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Disaster resilience and post-2015 development goals: the options for economics targets and indicators

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Executive summary

Economic damage from natural disasters is linked intimately with development, poverty and economic growth. Low-income countries (LICs) show high economic vulnerability to disasters. Damages to assets, public infrastructure and long-term productivity as a result of disasters can set back development and erode gains in poverty alleviation. Economic resilience to disasters is an important enabler of many broader development goals.

There is a trade-off to be made between relevance and measurability in selecting a target. Indicators like economic losses are relevant and powerful, yet come with measurement challenges. In particular, the annual volatility in loss means progress cannot be monitored every year. Yet input- and output-based indicators, like annual spending on DRR and exposed gross domestic product (GDP), while being informative and easy to measure, alone provide only a narrow view of overall resilience.

We would recommend the following target: 'Economic losses as a fraction of output are reduced by 20%'.[1] This formulation comes with a number of advantages:

- It can be measured at household, sector and national levels. This means it has the advantage of covering the whole economy.
- It should motivate action beyond traditional development agencies, stimulating action from households, firms and finance ministries.
- It should motivate action with a greater focus on DRR, rather than just *ex-post* action.
- It is pro-growth: the emphasis is on enhancing the resilience of growth.
- It will require ambitious action from high-, middle- and low-income countries.

The effectiveness of such a target could be strengthened with a complementary basket of indicators, which includes:

- Transparent 'input-' and 'output'-based indicators, against which it is possible to measure key dimensions of progress in terms of reducing economic vulnerability easily and clearly every year;

[1] The benchmark period could be defined as 2000-2010 and the target as 2020-2030. See discussion in Section 2.4.

- Indicators that directly reflect humanitarian priorities and poverty reduction goals, to ensure actions are directed at assisting the most vulnerable in society; and
- Model-based indicators of *expected* damages, which provide risk estimates and can be used to monitor progress annually and set meaningful benchmarks.

Developing an operational framework for monitoring performance against economic indicators will require significant investments in building capacity at international, national and local scales. There is a growing precedent for establishing such monitoring programmes at the local level in LICs and middle-income countries (MICs). Developing these capacities more widely will have co-benefits for DRM planning.

2.1 Introduction

In this chapter, we consider a range of economic indicators for monitoring disaster resilience within a post-2015 development framework. We evaluate their advantages and disadvantages, particularly in the context of their ability to motivate action to reduce the impacts of disasters on development. The outcome of this discussion is the proposal of a set of targets and indicators that could be used either as a standalone framework, or alongside other targets and indicators, for example related to the impacts of disasters on poverty or the existing MDGs.[2]

In this section, we introduce the concept of economic resilience and present the case as to why economic resilience to disasters is a crucial component of development and poverty alleviation, and therefore an important target within the upcoming post-2015 development goals. Section 2.2 then gives an overview of the types of indicators that could fit within the post-2015 framework. Based on this analysis, and the criteria set out by ODI, Section 2.3 proposes a single target and Section 2.4 a complementary basket of economic indicators. Finally, Section 2.5 provides some final thoughts on the feasibility of these.

Economic resilience can be defined as 'the policy-induced ability of an economy to withstand or recover from the effects of [exogenous] shocks' (Briguglio et al., 2008).[3] In this case, the exogenous shocks are natural hazards, such as floods and droughts.

But, why is *economic* resilience an important policy issue for LICs, where *humanitarian* losses from natural hazards are so considerable? And, following on from this, what is the role of *economic* indicators of disaster resilience within an international policy agenda that is focused on development and poverty alleviation?

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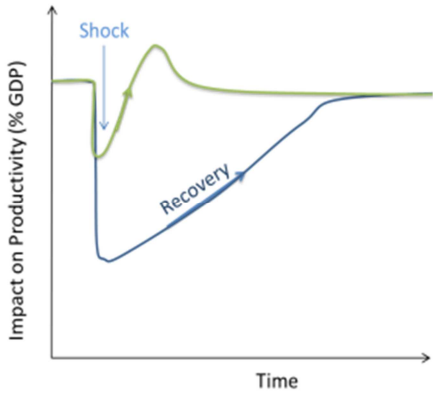
[2] For example, economic resilience to disasters is relevant to MDG 2 'Eradicate extreme poverty and hunger' and MDG 7 'Ensure environmental sustainability'.

[3] The concept of economic vulnerability and resilience is subject to some debate. It is often considered 'the positive connotation of vulnerability' (Matyas and Pelling, 2012); accordingly, Briguglio et al. (2008) define economic vulnerability as 'the exposure of an economy to exogenous shocks'. Matyas and Pelling (2012) suggest that the positive connotation of vulnerability is too narrow a definition for resilience, preferring to see it as a process than an outcome, including, for example, measures to reduce risks before a disaster strikes (including hard and soft protection) and reduce the impacts of an event when it occurs (social safety nets, emergency planning and insurance).

Development, poverty alleviation and economic resilience to natural hazards are intimately linked. The economic impacts of natural hazards have an immediate impact on poverty and human security and can set back development by several years (Figure 1).

In the short term, natural hazards damage and destroy property, assets (including crops, livestock and natural capital like forests), infrastructure and livelihoods, and disrupt economic activity. In poorer communities, which are more exposed and vulnerable to natural hazards,[4] this immediate loss of income and assets can force people into poverty and threaten human security (UNISDR, 2009a).

Figure 1: Schematic diagram illustrating the impact of a disaster on a developed economy (green) and a developing economy (blue)



Note: In a developed economy, the initial impact of the shock is less deep, owing to investments in risk reduction and preparedness, and the economy recovers more quickly; sometimes, there is even a productivity gain owing to increased production in the construction sector. In developing countries, the impact can be (relatively) larger and longer lived.
Source: Based on Hallegatte et al. (2007).

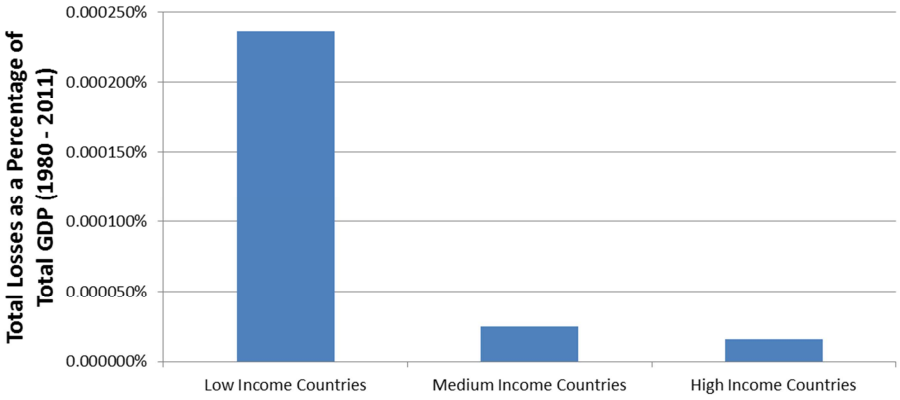
For poorer communities, the impacts can also be longer lived. Whereas in richer communities, financial reserves, social safety nets and mechanisms like insurance[5] mean communities can rebuild and recover from shocks quickly (Hoeppe and Gurenko, 2006), in poorer communities recovery is slower, and the cost of rehabilitation tends to divert resources away from more productive investments (Hallegatte et al., 2007). This is seen at all levels of organisation. For example, at the household level, investments may be diverted away from new equipment and educating children, reducing the long-term prospects for escaping poverty (UNISDR, 2009a). At the regional and national scales, investments in improved public services (health, education and utilities), sectoral development and infrastructure (roads, information and communication technology (ICT) and

[4] For example, poorer communities are typically more dependent on natural capital and climate-sensitive sectors, like agriculture and fisheries. They also usually invest far less in DRR and preparedness.
[5] While in the developed world, more than 40% of economic loss from natural hazards is covered by insurance, in developing countries around 97% of the cost falls on national governments and local firms and communities (Hoeppe and Gurenko, 2006).

energy) may be foregone. The result is a long-term decrease in productivity and economic growth (World Bank, 2010).

These effects can be seen clearly in a range of economic indicators. When expressed as a percentage of GDP, the direct (immediate) economic losses from natural disasters in LICs were more than 14 times higher than in high-income countries (HICs) between 1980 and 2011 (Figure 2). Looking longer term, Raddatz (2009) finds that, on average, in LICs, the total cost of disasters is equivalent to 1% of GDP (or 2% for droughts); in HICs, it is around 0.25% of GDP.

Figure 2: Relative Economic Impacts



Source: Authors' calculation based on data provided by Munich Re.

Mitchell (2012) describes disaster resilience as an enabling factor in sector-oriented development goals, including those concerning water, food, education, infrastructure and health. As described above, economic factors are crucial in each of these.

