DELIVERED THROUGH THE EXPERT ADVISORY CALL-DOWN SERVICE (EACDS) LOT B:

STRENGTHENING RESILIENCE AND RESPONSE TO CRISES

Department for International Development

# TOOLS FOR MEASUREMENT OF RESILIENCE IN NEPAL

## LITERATURE REVIEW

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March 2019

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First Published
March 2019

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| CBA | Cost-benefit analysis |
| CCA | Climate change adaptation |
| CEA | Cost-efficiency analysis |
| DRR | Disaster risk reduction |
| DFID | Department for International Development |
| GoN | Government of Nepal |
| HKH | Hindu Kush Himalayas |
| ICIMOD | International Centre for Integrated Mountain Development |
| M&E | Monitoring and Evaluation |
| MCA | Multi-criteria assessment |
| MEL | Monitoring, Evaluation and Learning |
| MLVI | Multi-Level Vulnerability Index |
| PCBA | Participatory cost-benefit analysis |
| SAHR | South Asia Research Hub |
| SoVI | Social Vulnerability Index |
| VACA | Vulnerability and Adaptive Capacity |

# EXECUTIVE SUMMARY

## CONTEXT

This Literature Review presents the results of an assignment commissioned by DFID's South Asia Research Hub (SARH) on behalf of DFID's Nepal Country Office. The assignment was carried out by IMC Worldwide, in partnership with Garama 3C Ltd, and though DAI Europe. The purpose of the Review is to identify tools and methods for the measurement of resilience, that are potentially applicable to or adaptable for DFID Nepal's Resilience Portfolio and wider portfolio, over the three themes of Growth, Governance and Inclusion. The principal purpose of the Review is to identify tools and methods that can be used to assess the resilience benefits delivered by the DFID Nepal portfolio.

To operationalise the concept of resilience, it is important to identify the system (or population) whose resilience is being addressed, the hazards (shocks and stresses) to which the system needs to be resilient, and the impacts of those hazards that improved resilience is assumed or intended to reduce. This framing indicates that resilience might be measured in terms of (i) the magnitude of a particular type of hazard (e.g. earthquake, flood, drought etc.) that a system can accommodate without experiencing unacceptable harm, (ii) the magnitude of the impacts of hazard on a system (i.e. losses and damages), and (iii) the set of characteristics that influence a system's resilience to one or more hazards. This framing is used to organise the literature on resilience measurement according to the measurement approach taken (i.e. hazard, impact or system-focused approach).

## METHODOLOGY

The methodology for conducting the Literature Review consisted of the following seven steps:

1. Identification of a "long list" of literature relating to resilience measurement through keyword searches on Google and Google Scholar, and consultation with stakeholders including DFID Nepal and DFID MEL Unit;
2. Elimination of literature not relating to tools or methods for measuring resilience and identification of the measurement approach described, where relevant, plus identification of key characteristics;
3. Sorting of the remaining literature by measurement approach and elimination of less relevant literature using a set of exclusion criteria agreed with DFID Nepal;
4. Detailed assessment of relevance of literature to DFID Nepal's portfolio, based on a set of relevance criteria developed in consultation with DFID, and scoring each reference from 1-3 against each criterion (following the exclusion of further references based on detailed reading and additional exclusion criteria);
5. Assessment of quality of literature using a set of quality criteria adapted from those in the DFID How To Note on Assessing the Strength of Evidence (2014) and agreed with DFID, and scoring each reference from 1-3 against each criterion;
6. Prioritising references based on their combined relevance and quality score (from 1-3);
7. Presentation of results and identification of a shortlist of high-scoring references for further assessment and possible adoption/adaptation by DFID Nepal.

## RESULTS

### OVERVIEW OF RESULTS

A total of 718 references were examined. Once references that did not describe specific tools and methods for measuring resilience were eliminated this number fell to 500. After elimination of less relevant references based on the exclusion criteria, a total of 161 references remained. A second round of screening based on additional exclusion criteria reduced this number to 98 references, which were subject to relevance and quality scoring based on a minimum score of 1 and a maximum score of 3. Given DFID's desire for a shortlist containing something of the order of 10 tools or methods for further consideration, a threshold of 2.4 was chosen to isolate the highest scoring references. Seventeen references scored above this threshold.

The majority (12) of these are based on a systems-focused approach to measuring resilience, using either qualitative or quantitative indicators to characterise the resilience of a system, population or community in terms of a set of capacities and capabilities (e.g. socio-economic conditions, demographics, assets, infrastructure, access to resources and services, knowledge, governance, etc.). Three methods adopt an impact-focused approach, measuring the costs and benefits of resilience measures using conventional cost-benefit analysis (CBA) and participatory CBA. One method takes a hazard-focused approach, measuring resilience in terms of the time taken to recover from a hazard. These references represent tools and methods addressing a range of scales, from the household scale to the national scale.

The 17 shortlisted references represent four broad approaches/methods to measuring resilience, representing five potential entry points for measurement across the DFID Nepal resilience portfolio (qualitative assessment using scorecards can be viewed as representing a single 'method' but is applicable to the two entry points of city/municipal resilience and the resilience of local governments in rural areas). These four approaches/methods are represented by 10 of the 17 high-scoring references, with the remainder offering potentially useful lessons and insights, alternative tools, or representing potentially useful datasets. The four broadly defined methods, and associated tools and studies, are summarised below.

### METHOD 1: QUANTIFYING 'RESILIENCE DIVIDENDS' USING CBA

One of the most promising methods identified is that of **Tuan et al. (2015)** and **Tran Tuan Anh et al. (2016)**, based on conventional CBA. This method involves calculating the additional costs of building disaster-resilient infrastructure and comparing these with the (avoided) costs of damages resulting from relevant hazards. These studies apply this method to the storm-proofing of houses in Vietnam, but the method can be applied to other hazards, scales and types of infrastructure. For example, the method might be applied to assess the benefits of construction or renovation incorporating earthquake-resilient features in individual dwellings, other infrastructure, or city districts, or to flood-resilient small-scale rural infrastructure. Once typical or indicative costs and benefits have been established per unit of infrastructure, these can be used to quantify the benefits of interventions supporting disaster-resilient reconstruction or renovation.

**Alves (2015)** and **Yaron (2017)** describe participatory CBA, which can extend the conventional CBA approach by including resilience benefits that would be missed in conventional CBA analysis, providing a more complete description of the benefits of resilience interventions or the 'resilience dividend'. This can further strengthen the case for resilience interventions, participation and co-financing. Demonstrating the benefits of resilience building can incentivise private investment in resilience and adaptation measures, potentially shifting some of the costs of disaster response away from public to private resources. This might be further encouraged through mechanisms such as interest-free loans, revolving credit facilities, one-time resilience building transfer payments/ subsidies, and hazard insurance for individuals or organisations engaging in such resilience building.

CBA-based methods are most relevant to programmes targeting infrastructure, such as the Rural Access Programme under the Growth theme, the Nepal Health Sector Support Programme and proposed Gurkha WASH and DRR Programme under Governance, and the resilience-related programmes clustered under the Inclusion/Inclusive Development theme.

### METHOD 2: TRACKING RESILIENCE USING SCORECARD-BASED INDICATORS

The use of scorecards to assess the resilience of local governments and the areas and populations for which they are responsible represents two entry points for measuring resilience: at the city or municipality (nagarpalika) level, and at the local government level in rural areas (i.e. the guanpalika level).

The most promising tool for assessing resilience at the city/municipal level is the **UNISDR (2014) Disaster Resilience Scorecard for Cities**, which offers a good balance between user-friendliness and comprehensiveness. This consists of scorecard-based indicators grouped under 10 'Essentials for Making Cities Resilient', representing 47 indicators that can be used for a preliminary or detailed assessment of resilience. The preliminary assessment is carried out in by a working group over 1-2 days in a multi-stakeholder workshop. Most scorecards/questions are likely to be relevant to large municipalities in Nepal, although it would be

prudent to assess the extent to which this tool might be adapted to take account of local (e.g. governance) contexts. The tool is transparent, user-friendly, and readily downloadable in both Excel and pdf format.

At the scale of the ward or gaunpalika, the **Torrens Resilience Institute (2012) Community Disaster Resilience Scorecard Toolkit** and the **GOAL (2015) Toolkit for Measuring Community Disaster Resilience** are relevant. These use scorecards to characterise resilience at the community level but could be adapted for use at the gaunpalika level, either through ward-level assessments or directly at the scale of a gaunpalika. The Torrens Resilience Institute toolkit relies on a mix of qualitative and quantitative data and is more reliant on the existence of secondary data than the GOAL toolkit, which uses only qualitative information generated by the questions in the scorecards. These tools should be easily adaptable to the Nepal context.

All three of the above tools involve stakeholders answering questions relating to socio-economic conditions, governance, hazards and associated risks, disaster planning and response, and other related areas. This will be achieved most effectively through dedicated workshops that bring together relevant stakeholders, including local government / city planners and other staff, and representatives of communities and other key stakeholder groups. This would require significant engagement with these stakeholders on the part of DFID Nepal and its partners. However, the convening of such workshops on a regular (e.g. annual or biennial) basis to complete the scorecards would enable changes in resilience to be tracked over time effectively. For all three tools, the results of these assessments can be displayed using 'radar' or 'cobweb' diagrams that represent all the dimensions of resilience and reveal how these are changing over time. These can provide a rapid and powerful means of illustrating where resilience is static or in decline, and thus demonstrate where action to build resilience is most urgently needed. Conversely, where resilience is improving, the measures taken to address that particular dimension of resilience can be identified and interrogated to assess their contribution.

If regular reporting using modified versions of the above tools could be embedded at the local government level, this would provide a powerful tool for tracking changes in resilience (e.g. before and after resilience interventions) without the need to gather large amounts of secondary data. Initial investment in establishing such a mechanism in key areas targeted by DFID Nepal and its partners could facilitate effective resilience tracking in the medium to long-term.

The above methods are relevant across the three main themes of DFID Nepal's portfolio, but are particularly relevant to programmes under the Governance theme (Governance, Governance Facility, Local Government Support Programme) and Inclusion theme (Post-Earthquake Reconstruction, Strengthening Disaster Resilience, Climate Smart Development) (Annex 2). They represent two entry points for measuring resilience, at the municipal (nagarpalika) level and at the level of local governments (gaunpalikas) in rural areas.

### METHOD 3: MEASURING RESILIENCE USING SECONDARY DATA

**Cutter et al. (2010), Burton et al. (2015)** address resilience at the county level in the United States, at scales that are broadly comparable with those of Nepal's new local government units. They represent the most methodologically relevant of the methods based on secondary data. These studies are notable in the way they identify relevant indicators. Cutter et al. (2010) assess the correlations between potential resilience indicators to reduce the number of indicators, eliminating redundant variables where significantly high correlations were found. Burton et al. (2015) examine the relationship between potential resilience indicators and disaster recovery times to identify variables that are good predictors of recovery, placing the identification of resilience indicators on a sound empirical footing. Either of these methods could be used to identify useful indicators of resilience from available secondary data in Nepal. The method of Burton is recommended if variables representing potential resilience indicators can be validated against disaster outcome or recovery data.

### METHOD 4: MEASURING RESILIENCE BASED ON RECOVERY TIMES

**Vollenweider (2015)** measures vulnerability and resilience in terms of household food consumption and the time taken for a household to recover to pre-shock levels of consumption following a hazard such as a drought or flood. A weather vulnerability index is defined, in relation to a specific hazard of a given magnitude, as the difference in household food consumption between (i) normal conditions and consumption associated with the

poverty line, for households above the poverty line, and (ii) normal conditions and hazard conditions, for households below the poverty line. A climate vulnerability index is then constructed as the expected or average increase in the poverty gap in the year following a weather shock, based on the probability of all shocks given the expected distribution of shocks of different magnitude.

A weather resilience index is defined in relation to a specific hazard, as the expected time for a household to recover from a weather shock to its pre-shock level of consumption. A household that can recover before the next shock is deemed to have some resilience. A climate resilience index is then constructed that measures the expected or average recovery time across multiple households, based on the probability of all shocks.

This method might be adapted to address a variety of hazards, with vulnerability and resilience using a variable that is a proxy for the functioning of a system. For example, vulnerability might be measured in terms of changes in the capacity or performance of transport, water or energy infrastructure following a shock, with the time taken for the infrastructure to return to its pre-shock capacity/performance being used to measure its resilience to a specific hazard of a given magnitude. Vollenweider (2015) measures vulnerability and resilience to drought that recurs every 5 years on average. In Nepal, this method could be applied to households or infrastructure in relation to annual floods, or to earthquakes with much longer return periods. When applied to climate related hazards that recur on multi-annual timescales, the effects of climate change on the magnitude and frequency of these hazards would need to be taken into account.

This method is particularly relevant to programmes targeting communities and households through social protection measures, but potentially has much wider application.

## OTHER METHODS/DATASETS AND CONCLUDING REMARKS

The individual studies and tools described above represent four broad approaches/methods for measuring resilience that are potentially applicable to the DFID Nepal portfolio, and to development interventions in Nepal more generally, without the need for resource-intensive campaigns to gather additional primary data. Used in combination, these tools and methods should provide a nuanced picture of resilience across different areas of DFID Nepal's portfolio, in terms of avoided costs to (and potentially beyond) infrastructure, preparedness and responsiveness, population and system resilience, and ability to recover from shocks.

Relevant data relating to population vulnerability and resilience have been generated for the Karnali and Central Terai regions of Nepal by the **Global Flood Resilience Alliance (Keating et al. 2017)**; for the whole of Nepal at the scale of the VDC in the form of the **Social Vulnerability Index (Aksha et al. 2019)**; and for the Koshi region as part of ICIMOD's[1] **Multi-Level Vulnerability Index (MLVI) (Gerlitz et al. 2017)**[2] These datasets might be useful in terms of baselines and secondary data, but would require significant resources to replicate.

**The Economist (2014)** and **Guillaumont (2017)** present national level resilience indices that include Nepal and serve as useful comparisons with sub-national indices; the former's **South Asia Women's Resilience Index** is a useful check for gender relevance. The **Arup/Rockefeller Foundation (2015) City Resilience Framework** is a potential alternative to the UNISDR scorecard tool but is less user-friendly and requires a greater level of input due to the larger number of indicators/variables. **Shim and Kim (2015)** present a study of urban resilience in South Korea, using secondary data at a similar scale to Cutter et al. (2010) and Burton et al. (2015) that is also instructive in terms of the method and types of indicators used.

The MEL Unit[3] is already developing scorecard indicators based on 13 indicator areas identified from a review of existing indicators used in Nepal (IOD PARC 2018), including by Practical Action through their implementation of the methodology described in Keating et al. (2017) and by Lutheran World Relief. These

[1] The International Centre for Integrated Mountain Development (ICIMOD) is a regional intergovernmental learning and knowledge sharing centre serving the eight countries of the Hindu Kush Himalaya and based in Kathmandu, Nepal.

[2] This study is an 'outlier' scoring below the threshold of 2.4 that was deemed relevant due to its geographic focus.

[3] DFID Nepal MEL Unit

might fulfil the same function as, or alternatively complement, the above scorecard and secondary data methods.

# PART I: BACKGROUND AND METHODOLOGY

## 1 INTRODUCTION

### 1.1 PURPOSE AND STRUCTUE OF THIS LITERATURE REVIEW

This Literature Review presents the results of an assignment commissioned by DFID's South Asia Research Hub (SARH) on behalf of DFID's Nepal Country Office. The assignment was carried out by IMC, in partnership with Garama 3C Ltd, and though DAI Europe. The purpose of the review is to identify tools and methods for the measurement of resilience, that are potentially applicable to or adaptable for DFID Nepal's Resilience Portfolio and wider portfolio.

The review discusses the background and context of DFID Nepal's desire for resilience measurement tools, focusing on the nature of the Resilience Portfolio and the development context in Nepal. It then presents a brief conceptual framework for the measurement of resilience, based on DFID's Resilience Framework and three approaches to resilience measurement related to this framework. These approaches differentiate between the measurement of resilience in terms of the magnitude of a disturbance that a system can accommodate (hazard approach), the actual or anticipated experienced or avoided losses resulting from a disturbance (impact approach), and the characteristics or attributes that influence a system's ability to cope with a disturbance (system approach). These three approaches are used to organise the analysis and the interpretation of results.

Discussion of the background, context and framing of the Review is followed by a detailed outline of the methodology used to carry out the review, and the presentation of results. Results summarise the tools and methods examined during the review, and present in more detail the most promising tools and methods for use across DFID Nepal's Resilience and wider portfolio.

### 1.2 THE NEPAL CONTEXT

The Government of Nepal (GoN) has a long-term development strategy "*Envisioning Nepal 2030*". The vision is for Nepal to graduate from Least Developed Country (LDC) status by 2022 **(Bank 2016).** A central strategy under this vision is "*building resilience against the risk of natural disasters and climate change*". This strategy is reflected in the 14th Periodic Plan 2016-2017 to 2018-2019 and in UNDP programming priorities **(UNDP 2018)**, as ratified by GoN. The UN System in Nepal plays a significant role in resilience building as co-lead, with government agencies, of the country's humanitarian response for preparedness and during disasters.

Envisioning Nepal 2030 identifies greater resilience to disaster and other shocks as one of six transformational initiatives to remove structural constraints and facilitate key growth drivers in the economy **(Bank 2016)**. The importance of resilience to GoN national development strategies is closely linked to recovery from the 2015 earthquakes, notably that "*resilient cities and human settlements*" is an outcome of the 2016 New Urban Agenda's Plan of Action. This Plan seeks to address 30 strategic issues over five years to 2021 **(GoN 2016)**.

An initial examination of GoN documentation reveals minimal GoN policy guidance on resilience measurement and metrics, reinforcing the need to learn from the wider global body of literature and practice. There are no resilience indicators or measurement metrics attached to the Plan of Action. Documentation relating to UN system investments in Nepal references indicators to measure preparedness, response and recovery at the outcome level over the period to 2022, based on measures of loss of life and economic loss and damage.

### 1.3 DFID NEPAL'S RESILIENCE AND WIDER PORTFOLIO

DFID is supporting the GoN through a number of programmes under its Resilience Portfolio. Resilience is a cross-cutting theme for DFID Nepal, as the country is subject to numerous natural hazards, and its development status makes it particularly vulnerable to other shocks, for example economic shocks, increases in commodity prices and health-related shocks. Resilience to these shocks is critical for poverty reduction, economic growth, a successful transition to the new federal system. Nepal is highly prone to natural hazards - floods, landslides and earthquakes. A combination of climate change, rapid urbanisation and mountainous terrain makes Nepal highly vulnerable to such hazards. Repeated shocks associated with natural hazards have hampered poverty

reduction efforts and meant that progress on poverty reduction has been geographically uneven. Climate change has resulted in an intensification of hydro-meteorological hazards, and this intensification will continue indefinitely as climate change progresses.

DFID Nepal's Resilience Portfolio, which this literature review supports, is a recognition of the importance of building resilience into investments in a cross-cutting manner. The UK's climate and disaster resilience programmes in Nepal are focused on strengthening the institutional architecture for Disaster Risk Reduction (DRR) and supporting a multi-hazard approach to risk reduction in vulnerable communities. These programmes aim to increase preparedness and improve the capacity of Nepal's disaster management systems as well as building the resilience of infrastructures (e.g. roads, hospitals, water supply) and people to earthquakes and other shocks. **Annex 1** provides an overview of DFID Nepal's Resilience Portfolio.

