causality can be traced through a historical analysis of the 'production of vulnerability' (processes involving socially differentiated access to resources and opportunities).

From this perspective, the root causes of vulnerability are related to the dynamics of social systems such as extraction, accumulation and marginalization. The fact that vulnerability is produced by ongoing processes must be considered in responses. Ultimately, the 'vulnerability to outcome' approach proposes to identify the social, political and economic processes that produce vulnerability through the allocation of state funds and through the structuring of socially differentiated access to alternative opportunities. Once identified, these processes need to be confronted, going 'beyond redistribution to identify and nurture countervailing processes' (Ribot 1995, p. 121). In this approach, climate information is welcome, but not indispensable, for vulnerability reduction. An increase in entitlements would result in climate extremes having relatively less influence on the food security of the population. Such is currently the case with localized droughts in regions of Europe and the Americas. The key to vulnerability reduction is to address resilience, increasing the options to satisfy basic needs.

In the case of climate predictions, this approach embraces the 'bundles of powers' framework. This framework is defined by Ribot and Peluso (2003) as follows: identifying the constellations of means, relations and processes that enable various actors to derive benefits from access to information. Additionally, the 'vulnerability to outcome' paradigm seeks to concentrate efforts on addressing the root causes of vulnerability. Options may include collective democratic action to reduce the price of farming inputs suitable for expected conditions. Additional options include risk-sharing through market- or community-based mechanisms, diversifying the local economy, investing in capacity building, strengthening the role of subsistence farmers' associations in the definition of regional agricultural policies, and incorporating the concerns of marginal sectors in the development of the research agenda of the natural and social sciences involving climate. In short, the idea is to identify and transform the processes that perpetuate the production of vulnerability, increasing the bundle of entitlements so that the ability to meet basic needs is not so dramatically affected by climatic extremes.

There is a need to harmonize the fields of disaster risk reduction and regional development (World Bank 2000). Sen (1996) concludes that the goal of development should be to replace the dominance of circumstances and chance over individuals by the dominance of individuals over chance and circumstances. The same could be said of climate change adaptation, particularly with regards to those disproportionately at risk.

RETHINKING THE ROLE OF CLIMATE PREDICTIONS

The large amount of resources currently being used to improve our ability to make accurate climate forecasts is not well harmonized with efforts to increase our preparedness to act on that information, or strategies to reduce our susceptibility to climate variability. This is especially true among the most vulnerable sectors of the global rural population. The current emphasis on forecast development offers us the opportunity to simultaneously embrace the recommendations of the perfect information, vulnerability to hazard, and vulnerability to outcome approaches through the process of forecast communication. Even though they reflect very different views of political economy, the policies implied by these approaches are neither inconsistent nor mutually exclusive (Table 8.1).

The dissemination of predictions at local and regional levels could be embedded in a larger process aimed at: (1) seeking to facilitate the flow of available forecasts, and identifying the critical aspects of climate phenomena that people would want to have predicted with better accuracy at the local level; (2) identifying and addressing the bottlenecks in the potential use of forecasts; and (3) exploring opportunities to address the root causes of vulnerability. This integration can lead to synergies between these three policy approaches and also innovative strategies for increasing human security and well-being. For this to occur, the use of climate forecasts needs to be incorporated not only into hazard mitigation efforts, but also into the design of regional development initiatives. By so doing, people may be assured of having the means to take advantage of climate forecasts.

There is an opportunity to integrate the three approaches, bringing together all levels of analysis in a search for short- and long-term risk reduction. The objective should be to foresee climate-related threats and reduce their direct negative effects, as well as to reduce the numerous other causes that make the direct climatic events disasters. As Dilley and Boudreau suggest, the hazards approach works best for bolstering the security of those most vulnerable to a well-defined climatic threat. The question of why those households came to be vulnerable in the first place requires a 'second level of analysis', looking into 'historical, social, political and economic developments that determine who has sufficient access to the means for ensuring their own well-being and who does not' (Dilley and Boudreau 2001).

Information about future climate conditions is most useful in two ways. First, it can serve to help people prepare to cope with the hazard. Second, it can serve as a trigger for beginning to reverse existing processes of

Table 8.1 Policy recommendations emerging from each approach

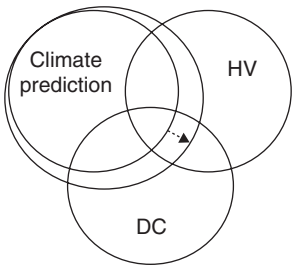
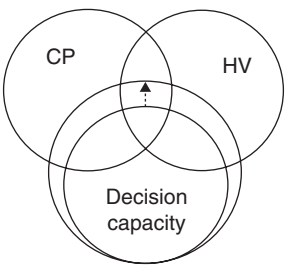
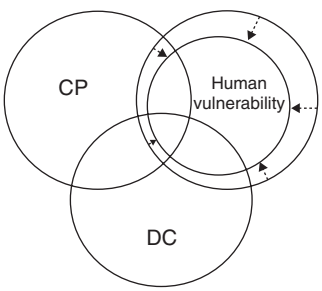
Approach	Policy recommendation	Focus
Perfect information	Produce better forecasts in order to fulfill the requirement of 'perfect foresight'. *Example:* Invest in science and technology for monitoring and modeling climate system. Improve skill of forecasts, expand their spatial and temporal coverage. Assumption: actors and markets will adjust to expected conditions.	Expand *Climate prediction* 
Vulnerability to hazard	Increase the ability to take action in response to climate forecasts. *Example:* Invest in early warning systems. Improve communication and understanding of predictions. Enhance preparedness, response and recovery mechanisms.	Expand *Decision capacity* 
Vulnerability to outcome	Address root causes of vulnerability. Increase ability to meet basic needs by reversing processes of marginalization. *Example:* Reduce price of agricultural inputs through collective democratic action. Diversify local economies. Strengthen role of vulnerable communities in	Reduce *Human vulnerability* 