The urgency of building economic resilience to natural hazards is underlined by the rapid increase in economic losses from disasters observed around the world. Today, economic losses from natural disasters cost on average $125 billion per year[6] globally, and are rising at a rate of around $30 billion per decade (Figure 3). Much of this trend results from growing exposure to disasters (Handmer et al., 2012),[7] but losses are growing more rapidly than GDP and population (ibid.). This suggests other factors are at play.[8] To some extent, it is inevitable that, in a much richer, more populous world, losses will rise (Hallegatte, 2012), but there can be considerable benefits, both humanitarian and financial, to making growth more resilient to natural hazards (Bowen et al., 2011).

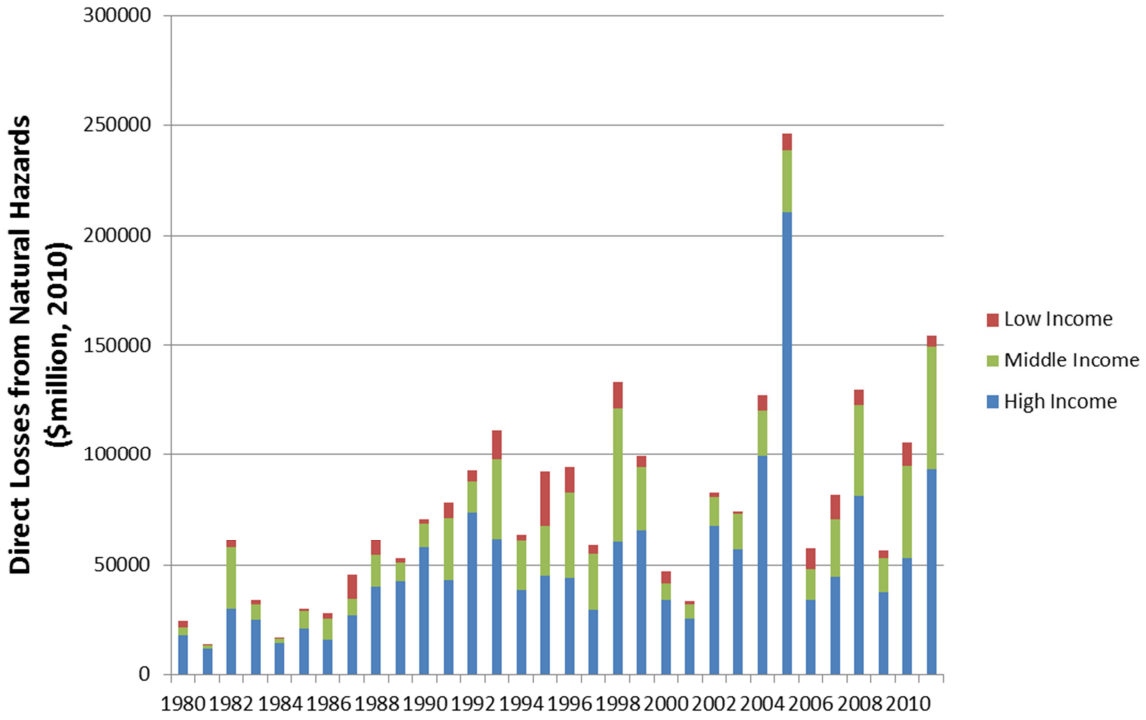
[6] All economic values here are given in 2010 US$ unless otherwise stated. These values represent only the direct losses, such as damage to infrastructure and property, and do not capture the indirect economic impacts, such as the loss of long-term productivity and reduced economic growth.

[7] There is no evidence that climate change has played an important role (Handmer et al., 2012). Data issues and the inability to quantify trends in vulnerability mean it is difficult to draw out any firm conclusions on trends resulting from climate change.

[8] For example, one important factor is urbanisation, which can concentrate exposure in hazard-prone regions adjacent to coasts and rivers.

In addition, while there is some evidence that resilience is increasing on average (UNISDR, 2009a), progress is unequal. Some of the poorest communities are being left behind, and some are becoming more vulnerable to natural hazards.

Figure 3: Economic losses grouped by World Bank income class, 1989-2010



Source: Authors' calculation based on data provided by Munich Re.

Without building economic resilience to natural disasters, the gains in development, poverty alleviation and human security promoted by the post-2015 development agenda will be repeatedly eroded (Mechler, 2009; World Bank, 2010). This is particularly concerning when we consider that climate change is expected to increase the severity of climate hazards over the coming decades (Handmer et al., 2012).

2.2 Economic indicators of resilience

In this section, we review economic indicators of resilience. We introduce a typology to group these indicators into one of four types, and then discuss the advantages and disadvantages of the indicators within each grouping in the context of measuring progress against a goal to increase the resilience to disasters.

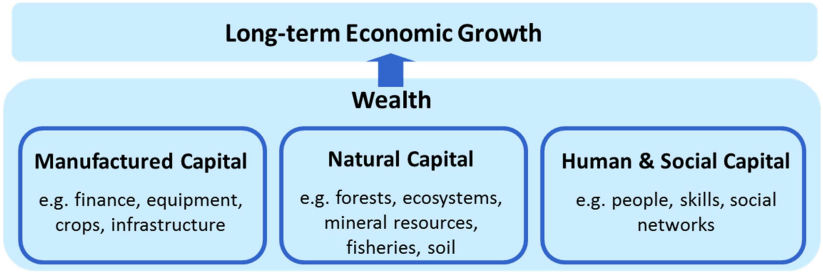
Definition of an 'economic' indicator

It is useful first to define what we mean by an economic indicator. The narrowest definition would be an indicator that has some monetary quantity, such as the value of property damaged, or the value of exposed assets. An alternative approach is to include all factors that influence wealth and long-term economic growth. In this chapter, we move towards the later definition. This is consistent

with the latest discussion on 'beyond GDP' approaches (highlighted within the Rio+20 dialogue),[9] which recognise that long-term economic growth, which is vital for poverty alleviation (Dercon, 2012), is a process of accumulation and management of a portfolio of assets, including manufactured capital (the traditional 'economic' component), natural capital and human and social capital.[10]

We limit the scope of our coverage of economic outcomes from disasters to *traditional monetary* factors (Figure 4). This is because mortality and other non-monetary outcomes, including health and education, are covered in accompanying chapters. However, we take a broader view on the drivers of economic resilience. The rationale for applying this approach in this context is that damages to any of these types of assets could have a material impact on traditional monetary wealth; for example, damages to agricultural land or water resources could have significant impacts on long-term economic growth. Similarly, building the resilience of human and natural assets, through, for example, risk education or restoring mangroves, respectively, will reduce the economic impacts of disasters and should be included in the definition of economic resilience. By narrowing the definition to traditional monetary factors, there is a chance of disincentivising investments in building the resilience of natural and human capital.

Figure 4: Framework for conceptualising economic factors adopted in this paper



Source: Adapted from http://siteresources.worldbank.org/EXTSDNET/Resources/Natural-Capital-Accounting-Fact-Sheet.pdf

The impacts on natural capital are an important gap in the chapters. Natural capital accounting is now becoming available and accepted internationally, and so it may be feasible to include it in measures of economic loss and resilience. This option should be considered carefully; for example, including natural capital in economic resilience could reduce the transparency of indicators[11] and delay monitoring while the necessary additional capacity and accounting frameworks are developed.

A typology of indicators

We have already discussed a number of economic indicators in Section 2.1, including direct losses and losses as a fraction of GDP. These are the two most common 'outcome-based' measures of the economic resilience to natural hazards. We suggest indicators can be placed into one of four categories:

[9] http://www.worldbank.org/en/news/feature/2012/05/30/rio-20-natural-capital-accounting-feature
[10] This framework was based on the classic livelihoods perspective and later supplemented with recognition of the importance of political economy, including governance structures (Dercon, 2012).
[11] Some disaggregation will be desirable to identify weaknesses and inform policy.

1. Indicators that measure *inputs*, or specific actions, like the scale of investment in disaster resilience;
2. Indicators that measure the *outputs* of action, such as the fraction of the population living in regions exposed to natural hazards;
3. The *outcomes* themselves, such as actual economic losses and damages to critical infrastructure; and
4. The *impact* on the overarching goal – development and poverty alleviation.

Figure 5 illustrates this framework.

Impact- and outcome-based measures can provide a picture of the actual realised risk and resilience of a country, sector or community. Input- and output-based indicators provide information about specific drivers of exposure and vulnerability to natural hazards, providing a slice of the whole picture of resilience, albeit in more detail.