### 1.3.1 DFID Nepal's portfolio at large: key themes

Discussions with DFID Nepal, and examination of materials provided by DFID Nepal and materials presented at workshops held in the DFID Nepal office in Kathmandu on 28th and 29th November 2018, identifed three key and overlapping themes in DFID Nepal's programming, as well as three 'Big Change Areas', which broadly map onto each other as follows:

| Key Themes | Big Change Areas |
|---|---|
| 1. Governance / Transition to Federalism | **Effective and legitimate institutions**, involving the implementation of the federal constitution and accountability to citizens in this context through: empowerment, decision-making, representation, accountability, effective governance structures, rule of law); |
| 2. Growth / Economic Transition | **Inclusive economic growth**, involving transformational growth that offers more equal access to prosperity through: regulatory business frameworks, investments, competition, skills, migration, remittances, infrastructure services for all; |
| 3. Inclusion / Inclusive Development | **Leave no one behind**, such that all citizens enjoy their constitutional rights including: services, meeting of basic needs, gender equality, access to justice, protection of the most vulnerable from shocks, social protection, accountability, peace. |

While the Big Change Areas map onto the three key themes, they also cut across them and demonstrate the linkages between them. For example, inclusive economic growth by definition links Growth and Inclusion. The three key themes can also be broken down into different elements; for example, Growth encompasses (i) 'inclusive growth', which includes market and skills development, rural livelihoods and small-scale infrastructure at the community level, and (ii) macro growth, which covers economic policy, trade and large-scale infrastructure, as well as special economic zones and disaster recovery for the Nepal Rastra Bank.

### 1.3.2 Linking the Resilience and wider portfolios

The DFID Nepal 2-page document on Resilience Mainstreaming defines three key themes, of **Growth, Governance** and **Resilience,** implicitly mapping Resilience to **Inclusion**. DFID Nepal has linked resilience and inclusion explicitly through an **Inclusive Growth and Resilience Strategy,** which includes the following programmes:

1. Rural Access Programme 3
2. Climate Smart Development
3. Strengthening Disaster Resilience in Nepal
4. Sabalaa Support for Economic Empowerment of Women
5. Samarth MDP

The Resilience Mainstreaming Strategy document identifies programmes 2 and 3 above as resilience programmes, along with Post-Earthquake Reconstruction, and identifies other programmes that are

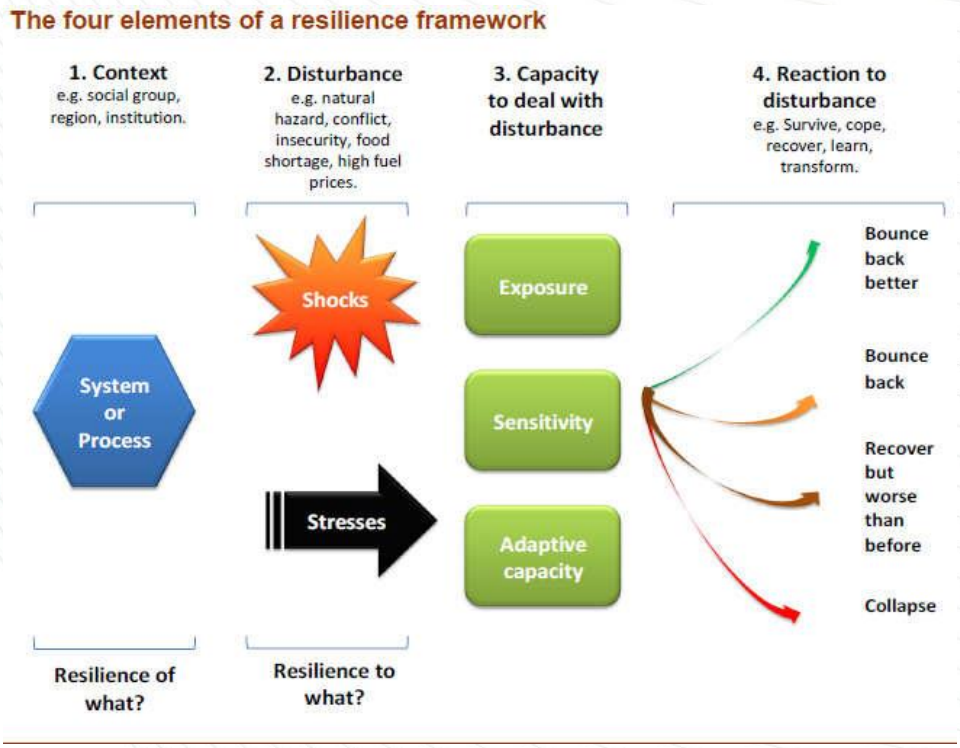
contributing towards resilience under the Growth and Governance themes. The Mainstreaming Strategy also identifies future programmes that might mainstream and contribute to resilience in the areas of social protection, urban development, capacity building for sub-national government/new modes of service delivery, productive jobs, and a local infrastructure development fund.

**Annex 2** maps existing and pipeline programmes listed in the Mainstreaming Strategy document to activities under the Big Change Areas, and identifies results, milestones and indicators associated with these programmes and Change Areas. This mapping is used to identify categories of resilience measurement that form the basis of assessments of the applicability of resilience measurement tools and methods to the DFID Nepal portfolio (Step 4 in the methodology outlined below).

# 2 MEASURING RESILIENCE: A CONCEPTUAL FRAMEWORK

In recent years, the focus of the development community has shifted from vulnerability to resilience. This shift has also occurred in the community of practice working on climate change adaptation. Resilience features in all four of the major development frameworks: the Sendai Framework for Disaster Risk Reduction, The United Nations Sustainable Development Goals, the Paris Agreement on Climate Change, and the World Humanitarian Summit Framework **(Peters et al. 2016)**.

**Figure 1 The DFID Resilience Framework (DFID 2011)**




There are many different definitions and conceptualisations of resilience, and these vary across contexts and sectors. The definitions of resilience that are most pertinent to this study are those that relate to development and disaster risk. However, definitions from economics, finance, infrastructure development, climate change adaptation, ecology and conflict management are also pertinent

Some definitions from key sources and sectors are detailed in **Annex 3** of this review. Most of these definitions reflect the longstanding ecological view of resilience as the ability of a system to accommodate a shock while maintaining its essential character and functions **(Holling 1973, Walker et al. 2004)**. However, most go beyond

the idea of resilience as simply 'bouncing back' to maintain a steady state, and see the continued capacity of systems to adapt, learn and transform themselves (for example in pursuit of development goals) as central to resilience. The DFID definition casts this in terms of community/economic development and growth, or the ability to 'bounce back better' (**Figure 1**).

The conceptual framework for this literature review is provided by the DFID Resilience Framework (**DFID 2011** and **Figure 1**). The DFID Resilience Framework addresses the resilience of a **system** (or process) to a **shock or stress** (disturbance or hazard), and describes the **reaction** of the system to the shock, which is mediated by the system's **capacity** to deal with the shock or stress. The shock or stress will have an **impact** on the system which, depending on the system's reaction, may be short-lived (bouncing back or bouncing back better) or persistent (recover but worse than before or collapse) (Figure 1).

The DFID Resilience Framework thus suggests three ways in which resilience may be measured[4]:

1. In terms of the magnitude of the shock or stress that a system can accommodate without experiencing a specified level of harm – i.e. a ***hazard-focused approach***;
2. In terms of the actual or anticipated consequences of a hazard for a system – i.e. an ***impact-focused approach***;
3. In terms of the characteristics or attributes of a system that influence its capacity to deal with a hazard – i.e. a ***system-focused approach***.

All three of the above approaches are represented in the literature relating to resilience and climate change adaptation. The hazard-focused approach is closely related to the coping range concept (e.g. **European Commission 2013**). The impact-focused approach includes calculations of actual or anticipated losses or avoided losses from disasters or climate change **(e.g. Zimmerman et al. 2010, UNFCCC 2011)**. The system-focused approach is used widely in studies that define dimensions of resilience and identify associated system-related indicators, and also reflects approaches based on the **IPCC (2007)** definition of vulnerability, the DFID Livelihoods Framework **(Solesbury 2003)**, and other approaches that characterise resilience or vulnerability in terms of capitals and capacities **(e.g. FAO 2016)**.

**The hazard, impact and system focused approaches to measuring resilience are used to frame this literature review and to organise resilience measurement tools and methods for analysis.**

# 3 RESILIENCE MEASUREMENT IN NEPAL

Despite the proliferation of tools and methods for resilience measurement, development agencies and other actors in the field of development are struggling with how to measure resilience in practice, on temporal and spatial scales that are relevant to their programming at large. With a few exceptions, such as the measurement of resilience to food insecurity, resilience measurement in the development sector is in its infancy, both globally and in Nepal. Nonetheless, some organisations are piloting resilience measurement inside Nepal, while others have gathered data for the related activity of measuring vulnerability to natural and other hazards.

One of the most notable actors in the area of resilience measurement in Nepal is Practical Action, which is applying the methodology developed by the Zurich Insurance led Global Flood Resilience Alliance (of which it is a member) to measure community resilience to floods in the Karnali region and the central Terai[5]. This methodology is discussed in the results section of this review, based on documentary sources and information gathered in a meeting with Practical Action in Kathmandu. In brief, the methodology uses 88 indicators to characterise community resilience based on information from household surveys, focus groups, key informants

[4] For a more detailed discussion of these approaches to resilience measurement, see the First Progress Report submitted as part of this Tools for Resilience Measurement in Nepal Literature Review assignment, submitted to DFID Nepal on 20th November 2018.

[5] Based on an interview with Sunil Acharya and Gopal Ghimire at Practical Action Nepal in Kathmandu on 30th November 2018.

and secondary sources. It has been applied in 75 communities, each representing some 75 to 300 people, and will be applied in additional communities in the near future.

The scoping note on resilience measurement prepared by the MEL Unit **(IOD PARC 2018)** compares the indicators used by Practical Action in the above contexts with resilience indicators used by Lutheran World Relief in Nepal, and identifies 22 indicators that are common to both methods, spanning four 'capitals' (financial, human, physical, social). The MEL Unit scoping note also identifies 12 key resilience indicators from a wider review of literature that are judged to be 'routinely monitorable', which address access to services and key infrastructure, governance and disaster responsiveness, and issues related to livelihoods. The MEL Unit has reviewed the publicly available log-frames of DFID programmes against these indicators.

The indicators discussed above clearly align with the system-focused approach to resilience measurement. However, DFID has also expressed interest in economic/financial metrics (e.g. avoided losses, economic returns on resilience investments) for resilience that are aggregable across contexts and programmes, and would most likely align with the impact-focused approach. During workshops with DFID and the MEL Unit in Kathmandu in November 2018, considerable interest was also expressed in ways of framing resilience in terms of response and recovery to shocks, which would also align with the impact approach.

These observations suggest that DFID Nepal would benefit from a small number of tools, methods or metrics for measuring resilience in different ways, spanning well-established system-type indicator approaches, impact-type measures of costs, losses and/or benefits, and impact-type measures based on response and recovery to shocks.

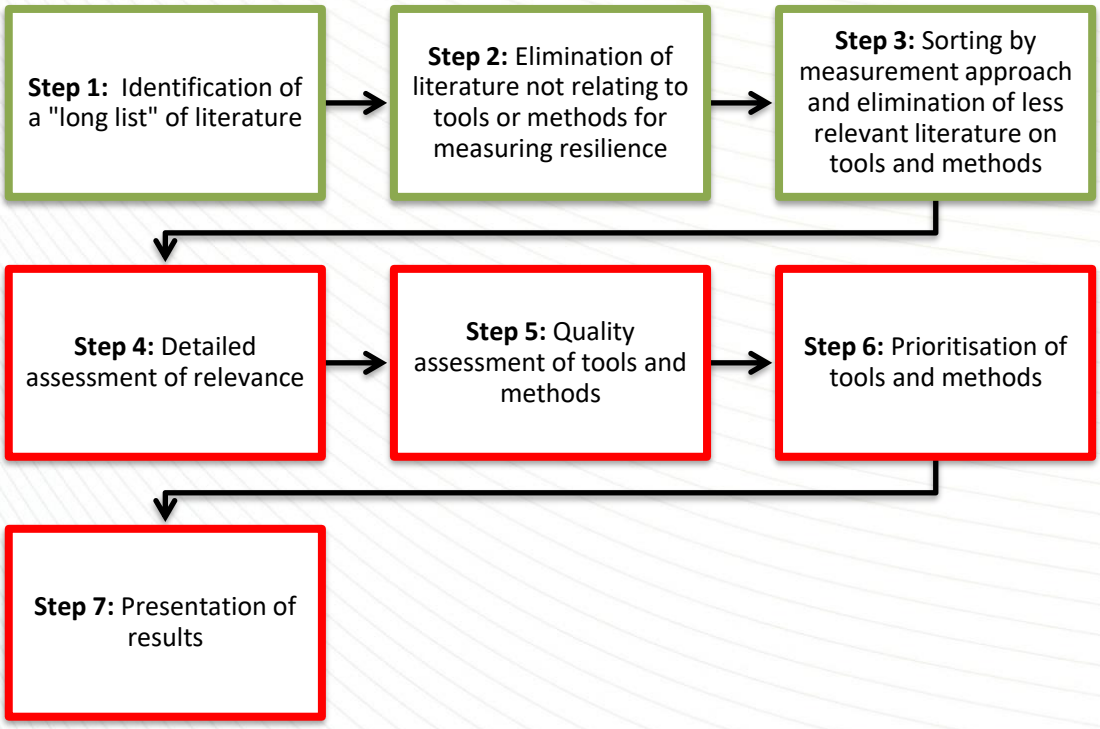
Another clear message from these workshops was the need to focus on securing development in the short-term in the form or poverty reduction, better access to services, and improved disaster planning and responsiveness, to address the suite of hazards and associated vulnerabilities already confronting Nepal. A recurrent theme was that people cannot be resilient if they are below the poverty line and lack access to basic services. To a large extent, resilience therefore results from basic development. However, the services, infrastructure and institutional arrangements underpinning this development themselves need to be resilient if the benefits they deliver are to be sustained in the face of shocks. Indeed, the ultimate purpose of resilience is to secure development and human wellbeing in the face of hazards that might undermine it. There is therefore a circularity to the relationship between development and resilience, and this must be acknowledged.

Similarly, while there is an urgent need to deliver resilience to shocks associated with existing hazards in the near term, resilience to longer-term stresses and potential future hazards must be built into development if it is to be sustainable in the longer term, for example in the face of climate change. Building adaptive capacity therefore should be a key component of resilience building activities.

# 4 METHODOLOGY

This literature review involves the identification of a set of references relating to resilience measurement through a literature search, and the subsequent assessment of the relevance and quality of these references to identify tools and methods that might be relevant to DFID Nepal's Resilience Portfolio and wider portfolio. The methodological steps are illustrated in Figure 2, and each step is described in more detail below. Throughout the assignment, the literature review team has engaged with DFID Nepal and the MEL Unit (remotely and through meetings in Kathmandu), as well as external experts and stakeholders. Representatives of organisations operating in Nepal that are active in resilience measurement have also been consulted. Details of engagement with DFID and non-DFID stakeholders are provided in **Annex 4**. Additional details of certain methodological steps are provided in **Annex 5** where appropriate.

**Figure 2 Methodology for the literature review. Steps in green were carried out prior to the submission of the Draft Literature Review; steps in red were carried out in the final phase of the review.**




## STEP 1: IDENTIFICATION OF A 'LONG-LIST' OF LITERATURE

Literature relating to the measurement of resilience was identified using the following techniques:

- Keyword searches on Google and Google Scholar, to identify general literature and academic literature respectively. General literature includes grey literature such as working papers, reports, government documents, etc., as relevant. Academic literature consists predominantly of peer-reviewed papers.
- Sorting and prioritisation of the literature listed in the DFID Nepal spreadsheet on resilience measurement tools.
- Engagement with DFID Nepal, the MEL Unit, Practical Action Nepal, and thought leaders in the field of resilience measurement.
- Review of material of the 2018 Resilience Measurement, Evidence and Learning Conference[6] (12th – 15th November 2018, New Orleans, USA).

Literature searches were limited to Google and Google Scholar for the following reasons:

1. Sources on other databases (e.g. Ingenta Connect, Science Direct, Web of Science, JSTOR, etc.) tend to be represented in the results of searches on Google Scholar, as attested by the number of sources on such databases identified through in the Google Scholar searches;
2. Searching multiple databases would therefore be largely redundant and reduce time and cost efficiency;

[6] This conference was organised by the Resilience Measurement, Evidence and Learning (RMEL) Community of Practice (CoP). RMEL CoP is a growing network of over 250 resilience measurement, evaluation and learning specialists committed to making the concept of resilience actionable (http://www.measuringresilience.org/).

3. Many descriptions of resilience measurement tools and methods are in the form of reports and guidance published as 'grey literature' by organisations involved in development practice, that are represented in the results of Google searches but not in searches on academic databases.

Searches on Google and Google Scholar consisted of terms related to measurement and quantification combined with the term 'resilience'. These were then qualified with additional mandatory terms related to specific sectors, hazards and topics of particular relevance to the review. A list of search terms is provided in **Annex 5**.

Successive pages of search results were examined until either (i) all pages of results had been examined, or (ii) the majority of results on a page were judged to be irrelevant to the topic of resilience measurement or consisted of repetitions of earlier results (e.g. different versions of the same paper). Where searches returned only a few pages of results.

Searches were limited to the period from the beginning of 2013 to late 2018 (when this review was carried out). This time range was selected to focus the search on recent literature published over the period during which interest in resilience and its measurement has grown significantly in the fields of international development, climate change adaptation, and more generally. This growth in interest is reflected in the frequency of searches relating to resilience, which increase after the beginning of 2013 as illustrated in **Annex 6**. Where references from this period highlighted earlier studies of particular interest, these were included in the list of literature for review.

References that were judged to be potentially relevant to the purpose of the literature review were downloaded and imported in the Zotero reference manager to create a 'long-list' of references for further analysis.

References relating to resilience measurement listed in the Resilience Spreadsheet provided by the MEL Unit were cross-referenced against the long-list of references resulting from the online searches to ensure that no relevant references had been omitted. Other references suggested by stakeholders consulted by the Review Team were similarly cross-referenced and included in the long-list where appropriate.

### STEP 2: ELIMINATION OF LITERATURE NOT RELATING TO TOOLS OR METHODS FOR MEASURING RESILIENCE

Once the initial 'long-list of literature had been identified, the Review Team divided the references into 3 sets of equal number. Each member of the team reviewed their set to eliminate references that did not describe a tool or method for measuring resilience, based on a rapid review of abstracts or, where abstracts were not available, of the general text of the reference. Reviews were removed from the long-list and treated separately (see Box 1).

**Box 1. Review of reviews**

Reviews were removed from the main body of references and examined separately to identify any references describing additional tools and methods that had been missed by the literature search. These references were then subjected to the same methodological steps as those remaining in the original long-list after the removal of references that did not describe tools and methods. The assessment of additional references identified from the reviews was carried out separately from the main analysis representing Steps 1-3, with the resulting references being integrated with the main body of references at Step 4 (detailed assessment of relevance). This was for reasons of practicality, given the need to carry out a relatively rapid initial assessment of the literature for inclusion in the Draft Literature Review submitted halfway through the assignment; assessment of 18 reviews resulted in the identification of 96 additional references that were processed in the second phase of the review process.

Each reference that was not eliminated was characterised as representing one of the three approaches to resilience measurement defined in Section 2 above, namely:

1. **Hazard-focused approach:** resilience measured in terms of hazard characteristics (e.g. magnitude of hazard that can be accommodated)

2. **Impact-focused approach:** resilience measured in terms of actual, anticipated or avoided impacts of a hazard (e.g. losses, or avoided losses resulting from a resilience-building intervention)
3. **System-focused approach:** resilience measured in terms of the characteristics of a system or population that make it more or less able to anticipate, avoid, plan for, cope with, recover from and/or adapt to evolving hazards.