Table 8.1 (continued)

Approach	Policy recommendation	Focus
	definition of public policies. Assure fair market access and access to land and other resources.	

marginalization which contribute to converting an event into an undesired outcome. Climate predictions – when combined with analysis of likely outcomes – are particularly well suited for attracting the attention of vulnerable people who tend to be both sensitive to, and have reason to be interested in, weather and climate patterns. Participatory workshops for forecast communication convened in collaboration with local leaders can provide an opportunity for the community to come together, learn the basics of climate science as they relate to forecasting, identify and prioritize their most critical sensitivities to climate variability, and explore ways to respond to the forecast. There is evidence that this participatory approach can lead to significantly better decisions (Patt et al. 2005b). Ultimately this approach could be expanded in its scope, aiming to build resilience through action at the individual or collective level, as well as with help from government or aid organizations. Once the discussion gets started, it is possible to introduce questions about the processes that perpetuate conditions of vulnerability. This, in turn, should lead to an exploration of ways in which the community, with the help of policymakers at all levels, can fortify its assets and increase its ability to meet basic needs.

The synergies created by integrating the three approaches could provide many positive feedbacks. For example, if potential users of forecasts identify ways to put that information to good use, they may become advocates for increased investment in the development of climatic knowledge and add strength to efforts aimed at securing resources for monitoring and research. Farmers who learn about a useful prediction may also want to increase their access to other forms of information, from new agricultural practices to expected market conditions for their products, therefore improving the overall flow of information. Similarly, regional development policies that increase the bundle of entitlements of poor peasants in rural Africa would also enhance the subsistence farmers' capacity to take action to reduce risk or improve yields based on the contents of a seasonal precipitation forecast.

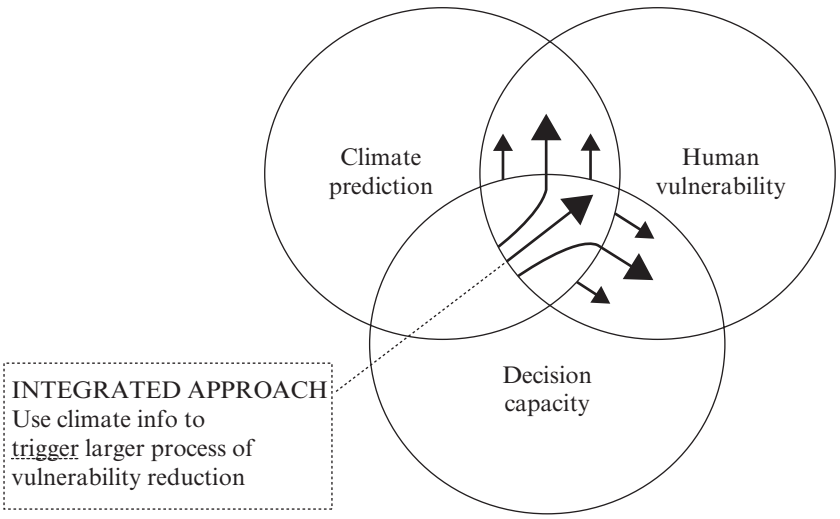


Figure 8.2 Innovative approaches can combine the three policy recommendations listed in Table 8.1, aiming to reduce vulnerability while promoting the improvement of climate predictions and augmenting decision capacity

Figure 8.2 portrays the recommended approach: a concerted, simultaneous reduction of human vulnerability and expansion of climate predictions and decision capacity in response to those predictions, through participatory processes and government engagement aimed at increasing the usability of climate forecasts and at reducing the risk of undesired outcomes.

CONCLUSIONS

The value of climate information depends not only on how it is used but also on the method by which it is introduced into a particular environment. This can also contribute to vulnerability reduction by helping to reshape the internal dynamics of the socio-economic system. The potential role of forecasts with respect to differential vulnerabilities across regions, productive sectors and socio-economic characteristics deserves further investigation.

This chapter argues that the best use of climate forecasts is not just to anticipate the future, but also to integrate them in processes aimed at identifying and resolving bottlenecks in the flow of information. In addition, such information can be used to explore the possibility of creating and

nurturing processes that can countervail the production of vulnerability. Forecast dissemination could be implemented in creative participatory ways, thinking of information-as-process rather than information-as-commodity. In the case of climate change, efforts to communicate new knowledge will also need to address global, national and local economic, social and political obstacles to putting that information to use among the most vulnerable.

Increased understanding of atmospheric processes will, and should, continue to grow. Undoubtedly, climatic forecasts can be of high value for agricultural production and other economic activities; their potential applications for improving livelihoods are undeniable. However, market forces alone are not effective for channeling climatic information to where it can best help reduce vulnerability to famine and other disasters. If forecasts are to be used for reducing the probability of negative outcomes among the poor and most vulnerable, it is imperative to give adequate consideration to how this particular type of information is produced and disseminated. Likewise, it is important to address the constraints faced by households that deserve the highest priority with respect to this information. Without an effort to integrate forecast development with the policy options derived from the 'vulnerability to hazard' and 'vulnerability to outcome' approaches, the causal factors that perpetuate the reproduction of vulnerability will continue to create conditions of avoidable risk for marginal populations.

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