Figure 5: Typology of resilience indicators

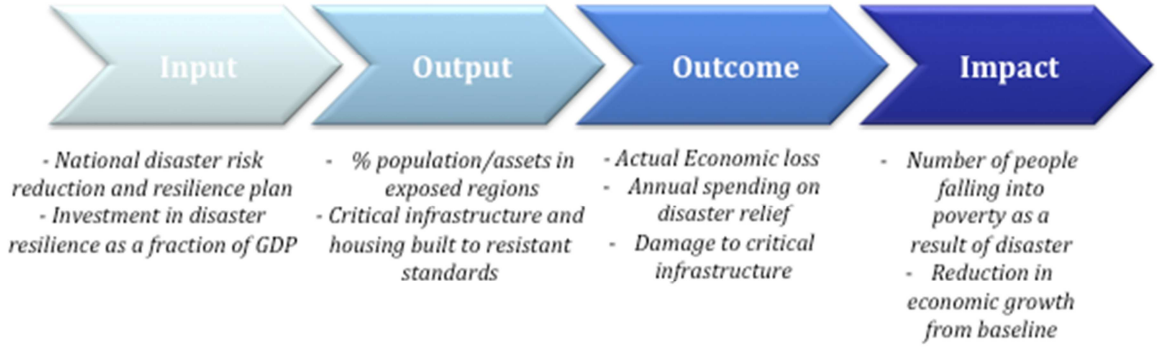


Table 2 gives examples of a range of economic indicators across each of these categories and summarises some their general advantages and disadvantages. Below, we provide a more detailed discussion of the strengths and weaknesses of these various indicators in terms of measuring progress in disaster resilience. This is supplemented by Appendix A, which provides a summary of the economic indicators used in practice today.

Table 1: Typology of economic indicators of resilience, populated with examples from Appendix A

Indicator type	Sub-grouping	Specific indicator	Pros and cons
Impact-based		• # of people falling into poverty as a result of a disaster • Long-run impact of disasters on economic growth	+ Simple to communicate - May incentivise *ex-post* action rather than *ex-ante*
Outcome-based	Actual losses	• Economic losses (direct/indirect, intensive/extensive) • Economic losses per unit GDP • Damage to household assets • Government expenditure on disaster relief and recovery • Damage to critical infrastructure • Local Disaster Index (IADB)	+ Simple to communicate + Politically motivating + Incentivises *ex-ante* action + Relevant at multiple scales - Cannot track annual progress - Difficulty in defining benchmarks - Requires significant investment in developing monitoring capacity - Economic loss can give more weight to impacts on higher income

			groups
	Modelled losses and hybrid indices	• Expected loss (e.g. average annual loss or 1-in-100-year loss) • Hybrid indicators (combining expected and actual losses) • Disaster Deficit Index (IADB)	+ Progress can be monitored annually - Difficult to communicate - Lack of transparency - Model-dependent assessment (prone to uncertainties) - Poor coverage and expensive to create and update
Output-based	Composite indices	• Prevalent Vulnerability Index (IADB) • Risk Management Index (IADB)	+ Capture broad range of factors + Measure progress annually - Lack of transparency - Difficult to communicate
	Exposure	• % of assets/population exposed	+ Cheap and easy to measure + Can guide action - Describes only a narrow component of overall resilience
	Vulnerability	• % of population with access to livelihood asset protection measures – insurance and social safety nets • % of buildings complying with hazard-resistant building codes	
Input-based	Government	• % of government expenditure invested in DRR	+ Cheap and easy to measure + Can guide action - Describes only a narrow component of overall resilience - Poor at assessing potential outcomes, quality and effectiveness
	Sector/firms	• % of firms adopting international risk management standards	
	Households	• % of population with access to risk information	

Outcome- and impact-based indicators

Actual economic loss

Economic loss is the most comprehensively measured indicator of disaster resilience. It has long been used as an indicator by many organisations,[12] and has several advantages:

1. **Transparent and easy to communicate:** economic loss is understandable by all and tangible and relevant to all, including HICs and LICs.
2. **A political motivator of action:** unlike non-monetary indices, economic indicators, because they are directly tied to growth and prosperity, are of strong interest to households, government (including, importantly, finance ministries), firms and politicians, so can motivate action across the board.
3. **Motivator of *ex-ante* risk reduction:** it is difficult to reduce direct economic losses through *ex-post* action, so economic loss focuses more attention on *ex-ante* measures. This has benefits for mortality, education, health and poverty dimensions of resilience to disasters.
4. **Relevant and applicable at a range of spatial scales:** a target should aim to cover the whole economy, not just the very poorest communities, and should be relevant across households, firms and government. In theory, economic loss can be calculated at household, community,

[12] For example, global losses used by the Intergovernmental Panel on Climate Change (IPCC), national losses used by the UN International Strategy for Disaster Reduction (UNISDR) (e.g. in its Global Risk Assessments and HFA Monitor), regional losses used by the World Bank (its hotspots study) and household- and firm-level losses used by the insurance industry.

meso or national scale. It can be aggregated across regions and countries. The only limitation on spatial scale is the granularity of the data. The most common level of resolution is national, but this can hide imbalances across a country.

However, there are challenges in applying economic loss as an indicator of resilience:

1. **Technical and capacity challenges in increasing the quality and scope of monitoring:** the availability of reliable local data on economic damages is a challenge in most countries (IFRC, 2007). The most comprehensive records are those held by the insurance industry, but these have coverage that is biased towards HICs, and they often lack transparency and are not freely available. Economic indicators are much more difficult to *count* than, say, fatalities or injury, and are more prone to inconsistencies in accounting methods,[13] errors and biases.[14] Extending coverage and increasing quality will require significant investment and capacity building from the bottom up as well as top-down auditing.
2. **Inability to track progress annually:** hazards occur relatively infrequently and so it takes many years or even decades to build up a record long enough to monitor progress in building resilience.[15] This also creates a challenge in identifying a benchmark to monitor progress against. For example, it would be ludicrous to define a single benchmark year, like 2010, as this may have been a particularly active year (in terms of hazard occurrence) in some countries and not in others. Benchmarking would need to be carried out over an extended period (at least 10 years at the global level, and preferably more locally), but even then would be prone to biases. This is particularly a problem for measuring resilience to extreme events; for example, to measure progress in building resilience to a 1-in-50-year event, one would need to monitor for around 100 years or more.
3. **Bias towards high-income groups:** a drawback of economic loss as a motivator of action is that it will naturally bias action towards building the resilience of higher income groups. **Loss per unit output (e.g. GDP or household output)** provides a more equitable way to compare losses across society, placing a greater weight where losses represent a larger portion of output (Figure 1). A more technical version is the **normalised loss,**[16] often calculated in the academic community (e.g. Pielke and Landsea, 2007). Normalised loss would not be an appropriate indicator of resilience because it removes the effects of important drivers of resilience, like urbanisation.

[13] Different aspects of loss estimates have differing quality, and there is little consistency in accounting methods between databases. For example, insured losses are most accurate (but limited geographically), while estimates of indirect losses are patchy; Pelling (2006) and Matyas and Pelling (2012) highlight that some aspects of loss, such as damage to informal housing and impacts on livelihoods, are missing. Existing databases also tend to be biased toward large (*intensive*) events, while the smaller and more frequent (*extensive*) events are missed from records.

[14] For example, too much emphasis on losses from intensive events could lead to decisions that put more emphasis on social safety nets and insurance and less weight on *ex-ante* risk reduction. Not representing indirect losses could mean investments to reduce long-run impacts on development are foregone.

[15] For example, the large year-to-year variability in Figure 3 (which is far 'noisier' at local scale). Some have tried to overcome this problem by studying loss per event, but to truly correct for event occurrence one would need to normalise for event magnitude, size, where it strikes and all the other unique circumstances. This would require data series longer than currently exist. Calculating loss per event does have the advantage of removing some of the influence of climate change from trends.

[16] Normalised loss accounts for factors such as differences in population densities, capital assets and the size and frequency of events (etc.) to give a 'purer' estimate of resilience.

Some initiatives are addressing the gaps in data availability. For example, the DesInventar programme[17] is now utilised in several countries across Latin America and beyond to provide bottom-up municipality-level estimates of the impacts of natural hazards (feeding into the Local Disaster Index of the Inter-American Development Bank (IADB)) using a consistent method. Such initiatives not only have advantages for monitoring, but also build knowledge that can be applied in informing DRM.

Modelled loss and hybrid indices

The insurance industry has for many years used probabilistic 'catastrophe risk models' to help overcome problem (2) above. These models simulate the losses from thousands of possible events, allowing for an assessment of *expected damages* (Muir-Wood, 2012) in an average year. They are based on detailed data on exposure and vulnerability and simulation models and/or historical data on physical hazards.