In addition to characterisation by measurement approach, other key characteristics such as scale, hazard and framing (e.g. climate change adaptation, disaster risk reduction, economic) were recorded for each tool/method. These are listed in **Annex 5**.

### STEP 3: SORTING BY MEASUREMENT APPROACH AND ELIMINATION OF LESS RELEVANT LITERATURE ON TOOLS AND METHODS

Once references that did not describe tools or methods had been eliminated (Step 2), the remainder were organised by measurement approach (i.e. hazard, impact or system), resulting in three sets of references. Each team member assessed one of these sets based on their expertise, to identify references that were potentially relevant to the measurement of resilience in the context of the DFID Nepal Resilience Portfolio and wider portfolio, and eliminate references that were unlikely to be relevant. References were assessed using a set of **exclusion criteria** list (**Annex 5, Table A7**). This step in the assessment required a more detailed reading of the references and was fairly conservative, excluding only references that most obviously met the exclusion criteria.

The set of potentially relevant tools and methods identified by eliminating less relevant references using the exclusion criteria in Table 3 was subject to a preliminary assessment based on the auxiliary characteristics listed above and in Step 2. This preliminary assessment focused on the range and variation of methods, framings and scales represented within each measurement approach, and formed the basis of the Draft Literature Review submitted DFID Nepal in December 2018.

### STEP 4: DETAILED ASSESSMENT OF RELEVANCE

In discussion with DFID Nepal, a set of 3 criteria for assessing the relevance of tools and methods to the DFID Nepal portfolio was developed, in order to prioritise tools and methods on the basis of their likely utility (**Annex 5, Table A8**). A tool or method was assigned a score of 1-3 against each criterion, based on the scoring system indicated in Table 4. Scores were summed across all three criteria to yield an overall relevance score. Where a tool or method was described by multiple references, the scoring was undertaken for the most relevant or 'primary' reference, considering any additional information contained in additional or 'secondary' references.

### STEP 5: QUALITY ASSESSMENT OF TOOLS AND METHODS

A set of quality criteria was developed based on the principles of quality outlined in Table 1 of the *DFID How To Note on Assessing the Quality of Evidence* **(DFID 2014)**, in consultation with DFID (**Annex 5, Table A9**). These criteria were adapted the questions from Table 1 of the How to Note to the context of the literature review and includes quality considerations in terms of conceptual framing and measurement of resilience.

As with the assessment of relevance, a tool or method was assigned a score of 1-3 for each quality criterion, with 1 indicating low quality and 3 high quality. Where a criterion is associated with multiple questions/sub-criteria, quality was be judged as 'high' if all criteria are met, 'moderate' if some criteria are met, and 'low' if no criteria are met. Where a criterion is associated with a single question, reviewers made a subject judgment about the extent to which this criterion is met.

For each tool/method, scores were summed across the criteria to yield an overall quality score. As for the relevance assessment (Step 4), scoring was undertaken for the most relevant or 'primary' reference, considering any additional information contained in additional or 'secondary' references. The quality scoring was undertaken at the same time as the relevance scoring, using a single spreadsheet.

### STEP 6: PRIORITISATION OF TOOLS AND METHODS

Once tools and methods had been assigned scores for the 3 relevance criteria and the 5 quality criteria, an overall prioritisation score was calculated by averaging the scores across the relevance criteria and quality criteria separately, and then calculating the average of the two resulting scores. This yielded a possible maximum score of 3, and minimum score of 1.

Tools and methods were then sorted in a spreadsheet based on their scores, and the highest priority tools and methods identified for further assessment by DFID Nepal and the MEL Unit.

### STEP 7: PRESENTATION OF RESULTS

The highest priority tools and methods are discussed below under Results. Recommendations are made regarding how they might be used in the context of DFID Nepal's Resilience Portfolio and wider portfolio, as are suggestions as to what additional research or actions might be desirable before they can be adopted and implemented by DFID Nepal. These tools and methods, and the wider lessons from the Literature Review, will be presented to DFID Nepal and other stakeholders in Kathmandu. The results of the Review are summarised in a PowerPoint Presentation that was presented to DFID Nepal in Kathmandu on 12th March 2019.

# PART II: RESULTS

## 5 OVERVIEW OF RESULTS

### 5.1 THE INITIAL LONG-LIST AND SCREENING FOR TOOLS & METHODS

The initial literature search using Google and Google Scholar (**Annex 5**), along with additional references from the MEL Unit list and other stakeholders, resulted in the identification of **615** references (**Step 1**). This list constituted the long-list that was the basis for subsequent analysis of the resilience measurement literature (**Annex 7a)**. The additional 96 references identified in the subsequent 'review of reviews' (Box 1) increase the total number of references examined to **711**, with an additional 7 references identified during the scoring (Steps 4 and 5) giving a final figure for the number of references examined of **718**.

Once references that did not describe tools or methods for resilience measurement were eliminated (**Step 2**), the long-list was reduced to a set of **397** references. These references are listed in **Annexes 7b-d**, according to the initial assessment of measurement approach (i.e. hazard, impact or system[7]). This number increases to **493** when the 96 additional references identified in the later review of reviews are included, and to **500** when references identified during the scoring process (Steps 4 and 5) are taken into account (**Table 4**).

**Table 4 Summary of results in numbers and percentages: (i) references to tools and methods identified from initial 'long-list', (ii) references classed as potentially relevant to DFID Nepal's portfolio, (iii) relevent references subject to relevance and quality scoring, (iv) relevant references scoring above shortlist threshold of 2.4. Numbers given are those when additional items from the 'review of reviews' and the detailed reading of references during stages 4 and 5 are taken into account, except for those in brackets, which are based on the initial long-list.**

| Approach | (i) References to tools/methods | (ii) 'Potentially relevant' references | (iii) No. of references scored | (iv) No. scoring > 2.4 | (v) Outliers |
|---|---|---|---|---|---|
| Hazard | (39) [10%] | 4 (4) [2%] | 4 [4%] | 1 [6%] | 0 [0%] |
| Impact | (160) [40%] | 48 (48) [30%] | 33 [34%] | 5 [29%] | 5 [21%] |

[7] Note that 'mixed' approaches are included with the 'hazard' approaches in the file representing **Annex 7b**.

| | | | | | |
|---|---|---|---|---|---|
| System | (198) [50%] | 109 (92) [68%] | 61 [62%] | 11 [65%] | 19 [79%] |
| TOTALS | 500 (397) | 161 (142) | 98 | 17 | 24 |

## 5.2 INITIAL SCREENING FOR POTENTIAL RELEVANCE

The initial filtering to identify 'potentially relevant' references (**Step 3**) reduced the 397 references to tools and methods to **142** that had the potential to be useful to DFID Nepal. When this filtering was applied to additional references from the review of reviews (Box 1) it yielded a further 12 potentially relevant references, taking the figure to **154** (**Table 4**).

It is notable that the proportion of references relating to the hazard and impact approaches decreases significantly when the exclusion criteria to eliminate less relevant references are applied in Step 3. This reflects the fact that many hazard and impact-focused tools and methods (with the exception of CBA and related methods) were not well developed, were highly technical, and/or were not described sufficiently comprehensively to be practical. System-focused tools and methods for measuring resilience are generally much more established and transparent.

## 5.3 SCORING FOR RELEVANCE AND QUALITY

The 154 potentially relevant references were listed for prioritisation based on scoring against the relevance and quality criteria detailed in **Steps 4 and 5** respectively. This required a detailed reading of these references, which resulted in the identification of a small number of additional relevant references that were included in the dataset for this step in the review. This resulted in a total of **161** references being listed for relevance and quality scoring. These references, along with the scoring results, notes, and other key information relating to particular characteristics of the tools and methods represented, are listed in **Annex 7e**.

On detailed examination, 63 references were excluded at this stage for reasons including:

- Being behind a paywall (some such references had been included with prior assessment being based on abstracts or other ancillary information, pending a decision on whether to seek additional budget for purchasing);
- A lack of methodological explanation;
- A lack of explanation of data needs;
- Meeting exclusion criteria used in Step 3, where the Review Team had been conservative in the application of these criteria during the previous less detailed examination of a source;
- Being a 'secondary reference' describing a tool or method described in more detail by another reference.

Twenty-three references were excluded from the scoring process because they were classed as secondary references, and 40 for other reasons listed above. Where multiple references described the same tool or method, these were examined to identify the most pertinent or 'primary' reference. Scoring was performed only on these primary references, although information from secondary references was taken into account where relevant, to ensure that the scoring reflected the tool or method rather than a single description of it, as far as possible. References excluded on the above grounds were not subject to scoring.

The **98** remaining references, each of which represented a distinct tool, method or application, were assigned an overall score based on a combination of relevance and quality (Step 6 and Annex 7e). The minimum possible overall score was 1; the maximum possible score was 3. Actual scores ranged from 1 to 2.8.

In order to ensure that promising but perhaps as yet under-developed tools and methods were not ignored, references that did not score highly but exhibited elements of particular interest were marked as 'outliers' for further consideration. Twenty-four such outliers were identified. These are listed in **Annex 8.** A detailed discussion of these outliers is outside the scope of this report, but certain outliers are mentioned in the results section of the text where they are particularly relevant, and Annex 8 provides detailed notes for each outlier.

## 5.4 OVERVIEW OF THE 98 REFERENCES SUBJECT TO SCORING

Of the 98 references subject to the above scoring, 39 were articles in peer-reviewed journals, 21 were tools or guidance developed by organisations, 2 were dissertations, and the remainder were reports or other forms of grey literature (**Annex 7e**). Accounting for grey literature in the form of academic working papers and similar documents, 47 references can be said to originate in the academic sector, 49 in the development sector, and 2 in the private sector. Many of the academic references describe practical applications of tools and methods, some of which have been developed outside of academic contexts (e.g. Keating et al. 2017, which describes the method of the Zurich Insurance led Global Flood Alliance).

**Figure 3** shows the breakdown of the 98 references subject to scoring (**Annex 7e**) by a number of key factors, namely:

1. Scale, i.e. micro (household to community), small (ward to gaunpalika or equivalent), meso (districts & municipalities), large (national), or multiple;
2. Type of resilience, i.e. hard (i.e. infrastructural), soft (i.e. non-infrastructural) or mixed;
3. Framing, i.e. general/multi-hazard, disaster risk reduction (DRR), climate change adaptation (CCA), or economic;
4. Area of applicability to the DFID Nepal portfolio, i.e. calculation of avoided losses, addressing climate risk management, DRR and responsiveness, infrastructural resilience, general population or societal resilience, or multiple applications.

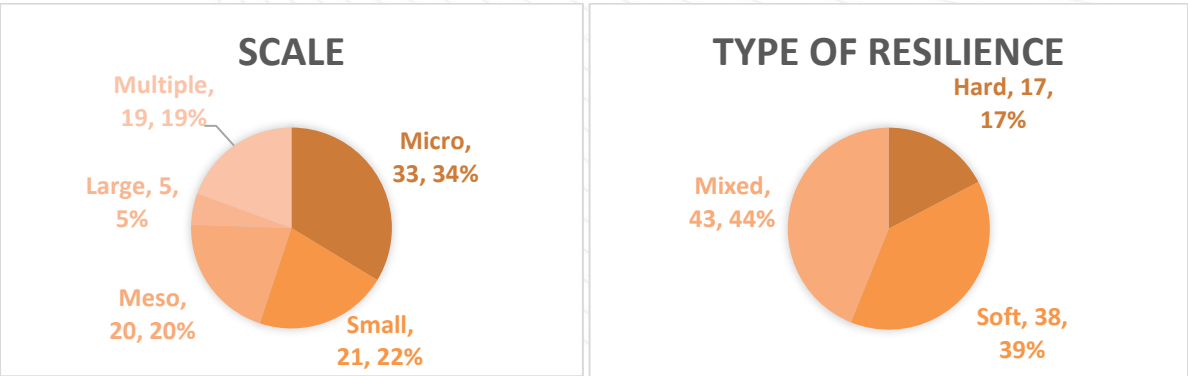
There is a relatively equal distribution of scales represented at the sub-national level, although the scale represented by the largest number of references is the micro scale (i.e. household to community level). This reflects the large body of literature relating to the measurement of community resilience.

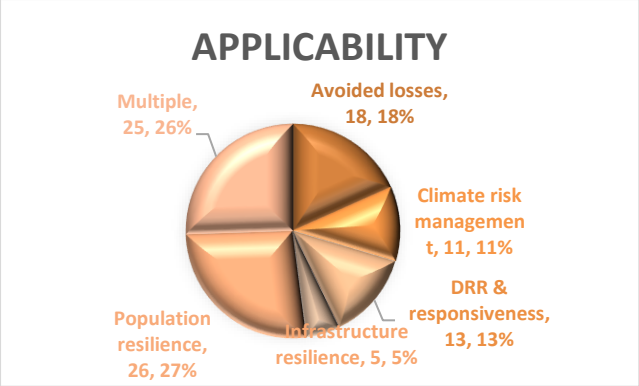
Most tools and methods address either 'soft' resilience associated with factors related to capacities and capabilities or a mixture of soft and hard resilience. Only 17 of the 98 references focus mainly or solely on 'hard' resilience associated with infrastructure.

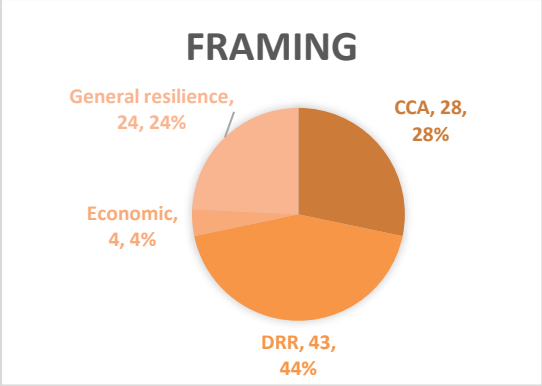
Nearly half of the references a framed in terms of DRR, while just under a third are framed in terms of climate change adaptation, and a quarter a more general in nature (i.e. address multiple hazards including those associated with climate change, conventional disaster risk and other shocks such as economic crises).

Around a quarter of the methods described measure resilience of the general population, generally through system-focused approaches that employ socio-economic, environmental related data. Another quarter blend this with other approaches such as measures of infrastructure resilience. The remainder focus more narrowly on climate resilience/adaptation, DRR and disaster responsiveness, the resilience of infrastructure, or the measurement of avoided losses.

**Figure 3 Breakdown of the 98 references subject to relevance and quality scoring by (clockwise from top left) scale, type of resilience, framing, and applicability to DFID Nepal's portolio. See main text for explanation of terms.**






### 5.5 PRIORITISATION AND THE FINAL SHORTLIST

Based on discussions with DFID Nepal in which a shortlist consisting of the order of 10 potentially applicable tools and methods was indicated to be desirable, the Review Team identified a conservative threshold of 2.5, and a more liberal threshold of 2.4, for identifying the most promising references. **Nine references exceeded the 2.5 threshold, while 17 exceeded the 2.4 threshold** (**Table 4**). Two of these (Tuan 2015, Tran Tuan Anh et al. 2016) used effectively the same method, taking the **number of distinct tools and methods to 16**. These are discussed in detail below.

## 6 DISCUSSION OF PRIORITY TOOLS AND METHODS

**Table 5** lists the tools and methods scoring above the threshold of 2.4, along with the relevant primary references, their overall scores, the approach represented, the scale at which they are applicable, and whether they originated from the academic[8], development[9] or private sector[10].

**Table 5 High-priority tools and methods scoring above 2.4 in the combined assessment of relevance and quality. Hazard-focused methods are highlighed in yellow and impact-focused ones in pink; the remainder are system-focused. Note that the second and third references use a very similar approach and should be considered as representing one method.**

| Tool/method name or type | Reference | Score | Approach | Scale | Origin |
|---|---|---|---|---|---|
| Community Disaster Resilience Scorecard | Torrens Resilience Institute, 2012. Developing a model and tool to measure community disaster resilience: Community Disaster Resilience Scorecard Toolkit. Torrens Resilience Institute, Adelaide, Australia. | 2.80 | System | Small | Academic sector |
| CBA | Tran Tuan Anh, Tran Huu Tuan, Tran Vran Ciai Phong, 2016. Cost-Benefit Analysis of Climate-Resilient Housing in Central Vietnam (No. 2016-RR6), EEPSEA Research Report. Economy and Environment Program in Southeast Asia. | 2.73 | Impact | Micro | Development sector |
| CBA | Tuan, T.H., Tran, P., Hawley, K., Khan, F., Moench, M., 2015. Quantitative cost-benefit analysis for | 2.73 | Impact | Micro | Academic sector |

[8] References and associated tools/methods classified under academic sector were extracted from an academic journal or were produced by an institute/department of an university.
[9] References and associated tools/methods classified under development sector were produced by a development organisation (e.g. NGOs, international development think tanks, foundations, UN agencies).
[10] References and associated tools/methods classified under private sector were produced by a for-profit organisation that does not distinctively and primary work in the development sector (e.g. insurance companies, businesses).

| | | | | | |
|---|---|---|---|---|---|
| | typhoon resilient housing in Danang city, Vietnam. Urban Climate 12, 85–103. https://doi.org/10.1016/j.uclim.2015.01.002 | | | | |
| CBA, participatory methodology | Alves, F.M.M., 2015. Cost-Benefit Analysis in Climate Change Adaptation 77. | 2.73 | Impact | Meso | Academic sector |
| Community resilience | Aksha, S.K., Juran, L., Resler, L.M., Zhang, Y., 2018. An Analysis of Social Vulnerability to Natural Hazards in Nepal Using a Modified Social Vulnerability Index. International Journal of Disaster Risk Science. https://doi.org/10.1007/s13753-018-0192-7 | 2.70 | System | Micro | Academic sector |
| Community resilience | The Economist, 2014. The South Asia Women's Resilience Index Examining the role of women in preparing for and recovering from disasters. The Economist Intelligence Unit. | 2.67 | System | Large | Private sector |
| Urban resilience | Rockefeller Foundation, 2015. City Resilience Framework. | 2.57 | System | Meso | Development sector |
| ZFA | Keating, A., Campbell, K., Szoenyi, M., McQuistan, C., Nash, D. and Burer, M. 2017. Development and testing of a community flood resilience measurement tool. *Natural Hazards and Earth System Sciences* 17,77-101. | 2.57 | System | Micro | Development sector[11] |
| Disaster resilience scorecard for cities - UNISDR 2014 | UNISDR (UN Office for Disaster Risk) (2014) 'Disaster resilience scorecard for cities'. Geneva: UNISDR. | 2.53 | System | Meso | Development sector |
| | | | | | |
| Baseline Resilience Indicators for Communities - BRIC (Cutter et al. 2010) | S.L. Cutter, C. Burton, T. Emrich, 2010. Disaster resilience indicators for benchmarking baseline conditions, J. Homel. Secur. Emerg. Manag. 7 14, | 2.47 | System | Meso | Academic sector |
| Community resilience | Burton, C.G., 2015. A Validation of Metrics for Community Resilience to Natural Hazards and Disasters Using the Recovery from Hurricane Katrina as a Case Study. Annals of the Association of American Geographers 105, 67–86. https://doi.org/10.1080/00045608.2014.960039 | 2.47 | System | Meso | Academic sector |
| Community resilience | GOAL, 2015. Toolkit for Measuring Community Disaster Resilience: Guidance Manual. GOAL. | 2.47 | System | Micro | Development sector |
| Urban resilience | Shim, J. and Kim, C. (2015). Measuring Resilience to Natural Hazards: Towards Sustainable Hazard Mitigation. *Sustainability*, 7(10), pp.14153-14185. | 2.47 | System | Meso | Academic sector |
| Vollenweider (2015) | Vollenweider, X., 2015. Measuring Climate Resilience and Vulnerability: A Case Study from Ethiopia. USAID, Washington, D.C., USA. | 2.47 | Hazard | Micro | Development sector |
| Multi-criteria Analyses | Guillaumont, P., 2017. Vulnerability and Resilience: A Conceptual Framework Applied to Three Asian Countries—Bhutan, Maldives, and Nepal. Asian Development Bank. http://dx.doi.org/10.22617/WPS179069-2 | 2.43 | System | Large | Development sector |
| TAMD | Brooks, N., Fisher, S., 2014. Tracking Adaptation and Measuring Development: a step-by-step guide. International Institute for Environment and Development, London. | 2.43 | System | Multiple | Development sector |
| CBA, participatory methodology | Yaron, G., Win, K., Wilson, D., 2017. Resilience Dividends of Community-Level Interventions: Evidence from Myanmar. ITAD, 2017. | 2.43 | Impact | Micro | Academic sector |

[11] Although this reference is an academic article, this refers to a method that originated from a multi-sector partnership made of development organisations (Zurich Flood Resilience Alliance).