These models do have several drawbacks. For example:

- The loss estimates are model dependent – different models will give different estimates.
- The quality of risk estimates will depend on the quality of data inputs, which is limited in LICs.
- Risk models inevitably apply simplifications that may lead to misleading results and so could misinform action.[18]
- Models are expensive to create and need to be updated regularly. Across many LICs, risk modellers will be building models from scratch.
- Models require a high degree of technical capacity to use, update and interpret.
- Finally, the issue of trust in models – relying on a 'black-box' model – limits transparency and so may be unappealing to politicians and the public.

Despite this, risk models can add value by complementing measures of actual losses. For example, they might be used in parallel, to demonstrate annual progress, and help inform future policy.[19] Simple, transparent risk models can be particularly useful as a complementary tool (e.g. the Ranger et al. 2011 risk model for flooding in Mumbai). Systematic errors are not necessarily an issue, as it is the *relative change* in an indicator that is important rather than the *absolute level*.

In addition, risk models add value by providing risk information for disaster resilience planning, for example allowing a policymaker to view the potential impacts of a simulated 1-in-200-year event and assess the financial benefits of different risk reduction strategies (e.g. Mechler et al., 2009). Several initiatives are now extending the coverage of catastrophe risk models to LICs, for example

[17] http://www.desinventar.org/

[18] For example, modelling of the response of different crops to rainfall variability or the damages to infrastructure caused by flooding will be simplified and so could misrepresent true risk. Risk models to date have typically focused on direct economic losses, and not captured indirect impacts.

[19] Clarke (2012) take this to the next level, by proposing a hybrid indicator that combines actual and modelled losses numerically to smooth annual loss trends. A challenge here is simplicity and transparency.

the Global Earthquake Model[20] and the World Bank's Central American Probabilistic Risk Assessment (CAPRA) platform.[21]

Other outcome- and impact-based indicators

More easily measurable indicators of the economic outcomes of disasters include, for example, government spending on disaster relief and rehabilitation. This type of indicator is informative but has a narrower scope.

Possible impact-based indicators include the number of people forced into poverty as a result of a disaster, and the long-run impacts of disasters on economic growth. A complication with these indicators is that poverty and economic growth are driven by many factors beyond disaster resilience, and so it is difficult to define a meaningful baseline and attribute impacts to the disaster.[22]

Input- and output-based indicators

Input- and output-based indicators have the advantage over the previous sets of indicators of being relatively easy to measure, and progress can be monitored annually.[23] An array of such indicators is used in the disaster risk community at a variety of scales. A full list is given in Appendix A. This includes for example:

1. **Measures of exposure to disasters:** this includes the number of people living within 5m elevation from mean sea level, or the 'exposed GDP' indicator used in the UNISDR's Global Risk Assessment.
2. **Measures of vulnerability to disasters:** this includes specific factors such as the proportion of the population with access to EWSs or government financial reserves and contingency mechanisms (UNISDR's Hyogo Monitor) and aggregate proxy indices, such as the Economic Resilience Index (Briguglio et al., 2008), which incorporates governance, social development, macroeconomic stability and microeconomic market efficiency. Indeed, generic development indices, such as the Human Development Index, have been shown to be good indicators of disaster resilience (Matyas and Pelling, 2012).
3. **Monitoring of specific actions that influence exposure and vulnerability:** these include 'the proportion of development decisions that incorporate disaster risk and resilience' and 'annual spending on DRR' (Appendix B).
4. **Composite indicators of vulnerability and exposure:** these include the Community-based Risk Index used by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Risk Management Index used by the Inter-American Development Bank (IADB) and the Disaster Risk Index used by the UN Development Programme (UNDP).

A drawback of specific indicators like 'number of people living within 5m elevation from mean sea level' or 'annual spending on DRR' is that, while they provide transparent and specific information, they also give a narrow view on the drivers of resilience. An advantage of aggregate indicators,

[20] http://www.globalquakemodel.org
[21] http://www.ecapra.org
[22] For example, one would need to estimate the baseline rate of economic growth and level of poverty if the disaster had not occurred to create a meaningful indicator of resilience.
[23] Indicators are 'deductive' rather than 'inductive' and so are less reliant on actual loss data (Pelling, 2006).

compared with individual indices, is that they capture several aspects of resilience. A drawback is that they do not make good communications tools or motivators because they are not transparent or meaningful to the average politician, firm or community.

Summary

A conclusion from this analysis is that, in identifying a target, or set of indicators, for disaster resilience we come up against a trade-off between relevance and measurability:

- **Relevance:** outcome-based indicators, like the economic loss from disasters, provide a picture of overall economic resilience, and are relevant to all stakeholders, whereas input- and output-based indicators, like annual spending on DRR, provide a more narrow (albeit more detailed) view, which could not claim to represent overall resilience.
- **Measurability:** input- and output-based indicators are easier to measure and progress can be measured every year. Outcome- and impact-based indicators come with more significant measurement problems and, in some cases, volatility in losses means progress cannot be monitored every year.

The appropriate target and indicators will depend on the objectives and criteria set out by the post-2015 framework. Examples are given in the following sections.

For all indicators, the indicator will only be as good as the underlying data; in many developing countries, data on hazards, vulnerability and exposure can be scarce and unreliable, with observation networks and data infrastructure often in need of modernisation and upgrading (UNFCCC, 2012). Investing in developing the core data (disaster loss information, exposure mapping and socioeconomic data), including data collection, processing, storage and analysis, will bring many co-benefits for risk management and development planning. To be useful, such investments must be complemented by support for capacity building (including training, skills, guidance and institutional frameworks). Neither can be a one-off, but require sustained effort.

2.3 A proposed economic target for disaster resilience

A number of organisations have suggested criteria for international targets (DARA, 2011; UNISDR, 2008a). In this chapter, we adopt those of ODI, which suggest there are six criteria for an effective target:

1. Is it a priority for poor people?
2. Would concerted action on the target actually make a positive difference?
3. Is there a good basis on which to calibrate the target (measurable and ambitious yet achievable)?[24]
4. Is the target meaningful at all scales?
5. Does it reinforce human rights?

[24] We add to this that targets should be measurable; the most powerful of the original MDGs were those that had clear, specific and measurable outcomes, such as the reduction in maternal deaths in childbirth (Muir-Wood, 2012).

6. Is it simple and easy to understand (as a communication tool)?

We assume there will be only one target for economic resilience, which must perform well against each of these criteria.
Table 3 lists each input and output target currently proposed (from Appendix B) and gives an assessment of their performance against each of the six criteria. This assessment is high level, based on a review of the literature (e.g. Bandura, 2008; UNFCCC, 2012; UNISDR, 2008), and, therefore, we apply only a coarse index, where performance is ranked on a three-point scale (0 = not at all, 1 = somewhat, 2 = definitely). A more detailed appraisal could consider a more refined index and take inputs from expert elicitation.

The shaded rows in Table 3 are those proposed targets that meet three or more of the criteria. In reality, some criteria may be weighted more strongly than others.

From this analysis, we draw the following conclusions:

- Only two of the proposed targets strongly meet the criteria that targets reinforce human rights and are a priority for poor people: 'No people falling into poverty as a result of a disaster' and 'Disasters don't add to inequality'.
- The second criterion, that concerted action would make a positive difference, may exclude many of the input- and output-based indicators, as these are often too narrow to claim they could make a real difference by themselves.
- The requirements that the target be simple and easy to understand, meaningful at all scales and is ambitious yet achievable exclude many of the possibly targets, for example the model-based outcome indicators (not simple and easy to understand) and the halving of economic impacts (unlikely to be achievable).

Based on this analysis, we suggest two possible types of targets for disaster resilience, which each perform well against the criteria.

1. **Absolute losses, e.g. economic losses,[25] reduced by 20% by the 2030s; and**
2. **Relative losses: e.g. economic losses as a fraction of output, reduced by 20% by the 2030s, or stabilised with respect to economic growth.**

The targets that refer directly to poverty (e.g. 'No people falling into poverty as a result of a disaster') and development (e.g. 'Disasters do not impact economic growth beyond the year in which they occur') perform strongly against the criteria but are not recommended because they pose very significant measurement challenges that make them infeasible to apply in practice.[26]

[25] The reader will note that we have reduced the ambition of the proposed targets compared with the targets outlined in the literature (Appendix B).
[26] This was a conclusion of the expert review of the targets. See also Section 2.2.

Table 2: Analysis of how proposed targets[27] perform against a set of criteria

	Type	Ranking against criteria						Main pros and cons
		Is it a priority for poor people	Would concerted action make a positive difference	Is there a good basis on which to calibrate the target	Is the target meaningful at all scales	Does it reinforce human rights	Is it simple and easy to understand	
# of people falling into poverty as a result of a disaster	Impact	2	2	0	2	2	2	+ A priority for poor people and links to human rights - Could incentivise *ex-post* action rather than *ex-ante* - Unlikely to be achievable - Difficult to measurable
Stabilise level of losses in spite of GDP growth	Outcome	1	2	2	2	1	2	+ Simple and easy to understand - Not a priority for poor people
***Nations* to halve disaster-related economic loss by 2030**	Outcome	1	2	1	0	1	2	+ Simple and easy to understand - Unlikely to be achievable
20% reduction in *expected* economic losses	Outcome	1	2	1	2	0	0	- Not simple to understand - Not a priority for poor people
Halve expected economic impact of extreme disasters (e.g. 1-in-50 year)	Outcome	1	1	1	2	1	0	- Unlikely to be achievable - Relies on risk models + Relevant at al scales
Eliminate negative impact of disaster on poverty level	Impact	2	2	1	2	2	2	+ Priority for poor people - Could incentivise *ex-post* action rather than *ex-ante*
Zero household asset depletion	Outcome	1	1	0	0	1	0	- Difficult to understand - Not meaningful at all scales
Halve average	Outcome	1	2	0	0	1	1	- Not meaningful at all scales

[27] From Mitchell, 2012, UNISDR and DIFID/ODI workshop, London, December 2012

	Type	Ranking against criteria						Main pros and cons
		Is it a priority for poor people	Would concerted action make a positive difference	Is there a good basis on which to calibrate the target	Is the target meaningful at all scales	Does it reinforce human rights	Is it simple and easy to understand	
household income loss								- Large data gaps
Disasters do not add to inequality	Impact	2	1	0	2	2	1	- Not simple and easy to understand - Difficult to quantify
Halve disaster-related economic loss in the period 2015-2030 (from 2000-2015)	Outcome	1	2	1	2	1	2	- Unlikely to be achievable + Easy to understand
Direct economic losses as % of GDP over 15-year period (compared with baseline period)	Outcome	1	2	1	2	1	2	- Unlikely to be a priority for poor people (could be improved by expressing relative to income or household assets, rather than GDP)
By 2025, have 5% of national budgets committed to reducing disaster risk each year	Input	1	1	2	0	1	2	- Too narrow to have a meaningful impact
Disasters do not impact economic growth beyond the year in which they occur	Impact	2	2	1	2	1	1	+ Priority for poor people - Could incentivise *ex-post* action rather than *ex-ante* - Difficult to measure (problematic accounting owing to reconstruction efforts)

We can compare the benefits of absolute and relative loss targets as follows:

- **Absolute loss targets, because they are not linked to output, are particularly ambitious** and should focus attention on the need to tackle the long-term drivers of rising losses, such as rapid growth in hazard-prone areas.
- **Absolute loss targets could be seen as 'anti-growth', while relative loss targets are pro-growth.** Economic losses will be strongly driven by economic growth. While a target should aim to make economic growth resilient, it should not be anti-growth. Monitoring absolute levels would send the wrong signal, as a development framework would not want to suppress activities that can be pro-poor, such as urbanisation and economic growth (Hallegatte, 2012).
- **Absolute loss targets could bias action towards those activities that build the resilience of the highest income groups.** Relative loss targets will help rebalance efforts towards activities that reduce the greatest proportional loss.

Given this discussion, we recommend the target:

Economic losses as a fraction of output are reduced by 20% by the 2030s

The appropriate benchmark periods and target periods for this target are open to debate. A longer period is preferable, particularly at the national scale. At the global level, a 10-year period (as a minimum) may be suitable, for example using a benchmark period of 2005-2015 and a target period of 2020-2030.[28] At the national or sub-national scale, with such a short 10-year measurement period, there would be considerable volatility. This would need to be considered when reporting on progress.

There are a number of technical issues to consider when implementing such a target:

- **Operational issues:** monitoring will require building significant capacity locally and nationally, as well as implementing auditing procedures and data collection at the international level. It will also require agreement on standardised accounting frameworks.
- **Scale**: economic losses could theoretically be monitored at any scale, but for international reporting it might be limited to national, regional or sectoral aggregates, to ensure greater data quality.
- **Scope:** it could be beneficial to limit the scope of measurement to direct economic losses for international reporting, as indirect losses are more prone to biases.[29] It may also be beneficial to disaggregate by disaster type to better inform risk management planning. There is an open question over whether the measurement should include natural capital.
- **Output indicators***:* GDP is the easiest output indicator to apply, but other indicators may be more relevant, particularly at the sub-national scale, including income or capital measures. National

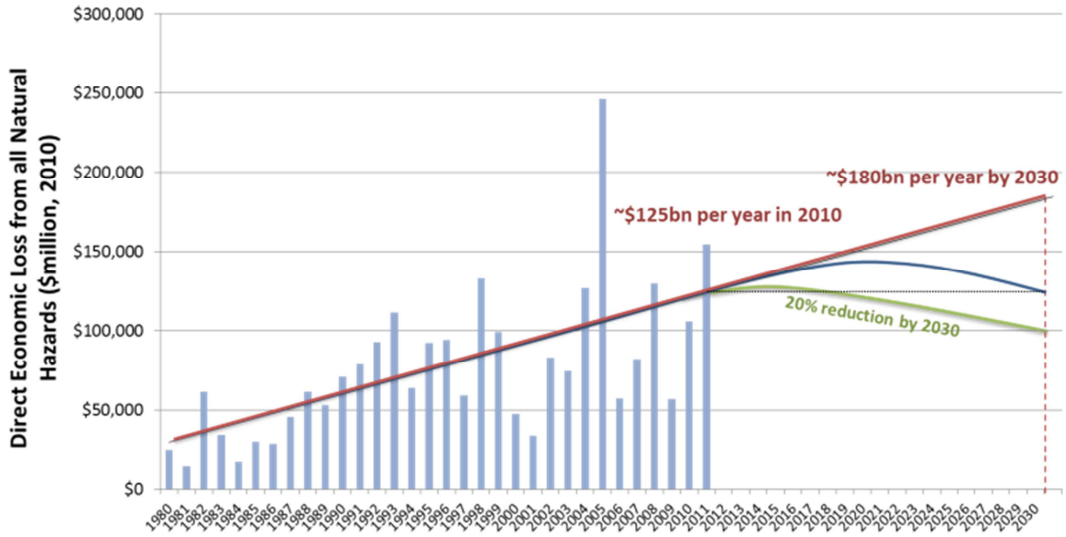
[28] Progress could be measured at interim periods (e.g. 2010-2020 and 2015-2025).

[29] Extending the target to also cover indirect losses would draw attention to the need to act to reduce the drivers here (including, e.g., preparedness, EWSs and social safety nets), which is crucial for poverty alleviation and securing development gains.

savings (Mechler, 2009) or capital accumulation are other potential indicators, but are subject to significant data limitations. If economic loss measures include natural capital, then the weighting measure should also account for natural capital (Section 2.2).

- **Complementary indicators:** there may be complementary role for modelled indicators, to help monitor progress year on year and to establish benchmarks (Section 2.2). Complementing an economic loss target with a broader set of indicators should also help ensure action is not limited to those sectors and areas with greatest economic value (Section 2.4).
- **Setting the level of ambition:** we suggest an aspirational target of a 20% decline in economic loss relative to output by the 2030s, but this is open to debate. The target should be set at a level that is ambitious but achievable. It should reflect an appropriate balance between the costs and benefits of action, recognising that some risk taking can be productive and beneficial (Hallegatte, 2012). We are aware of no research available to guide such a level.[30] Given this, we suggest that a desirable target for economic resilience might then be that trends in economic losses *at least decouple* from rising economic output, such that losses grow, on average, more slowly than output. This would imply that economic growth is becoming more resilient to disasters. A point of reference is that, on current trends, direct economic losses are set to rise by more than 40% by 2030 (Figure 7) and there are reasons to believe that this is an underestimate.[31]

Figure 6: Global (direct) economic losses from natural disasters (corrected for inflation)



Note: Since 1980, total losses have exceeded $2.4 trillion globally.
Source: Natural hazard data provided by Munich Re and socioeconomic data by the World Bank.

[30] Indeed, this level is likely to be different between countries.
[31] Over the coming two decades, we expect continued growth in population and wealth, but an increasingly large portion of this growth will be focused in LICs and lower-middle-income countries (LMICs), which are more vulnerable to natural hazards, and in urban areas, which tend to be located in more hazard-prone areas near coasts and rivers (UNISDR, 2009a). At the same time, climate change will, on average, increase the intensity of weather extremes, pushing losses to even higher levels.

Finally, we conclude that **this target would need to be complemented by a basket of indicators that more directly reflect humanitarian priorities and poverty reduction goals** to ensure action is directed at the most vulnerable in society. The next section considers the design of such a basket of indicators.