## 6.1 HIGH-PRIORITY TOOLS/METHODS: HAZARD-FOCUSED APPROACH

Only one hazard-focused method scored above 2.4, that of **Vollenweider (2015),** which is described in a study funded by USAID and prepared by the Famine Early Warning Systems Network (FEWS NET). As the only high-scoring hazard-focused approach, this study is described here in some detail. Vollenweider (2015) presents a framework that simultaneously estimates individuals' vulnerability and resilience to climate shocks such as droughts and floods. Conceptually, resilience is defined and measured in this study as the speed of recovery after a shock. To measure vulnerability and resilience, Vollenweider (2015) defines and uses the following set of indices:

- The **weather vulnerability index** measuring the expected poverty gap caused by an adverse weather shock and designed to summarize weather sensitivity.
- The **climate vulnerability index** providing the average weather-induced poverty gap, considering the expected distribution of all-weather shocks of different magnitudes over time.
- The **weather resilience index** giving the expected speed of recovery after a given weather shock.
- The **climate-resilience index** setting out the average recovery time, taking into account the expected distribution of weather-related shocks of different magnitudes.

As part of a case study in Ethiopia, Vollenweider used Ethiopian panel datasets and applied a modelling strategy for the assessment of relationships between climate shocks and the change in food consumption over time. Once the relationship between climate and food consumption was clearly established by the model, the results in the vulnerability and resilience indices were summarised. Essentially, the vulnerability indices intended to summarize the climate-consumption relationship, while the resilience indices were meant to capture the time-consumption relationship.

Vollenweider used two different estimation techniques in the analysis. The first involved using standard Ordinary Least Squares (OLS) regressions to estimate the climate-consumption relationships in the single-period context. The second technique employed a novel Distributed Lag Non-linear Model (DLNM) to account for consumption dynamics.

This method is of particular interest because of the following benefits:

- It could be applied for measurement of <u>population resilience in the context of climate change</u> in Nepal.
- It has been <u>tested in a developing country context</u> (by USAID/FEWS NET in Ethiopia).
- It <u>received extensive feedback/consultation</u> (described in the acknowledgements section of the study).
- It <u>can be used solely with secondary data</u> to ensure that it is easily replicable and can be employed in contexts in which primary data collection is not practical and possible. Indeed, only secondary data were used in the study described by Vollenweider (2015): the Standardized Precipitation Evapotranspiration Index was used for weather risk variables, and food consumption data were obtained from national household income and expenditure datasets[12].
- Another benefit of this method for DFID Nepal and more globally is that it has <u>potential for resilience measurement in a portfolio or across countries</u> for use in policy and programme design, targeting and evaluations.
- One of the benefits of the DLNM's reliance on climate data for dynamics is that it was able to <u>measure the cumulative effect of shocks and estimate the impact of repeated shocks</u>. Even though a household might cope with an isolated drought, two abnormally dry years might exceed its absorptive capacity and send it on a downward trajectory. Accordingly, Vollenweider justifies that the DLNM model is well-suited to estimate vulnerability and resilience with respect to such repeated shocks and thus demonstrates its suitability as both a hazard-approach method by showing when absorptive capacity

[12] Namely, the Ethiopia Rural Household Survey (ERHS), that provides a multi-round panel data series from 1994 to 2009; the Ethiopian Nile Basin Climate Change Adaptation Dataset (ENBCCA), a dual-round panel series from 2005 and 2012; and the Ethiopia Living Standards Measurement Study (LSMS), which is a nationally representative, cross-sectional household survey from 2012.

is exceeded and an impact-approach method for measuring effects resulting from a shock or a combination of shocks.

- The strength of this approach is that, depending on the availability of data, it can be applied at multiple scales (from micro to large scales).
- The other benefit of Vollenweider's method is the visualization of the results, which can provide a quick overview of vulnerability and resilience status in relation to climate related shocks and where improvements are most needed.

Recognised limitations include:

- Broad national data sets such as the one used in this study was at least three years old when the analysis was conducted in 2015. Thus, there will be limitations on the accuracy and application of the climate resilience and vulnerability findings for this type of top-down large-scale method.
- Only a summary of this study was accessible in the public domain. As such, the full methodological steps could not be analysed. The review team was also not able to investigate whether this method has been applied in other contexts. Analysing the applicability of this method in other contexts would have enabled to generate more learning and further confirm the reliability of this method.
- Another caveat to consider for DFID Nepal is that this method requires expertise in using the two estimation techniques mentioned above (OLS regressions and DLNM).
- Methodologically, Vollenweider (2015) recognises that further research is required on the use of interaction variables in the DLNM in order to allow for impact evaluation as well as on the use of spatially varying DLNM for early warning and policy targeting.

## 6.2 HIGH-PRIORITY TOOLS/METHODS: IMPACT-FOCUSED APPROACH

Three CBA-type methods are jointly ranked as the second highest scoring tools/methods. Two of these address CBA of climate resilient housing in Vietnam (Tuan et al. 2015, Tran Tuan Anh et al. 2016). The former is published in a peer-reviewed journal; the latter is a report. The third is described in a thesis (Alves 2015) and applies participatory CBA in a European context.

### 6.2.1 Conventional CBA

**Tuan et al. (2015)** and **Tran Tuan Anh et al. (2016)** examine the costs and benefits of typhoon resilient housing measures in different locations in Vietnam using essentially the same method (effectively reducing the number of high-scoring tools and methods to 16). They find that, in the contexts examined, returns on investment in storm-resilience measures are positive when typhoons occur early in the lifetime of a house. They examine quantifiable disaster impacts including working days lost, evacuation costs, health and medical fees, costs of hiring local builders, costs of purchasing materials for housing repair or reconstruction, and average damage per house expressed in monetary terms. These data were gathered through household surveys and checked against official data where possible. The costs of damages incurred from typhoons are compared for a standard non-storm-resistant house and a storm-resistant one. Using these data in conjunction with data on the costs associated with building a resilient house, the authors assessed economic efficiency using net present value (NPV), benefit-cost ratio (BCR), and internal rate of return (IRR). Past hazard impacts and future hazard impacts were addressed using backward and forward-looking analysis, the latter with and without climate change, and using different discount rates.

These studies also highlight the potential of traditional CBA to demonstrate the benefits of resilience building and thus incentivise private investment in auto-adaptation, for example at the household level. The method employed by Tuan et al. (2015) and Tran Tuan Anh et al. (2016) has considerable potential to be applied in Nepal, as discussed under 'Recommendations' below.

### 6.2.2 Participatory CBA

Participatory CBA tools and methods that cluster benefit cost ratio (BCR) economic valuation techniques with participatory methods to incorporate non-monetizable benefits into the investment decision-making process are particularly interesting from the international development assistance perspective. This is because these

methods can address issues of equity, injury and loss of life, and distributive and environmental factors, while retaining links to the familiar economic concepts of efficiency of resource allocation and returns on capital invested. These methods can provide sound value for money justification to decision-makers and the public. However, they are more data intensive than conventional CBA tools because of their need for properly structured beneficiary consultations that yield representative weightings for the various investment options.

Nonetheless, participatory CBA requires less technical knowledge than conventional CBA and allows input from many different stakeholder (e.g. community) groups. Participatory CBA uses participatory research appraisal (PRA) methods to identify the financial, social and environmental benefits and costs of an activity. As a result, participatory CBA captures information that is often unavailable from traditional data sources and is thus omitted from conventional analyses, and can be relatively quick and inexpensive to implement. Participatory cost benefit analyses are particularly effective with diverse groups of stakeholders and can be facilitated via shared learning dialogues at virtually any level (community, city, state, national).

**Alves (2015)** contains useful guidelines for applying traditional CBA tools alongside participatory methodology to develop a robust Participatory CBA approach to selecting impact hazard-reducing investments with the greatest Net Present Value and highest community value weighting. Topics relevant for further research by DFID Nepal include (i) setting of discount rates to calculate the Net Present Value (NPV) of avoided losses from individual investment options over the operating life of each asset; and (ii) adopting a structured approach to citizen engagement to minimise inefficiencies and reduce the opportunity for biased or irrational weightings to be given to non-monetisable benefits. Both disciplines need to be developed to effectively apply this method.

**Yaron, et al (2017)** incorporates practical examples of how to apply the Participatory CBA method in the East Asia Region, referred to as "*community resilience planning*" (p.10), and considers community weighting given to avoided deaths and costs of hygiene and health management post-event. The examples are at the micro and small scales and relate to agricultural community investments in resilience more broadly, including income generation. The literature recognises the high cost that the community places on investments with long-term returns; and the higher value placed on investments with a short-term return. The advantage of hazard-reduction investments that include 'on-benefits', being the day-to-day economic benefits arising from the hazard-reduction investment, are identified and added to losses avoided in calculating the NPV of various investment options.

## 6.3 HIGH-PRIORITY TOOLS/METHODS: SYSTEM-FOCUSED APPROACH

All 12 system-focused methods scoring above the 2.4 threshold use indicators to characterise the resilience of people or systems at different scales. Nine of these methods group individual indicators under what are variously referred to as capitals (Keating et al. 2017), categories (The Economist 2014, Rockefeller Foundation 2015), components (Cutter et al. 2010, Torrens Resilience Institute 2012, Aksha et al. 2018), subcomponents (Burton et al. 2015), dimensions (Shim and Kim 2015), and thematic areas (GOAL 2015). Of these nine methods, none defines more than six such indicator groupings. Seven methods define dimensions that broadly map onto the concepts of human, social, physical, financial and natural capital. Three of these seven, and three other methods, include an explicit or implicit institutional dimension.

UNISDR (2014) takes a slightly different approach to indicator groupings, in the form of ten "essentials for making cities resilient".

### 6.3.1 Quantitative indicators using secondary data

Five of the 12 high-scoring system-focused methods employ quantitative indicators using data that may be available from secondary sources. These include the meso-scale methods of **Cutter et al. (2010)** and **Burton et al (2015)**, applied at the county level in the United States, at scales broadly comparable to those of a district or urban municipality (Nagarpalika) in Nepal. These both employ a similar number on indicators (>50) to address social, economic, institutional and infrastructural resilience as well as 'community capital', with Burton et al. (2015) adding a further dimension that addresses environmental resilience. The method of Cutter et al. (2010) was included in the analysis despite dating from before the 2013 cut-off for the initial search, as it is widely cited

(e.g. Burton et al. 2015, Shim and Kim 2015, Keating et al. 2017) and is used as a basis for other, more recent methods such as that of Aksha et al. (2017).

**Shim and Kim (2015)** examine resilience in metropolitan districts in South Korea, using factor analysis of indicators representing the biophysical, built environment and socioeconomic dimensions of resilience. Their method uses data from national sources. While the development context is very different in South Korea compared with Nepal, comparable data may well be available in Nepal, and this method and comparable indicators might be tested/validated in Nepal. This method operates at a similar scale to Burton et al. (2015) and Cutter et al. (2010).

**Guillaumont (2017)** employs multi-criteria analysis to develop a resilience framework consisting of six indices designed to capture to capture aspects of policies and institutions, economic vulnerability, physical vulnerability to climate change, fragility, and whether a country is an LDC or small island state. These indices are equally weighted and summed to calculate resilience to an exogenous shock. This approach uses national-level statistics and is used to compare resilience across countries.

**Aksha et al. (2017)** focus explicitly on social vulnerability rather than resilience. The authors develop a Social Vulnerability Index (SoVI) tailored to the Nepali context by adapting a method employed by Cutter et al. (2003) in the United States. They reduce the number of indicators from 200 in the US case to 39 in the Nepali context, using 2011 census data from the Nepal Central Bureau of Statistics, and including nationally relevant indicators such as those relating to caste and the ability to speak Nepali. They use principle component analysis to reduce these 39 variables to just seven, based on the covariance of indicators. While they frame the index as one representing vulnerability to natural hazards, they do not validate it against disaster outcome data. Despite this lack of validation and the framing of this index in terms of vulnerability rather than resilience, the Nepali context and use of census data to describe vulnerability at the local scale make this study highly relevant. While the SoVI might not be adopted as it stands, it points to a number of indicators for which data should be available, that can serve as proxies for vulnerability or resilience. These indicators are listed in Table 1 of the paper. The data cover the entire country at the level of the district, using data scaled to the administrative units in use prior to the transition to federalism at the resolution of the old Village Development Committee (VDC). These data support the use of other methods requiring secondary data, although (i) they would need to be transformed to represent the new administrative units, and (ii) they give only a snapshot, and further data collection would be required to track changes in the variables represented over time.

#### 6.3.2 Use of scorecards to measure resilience

Five of the high-scoring system-focused methods employ scorecards based on questionnaires.

These include the two-explicit urban resilience measurement tools, the Disaster Resilience Scorecard for Cities (DRSC) developed by UNISDR (2014) and the City Resilience Framework (CRF) developed by the Rockefeller Foundation (2015). Both of these tools consist of a similar number of indicators (although see below), the values of which are generated by prescribed sets of answers to questions organised in an Excel spreadsheet.

**The UNISDR (2014) Disaster Resilience Scorecard for Cities (DRSC)** is organised around 10 Essentials for Making Cities Resilient. The answers to these questions yield scores for 47 indicators. The essentials are as follows, with the number of questions/indicators for each given in brackets:

1. Organize for disaster resilience (3);
2. Identify, understand & use current & future risk scenarios (5);
3. Strengthen financial capability for resilience (4);
4. Pursue resilient urban development & design (4);
5. Safeguard natural buffers to enhance the protective functions offered by natural capital (3);
6. Strengthen institutional capacity for resilience (6);
7. Understand & strengthen societal capacity for resilience (4);
8. Increase infrastructure resilience (9);
9. Ensure effective disaster response (7);
10. Expedite recovery & build back better (2).

**The City Resilience Framework developed by the Rockefeller Foundation and Arup (Rockefeller Foundation 2015)** organises resilience into the four categories of health and wellbeing, economy and society, infrastructure and environment, and leadership and strategy, which are linked with 12 goals and measured using 52 indicators described by 152 variables. This framework is comprehensive, but using it to measure resilience requires measurement of all 152 variables associated with the indicators. However, it might be adapted for use with a smaller number of indicators and variables across the 12 goals.

The UNISDR DRSC appears to be more straightforward to use, and includes explicit fields for general comments, recording responsible institutions, timescales, and actions to achieve maximum resilience. Both tools include fields in which to provide evidence and explanation to support answers. Both are relevant to municipal governments / nagarpalikas in Nepal, and could be adapted for use at the guanpalika level.

**The Torrens Resilience Institute (2012) Community Disaster Resilience Scorecard Toolkit** is a subjective resilience assessment tool developed and piloted with indigenous communities in Australia that could in principle be adapted and mainstreamed at the at the sub-Palika (e.g. Settlement) level in Nepal. However, this would require information to be gathered routinely by local governments and made readily accessible for comparison at the sub- and supra-palika level.

**The *Toolkit for Measuring Community Disaster Resilience* (GOAL 2015)** builds on work supported by DFID and has been validated in Honduras, Haiti, Malawi and Ethiopia. It involves the collection of data on the general context of communities through questionnaires, followed by a survey featuring 30 consultation questions designed to generate information on specific aspects of resilience across five dimensions, namely governance, risk assessment, knowledge and education, risk management and vulnerability reduction, and disaster preparedness and response. Each question addresses a particular resilience characteristic, and results in a score of 1 to 5. The answers to the 30 questions can be plotted on a 'dashboard' or radar chart to represent a community's resilience. While this approach might be resource intensive, it could potentially be adapted for use at the palika level in Nepal, applied at either the palika or ward level, and embedded in local government systems or coordinated at the provincial level.

**The *Tracking Adaptation and Measuring Resilience* (TAMD) framework (Brooks and Fisher 2014)** is a framework that seeks to link climate change adaptation and development, through (i) assessments of institutional climate risk management, (ii) measurement of 'adaptation performance' in terms of improved resilience and adaptive capacity, and reduced vulnerability, and (iii) improved development performance and human wellbeing in the face of intensifying climate hazards, linked to and derived largely from, improved resilience.

TAMD has been piloted in multiple countries. It does not prescribe resilience indicators or indicators of development performance and human wellbeing but offers guidance on how to approach this in different contexts, including national planning (Rai et al. 2015) and local planning (Karani et al. 2105). TAMD offers guidance on linking impact-level development/wellbeing indicators with climate information to assess adaptation success in relation to climate hazards, which maps onto the impact-focused approach to measuring development here. However, it does specify eight institutional CRM indicators in the form of scorecards, to be applied to a specified institutional context. Two of these have been adapted as Key Performance Indicators Nos. 13 and 14 for the UK's International Climate Fund (ICF).

TAMD has some potential utility in the Nepal context for assessing institutional preparedness, via possible modification of the CRM indicators. However, this may be redundant if either of the city-level scorecard tools (UNISDR 2014, Rockefeller Foundation 2015) is adopted. The TAMD framework may have a role to play as an overarching theory of change and template for developing resilience and adaptation tracking and M&E systems.

#### 6.3.3 Combining quantitative and qualitative indicators for resilience measurement

**The Global Flood Resilience Alliance approach (Keating et al. 2017),** developed by a consortium led by **Zurich Insurance**, is based in part on the methodology of Cutter et al. (2010), and has been piloted in a number of countries, including Indonesia, Afghanistan and Nepal. In Nepal, it is being implemented by Practical Action, a

member of the Flood Resilience Alliance, in the Karnali and Central Terai. The Review Team Leader met with representatives of Practical Action in Kathmandu on 30th November 2018 to discuss this methodology, which employs 88 indicators representing the five capitals (human, social, physical, financial and natural). The indicators, which are universal, have been developed based on a combination of literature review, expert judgment, and validation by communities, and are measured before and after flood events. Each indicator is scored from A (strong resilience) to D (weak resilience), and only indicators that are relevant are used in any given context. While this approach is resource intensive, its deployment in key areas in Nepal that match DFID's geographical priority areas (Karnali River and Central Terai, with other areas to follow) means that it offers the potential to generate significant amounts of secondary data that might be aggregated for the measurement of resilience, and an opportunity for measurement partnerships.

**The Economist (2014)** describes the **South Asia Women's Resilience Index**, which addresses the role of women in preparing for and recovering from disasters. This index is of particular interest given DFID's mandate for mainstreaming gender into its programming, and due to its direct relevance to resilience in the context of disaster programming.