2.4 A basket of indicators of economic resilience

In this section, we propose a basket of indicators that could complement the target proposed in Section 2.3 (or another target). ODI suggests there are five criteria for an effective indicator:

1. Can progress be measured every year?
2. Do reliable, comparable, disaggregated data already exist or can they be developed?
3. Is measurement likely to be relatively transparent/corruption free?
4. Is there capacity to measure progress everywhere or can it be developed easily?
5. Does the indicator link to the target?

Indicators should be more focused on specific actions, for example 'DRR integrated within the national development plan', and should aim to motivate appropriate action at the national, sectoral and local scales. They should also capture the main risks (e.g. risks to the agriculture sector) and priorities (e.g. reducing poverty). The basket of indicators will therefore need to be tailored to a country, sector or locale.

We propose a possible basket of indicators, drawing on those already used today (Table 4). We have limited the number to 10 for simplicity and ranked each against the 5 ODI criteria (0 = not at all, 1 = somewhat, 2 = definitely) as in Section 2.3.

From the list given in Table 4, different actors (firms, sectors) and countries can select the most appropriate three to five indicators for their circumstances. For example, a HIC might select Indicators I, II, V, VIII and X. A low-income agricultural economy might select Indicators, I, II, III, IV and XI.

Note that all the indicators given in Table 3 could also be added to this list. In addition, many of the existing MDG indicators will be indicators of resilience to natural hazards, for example proportion of the population below $1 per day (Indicator 1.a) and proportion of the urban population living in slums (Indicator 7.10).

Table 3: Indicators of disaster resilience

	Indicator type	Proposed indicator	Can progress be measured every year?	Do reliable, comparable, disaggregated data already exist /can they be developed?	Is measurement likely to be transparent?	Is there capacity to measure progress everywhere or can it be developed easily?	Does the indicator link to the target?
I	**Input-based, national**	National DRR and resilience plans adopted and budgets earmarked in national development plans, and integrated into national, sectoral and local programmes (Mitchell, 2012)	2	2	2	2	2
II	**Outcome-based, national**	Fraction of GDP allocated to DRR and preparedness (Matyas and Pelling, 2012)	2	2	1	2	2
III	**Outcome-based, national**	Annual spending on humanitarian relief and reconstruction financing* (IRDR, 2012; Mitchell, 2012)	1	2	2	2	2
IV	**Outcome-based, sectoral**	% loss of agricultural output	1	2	2	2	2
V	**Output-based, multi-scale**	% of critical infrastructure (schools, hospitals, utilities) at risk from natural hazards (IRDR, 2012)	2	2	2	2	2
VI	**Output-based, multi-scale**	% of fixed assets (buildings and infrastructure) at risk from natural hazards	2	1	1	1	2
V	**Output-based, multi-scale**	% of population in areas that are at risk from natural hazards	2	1	1	1	2
VI	**Output-based, local**	% of population with ability to access disaster risk information and EWSs	2	2	2	2	2
VII	**Output-based, local**	% of firms adopting recognised standards for business continuity and risk management	2	2	2	2	2
VIII	**Output-based, local**	% of population with access to formal or informal risk transfer/sharing (Matyas and Pelling, 2012) (including insurance and social safety nets)	2	2	2	2	2
XI	**Impact-based, local**	# of people entering poverty owing to a disaster	1	2	2	2	2

X	**Outcome-based, local**	Total economic losses per unit output by sector and region	1	1	0	2	2

Note: * This should not be seen as a negative indicator.

2.5 Final thoughts

In this chapter, we have appraised a range of possible indicators of economic resilience. A full analysis of the advantages and disadvantages of economic indicators relative to other types of indicators is beyond our scope, but we are able to draw the following conclusions:

1. Economic indicators are important in capturing the immediate and long-run impacts of disasters on development, human security and poverty, and may help motivate action to reduce risks *ex-ante* from a broad range of actors. An outcome-based indicator like economic loss could therefore be a highly relevant target within the post-2015 framework.
2. However, outcome-based indicators do come with measurement challenges. Particularly important for the post-2015 framework is the problem that progress cannot be monitored annually. To make these indicators operational will also require a significant investment in capacity at international, national and local levels (which could itself be beneficial). In assessing the suitability of economic loss as a target for resilience, one must weigh up its high relevance with the operational challenges involved.
3. To help overcome these challenges, we recommend complementing the target with a basket of indicators that monitor more specific actions and drivers of resilience, like annual spending on DRR, that are more easily measurable on an annual basis.
4. Finally, economic indicators and targets should be complemented by a range of indicators that more directly reflect humanitarian priorities and poverty reduction goals. Economic indicators alone do not capture the humanitarian impacts of disasters well. Complementing an economic target with a broader set of indicators should ensure that action is focused appropriately.

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http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8354.pdf.

References

Bandura, R. 2008. A Survey of Composite Indexes Measuring Country Performance: 2008 Update. UNDP/ODS Working paper. Office of Development Studies, United Nations Development Programme, New York.

Baritto, F. 2009. Disasters, Vulnerability and Resilience from a Macro-economic Perspective, Lessons from the empirical evidence Background paper for the 2009 ISDR Global Assessment Report on Disaster Risk Reduction.

Birkmann, J., 2007. Risk and vulnerability indicators at different scales: applicability, usefulness and policy implications. Environmental Hazards 7, pp 20-31.

Bollin, C., Hidajat, R., 2006. Community-based disaster risk index: pilot implementation in Indonesia. In: Birkmann, J. (Ed.), Measuring Vulnerability to Natural Hazards—Towards Disaster Resilient Societies. UNU-Press, Tokyo, New York, Paris.

Bowen, A., Cochrane, S., and Fankhauser, S. 2011. Climate Change, Adaptation and Economic Growth. Climatic Change. Doi:10.1007/s10584-011-0346-8

Briguglio, L., Cordina, G. , Farrugia, N., Vela, S. 2008. Economic Vulnerability and Resilience Concepts and Measurements, Research paper United Nations University.

Cardona, O.D. 2011. Updating the Indicators of Disaster Risk and Risk Management for the Americas Journal of Integrated Disaster Risk Management 2011.

Cardona, O.D. 2003. Indicators for Risk Management: methodological fundamentals, Information and Indicators Program for Disaster Risk Management, IADB/ECLAC/IDEA

Clarke, D. 2012. Disaster Resilience Development Indicators: A hybrid Approach: Discussion Note

DARA, 2011. Analyses of the capacities and conditions for Disaster risk reduction. Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama and the Dominican Republic. Available at: http://daraint.org/wp-content/uploads/2010/10/RRI.pdf

Dercon, S. 2012. Is Green Growth Good for the Poor? World Bank Policy Research Paper. The World Bank, Washington, DC.

Dilley, M., Chen, R.S., Deichmann, U., Lerner-Lam, A., Arnold, M., 2005. Natural Disaster Hotspots. A Global Risk Analysis. The World Bank, Hazard Management Unit, Washington, DC.

Global Network of Civil Society Organisations for Disaster Reduction (GNDR) 2009. 'Clouds but little rain': views from the frontline 2009 - A local perspective of progress towards implementation of the Hyogo Framework for Action. Available at: http://www.google.co.uk/url?q=http://www.preventionweb.net/english/professional/publications/v.php%3Fid%3D9822&sa=U&ei=HaEGUbWvLoe2hAeV44GICg&ved=0CBoQFjAA&usg=AFQjCNGyP4ee07XWFiBkHFD0kKm7Veem7w.

Hallegatte, S. 2012, “An Exploration of the Link between Development, Economic Growth, and Natural Risks”, Policy Research Working Paper 6216, The World Bank.

Hallegatte, S. 2008, “An Adaptive Regional Input-Output Model and Its Application to the Assessment of the Economic Cost of Katrina”, Risk Analysis 28, 779–799.

Hallegatte S., J. C. Hourcade and P. Dumas 2007, Why Economic Dynamics Matter in Assessing Climate Change Damages: Illustration on Extreme Events, Ecological Economics 62, 330–340.

Handmer, J., Y. Honda, Z.W. Kundzewicz, N. Arnell, G. Benito, J. Hatfield, I.F. Mohamed, P. Peduzzi, S. Wu, B. Sherstyukov, K. Takahashi, and Z. Yan, 2012: Changes in impacts of climate extremes: human systems and ecosystems. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field,

C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 231-290

Hoeppe, P. and Gurenko, E. 2006. Scientific and Economic Rationales for Innovative Climate Insurance Solutions, in Climate Policy, Special Issue on Insurance and Climate Change [E. Gurenko, Ed.].

Integrated Research on Disaster Risk (IRDR) 2012: Key risks, opportunities and indicators for sustainable development, and potential SDGs, from the viewpoint of disaster risk management Briefing Note, November 2012

Inter-American Development Bank 2003.Study of Phase III on: Comprehensive Risk Management by Communities and Local Government. Component III: Indicators and Other disaster risks management instruments for communities and local governments. Study coordinated by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH International Services.

Inter-American Development Bank (IADB), 2010. Indicators of Disaster Risk and Risk Management. Programme for Latin America and the Caribbean Summary report. Available at:http://www.ciesin.org/confluence/download/attachments/16384145/Birkman+Vulnerability+Indic.pdf?version=1

Inter-American Development Bank 2005 Indicators of Disaster Risk and Risk Management Summary Report for WCDR, avialable at : http://www.iadb.org/publications/search.cfm?language=English&keywords=&title=disaster&author=&topics=&countries=&searchLang=&fromYear=&toYear=&x=17&y=6

International Federation of Red Cross and Red Crescent Societies 2007: Risk Reduction and Disaster Preparedness Indicators, Lima.

International strategy for Disaster Reduction (ISDR), 2011. Hyogo Framework for Action 2005-2015. Building the resilience of nations and communities to disasters. Mid Terms review 2010-2011. Available at: http://www.google.co.uk/url?q=http://www.preventionweb.net/files/18197_midterm.pdf&sa=U&ei=goESUY3wMuvL0AWArYHwCA&ved=0CBUQFjAA&usg=AFQjCNG3t3QKT-B9irT_Sy702KN-1-4qCw .

Matyas, D. and Pelling, M. (2012) 'Disaster Vulnerability and Resilience: Theory, Modelling and Prospective'. Available at: www.bis.gov.uk/assets/foresight/docs/reducing-risk-management/supporting-evidence/12-1298-disaster-vulnerability-resiliencetheory.pdf

Mechler, R., Hochrainer, S., Pflug, G., Lotsch, A., Williges, K. 2010: Assessing the Financial Vulnerability to Climate-Related Natural Hazards, World Bank Policy Research Working Paper 5232.

Mechler, R. 2009a. Disasters and Economic Welfare. Can National Savings Help Explain Post-disaster Changes in Consumption? World Bank Policy Research Working Paper 4988, The World Bank Sustainable Development Network and Global Facility for Disaster Reduction and Recovery Unit.

Mechler, R., Hochrainer, S., Pflug, G., Lotsch, A. with Williges, K. 2009b. Assessing the Financial Vulnerability to Climate-Related Natural Hazards. Background Paper for the Development and Climate Change World Development Report 2010. Policy Research Working Paper 5232. World Bank, Washington, DC

Mitchell T., 2012. Options for including disaster resilience in post-2015 development goals. Background note September 2012, Overseas Development Institute (ODI). http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7820.pdf

Muir Wood, R, 2012. THE USE OF CATASTROPHE LOSS MODELLING METHODOLOGIES TO DESIGN AND MONITOR DISASTER RESILIENCE GOALS AND INDICATORS IN A POST-MDG FRAMEWORK. RMS.

OECD 2008. Handbook on Constructing Composite Indicators. Methodology and User Guide. Paris: OECD.

Pelling, M., 2004. Vision of Risk: A Review of International Indicators of Disaster Risk and its management . UNDP – Bureau for Crisis Prevention and Recovery (BRCP). Geneva.

Pelling, M., 2006. Review of global risk index projects: conclusions for sub-national and local approaches. In: Birkmann J., Measuring Vulnerability to natural Hazards – Towards disaster resilient societies. UNU Press, Tokyo, New York, Paris.

Pelling, M., A. Özerdem and S. Barakat 2002, "The Macro-economic Impact of Disasters", Progress in Development Studies 2, 283–305.

Raddatz C. 2009, The Wrath of God: Macroeconomic Costs of Natural Disasters,World Bank Policy Research Working Paper 5039.

Ranger N., S. Hallegatte, S. Bhattacharya, M. Bachu, S. Priya, K. Dhore, F. Rafique, P. Mathur, N. Naville, F. Henriet, C. Herweijer, S. Pohit, J. Corfee-Morlot, 2011. A Preliminary Assessment of the Potential Impact of Climate Change on Flood Risk in Mumbai, Climatic Change, in press, doi:10.1007/s10584-010-9979-2

Saisana M., Tarantola S., & Saltelli A. 2005. Uncertainty and sensitivity techniques as tools for the analysis and validation of composite indicators. Journal of the Royal Statistical Society, 168(2), 1-17

Surminski, S and Williamson, A. 2012: Policy indexes – what do they tell us and what are their applications? The case of climate policy and business planning in emerging markets

United Nations International Strategy for Disaster Reduction (UNISDR), 2011. HFA Progress in Asia Pacific. Regional Synthesis Report 2009-2011. Available at:
http://www.unisdr.org/files/21158_hfaprogressinasiapacific20092011.pdf

United Nations 2008. Disaster Preparedness for Effective Response. Guidance and Indicator Package for Implementing Priority Five of the Hyogo Framework. Available at:
http://www.google.co.uk/url?q=http://unocha.romenaca.org/Portals/0/Docs/Disaster-Preparedness-for-Effective-Response%5B1%5D.pdf&sa=U&ei=Fl0GUZaMCc6QhQemrIHoBg&ved=0CB4QFjAC&usg=AFQjCNG_YuFzOkSOnmcegtfBXiDiI65z2A.

United Nations Development Program (UNDP) 2011. Caribbean implementation of the Hyogo framework for action HFA mid-term review. Available at:
http://www.google.co.uk/url?q=http://www.bb.undp.org/uploads/file/pdfs/crisis/crmi-hfamtrcarib-rt-2011-en.pdf&sa=U&ei=q7YHUfWAJaeq0AXYmYGAAg&ved=0CCsQFjAF&usg=AFQjCNH61SYFtyVM43Z8S-ctdAs1CF2OVw

UNFCCC, 2012. Current knowledge on relevant methodologies and data requirements as well as lessons learned and gaps identified at different levels, in assessing the risk of loss and damage associated with the adverse effects of climate change. United Nations Framework Convention on Climate Change (UNFCCC). Technical paper, FCCC/TP/2012/1. http://unfccc.int/resource/docs/2012/tp/01.pdf [accessed 23 January 2013].

United Nations International Strategy for Disaster Reduction (UNISDR) 2008. Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action. Available at:
http://www.google.co.uk/url?q=http://www.unisdr.org/we/inform/publications/2259&sa=U&ei=AMACUbqVK8ep0AWq84FQ&ved=0CBYQFjAA&usg=AFQjCNEsKfbw1vyjXoJC30mH41HCrIaoaA .

United Nations International Strategy for Disaster Reduction (UNISDR) 2010. Toolkit for National Platforms for Disaster Risk Reduction in Africa Contributing to the implementation of the Hyogo Framework for Action and the Africa Regional Strategy and Programme of Action for DRR. Available at:
http://www.unisdr.org/we/inform/publications/26441

United Nations International Strategy for Disaster Reduction (UNISDR) and Intern-parliamentary Union. Disaster Risk Reduction: An Instrument for Achieving the Millennium Development Goals. Available at:
http://www.unisdr.org/files/15711_parliamentariankitfinal.pdf

UNISDR Preventionweb website (access 6-02-2013) Economic of DRR. Available at: http://www.preventionweb.net/english/themes/economics/ .

Westermeyer et.al 2011. Climate Observations and African Development, Global Climate Observing System, 2011.

World Bank, 2010. World Development Report 2010: Development and Climate Change. The World Bank, Washington, DC.

WMO 2008. Analysis of the 2006 WMO Disaster Risk Reduction Country-level Survey – Capacity Assessment of National Meteorological and Hydrological Services in Support of Disaster Risk Reduction.