# 7 RECOMMENDATIONS

Of the 17 references identified by the literature review as being particularly relevant to the DFID Nepal portfolio, 10 stand out as being most relevant in terms of practicality and utility.

These 10 most relevant references represent five entry points for the measurement of resilience across the DFID Nepal portfolio, namely:

i. Cost-benefit analysis (with participatory elements), for the assessment of 'resilience dividends' from infrastructure (and potentially other) interventions;
ii. Scorecard assessment of resilience at the municipal/nagarpalika level, addressing the preparedness and responsiveness of populations and municipal institutions;
iii. Scorecard assessment of resilience at the rural/gaunpalika level, addressing the preparedness and responsiveness of populations and local governments in rural areas;
iv. Resilience characterisation using secondary data at the palika level in general, based on demographic, environment, infrastructural and related characteristics;
v. Measurement of resilience in terms of recovery times, applied to households and potentially other (e.g. larger-scale) units of analysis.

The above five entry points can be viewed as representing 4 very broadly defined methods, with the use of scorecards at either the nagarpalika or guanpalika level representing one method. We recommend that DFID Nepal further assess these four methods of measuring resilience for utility and practicality, based on the 10 most relevant references, along the lines discussed below for each method. These 10 references are highlighted in bold in the following discussion.

The remaining seven references describe variations on the above methods, datasets on which DFID might draw for the measurement of resilience in Nepal, or indices and frameworks that offer potential lessons on resilience measurement, in terms of either specific indicators or general approach. These references (and one additional 'outlier') are discussed in terms of their relevance to the four methods where appropriate and are underlined for ease of identification.

### METHOD 1: QUANTIFYING RESILIENCE DIVIDENDS USING AVOIDED LOSSES

**We recommend that DFID Nepal considers how the method based on conventional CBA described by Tuan et al. (2015) and Tran Tuan Anh et al. (2016) can be applied in Nepal, particularly in relation to earthquakes and floods. The participatory methods described by Alves (2015) and Yaron (2017) should be considered in order to include non-monetary benefits, or to monetise benefits that cannot be measured in terms of costs and damages to infrastructure.**

In terms of quantifying a 'resilience dividend', the CBA method described by **Tuan et al. (2015)** and **Tran Tuan Anh et al. (2016)** is particularly promising and should be considered for adoption by DFID Nepal. This method involves calculating the additional costs of building disaster-resilient infrastructure and comparing these with the (avoided) costs of damages resulting from relevant hazards. These studies apply this method to storm-proof houses in Vietnam, but the method can be applied to other hazards, scales and types of infrastructure.

For example, the method might be applied to assess the benefits of construction or renovation incorporating earthquake-resilience measures, for individual dwellings, other infrastructure, or city districts. While the initial assessment of costs and benefits is likely to require some (e.g. household) survey, once typical or indicative costs and benefits have been established per unit of infrastructure, these can be used to estimate the resilience dividend of interventions supporting disaster-resilient reconstruction or renovation based on assumed unit costs and benefits. This might be applied to earthquake resilience in urban areas, flood resilience in rural areas, or in other contexts.

These studies highlight how demonstrating the benefits of resilience building can incentivise private investment in resilience and adaptation measures, potentially shifting some of the costs of disaster response away from public to private resources. This might be further encouraged through mechanisms such as interest-free loans, revolving credit facilities, one-time resilience building transfer payments/ subsidies, and hazard insurance for individuals or organisations engaging in such resilience building.

Participatory CBA as described by **Alves (2015)** and **Yaron (2017)** can extend the above analysis to include resilience benefits that would be missed in conventional CBA analysis, providing a more complete description of the benefits of resilience interventions, which can strengthen the case for resilience interventions, participation and co-financing. Participatory CBA can incorporate social "willingness to pay" information that is often difficult to incorporate into conventional CBA.

Participatory CBA could be operationalised by outsourcing the participatory research element to local NGOs; and outsourcing the traditional CBA element to economic/ technical engineering and data acquisition capacities understood to be available in Nepal.

Estimation of costs and benefits of resilience measures based on the above methods has the potential not only to provide robust measures of resilience benefits but could also play a key role in informing policies and investment decisions by a range of actors including the Government of Nepal. A focus on the concept of the 'Resilience Dividend', defined as the net benefit of a resilience intervention versus a business-as-usual counterfactual (e.g., no intervention or an intervention that does not incorporate resilience building measures), may be useful in advocating for needed resilience interventions, where this is based on sound evidence from (participatory) CBA.

CBA-based methods are most relevant to programmes targeting infrastructure, such as the Rural Access Programme under the Growth theme, the Nepal Health Sector Support Programme and proposed Gurkha WASH and DRR Programme under Governance, and the resilience-related programmes clustered under the Inclusion/Inclusive Development theme (Annex 2).

### METHOD 2: TRACKING RESILIENCE USING SCORECARD-BASED INDICATORS

**We recommend that DFID Nepal considers adapting the UNISDR (2014) Disaster Resilience Scorecard for Cities for assessing the resilience of larger municipalities in Nepal.**

This tool appears to offer a good balance between user-friendliness and comprehensiveness. Most of the questions under the 10 Essentials for Making Cities Resilient are likely to be relevant to large municipalities in Nepal. Where they are not, they can be adapted, and/or the scorecards modified to suit the relevant contexts. The Rockefeller/Arup (2015) City Resilience Framework is also of interest in this context. However, it is likely to be more resource-intensive given the larger number of variables and is not quite as user-friendly. The TAMD climate risk management indicators (Brooks and Fisher 2014) offer a potentially simpler set of scorecards but are not as well developed as either of the above methods.

**We recommend adapting the Torrens Resilience Institute (2012) Community Disaster Resilience Scorecard Toolkit, and/or the GOAL (2015) Toolkit for Measuring Community Disaster Resilience for assessing resilience at the level of the gaunpalika.**

Both these tools are targeted at the community level but could be adapted for use at the gaunpalika level, either through ward-level assessments or directly at the scale of a gaunpalika.

All four of the above tools involve stakeholders answering questions relating to socio-economic conditions, governance, hazards and associated risks, disaster planning and response, and other related areas. This will be achieved most effectively through dedicated workshops that bring together relevant stakeholders, including local government / city planners and other staff, and representatives of communities and other key stakeholder groups. This would require significant engagement with these stakeholders on the part of DFID Nepal and its partners. However, the convening of such workshops on a regular (e.g. annual or biennial) basis to complete the scorecards would enable changes in resilience to be tracked over time effectively. For all four tools, the results of these assessments can be displayed using 'radar' or 'cobweb' diagrams that represent all the dimensions of resilience and reveal how these are changing over time. These can provide a rapid and powerful means of illustrating where resilience is static or in decline, and thus demonstrate where action to build resilience is most urgently needed. Conversely, where resilience is improving, the measures taken to address that particular dimension of resilience can be identified and interrogated to assess their contribution.

If regular reporting using modified versions of the above tools could be embedded at the local government level, this would provide a powerful tool for tracking changes in resilience (e.g. before and after resilience interventions) without the need to gather large amounts of secondary data. Initial investment in establishing such a mechanism in key areas targeted by DFID Nepal and its partners could facilitate effective resilience tracking in the medium to long-term.

The above methods are relevant across the three main themes of DFID Nepal's portfolio, but are particularly relevant to programmes under the Governance theme (Governance, , Local Government Support Programme) and Inclusion theme (Post-Earthquake Reconstruction, Strengthening Disaster Resilience, Climate Smart Development) (Annex 2).

### METHOD 3: MEASURING RESILIENCE USING SECONDARY DATA

**We recommend that DFID consider applying the methods described by Cutter et al. (2010) and Burton et al. (2015) to identify appropriate resilience indicators from existing datasets in Nepal. and Shim and Kim (2015), Guillaumont (2017) and compare their indicators with (i) proposed indicators of resilience in Nepal described in the draft analysis by MEL Unit (IOD PARC 2018) and (ii) available data sources.**

**Cutter et al. (2010)** and **Burton et al. (2015)** address resilience at scales that are broadly comparable with those of Nepal's new local government units (palikas), using indicators based on secondary data from national or sub-national sources, distributed over a number of components or dimensions of resilience. **Cutter et al. (2010)** assess the correlations between potential resilience indicators to reduce the number of indicators, eliminating redundant variables where significantly high correlations are found. **Burton et al. (2015)** examine the relationship between potential resilience indicators and disaster recovery times (using data on the extent of reconstruction at different points in time following a hazard) to identify variables that are good predictors of recovery, placing the identification of resilience indicators on a sound empirical footing. We suggest that DFID use one or both of these methods to identify useful indicators of resilience from available secondary data in Nepal.

The method of Burton is recommended if variables representing potential resilience indicators can be validated against disaster outcome or recovery data. Whereas **Burton et al. (2015)** examine reconstruction rates/extents following Hurricane Katrina based on aerial photography, DFID might apply this technique to evidence of the extent and rate of earthquake reconstruction. This technique may work best for hazards that recur on timescales of several years or more, giving time for assessments of reconstruction at different times after the hazard. However, it might also be used for more frequent hazards such as annual floods, if resources can be mobilised quickly to assess recovery before to the next hazard occurs. While this might require substantial initial

investment, once proxies for resilience have been identified from secondary data, resilience can be mapped using these data without significant additional investment. However, it would be prudent to validate the resilience proxies periodically, to account for changes in development contexts.

Two high-scoring references and one 'outlier' describe methods or datasets used or developed in Nepal that might be useful sources of secondary data. These are:

1. The Global Flood Resilience Alliance approach (Keating et al. 2017), based on Cutter et al. (2010). Has been applied in the Karnali and Central Terai regions of Nepal and has generated community-level data on flood resilience and outcomes. This approach and the indicators used has also been discussed in the analysis by IOC PARC (2018).
2. The Social Vulnerability Index developed by Aksha et al. (2017), which provides a useful example of how the above method of Cutter et al. (2010) can be applied to Nepal and provides a dataset of vulnerability-related data at the scale of the old Village Development Committee (VDC), now replaced with the system of wards and palikas.
3. The Multi-Level Vulnerability Index (MLVI) developed by ICIMOD (Gerlitz et al. 2017), an 'outlier' in the Literature Review (Annex 8). This index covers the Himalaya-Hindu Kush region, and is based on the Vulnerability and Adaptive Capacity (VACA) survey carried out by ICIMOD in three sub-basins in the HKH region, including Koshi in Nepal.

The above datasets may provide useful baseline data for the measurement of resilience. They may also be useful for the identification of predictive indicators of resilience, through examination of their correlations with hazard/disaster outcome measures (e.g. losses, damages). To be useful for tracking changes in resilience over time (necessary for addressing the effectiveness of DFID or other interventions), the same data would need to be collected repeatedly in future, which would involve significant time and resources. However, if a small number of indicators could be identified that acted as good proxies for resilience (and predictors of how populations cope with and recover from hazards), mechanisms might be established for collecting the relevant data, perhaps as part of national data collection processes.

The Economist (2014) South Asia Women's Resilience Index, and Guillaumont's (2017) national level vulnerability and resilience indices, and are chiefly of interest in terms of the indicators used, which can be compared with available data in Nepal at the sub-national scale. The South Asia Women's Resilience Index in particularly will be a useful check for the gender sensitivity of any resilience indices or indicators derived from secondary data.

Methods based on secondary data are relevant across the DFID Nepal portfolio, particularly where programmes are concerned directly with the resilience of individuals and populations and their access to key services and resources.

### METHOD 4: MEASURING RESILIENCE BASED ON RECOVERY TIMES

**Vollenweider (2015)** measures vulnerability and resilience in terms of household food consumption and the time taken for a household to recover to pre-shock levels of consumption following a hazard such as a drought or flood. A weather *vulnerability* index is defined, in relation to a specific hazard of a given magnitude, as the difference in household food consumption between (i) normal conditions and consumption associated with the poverty line, for households above the poverty line, and (ii) normal conditions and hazard conditions, for households below the poverty line. A climate *vulnerability* index is then constructed as the expected or average increase in the poverty gap in the year following a weather shock, based on the probability of all shocks given the expected distribution of shocks of different magnitude.

A weather *resilience* index is defined in relation to a specific hazard, as the expected time for a household to recover from a weather shock to its pre-shock level of consumption. A household that can recover before the next shock is deemed to have some resilience. A climate *resilience* index is then constructed that measures the expected or average recovery time across multiple households, based on the probability of all shocks.

This method might be adapted to address a variety of hazards, with vulnerability and resilience using a variable that is a proxy for the functioning of a system. For example, vulnerability might be measured in terms of changes in the capacity or performance of transport, water or energy infrastructure following a shock, with the time taken for the infrastructure to return to its pre-shock capacity/performance being used to measure its resilience to a specific hazard of a given magnitude. Vollenweider (2015) measures vulnerability and resilience to drought that recurs every 5 years on average. In Nepal, this method could be applied to households or infrastructure in relation to annual floods, or to earthquakes with much longer return periods. When applied to climate related hazards that recur on multi-annual timescales, the effects of climate change on the magnitude and frequency of these hazards would need to be taken into account.

This method is particularly relevant to programmes targeting communities and households through social protection measures, but potentially has much wider application if readily measurable proxies for system performance/functioning can be identified and used to assess recovery following a hazard.

# 8 GENERAL DISCUSSION AND CONCLUDING REMARKS

The Literature has identified 10 highly relevant studies that represent four broadly defined methods for the measurement of resilience. These methods can potentially be used by DFID Nepal to measure resilience in relation to its interventions across its portfolio, targeting both small and large-scale infrastructure (resilience dividends via CBA), the preparedness and responsiveness of local governments and the areas and populations for which they are responsible (score-card based indicators addressing governance and related issues), the underlying resilience of populations at the palika scale (secondary data describing the characteristics that make populations resilient), and the impacts of hazards on poverty and development performance coupled with an assessment of resilience based on recovery times. **Table 6** provides a tentative mapping of the four methods described above to programmes under DFID Nepal's resilience and wider portfolio.

The broadly defined methods recommended in this review should be applicable given the extent of data availability in Nepal. The CBA approach will require data on the costs of resilient infrastructure and other resilience-building measures, and data on the damages and losses resulting from specific hazards. The former will be available from DFID programmes, while the latter may require some survey-based assessments if relevant data are not available from government or other secondary sources. The scorecard-based indicators largely rely on subjective assessments and require little or no quantitative data, depending on the precise version of the method used. The identification of appropriate resilience indicators from secondary data will require some initial statistical analysis of existing datasets. Assessment of resilience based on recovery times will require some survey-based data, depending on the contexts in which it is applied, and the scales targeted.

While significant effort will be required to operationalise all the methods proposed here, initial investment in this operationalisation should result in sustainable methods and mechanisms that, once up and running, will require much lower levels of input from DFID. Once values for costs and benefits of resilience measures have been established for the CBA-based method, calculation of resilience dividends should be relatively straightforward, based on standard formulae. Once mechanisms for resilience assessment using scorecards have been established with local governments, investment should be limited to support for periodic workshops during which these scorecards are completed. Once relevant indicators that can serve as proxies for (e.g. population) resilience have been identified from secondary data, these can be tracked based on secondary sources with minimal effort, and reviewed periodically. The method requiring the most sustained support is likely to be that involving the measurement of recovery times. If this is applied to social protection programmes, this can be built into their monitoring mechanisms.

It is important to note that DFID Nepal's MEL Unit has already identified 13 'indicator areas' for the measurement of resilience, based on a review of indicators used in Nepal and elsewhere, with a focus on those employed by Practical Action in their implementation of the Global Flood Resilience Alliance approach in Karnali and Central Terai, and those used by Lutheran World Relief in Nepal. The MEL Unit has begun to operationalise these 13 indicator areas through the development of scorecards for each indicator. These

scorecard indicators might fulfil the functions of Method 2 (scorecard-based assessment of resilience at the nagarpalika and guanpalika level) and potential Method 3 (measurement of resilience using secondary data) as proposed here. If this is the case, it would be useful to compare the 13 indicator areas and the associated MEL Unit scorecards with the scorecard indicators employed by UNSIDR for assessment at the municipal level, and the Torrens Resilience Institute and GOAL scorecards employed at the community level. Comparison with the indicators identified by the studies referred to in the discussion of secondary data (Method 3) is also recommended, in order to validate these indicator areas and identify any potential gaps.

The methods recommended here can support DFID in reporting against the UK International Climate Fund (ICF)'s Key Performance Indicators (KPIs) on resilience and adaptation. These are KPI 1 (number of people supported by DFID programmes to cope with the effects of climate change, KPI 4 (number of people whose resilience has been improved as a result of ICF support), KPI 13 (Level of integration of climate change in national planning as a result of ICF support), and KPI 14 (Level of institutional knowledge of climate change issues as a result of ICF support). For example, reporting against

KPI 1 can be supported by indicators that measure numbers of people benefiting from climate-resilient infrastructure (related to Method 1) and targeted by specific initiatives to improve preparedness and responsiveness (Method 2), and that capture improvements in service delivery during and following a hazard (Method 2 and potentially indicators under development by the MEL Unit).

KPI 4 reporting can be supported by all four methods, where measured improvements in resilience can be associated with numbers of people. Reporting against KPIs 13 and 14 can be supported by specific questions in the scorecards used under Method 2. Certain questions in these scorecards might also address some of the criteria for transformation identified in the methodological guidance for KPI 15, which measures the likelihood of transformation change (e.g. based on political will/commitment, the creation of enabling environments, and local ownership, among other criteria).

**Table 6 DFID Nepal programmes mapped against relevant methods for measuring resilience (Methods 1-4 as described in 'Recommendations' in the main text).**

| Programme | CBA (1) | Scorecards (2) | 2ndary data (3) | Recovery times (4) |
|---|---|---|---|---|
| **Nepal Local Governance Support Programme**<br>Parts of the programme ensure that Local Government's awareness and capacity on climate change adaptation, disaster resilience and environmentally friendly governance are improved. | | Preparedness, responsiveness | | |
| **Nepal Health Sector Programme III**<br>Parts of the programme ensure that hospitals in the most densely populated and/or at risk areas of the country are retrofitted in order to reach high standards of earthquake resilience. | Avoided damages | | | Functionality post-earthquake |
| **Post-Earthquake Reconstruction in Nepal - Building Back Better**<br>Establishes partnerships with local and central government, communities and businesses to support the districts affected by the 2015 Earthquake. This programme builds resilient (including climate resilient) infrastructure and institutions. Parts of the programme also ensure that most vulnerable recover their livelihoods and assets, and the Government of Nepal plan for and manage the response to the earthquake. | Avoided damages | | | Functionality post-earthquake |
| **Rural Access Programme 3**<br>Integrates climate variability & climate change into road building n& maintenance. Parts of programme aim to increasing awareness of communities to climate change and disaster resilience. | Avoided damages, disruption | Management, planning, preparedness | Access to services, markets, etc. | Connectivity during/ post-hazard (e.g. flood) |
| **Strengthening Disaster Resilience in Nepal**<br>Strengthens disaster resilience, particularly to earthquakes, by working with urban centres to build & plan more safely; supports strengthening of critical public infrastructure & national capacity to respond to crises & ensure international community is prepared & UK able to support humanitarian response to crises. | Avoided damages, disruption | Management, planning, preparedness | | Functionality (e.g. infrastructure) post-hazard |
| **Climate Smart Development for Nepal**<br>Helps Nepal cope with impacts of climate change & promote clean development by providing strategic support to the Government of Nepal to design & implement climate change policies & integrate resilience throughout government planning. Improves resilience of businesses & poor & vulnerable people in most remote districts to floods, landslides & droughts. | | Preparedness, responsiveness | Key population resilience proxies/ indicators | Poverty, consumption during/post hazard, recovery times |
| **Rural Water and Sanitation Programme Phase V**<br>Parts of the programme ensure that water supply schemes are earthquake resilient. | Avoided damages, disruption | | Access to (resilient) water supply | Water supply post-earthquake |
| **Anukulan project – BRACED programme** | Avoided losses (e.g. incomes) | | Key population resilience | Poverty, consumption, |

| Programme | CBA (1) | Scorecards (2) | 2ndary data (3) | Recovery times (4) |
|---|---|---|---|---|
| Aims to help poor & vulnerable people in rural Nepal to build resilience to climate change impacts (e.g. floods & drought) through small farm economic opportunities & investments in e.g. drip irrigation, conservation agriculture, essential oil production, multiple-use water systems & community-based renewable energy. | | | proxies/ indicators | income during/ post hazard, recovery times |
| **Seismic Retrofitting of Unsafe Housing in Nepal**<br>Improves resilience to future earthquakes through seismic retrofitting of damaged houses across earthquake affected districts. Builds capacity of the Government of Nepal, skilled masons & engineers to retrofit homes. | Avoided losses/ damages | Preparedness, responsiveness | | Recovery times (reconstruction , services, etc.) |
| **Integrated Programme for Strengthening Security and Justice**<br>Embeds cross-cutting priority on DRR. Targets improvements in seismic resilience of 'first responder' police infrastructure. Provides support to build infrastructure & shelters for communities to access services related to security and justice. Ensures such infrastructure meets adequate environmental standards in design & construction, for example, adequate water and sanitation provision and earthquake and disaster resilient. | Avoided losses for specific infrastructure | Preparedness, responsiveness | People with access to shelters and key services | Level of access to services during and post-hazard |
| **Sakshyam: Access to Finance**<br>Weather based insurance products for farmers, risk & resilience in national payment system | Avoided deficits in incomes, consumption, etc. | | | Recovery post-hazard (flood, drought) |
| **AiiN**<br>Disaster recovery system for the Nepal Rastra Bank, SEZs to reduce investor exposure to shocks, improving regulatory frameworks for large scale infrastructures resilience | Avoided losses | Preparedness | | Functionality post-hazard |
| **Sabalaa – women's income**<br>Working with government, private sector, civil society and local organisations to build robust and resilient institutional systems to deliver change at scale. | | | Key population resilience indicators | Downstream link with Method 4 |
| **Skills for Employment**<br>Improving skills & capability of workforce for at least 100,000 poor thereby increasing their economic resilience; providing skills to 7500 people in earthquake-resistant housing construction make reconstruction more resilient; investing in productive migration to increase returns & helping reinvestment of remittance savings for resilient livelihoods to increase financial resilience | Downstream link with Method 1 | | Key population resilience indicators | Downstream link with Method 4 |

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# ANNEX 1 - OVERVIEW OF DFID NEPAL'S RESILIENCE PORTFOLIO

**Table A1 Description of programmes under DFID's Resilience Portfolio, and how they relate to building resilience, based on the individual programme summaries and business cases accessible DFID's online Development Tracker[13]**

| N | Name of programme | Centrally managed or country programme | Budget | Dates | Relevance to resilience building |
|---|---|---|---|---|---|
| 1 | Nepal Local Governance Support Programme | Country programme | £68,099,997 | Dec 2013 to Nov 2019 | Parts of the programme ensure that Local Government's awareness and capacity on climate change adaptation, disaster resilience and environmentally friendly governance are improved. |
| 2 | Nepal Health Sector Programme III | Country programme | £84,999,999 | Jul 2016 to Dec 2020 | Parts of the programme ensure that hospitals in the most densely populated and/or at risk areas of the country are retrofitted in order to reach high standards of earthquake resilience. |
| 3 | Post-Earthquake Reconstruction in Nepal - Building Back Better | Country programme | £63,049,990 | Jun 2016 to Dec 2022 | The programme establishes partnerships with local and central government, communities and businesses to support the districts affected by the 2015 Earthquake. This programme builds resilient (including climate resilient) infrastructure and institutions. Parts of the programme also ensure that most vulnerable recover their livelihoods and assets, and the Government of Nepal plan for and manage the response to the earthquake. |
| 4 | Rural Access Programme 3 | Country programme | £58,049,981 | Jan 2013 to Oct 2020 | Climate variability and climate change are integrated in building new roads and maintaining existing roads through the programme. Parts of the programme also include increasing the awareness of communities to climate change and disaster resilience. |
| 5 | Strengthening Disaster Resilience in Nepal | Country programme | £45,999,998 | Sep 2016 to Mar 2023 | This programme strengthens disaster resilience in Nepal, particularly to earthquakes, by working with urban centres to build and plan more safely; supporting the strengthening of critical public infrastructure to earthquakes; working to strengthen national capacity to respond to crises and ensure that the international community is prepared; and ensuring that the UK is able to support a humanitarian response should a crises hit. |

[13] https://devtracker.dfid.gov.uk/countries/NP/projects

| N | Name of programme | Centrally managed or country programme | Budget | Dates | Relevance to resilience building |
|---|---|---|---|---|---|
| 6 | Climate Smart Development for Nepal | Country programme | £35,864,545 | Oct 2016 to Mar 2023 | This programme helps Nepal to cope with impacts of climate change and promote clean development by providing strategic support to the Government of Nepal to design and implement climate change policies and integrate resilience throughout government planning. Parts of this programme also improves resilience of businesses and poor and vulnerable people in most remote districts to floods, landslides and droughts. |
| 7 | Rural Water and Sanitation Programme Phase V | Country programme | £18,683,997 | Jun 2012 to Jun 2020 | Parts of the programme ensure that water supply schemes are earthquake resilient. |
| 8 | Anukulan project – Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programme | Centrally managed programme | BRACED total budget is £140,149,986. Allocation to Nepal is not known. | Sept 2013 to Sept 2019 | The project aims to help poor and vulnerable people in rural Nepal to build their resilience to climate change impacts (such as floods and drought) through small farm economic opportunities and investments in climate-smart technologies such as: drip irrigation, conservation agriculture, essential oil production, multiple-use water systems and community-based renewable energy. |
| 9 | Seismic Retrofitting of Unsafe Housing in Nepal | Country programme | £4,999,998 | Jun 2017 to Dec 2019 | This programme improves resilience to future earthquakes and benefit households seismic retrofitting of damaged houses across earthquake affected districts. The programme also builds the capacity of the Government of Nepal, skilled masons and engineers to retrofit homes. |
| 10 | Integrated Programme for Strengthening Security and Justice | Country programme | £45,499,997 | Jan 2014 to Dec 2020 | The programme embeds a cross-cutting priority on disaster risk reduction (DRR). It targets improvements in the seismic resilience of 'first responder' police infrastructure. Parts of the programme also provide support to build infrastructures and shelter homes for communities to access services related to security and justice. The programme ensures that such infrastructures meet adequate environmental standards in design and construction, for example, adequate water and sanitation provision and earthquake and disaster resilient. |

**Table 7** summarises DFID Nepal's investment in its three key themes of Growth, Governance and Resilience/Inclusion, and the percentage weighting of investment in each theme. These have been estimated using data from DevTracker[14].

**Table A2 - Summary of DFID Nepal's investment in Hard/ Soft Resilience by Theme, Scale and Investment value**

**DFID NEPAL - RESILIENCE MAINSTREAMING STRATEGY:**
**ANALYSIS OF CURRENT PROGRAMMES BY THEME, SCALE, INVESTMENT**

(Data source: https://devtracker.dfid.gov.uk/countries/NP/projects. Accessed 18 December 2019)

| DFID Nepal - Current programmes: Hard/ Soft Resilience; Theme; Program; Component(s) | SCALE, INVESTMENT (Investment in GBP'000,000's, project totals from Logical Frameworks) | | | | | | |
|---|---|---|---|---|---|---|---|
| | TOTAL | % | National | District/ City | Community/ Household | Infrastructure Unit/ Entity | Mixed |
| **HARD RESILIENCE** | | | | | | | |
| Growth | 34.4 | *24.9%* | 0.0 | 34.4 | 0.0 | 0.0 | 0.0 |
| Governance | 38.8 | *28.1%* | 0.0 | 0.0 | 7.8 | 31.0 | 0.0 |
| Resilience/ Inclusion | 65.0 | *47.0%* | 0.0 | 0.0 | 45.0 | 20.0 | 0.0 |
| **Sub-Totals** | **138.2** | ***100.0%*** | **0.0** | **34.4** | **52.8** | **51.0** | **0.0** |
| | | | ***0.0%*** | ***24.9%*** | ***38.2%*** | ***36.9%*** | ***0.0%*** |
| **SOFT RESILIENCE** | | | | | | | |
| Growth | 159.1 | *37.0%* | 48.0 | 0.0 | 38.0 | 41.6 | 31.5 |
| Governance | 182.6 | *42.4%* | 0.0 | 93.6 | 21.0 | 0.0 | 68.0 |
| Resilience/ Inclusion | 88.6 | *20.6%* | 0.0 | 3.4 | 38.3 | 0.0 | 46.9 |
| | | | | | | | |
| **Sub-Totals** | **430.3** | ***100.0%*** | **48.0** | **97.0** | **97.3** | **41.6** | **146.4** |
| | | | ***11.2%*** | ***22.5%*** | ***22.6%*** | ***9.7%*** | ***34.0%*** |
| **TOTALS** | **568.5** | ***100.0%*** | **48.0** | **131.4** | **150.1** | **92.6** | **146.4** |
| | | | ***8.4%*** | ***23.1%*** | ***26.4%*** | ***16.3%*** | ***25.8%*** |

## DATA CONSTRAINTS

A number of data constraints affected the analysis captured in the above tables. Funding data could not be identified for several 'Governance' projects/ outputs; and some outputs combined hard and soft resilience activities so these could not be disaggregated. Accordingly, the results in Table 1 are broadly indicative of the weighting DFID Nepal gives to relevance criteria but should not be considered a complete and/ or robust empirical analysis of the resilience portfolio.

## RESILIENCE THEMES ARE OF EQUAL PRIORITY FOR MEASUREMENT

In terms of resilience themes, portfolio funding is reasonably evenly weighted. The Review has assessed resilience measurement tools relevant to all themes. The weighting is as follows:

- Governance £221.4m (39%);
- Growth £193.5m (34%); and
- Resilience/ Inclusion £153m (27%).

[14] https://devtracker.dfid.gov.uk/. Accessed 18 December 2018

### RESILIENCE SCALES PRIORITISE MEASUREMENT TOOLS AT SUB-NATIONAL LEVELS

Resilience portfolio investment by Scale is not as evenly distributed. The District/ City, Community/ Household and Infrastructure Unit/ Entity investments comprise £374.1m (66%) of the total, before adding Mixed Scale investments in these categories. This significant weighting towards sub-national investment indicates that the Review needs to prioritise its research effort on resilience tools that use data, skills and methods that can readily be found at sub-national levels in Nepal. National level measurement tools will also be researched.

### 'SOFT' RESILIENCE MEASUREMENT TOOLS ARE HIGHER PRIORITY

Resilience portfolio investments in Soft infrastructure are £430.3m (76%), or three times greater than Hard infrastructure investments of £138.2m (24%). Consequently, the Review's primary focus is on soft resilience measurement tools, as these will have greatest relevance to DFID Nepal. A range of hard resilience measurement tools will also be assessed to ensure this investment area is properly considered by the literature review.

### LITERATURE REVIEW PRIORITISATION OF RESILIENCE MEASUREMENT TOOLS

The investment priorities reflected in DFID Nepal's portfolio suggests a prioritisation of tools and methods for the measurement of resilience:

- for 'soft' resilience investments;
- for interventions implemented at sub-national levels in Nepal;
- across the Governance, Growth and Resilience/ Inclusion themes more-or-less equally.

Resilience measurement tools relevant to investments in 'hard' resilience will be given equal attention in the prioritisation based on relevance and the assessment of quality. However, the emphasis on 'soft' investments may ultimately inform the final identification of 'most relevant' tools and methods. This will be a matter for discussion with and within DFID, based on the final shortlist of high-priority tools and methods.

# ANNEX 2. MAPPING OF ACTIVITIES, PROGRAMMES, MILESTONES AND INDICATORS

The tables in this annex map activities under DFID Nepal's 'Big Change Areas' to DFID Nepal programmes, results/milestones and indicators, based on the information contained in documentation provided to the Review Team by DFID Nepal, including the mainstreaming strategy and several presentations. Based on this mapping, and specifically on the identified indicators, types of tools and methods that are relevant to the DFID Nepal portfolio are identified. This mapping analysis is used to identify categories of applicability use to assess whether tools and methods for measuring resilience are relevant to the portfolio under Step 4 of the methodology. These applicability categories are listed under Criterion 1 in Table A8 of Annex 5 and used in the scoring spreadsheet that constitutes Annex 7e.

**Table A3 Mapping of activities, programmes, milestones and indicators for GROWTH / ECONOMIC TRANSITION**

| **Activities / Big Change Areas** (MERL presentation) | **Programmes** (Mainstreaming strategy) | **Results/milestones** (ToC, MERL presentation) | **Indicators** (Mainstreaming strategy) | **Relevant tools & methods** Based on indicators |
|---|---|---|---|---|
| *Enhancing economic resilience at macro, business & individual levels*<br>*Risk reduction through retrofitting, rebuilding and urban planning to reduce costs of future hazards/ disasters*<br>Regulatory business frameworks for innovation & sustainability<br>Productive and labour-intensive investments<br>Increase competition less cartels<br>Skills, safer migration<br>More productive use of remittances<br>Infrastructure services for all<br>Risk reduction through retrofitting, rebuilding and urban planning to reduce costs of future hazards/ disasters | **Sakshyam: Access to Finance -** weather based insurance products for farmers, risk & resilience in national payment system<br>**AiiN -**disaster recovery system for the Nepal Rastra Bank, SEZs to reduce investor exposure to shocks**,** improving regulatory frameworks for large scale infrastructures resilience<br>**Rural Access Program (Phase 3)** - incomes, road maintenance & standards for CR/DRR<br>**Sabalaa** – women's income<br>**Skills for Employment** | Middle Income Country by 2030<br>GDP >6% avg for 5 yrs<br>Increased FDI - $1.5 billion<br>EoBD ranking(?)<br>5 large infra.<br>1 GW energy<br>Xmil. w/ improved services<br>400,000 jobs (50% women) | **Number of people with** improved economic resilience | Methods relating to economic resilience of people, households, etc. (outcome level – system or hazard focus) |
| | | | **Number of institutions** selling products that will increase resilience | Methods relating to products and services that increase resilience (outcome level) |
| | | | **Number of infrastructure investments** with increased resilience measure in their design | Methods relating to resilience of large-scale infrastructure (outcome level) |
| | | | **Avoided costs of shocks** | Methods estimating avoided losses (impact level & focus) |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Table A4 Mapping of activities, programmes, milestones and indicators for GOVERNANCE / TRANSITION TO FEDERALISM**

| **Activities / Big Change Areas** (MERL presentation) | **Programmes** (Mainstreaming strategy) | **Results/milestones** (ToC, MERL presentation) | **Indicators** (Mainstreaming strategy) | **Relevant tools & methods** Based on indicators |
|---|---|---|---|---|
| *Federalism (institutional) resilience*<br>*Stockpiling, contingency planning and improved emergency response*<br>Empowered elected reps.<br>Deliberative decision-making in public interest<br>A more representative state<br>Stronger political accountability<br>Effective inter-governmental structures to reduce disputes<br>Rule of law; tackles elite impunity | **Nepal Health Sector Support Prog.** – hospital retrofitting/upgrading, national standards & policies for resilience health infrastructure, drugs/ immunization/disaster kits, supporting Health Emergency & Disasters Management Unit<br>**Governance** – resilience institutions, rights, buildings, justice, rural infra.<br>**Gurkha** – WASH & DRR (future)<br>**IPPSJ** – security & justice<br>**LG support programme** | Effective & account. Govt.<br>Federal transition<br>Transition justice<br>Increased access to justice for women<br>Reduced impunity<br>Improved gov. & TI scores | **Number of people** highly vulnerable accessing government resilience services with improved economic resilience | Methods relating to coverage or use of services that confer resilience benefits (outcome level) |
| | | | Number of local/Prov. Government **institutions** with resilient decision making, financial systems & implementation capacity | Methods relating to institutional resilience with focus on government & financial systems |
| | | | **Avoided costs of shocks** | Methods estimating avoided losses (impact level & focus) |
| | | | Clear roles on responsibilities for DRR and response at the Federal, provincial and local tiers | Methods relating to institutional responsiveness in relation to DRR |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

**Table A5 Mapping of activities, programmes, milestones and indicators for INCLUSION / INCLUSIVE DEVELOPMENT**

| **Activities / Big Change Areas** (MERL presentation) | **Programmes** (Mainstreaming strategy) | **Results/milestones** (ToC, MERL presentation) | **Indicators** (Mainstreaming strategy) | **Relevant tools & methods** Based on indicators |
|---|---|---|---|---|
| *Vulnerable groups / LNOB*<br>*Climate resilience and adaptation to protect development gains from future climate shocks & stresses, including heavy rainfall, floods (including GLOFs & floods associated with increased snow/ice-melt), droughts, heat & cold extremes, regime shifts*<br>Services and basic needs met e.g. health, water etc<br>Gender equality - potential & reducing vulnerabilities of women & girls<br>Access to justice for all<br>Most vulnerable protected from shocks (economic/natural disasters /CC)<br>Better social protection<br>Stronger social accountability<br>End of peace process<br>Equitable access to justice | **Post-Earthquake Reconstruction** – LG, community infrastructures, drinking water, housing<br>**Strengthening Disaster Resilience** - urban municipalities, critical public infrastructures, E/q resilient schools, social protection, disaster response capacity (multi-level), local & prov. Integration of resilience in planning.<br>**Climate Smart Development** - support LG on adaptation res. Infra., integrating climate finance – vulnerable, remote; RE LG & PS climate finance access. | Poverty <5% by 2030<br>XX % women GP chairs<br>Reduced inequality<br>Equal land rights<br>XXm poor & vulnerable protected<br>FP services delivered to women<br>Xm benefit from recon. Support (climate smart development) | **Number of people** with improved physical resilience | Methods relating to resilience of households, communities, vulnerable groups & women/girls through data aggregation or contextual factors such as access to services (outcome level) |
| | | | Key government **Institutions** policies, strategies and regulations reflect best practice (e.g. Sendai, Climate Smart Development) | Methods relating to institutional disaster, climate, other risk management |
| | | | **Avoided costs of shocks** | Methods estimating avoided losses (impact level & focus) |
| | | | Number of shock responsive **Government response systems** operational | Methods relating to institutional responsiveness in relation to DRR |
| | | | Number of people **directly helped** by post shock systems | Methods relating to effectiveness of response systems |
| | | | **Number of municipalities** with resilience strategies and committed resources | Methods relating to institutional resilience & responsiveness |
| | | | | |
| | | | | |

## CLASSIFICATION OF RESILIENCE MEASUREMENT METHODS, DERIVED FROM INDICATORS AND MILESTONES

Listed below are the types of methods for measuring resilience that are relevant to the DFID Nepal portfolio. These are taken from column 5 in the above tables, with repetitions omitted. Methods are grouped according to the types of resilience they target. These classifications can be used to assess the relevance of methods assessed in the Literature Review to the portfolio.