APPENDIX A: A review of economic indicators of disaster risk and resilience

Name	Specific Economic Target and/or indicator	Ownership	Geographic application
Risk Reduction Index (RRI)	RRI analyses the capacities and conditions affecting disaster risk reduction (DRR) and climate change adaptation (CCA) through the identification of four drivers of risk, including a wide range of socio-economic conditions, such as unemployment, poverty, limited access to health and education and deficiencies in road infrastructure.	DARA	Central and South America. The second phase of the Risk Reduction Index (RRI) in the West Africa region is currently underway.
Indicators of Disaster Risk and Risk Management / The Americas Indexing Programme	**1.Disaster Deficit Index (DDI**) The DDI captures the relationship between the demand for contingent resources to cover the losses caused by the Maximum Considered Event (MCE), and the public sector's economic resilience (ER) – e.g. availability of internal and external funds for restoring affected inventories. (See also below) **2.Local Disaster Index (LDI**) The LDI is equal to the sum of three local disaster Sub-indicators that are calculated based on data from the DesInventar database for number of deaths (K), number of people affected (A) and economic losses (L) in each municipality. **3. Prevalent Vulnerability Index (PVI).** The PVI is an average of three types of composite indicators: exposure and physical susceptibility, socio-economic fragility and lack of resilience. All three composites include economic indicators. **4. Risk Management Index (RMI)** The RMI is constructed by quantifying four public policies: identification of risk, risk reduction, disaster management, governance and financial protection. Relevant economic indicators: RR6 (Reinforcement and retrofitting of	Inter-American Development Bank (IADB-IDEA)	Latin America and the Caribbean

	public and private assets); FP3 (Budget allocation and mobilization); FP4. Existence of social safety nets and funds; FP5. Insurance coverage and loss transfer strategies for public assets; FP6. Housing and private sector insurance and reinsurance coverage.		
Hyogo indicator 'HFA Monitor'	Contains 3 economic indicators: (1.2) Dedicated and adequate resources are available to implement (4.3) Economic and productive sectoral policies and plans have been implemented to reduce the vulnerability of economic activities. (5.3) Financial reserves and contingency mechanisms are in place to support effective response and recovery when required.	United Nations International Strategy for Disaster Reduction (UNISDR)	Global
Community Based Risk Index	The total indicator system comprises 47 indicators, several of them have an economic dimension: • Exposure (E4) Local Gross Domestic Product. • Vulnerability (V10) Local resource base, (V11) Diversification (V12) stability (V13) accessibility • Capacity and measures: (C11) Local emergency funds (C12) Access to national emergency funds (C13) Access to international emergency funds (C14) Insurance Markets (C15) Mitigation Loans (C16) Reconstruction Loans (C17)Public works	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)	Global. Pilot project Indonesia.
Disaster Risk Index (DRI)	Includes indicators of physical exposure and a list of 24 socio-economic variables selected by an expert group to represent: economic status, type of economic activities, environmental quality,	United Nations Development Program	Global

	demography, etc…	(UNDP)	
World Bank Global Hotspots of Risk	absolute and relative economic losses as a proportion of GDP, calculated for each hazard	Columbia University and Worldbank	Global level with subnational scale of resolution
The International Disaster Database[32]	Number of events by type of disasters Fatalities by type of disaster Total Estimated Economic Losses by type of disaster	Emergency Events Database (EM-DAT)	Global
The Global Risk Identification Programme (GRIP)	Exposed Population (Floods, tropical cyclone and Earthquakes) Exposed GDP (Floods, tropical cyclone and Earthquakes)	UNDP	Global. Applied to about 40 countries
Disaster Deficit Index (DDI)	Economic resilience is estimated in terms of the feasible internal or external funds a government can have access once the damage has been produced, taking into consideration that the government is responsible for recovering or is the owner of the affected infrastructure. The assessment of risk and vulnerability applies use of a probabilistic tool, the CATSIM model. Depending on the specific macroeconomic and financial conditions of each country, in the *DDI* feasible internal or external funds are	Cardona et al, 2007 Mechler et.al (2009)	The Americas

[32] The Office of Foreign Disaster Assistance/ Centre for Research on the Epidemiology of Disasters (CRED) (www.em-dat.net). Université Catholique de Louvain, Brussels, Belgium

	accounted for in terms of the following components: • Insurance and re-insurance payments • Available reserves in disaster contingent funds • Aid funds and donations. • Possible new taxes that could be created in case of a major disaster event. • Budget reallocation margin, referred to the government's discretional expenditure margin. • Feasible external credit that could be obtained from multilateral bodies or from external capital markets. • Feasible internal credit from commercial banks and, in some cases, from the Central Bank.		
Economic Resilience Index (ERI)	Resilience is defined as r the *nurtured* ability of an economy to recover from or adjust to the adverse shocks to which it may be inherently exposed. Four components are considered in the computation of a Resilience Index, i.e.: i) Macroeconomic stability; ii) Microeconomic market efficiency; iii) Good governance; iv) Social development. **Macroeconomic stability:** • Fiscal deficit to GDP ratio • Sum of the unemployment and inflation rates	Briguglio et al, 2007	Global

	• External debt to GDP ratio **Microeconomic market efficiency:** • Size of government • Freedom to trade internationally		
Economic Vulnerability Index (EVI)	A country's susceptibility to exogenous shocks stems from a number of inherent economic features, including high degrees of economic openness, export concentration and dependence on strategic imports. **Economic openness** can be measured as the ratio of international trade to GDP. **Export concentration** can be measured by the UNCTAD index of merchandise trade (UNCTAD 2003:section 8), and Briguglio (1997) and Briguglio and Galea (2003) have devised an alternative index which also takes services into account. **Dependence on strategic imports** This variable can be measured as the ratio of the imports of energy, food or industrial supplies to GDP.	Briguglio et al, 2002	Global

Source: own analysis and Bandura (2008)

APPENDIX B: Proposed Targets and Indicators

Target / Indicator	**Source**
Nations to halve disaster related economic loss by 2030	UNISDR[33]
20% reduction in expected economic losses	DFID/ODI Workshop, London, December 2012
To halve economic impact of extreme disasters (expected economic loss from 1 in 50 year disasters	
To eliminate negative impact of disaster on poverty level	
Zero household asset depletion	
Halve average household income loss Disasters don't add to inequality	
Halve disaster-related economic loss in the period 2015-2030 (compared with 2000-2015)	Mitchell 2012
Direct economic losses as % of GDP over 15-year period (compared with the baseline)	
By 2025 to have 5% of national budgets committed to reducing disaster risk each year	
National DRR and resilience plans adopted and budgets earmarked in national development plans, and integrated into national, sectoral and local programmes	

Source: own analysis

[33] Integrated Research on Disaster Risk (IRDR): Key risks, opportunities and indicators for sustainable development, and potential SDGs, from the viewpoint of disaster risk management, Briefing Note, November 2012

Proposed indicators by scale

	International	**National**	**Sub-National (e.g., city level)**	**Local (individual, household and community levels. Note: not all indicators apply to each of these levels)**
Impact				- Number of people entering poverty due to a disaster
Outcome	-Disaster losses: economic and human, direct and indirect (including secondary/flow losses).	-Disaster losses: economic and human, direct and indirect (including secondary/flow losses). - Direct economic losses as percentage of GDP - Number of houses damaged / Number of houses damaged per million people per year - Annual spending on humanitarian relief	-Disaster losses: economic and human, direct and indirect (including secondary/flow losses).	-Disaster losses: economic and human, direct and indirect (including secondary/flow losses). - % loss of agricultural output due to natural hazards - % of household/firm assets lost due to natural hazards

Output	- Existence of 'effective' regional risk pools	- Effectiveness/ coverage of insurance sector - Proportion of the population living in areas that are exposed to natural hazards. - Proportion of the population living at an elevation below 5m above sea level. - Proportion of GDP in exposed areas - % of population with access to formal or informal risk transfer/sharing (including insurance and social safety nets).	- % of area complying with no development or no construction by-laws - % of buildings complying with building standards aimed at disaster resilience	- Access to formal and informal risk-transfer and –sharing (access and depth) - Access to and depth of insurance for critical infrastructure, industry, housing social and productive sectors. - % with the ability to access disaster risk information to enable informed choices - % with access to modern early warning systems - % of firms adopting standards for business continuity and risk management.

Input	- Proportion of global economy invested in risk reduction - Existence of international re-insurance sector willing to cover hazard risks - Balance between economic maximisation and resilience-based optimisation. - Transnational economic interdependence and susceptibility to contagion.	- National levels of inequality and income poverty (defined in terms of GDP per capita) and inequality - Proportion of GDP and of livelihoods reliant on agriculture and fisheries - Fraction of GDP allocated to disaster risk reduction and preparedness - Existence of disaster risk reduction legislation, policy and practice	- Proportion of development, planning and investment decisions incorporating consideration of disaster risk - Proportion of critical infrastructure and housing built to disaster resistant standards. - Sub-national distribution of inequality and income poverty (defined in terms of GDP per capita and limited non-monetary assets e.g. house ownership) and inequality - Livelihood and employment type - Diversity or homogeneity of economic sector - Investment in data management and science to identity disaster losses, and to identify and communicate hazard and vulnerability and capacity, and track this as it	- Assets (monetary, non-monetary and constraints on saving) e.g. cash savings, seed stores, livestock - Employment strategies and livelihood diversification - Dependence on agriculture (Proportion of population with rain-dependent livelihoods at risk from drought)

			changes over time.	

Source: based on Matyas and Pelling 2012 World Bank Data portal, UNISDR 2009, Mitchell 2012 and IRDR 2012