### Resilience of people

- Methods relating to the economic resilience of people, households, businesses, regions, etc. (outcome level – system or hazard focus)
- Methods relating to the physical resilience of people, households, communities, vulnerable groups & women/girls (outcome level)
- Methods relating to coverage or use of services that confer resilience benefits (outcome level)
- Methods relating to products and services that increase resilience (outcome level)

*Options*

1. *Retain above four categories (economic resilience, physical resilience, resilience from public services, resilience from private sector);*
2. *Represent by category of methods that characterise population resilience through intrinsic factors (e.g. individual, household capacities, assets, etc.) and contextual factors (e.g. availability of services – including those generated by the private sector, presence of appropriate infrastructure, etc.).*

*Ideally such methods would include some means of assessing the extent to which resilience benefits are conferred on the most vulnerable, marginalised, women & girls.*

### Resilience of infrastructure

- Methods relating to resilience of large-scale infrastructure (outcome level)

*Should include physical aspects of infrastructural resilience and regulatory measures to enhance resilience of infrastructure through retrofitting or standards for new infrastructure. Should this be 2 categories? Would be good to target this at any particularly relevant types of infrastructure.*

### Resilience of and derived from institutions

- Methods relating to institutional resilience with focus on government & financial systems
- Methods relating to institutional responsiveness in relation to DRR
- Methods relating to institutional disaster, climate, other risk management
- Methods relating to institutional responsiveness in relation to DRR
- Methods relating to effectiveness of response systems
- Methods relating to institutional resilience & responsiveness

*Possible categories include: (i) resilience of institutions, including government; (ii) responsiveness of institutions and systems responsible for managing and responding to disaster risk, (ii) extent to which institutions incorporate consideration of climate change and how hazards might evolve in the future.*

**Resilience in terms of avoided losses**

- Methods estimating avoided losses (impact level & focus)

## OPTIONS FOR CLASSIFYING RESILIENCE MEASUREMENT TOOLS AND METHODS

**Table A6 possible lists of tool/method categories, based on what type/aspects of resilience they target, derived from the classifications listed above. The left-hand column presents a more detailed classification, involving 10 categories of method, while the right-hand column presents a simplified classification, involving 6 categories of method. DFID expressed a preference for the simplified classification, and this is what was used to classify tools and methods in terms of their applicability to the DFID Nepal portfolio**

| Detailed categorisation | Simplified categorisation |
|---|---|
| *Populations*<br>1. Economic resilience or people, businesses & populations/areas<br>2. Physical/social resilience of populations<br>3. Resilience benefits from public services<br>4. Resilience benefits from private sector<br>5. Resilience building targeting women/girls, marginalised & most vulnerable<br>*Infrastructure*<br>1. Physical resilience of infrastructure<br>6. Regulatory measures to enhance resilience of infrastructure<br>*Institutions/governance*<br>7. Resilience of institutions including government institutions<br>8. Responsiveness of institutions & systems for DRR & disaster response<br>9. Institutional measures & systems to respond to climate change risks<br>*Impact measures*<br>10. Avoided losses | 1. Economic, social and physical resilience of populations (intrinsic & contextual)<br>2. Resilience of larger-scale infrastructure<br>3. Resilience of institutions<br>4. Institutional DRR & responsiveness<br>5. Institutional management of risks associated with climate change<br>6. Avoided losses |

## ANNEX 3. DEFINITIONS OF RESILIENCE

| Field | Definition | Source |
|---|---|---|
| Development,<br>Disaster risk reduction | The ability of countries, communities and households to manage change by maintaining or transforming living standards in the face of shocks or stresses without compromising their long-term prospects | Sturgess & Sparrey 2016<br>DFID 2011, p.6 |
| Insurance | The ability of a system, community or society to pursue its social, ecological and economic development and growth objectives while managing the disaster risk over time in a way that contributes to sustainable growth and helps to mitigate disaster risk. | Szoenyi et al. No 2016. |
| Disaster risk reduction | The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. | United Nations 2016 |
| Climate change adaptation | The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation. | IPCC 2014 |
| Ecology /<br>social-ecological systems | The capacity of a social-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. It describes the degree to which the system is capable of self-organization, learning and adaptation | Resilience Alliance, based on Holling 1973, Gunderson & Holling 2002 and Walker et al. 2004 |
| Development | The ability to anticipate, avoid, plan for, cope with, recover from and adapt to (climate related) shocks | DFID 2014a<br>Bahadur et al. 2015 |
| Urban development | Urban resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience. | 100 Resilient Cities |
| Economics (Static & Dynamic Economic Resilience) | Static Economic Resilience is: the efficient use of remaining resources at a given point in time. It refers to the core economic concept of coping with resource scarcity, which is exacerbated under disaster conditions. Static Economic | Rose 2015 |

| Field | Definition | Source |
|---|---|---|
| | Resilience does not restore damaged capacity and is thus not likely to lead to full recovery.<br><br>Dynamic Economic Resilience is: the efficient use of resources over time for investment in repair and reconstruction. Investment is a time-related phenomenon—the act of setting aside resources that could potentially be used for current consumption in order to re-establish productivity in the future. | |
| DRR | The ability of a system, community, or society to pursue its social, ecological, and economic development and growth objectives, while managing its disaster risk over time, a mutually reinforcing way. | Keating et al. 2014, also used by Atreya et al. 2016 |

# ANNEX 4. DETAILS OF STAKEHOLDERS CONSULTED

The Literature Review Team held a series of telephone conferences with DFID Nepal, the South Asia Research Hub, and the MEL Unit. The Team also participated in the Inception call for the Earthquake Review Team. In addition, the Team Leader travelled to Kathmandu between 25th and 30th November 2018, and met with the DFID Nepal Resilience Team, the MEL Unit, the SROs responsible for the Earthquake Literature Review, and representatives of Practical Action Nepal. During this week, the Team Leader also participated in two workshops at the DFID Nepal office, on DFID's Resilience Strategy, and Value for Money.

| N | Name | Affiliation | Justification | Contact details |
|---|---|---|---|---|
| ***International experts contacted*** | | | | |
| 1 | | Research Fellow in the Vulnerability and Poverty Reduction team at the Institute of Development Studies. | Lead author of the paper "Towards a Quantifiable Measure of Resilience" | |
| 2 | | Independent consultant | Specialized in the comparative VfM of resilience-building approaches and interventions | |
| 3 | | Consultant – USAID Center for Resilience | Panellist at RMEL conference for session on The Economics of Resilience Returns: When 1 + 1 > 2 | |
| 4 | | Center for Risk and Economic Analysis of Terrorism Events (CREATE) and Price School of Public Policy, University of Southern California, | Author of numerous academic papers on the economics of resilience, incl:<br>- "An economic framework for the development of a resilience index for business recovery"<br>- "Dynamic Economic Resilience and Economic Recovery from Disasters: A Quantitative Assessment"<br>- "Defining and measuring economic resilience to disasters" | |
| 5 | | Politecnico di Torino, Department of Structural, Geotechnical & Building Engineering (DISEG), Turin, Italy | Author of "Resiliency of Communities Affected by Natural Disasters: The Bay Area Case Study" | |

| N | Name | Affiliation | Justification | Contact details |
|---|---|---|---|---|
| 6 | | QA Manager, Forces and Resources Policy Center (FRP), National Security Research Division (NSRD); Senior Economist; Professor, Pardee RAND Graduate School | Lead author of "Resilience Dividend Valuation Model: Framework Development and Initial Case Studies "(including case study by Oxfam in Nepal) | |
| 7 | | GIZ | Lead on adaptation M&E for GIZ, author of Adaptation M&E Navigator Decision Support Tool. | |
| 8 | | OPM | Author of *Analysis of Resilience Measurement Frameworks and Approaches* (2016) and Regional Programme Development Manager, Action on Climate Today, responsible for reporting on resilience for programme in South Asia | |
| 9 | | Independent | Author of *A comparative overview of resilience measurement frameworks* (2015) | |
| 10 | | Sophoi (formerly of ITAD) | Associated Director of ITAD 2015-18 and MEL specialist with focus on resilience | |
| 11 | | IIED | Co-author of TAMD step-by-step guide on adaptation M&E | |
| 12 | | ODI | Head of Research for BRACED Knowledge Manager 2014-18; Coordinating Lead Author of the *Science for DRM 2017* report | |
| 13 | | ODI | Deputy Director, BRACED Knowledge Manager; disasters, resilience and conflict specialist | |
| 14 | | Pengwern Associates (formerly Associate Director of Vivid Economics) | Expert in environmental and climate change economics, contributor to recent report on *Innovative Finance for Resilient Infrastructure*, with Lloyds of London, which addressed modelled economic losses and counterfactual analysis for hydro-meteorological hazards. | |

| N | Name | Affiliation | Justification | Contact details |
|---|---|---|---|---|
| 15 | | Independent | Author of numerous reports on the economics of climate change and the costs and benefits of adaptation, many for/with DFID. | |
| ***International experts to be contacted*** | | | | |
| 16 | | Adviser, Monitoring, Evaluation, and Strategic Analysis (USAID – Center for Resilience) | Leads the resilience measurement, monitoring, evaluation and analysis work for the Center for Resilience at USAID | |
| 17 | | Senior Advisor, Climate & Resilience at iDE | Panellist at RMEL conference for session on Market Systems: Resilience Measurement Approaches | |
| 18 | | Practical Action UK | Worked on methodology for resilience measurement developed by Zurich Global Flood Resilience Alliance | |
| **Experts consulted in Nepal** | | | | |
| 19 | | Practical Action South Asia, Kathmandu | Working on measurement of flood resilience in Nepal using Zurich Global Flood Resilience Alliance methodology – interviewed in person on 30 November 2018 | |
| 20 | | Project Manager, Nepal Flood Resilience Project, Practical Action South Asia, Kathmandu | Working on measurement of flood resilience in Nepal using Zurich Global Flood Resilience Alliance methodology – interviewed in person on 30 November 2018 | |

# ANNEX 5. ADDITIONAL DETAILS OF METHODOLOGICAL STEPS

## STEP 1: DETAILS OF SEARCH TERMS USED

An initial search was carried out on Google and Google Scholar using the following search string, to identify literature relating to the measurement of resilience in general:

> **Intitle: measure OR measuring OR measurement OR quantify OR quantifying OR quantification" AND resilience -childhood -youth -adult –"mental health"**

This search string was designed to capture any literature relating to the measurement or quantification of resilience, while excluding the large body of work relating to psychological resilience and mental health, much of which focuses on children and adolescents (the '-' sign excludes the terms that it precedes from the search). The search string specifies that the terms included should appear in the title of literature identified in the search results.

The search string was then refined using additional search terms, relating to specific contexts, natural and other hazards, and activities/sectors highlighted in the Terms of Reference and during subsequent discussions with DFID and the MEL Unit. These terms were included in the search string by using the AND operator in conjunction with the term 'resilience'. Explicit inclusion of these terms generally produced far fewer search results, enabling the Review Team to carry out targeted searches relating to resilience measurement in specific contexts. These additional search terms address the instruction in the Terms of Reference that the review should examine tools and approaches for the measurement of resilience from outside the field of international development. These additional terms are listed below.

1. Agriculture
2. Avoided cost
3. Avoided losses/damages
4. Calculating loss OR losses AND damage OR damages
5. Capital investment
6. Climate change
7. Community
8. Conflict
9. Development
10. Disaster OR disasters
11. Disaster risk reduction (DRR)
12. Drought
13. Earthquake
14. Economic disruption
15. Financial OR economic shocks
16. Flood
17. Glacial lake outburst
18. Global and sovereign wealth fund
19. Heat extremes
20. Infrastructure
21. Infrastructure investment
22. Institution OR institutional
23. Insurance
24. Investment decision making
25. Landslide(s)
26. Nepal
27. Political uncertainty
28. Social transfers
29. Transfer payments
30. Transfers
31. Water

The initial search string was then modified to target literature relating to costs and benefits, by including these terms and terms relating to calculation and estimation, as follows:

> **Intitle: measure OR measuring OR measurement OR quantify OR quantifying OR quantification OR estimating OR estimate OR calculating OR estimate OR estimating OR estimation AND resilience AND cost OR costs AND benefit OR benefits**

This search was repeated replacing the term 'resilience' with **'adaptation'** to address the literature on climate change adaptation, which is closely related to resilience and highly relevant to the Nepal context.

In the results of the Google Scholar search for 'resilience' in combination with terms related to measurement and quantification, relevance declined rapidly after the 27th page of results (10 results per page) and many results were repeated. This occurred much more rapidly when the search was carried out using the Google search engine, which returned many of the same results as the Google Scholar search.

Inclusion of additional mandatory terms related to specific sectors and topics narrowed the search results dramatically, often returning only a few pages. Many of the results returned with the additional search terms also occurred in the general search.

For additional searches relating to costs and benefits of resilience and adaptation, relevance declined relatively rapidly in the results of the Google Scholar searches, with more relevant returns in the results of the general Google searches. Many results were repeated within and between these searches, and also between these and the initial searches targeting the measurement and quantification of resilience.

### STEP 2: KEY CHARACTERISTICS OF TOOLS AND METHODS

During the process of eliminating references that did not describe tools and methods for measuring resilience. The following key characteristics of the tools and methods reviewed were recorded:

1. Whether the reference contained a review element (i.e. of other tools/methods);
2. The framing of the tool or method in terms of (i) climate change adaptation (CCA), (ii) disaster risk reduction (DRR), (iii) economic resilience, or (iv) general resilience (i.e. to multiple types of stress and shock not confined to one of the other categories, or to unspecified stress/shocks);
3. The measurement method employed, i.e. (i) cost benefit analysis (CBA) or a variant thereof, (ii) indicators, (iii) measurement of recovery time, (iv) modelling, (v) survey, (vi) a mixture of these.
4. The sector in which the tool/method is intended to be applied (if relevant);
5. The hazard(s) in relation to which resilience is measured[15];
6. The scale or unit to which the measurement of resilience is applied (household, community, city, district, coupled social-ecological system, watershed, national, infrastructure unit or system).

### STEP 3: EXCLUSION CRITERIA

**Table A7 Exclusion criteria used to eliminate references that are unlikely to be relevant to DFID Nepal**

| Exclusion criterion | Explanation |
|---|---|
| General discussion | On closer examination, reference found not to provide detailed discussion of a tool or method, but instead consists of general discussion of resilience measurement and related methods. |
| Computationally intensive | The tool or method requires a high level of computation or simulation that is likely to be prohibitive. |
| Highly specific | The tool or method is highly specific to a sector or topic that is either not relevant in the context of DFID Nepal's portfolio, or is better suited to measurement by bodies managing a |

[15] Where the tool measures resilience to multiple types of disasters or related hazards, a classification of 'disasters' is used. Where it measures resilience to disasters and other types of hazards, a classification of 'multiple' is employed.

| Exclusion criterion | Explanation |
|---|---|
| | particular sector or system than resilience measurement by a donor and its partners; little or no scope for measurement across contexts/ programmes. |
| High technical capacity required | The tool or method requires a level of technical expertise that is unlikely to be available to DFID Nepal, or is unlikely to be sustained outside of a specific programme or project. |
| Large scale | The tool or method measures resilience at a scale that is too large to be useful, for example by comparing countries through the indicators representing the national level, with little explanatory utility at scales relevant to DFID's programming |
| OECD specific | The tool or method is focused on systems conforming to OECD standards, for example in infrastructure, and requires a level of data and monitoring that is unlikely to be available in Nepal (in practice closely related to high technical capacity). |
| Primary data intensity | The tool or method requires the collection of large amounts of primary data that is beyond the scope of DFID Nepal outside the context of specific interventions. |
| Small scale | The tool or method measures resilience at scales that are too small to be useful for measurement across DFID Nepal's portfolio, e.g. household or community level without scope for aggregation (in practice closely related to primary data intensity). |
| Specialist software | Tool or method employs specialist computer software requiring specialist training/knowledge (in practice closely related to high technical capacity & computational intensity). |
| Combination | A combination of the above reasons |
| Other | Reasons other than above (recorded in 'Notes' column in spreadsheet – see **Annex 7b-d**). |

Where a tool/method was classified as potentially relevant, additional auxiliary characteristics were noted to augment those recorded in Step 2, namely:

- Type of document (journal article, report, book section, thesis, other document);
- Whether it addressed 'hard' or 'soft' resilience, i.e. resilience of infrastructure (including natural/environmental infrastructure) or resilience based on social, economic, institutional, governance or other similar factors;
- Whether reference describing tool/method is behind a paywall to which team did not have access;
- Tool name (where relevant);
- Country context (i.e. where the tool has been developed or applied, if applicable).

## STEP 4 – RELEVANCE CRITERIA

**Table A8 Criteria for assessing relevance of references / tools and methods to DFID Nepal portfolio. Further explanation of these criteria is provided below.**

| No. | Relevance criterion | Explanation |
|---|---|---|
| 1 | Applicability to DFID Nepal portfolio | Applicability category (i.e. relevance of method to measurement of):<br>• Economic, social and physical resilience of populations (intrinsic & contextual)<br>• Resilience of larger-scale infrastructure<br>• Resilience of institutions<br>• Institutional DRR & responsiveness<br>• Institutional management of risks associated with climate change<br>• Avoided losses<br>*SCORING:*<br>*1: Not applicable or uncertain how applicable;*<br>*2: Likely to be applicable to one or more of above, but questions about how to operationalise;*<br>*3: clearly applicable to one or more of above.* |

| No. | Relevance criterion | Explanation |
|---|---|---|
| 3 | Transparency | Extent to which the method is described by publicly available case studies or guidance.<br>*SCORING:*<br>*1: Limited or negligible guidance on applying method in public domain;*<br>*2: Some guidance or case studies publicly available that can be used as template for applying method;*<br>*3: Clear, step-by-step guidance on how to apply the method is available in the public domain.* |
| 2 | Data fit | Extent to which method is likely to be practical given current or likely future data availability in Nepal, from public/government and other sources, including DFID programmes.<br>*SCORING:*<br>*1: Method requires data that are not available or of very limited availability in Nepal;*<br>*2: Method can be used with data that are available or likely to be available in Nepal, despite some gaps;*<br>*3: Most/all data required for method are readily available or very likely to be available in Nepal in foreseeable future.* |

**Criterion 1** was developed to assess the extent to which a tool or method might be applicable to any aspect of the DFID Nepal portfolio, based on the activities defined under DFID Nepal's 'Big Change Areas', the programmes listed under its Resilience Mainstreaming Strategy, the milestones identified in its draft portfolio-wide Theory of Change, and the indicators identified in its Mainstreaming Strategy Document. These are listed and mapped in **Annex 2**, in which results, milestones and indicators are used to define a set of applicability categories representing the types or aspects of resilience a tool or method might measure, that are relevant to the DFID Nepal portfolio. These criteria were agreed with DFID. This analysis was based on internal documents provided by DFID Nepal.

**Criterion 2** was intended simply to assess the extent to which information/guidance on how to apply a tool or method was readily available in the public domain. This eliminated literature protected by paywalls.

**Criterion 3** involved assessing the data required by a tool or method and making a judgment as to the extent to which these data are likely to be available in Nepal. Where a tool or method required a suite of standard development indicators or census-type data, it was assumed that at least some of these would be available.

## STEP 5 – QUALITY ASSESSMENT CRITERIA

### Table A9 Quality assessment of higher priority methods and tools (adapted from Table 1 in the DFID How to Note)

| Criterion | Associated questions |
|---|---|
| **(A) Strength of conceptual framing of resilience and resilience measurements** | • Is the tool/method based on a clear definition of and conceptual framework for resilience?<br>• Is it easily identifiable whether the method/tool relates to a specific approach of resilience measurements (i.e. hazard, impacts or system focus)?<br>• Does the resource acknowledge or make reference to other measurement approaches? |
| **(B) Transparency** | • Has the tool/method been tested in the contexts for which it has been developed?<br>• Did the views of stakeholders in these contexts inform the tool/method's development?<br>• Is stakeholder feedback on the tool/method's utility described in the documentation? |
| **(C) Appropriateness** | • Does the method/tool present methodological steps to measure resilience? |

| | |
|---|---|
| | • Does the method/tool demonstrate why the chosen method(s) are well suited to measure resilience in the specified context?<br>• Does the method/tool make reference to any data collection requirements?<br>• Does the method/tool address issues of attribution/contribution and explain how controls or counterfactuals should be approached? |
| **(E) Validity** | • Does the method/tool address the validity of the metrics and data used for measuring resilience (e.g. in relation to relevant hazards and the stated purpose of the measurement)? |
| **(F) Cogency** | • Does the author consider the method/tool's limitations and/or possible alternative interpretations of measurements? |

## ANNEX 6. OCCURRENCE OF 'RESILIENCE' IN GOOGLE SEARCHES

**Frequency of the word 'resilience' in Google searches over time since 1 January 2004. Top to bottom: (i) frequency of term 'resilience'; frequency of term 'resilience' in conjunction with the following terms: (ii) disaster, (iii) climate, (iv) earthquake, (v) ecological.**

# ANNEX 7. LISTS OF REFERENCES

**SUBMITTED AS SEPARATE EXCEL SPREADSHEETS, INCLUDING:**

**ANNEX 6a.** Initial 'long-list' of literature

**ANNEX 6b.** List of references describing tools or method based on **hazard-focused approach**, with charactersisation and assessment of potential relevance

**ANNEX 6c.** List of references describing tools or method based on **impact-focused approach**, with charactersisation and assessment of potential relevance

**ANNEX 6d.** List of references describing tools or method based on **system-focused approach**, with charactersisation and assessment of potential relevance

**ANNEX 6e.** List of references subjected to final relevance and quality assessment analysis (QA), with relevance scores, QA scores, final combined score, auxiliary information and notes.

## ANNEX 8. OUTLIERS IN THE LIST OF TOOLS AND METHODS THAT ARE OF INTEREST DESPITE LOWER SCORES.

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
|---|---|---|---|---|---|
| Guidance on climate change M&E | Spearman, M. and McGray, H., 2011. Making adaptation count: Concepts and options for monitoring and evaluation of climate change adaptation, manual. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ), and World Resources Institute (WRI). | 2.37 | System | Multiple | Outlier to consider for general guidance on the M&E of climate change adaptation. This paper provides a practical framework for developing M&E systems that can track the success and failure of adaptation initiatives in the development context. It set out how climate adaptation M&E/indicators/measurement stand out from other business as usual development practices. It provides guidance that encompasses both conceptual and practical matters, and places a strong emphasis on matching an intended progamme to environmental, institutional, and other key contexts. It is designed to be flexible, and it makes a point of addressing dilemmas and challenges in a way which encourages one to make sound decisions about them. It is based upon a series of convenings, case studies, and interviews conducted by the World Resources Institute (WRI) in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Readers with a portfolio, strategic or policy interest in M&E for adaptation will likely most appreciate Chapter 1 (Concepts: Introduction to Adaptation M&E for Development Practitioners), Chapter 2 (Early Efforts in Adaptation M&E: Lessons and Principles), and Chapter 4 (Conclusion: Priorities for "Learning by Doing" for Adaptation M&), while those responsible for designing an M&E system for a specific intervention will spend more time with the many details in Chapter 3 (Steps and Options: Developing M&E Systems for Adaptation Interventions) and the different annexes. In Chapter 3, this paper argues that choosing appropriate indicators for adaptation requires rooting an intervention's goals within its specific climate change and development context. Three adaptation dimensions are proposed to characterize indicators by type of outcome, and devise a baseline to measure progress within each. They consist of "Building adaptive capacity", "Implementing adaptation actions" and "Sustained Development in a Changing Climate". 'Assets' and 'institutional functions' are presented as two types of indicators that are particularly useful in describing adaptive capacity. Under adaptation actions the paper highlights activities and decisions that address particular 'climate hazards,' or work to reduce 'vulnerability drivers.' And 'ecosystem services' and 'livelihoods' are proposed as two useful types of indicators for demonstrating the long-term and systematic needs of sustaining development in a changing climate. This manual presents a useful framework and to lead the user through the design and development of M&E systems for CCA programming. |
| Disaster resilience of Hong Kong using UNISDR tool | Sim, T., Wang, D., Han, Z., 2018. Assessing the Disaster Resilience of Megacities: The Case of Hong Kong. Sustainability 10, 1137. https://doi.org/10.3390/su10041137 | 2.37 | System | Meso | The authors employ a blend of top-down and bottom-up approaches using the Sendai Framework Local Urban Indicators (LUI) Tools developed by UNISDR, to assess the disaster resilience of Hong Kong. The indicators were derived from UNISDR's Disaster Resilience Scorecard for Cities. Each indicator consists of a scorecard, with a score of zero representing indicating that no risks exist and no effort is required to address risk, and a score of 5 indicating a high level of risk and high levels of effort required to address risk. (domains), each with set of questions. This is a good adaptation of NISDR's Disaster Resilience Scorecard for Cities and should be considered for the Nepal context for this reason, as well as the potential to apply the tool at the city scale without intensive data requirements, although measurement does require engagement with city authorities. The approach could arguably also be adapted for use at the Palika level. four applicability categories of DFID Nepal portfolio (namely, DRR & responsiveness, Population resilience, Institutional resilience, Infrastructure resilience) relate to this tool. Another benefit is |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
|---|---|---|---|---|---|
| | | | | | that UNISDR's Disaster Resilience Scorecard for Cities has been tested extensively in developed and developing country contexts. |
| Vulnerability Index for Hindu Kush – Himalaya region | Gerlitz, J.-Y., Macchi, M., Brooks, N., Pandey, R., Banerjee, S., Jha, S.K., 2017. The Multidimensional Livelihood Vulnerability Index – an instrument to measure livelihood vulnerability to change in the Hindu Kush Himalayas. Climate and Development 9, 124–140. https://doi.org/10.1080/17565529.2016.1145099 | 2.27 | System | Meso | The Multi-Level Vulnerability Index (MLVI) covers the Himalaya-Hindu Kush (HKH) region, and is based on the Vulnerability and Adaptive Capacity (VACA) survey carried out by ICIMOD in three sub-basins in the HKH region, including Koshi in Nepal. This dataset might be useful for any intervetions in this region, but will have little or no utility elsewhere in Nepal unless the household-level data on which it is based are generated through further primary data collection. Even where data exist, further data collection would be required to assess changes in resilience over time. |
| Guidance on climate change & disaster M&E | Engle, N. et al., 2017. Operational Guidance for Monitoring and Evaluation (M&E) in Climate and Disaster Resilience-Building Operations. | 2.23 | System | Multiple | Detailed guidance for developing resilience measuring frameworks and indicators for climate and disasters. Menu of 323 indicators across 9 sectors, from World Bank projects. These include indicators measured pre and post hazard and can be used as a starting point for the development of a comprehensive approach to measuring resilience. Little attention to how indicators were identified or how appropriate they were in relevant project contexts, no information on processes through which indicators identiefied. although this is understandable given large number of projects and indicators represented. |
| National-level disaster resilience | M. Parsons, P. Morley, G. Marshall, P. Hastings, R. Stayner, J. Mcneill, et al., 2016. The Australian Natural Disaster Conceptual Framework and Indicator Approach, pp. 1–26 | 2.20 | System | Multiple | The index aims to provide a benchmark of national-level disaster resilience against which future changes can be assessed. It is meant to evaluate hot-spots of high or low disaster resilience in a country, and identify areas of strength in coping and adaptive capacity.This method coulld be used by DFID Nepal since it can presumably be adapted depending on availability of data. One of the benefits is that it relates to four applicability categories of DFID Nepal portfolio (namely, DRR & responsiveness, Population resilience, Institutional resilience, Infrastructure resilience). A limitation observed in the document is that the statistical analysis and index calculation are not described. In any top-down large-scale assessment such as the Australian Natural Disaster Resilience Index there will be limitations on the accuracy and application of the findings. Broad national data sets such as the 2011 Australian census was 7 years old when the index was released in 2017/18.There is also a ceiling spatial resolution at which the disaster resilience index can be applied. For example, the index explains variation in resilience at the smallest resolution of SA2 level of the 2011 Australian census, and some variables may have been collected at a broader resolution. Some community planning and engagement activities might ideally like to have finer scale information related to household preparedness activity or street level neighbourliness. This type of data is not collected in the index and indeed, would require a bottom-up survey approach. |
| Disaster Resilience Index and toolkit (urban resilience) | Khazai, B., Bendimerad, F., Cardona, O.D., Carreño, M.-L., Barbat, A.H., 2015. A Guide to Measuring Urban Risk Resilience: Principles, Tools and Practice of Urban Indicators. Earthquakes and Megacities Initiative., Quezon City, Philippines. | 2.20 | System | Meso | Useful resource. The Guidebook serves as a toolkit - a collection of useful methods, tools and cases relevant for dealing with the challenge of operationalizing indicators in urban disaster risk management. The Guidebook is designed specifically for urban DRM professionals to plan and implement a participatory process for assessing a city's risk and resilience from an integrated perspective. The Guidebook walks the users through the indicator design process and supports them in activities and exercises for selecting and weighting appropriate indicators.The Guidebook describes three urban risk indicator systems developed as complementary tools to communicate risk and promote discussion around appropriate local level risk and resilience strategies: Urban Disaster Risk Index (UDRi), Risk Management Index (RMi), and Disaster Resilience Index (DRI). Taking into account the focus of this |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
|---|---|---|---|---|---|
| | | | | | review, the third index (DRI) is the most relevant for DFID Nepal. The three indices are briefly described below.<br>Urban Disaster Risk Index (UDRi)<br>The quantitatively derived Urban Disaster Risk Index (UDRi) provides a holistic view of disaster risk by capturing through indices both the direct physical damages of buildings and infrastructure, as well as considering social fragility and lack of resilience issues (risk drivers) that can aggravate the physical effects. The main objective of this indicator system is to measure disaster risk from an integrated perspective and to guide decision-making, not only by considering the potential direct impacts of disasters but also by identifying multiple socio-economic and capacity/resilience factors.<br>Risk Management Index (RMi)<br>The disaster Risk Management Index (RMI) brings together a group of indicators that measure a city or country's risk management performance and effectiveness. These indicators reflect the organizational, development, capacity and institutional actions taken to reduce vulnerability and losses, to prepare for crisis and to recover efficiently from disasters.<br>Disaster Resilience Index (DRI)<br>The Disaster Resilience Index (DRI) was developed as a monitoring and evaluation tool for benchmarking and measuring progress (or lack of progress) on the mainstreaming of risk reduction and resilience approaches in the city's development policies and processes. The structure of the DRI is based on key thematic areas of resilience in cities and linked to EMI's analytical Disaster Risk Management Master Planning (DRMMP) model, which consists of strategies, policies, actions and processes for mainstreaming disaster risk reduction at the local level through a participatory planning process.<br>This method is interesting but not for fit for purpose as a standalone method at portfolio level given the need to collect a lot of primary data through participatory exercises. However, indicators and sub-indicators (of DRI in particular) could be relevant to DRR & responsiveness (as well as Institutional resilience and Infrastructure resilience) in Nepal and this might be folded into wider resilience measure or used as a stand-alone approach for specific programmes/areas. Wider principles might inform Nepal resilience measurement at large. In the same category of tool, UNISDR' Scorecard seems a better fit for DFID Nepal. |
| Urban earthquake resilience | E. Verrucci, T. Rossetto, J. Twigg, Multi-disciplinary Indicators for evaluating the Seismic Resilience of Urban Areas, in: Proceedings of the 15TH WORLD Conference Earthq. Eng. (15 WCEE). | 2.20 | System | Meso | This method coulld be used by DFID Nepal since it can be adapted depending on availability of data (as demonstrated in the case study). One of the benefits is that it relates to three applicability categories of DFID Nepal portfolio (namely, Infrastructure resilience, DRR & responsiveness, and Population resilience). Census and Tax Assessor data as well as Remote Sensing and GIS techniques have been used in the case study. Access to similar data sets and capability in using these techniques would be required to use this method. |
| Social vulnerability to floods | Rufat, S., Tate, E., Burton, C.G., Maroof, A.S., 2015. Social vulnerability to floods: Review of case studies and implications for measurement. International Journal of Disaster Risk Reduction 14, 470–486. https://doi.org/10.1016/j.ijdrr.2015.09.013 | 2.13 | System | Small | This study reviews the literature on social vulnerability to floods and identifies broadly defined 'theoretical indicators' based on their presence in the literature, then identifies 7 broadly defined 'leading empirical indicators' of social vulnerability to floods based on their frequency pf appearance in previous studies. |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
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| FM Global Resilience Index (national-level) | Oxford Metrica (2015) 2015 FM Global Resilience Index, Oxford. | 2.10 | System | Large | The FM Global Resilience Index is the first data-driven tool to rank 130 countries and territories according to their enterprise resilience to disruptive events. It aggregates 12 drivers of resilience into three factors (categories)—economic, risk quality and supply chain.<br>▪ The four drivers of the economic factor are productivity (i.e., gross domestic product [GDP] per capita), political risk, oil intensity (a measure of a country's vulnerability to changes in oil prices and supply) and urbanization rate.<br>▪ The risk quality factor consists of a country's exposure to natural hazards, the quality of its natural hazard risk management, the quality of its fire risk management and its inherent cyber risk.<br>▪ The supply chain factor includes control of corruption, quality of infrastructure, quality of local suppliers and visibility of supply chain across a country.<br>The primary purpose of this index is to provide executives with information to enable them to prioritize their enterprise risk management and investment/expansion decisions and gain powerful insights about risk and opportunities to guide their strategy in five key areas:<br>▪ Determine which locales are most resilient to disruptive events<br>▪ Site new facilities or expand existing ones<br>▪ Select suppliers<br>▪ Evaluate established supply chains<br>▪ Identify customers who may be vulnerable<br>The applicability of this index for DFID Nepal is uncertain. An assessment would be needed to determine if DFID Nepal could eventually benchmark and compare achievements of programmes building economic resilience of businesses with the national FM Global Resilience results for Nepal.. |
| Earthquake resilience | Xie, W., Rose, A., Li, S., He, J., Li, N., Ali, T., 2018. Dynamic Economic Resilience and Economic Recovery from Disasters: A Quantitative Assessment: Dynamic Economic Resilience and Economic Recovery from Disasters. Risk Analysis 38, 1306–1318. https://doi.org/10.1111/risa.12948 | 2.07 | Impact | Meso | Earthquake specific case study from China. CBA can establsih that adaptation investments can have benefits beyond CCA and are "no-regret" investments. This article analyzes the role of dynamic economic resilience in relation to recovery from disasters in general and to illustrate its potential in a case study of the Wenchuan earthquake. Analyzes specific examples of the dynamic resilience strategies adopted in the aftermath of the Wenchuan earthquake and analyze how they helped reduce economic output losses (BI), and how some of the strategies could further do so if enhanced. |
| Centennial Resilience Index (national-level resilience to multiple shocks) | Boorman, J., Fajgenbaum, J., Ferhani, H., Bhaskaran, M., Arnold, D., Kohli, H.A., 2013. The Centennial Resilience Index: Measuring Countries' Resilience to Shock. Global Journal of Emerging Market Economies 5, 57–98. https://doi.org/10.1177/0974910113494539 | 2.03 | System | Large | The Resilience Index intends to identify the factors that have increased the capacity of many emerging market and developing countries (EMDCs) to absorb external shocks and to respond effectively. The Resilience Index includes measures of macroeconomic policy, the growth of private debt above a sound threshold, and financial soundness elements typical of vulnerability exercises, but also contains important structural and institutional aspects of the economy, such as the quality of the civil service, governance, export dependency and diversity, and the relative size of international reserves. This index appears to have the power both to identify economies that are heading for trouble and to isolate the specific policy areas of weakness that lie behind their increasing vulnerability. The applicability of this index for DFID Nepal is uncertain. An assessment would be needed to determine if DFID Nepal could eventually benchmark and compare achievements of programmes building economic resilience of Nepal with the national resilience index results for Nepal.. |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
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| General resilience guidelines | OECD (Organisation for Economic Co-operation and Development) (2014) Guidelines for resilience systems analysis. Paris: OECD. | 2.00 | System | Multiple | This document consists of a step by step approach to resilience systems analysis, a tool that helps field practitioners to: (1) prepare for, and facilitate, a successful multi-stakeholder resilience analysis workshop; (2) design a roadmap to boost the resilience of communities and societies; (3) integrate the results of the analysis into their development and humanitarian programming. The added value of these guidelines in terms of resilience mesurement is the differentiation of indicator types i.e. system resilience indicators, negative resilience indicators, process indicators, process indicators, output indicators and proxy impact indicators. The main thing to take away from these guidelines that could be incorporated in any other method is the use of negative resilience indicators which look at whether people are using strategies to boost resilience that may have negative impacts on other areas of the system, for example turning to crime to deal with unemployment; or negative impacts on certain vulnerable people, for example by reducing the number of meals eaten a day, or taking children out of school. |
| Urban earthquake resilience | Tilio, B. Murgante, F. Di Trani, M. Vona, A. Masi, A. Lucano, 2011. Resilient city and seismic risk : a spatial multicriteria approach, pp. 410–422. | 2.00 | System | Meso | This method coulld be used by DFID Nepal since it can be adapted depending on availability of data (as demonstrated in the case study). To make full use of this method, technical capability in conducting spatial Multi Criteria Analysis (MCA) and using GIS platform pair wise comparison method are required, which can be a limitation for DFID Nepal. |
| Economic resilience to financial shocks | Shutters, S.T., Muneepeerakul, R., Lobo, J., 2015. Quantifying urban economic resilience through labour force interdependence. Palgrave Communications 1, 15010. https://doi.org/10.1057/palcomms.2015.10 | 2.00 | System | Meso | The authors address economic resilience to financial shocks, using the recession of 2007-2008 as an example, and focusing on the structure of the labour force. This study introduces the concept of system 'tightness', which measures the extent to which the components of an economic system are connected, integrated and interdependent. The authors model resilience in terms of occupational specialisations and links between different specialisations for metropolitan areas in the United States using employment data. It concludes that systems with a higher degree of tightness are more economically efficient in the absence of shocks, but are less resilient to such shocks, indicating a trade-off between resilience (which requires redundancy within a system) and efficiency (which is inversely related to redundancy). This approach could be employed in Nepal given sufficient data availability. However, it has a narrow focus on economic resilience to financial shocks, and thus does not address the hazards that are of most concern to Nepal. Most importantly, this approach requires a level of expertise that is unlikely to be available to DFID Nepal, or is unlikely to be sustained outside of a specific programme or project. The authors also argue that, although this study deals with economic shocks, quantitative metrics based on this methodology may help anticipate a city's response to shocks more generally, such as natural disasters, climate change, social unrest or significant policy shifts. |
| Community disaster resilience | Yoon, D.K., Kang, J.E., Brody, S.D., 2016. A measurement of community disaster resilience in Korea. Journal of Environmental Planning and Management 59, 436–460. https://doi.org/10.1080/09640568.2015.1016142 | 1.90 | System | Small | Degree of resilience = degree of capacity / degree of vulnerability. 45 indicators selected and correlations between them examined (using Cronbach's Alpha), leaving 24 indicators. Method might be applied at palika level, but indicators would need to be adapted. Little to no consideration of governance/institutional factors. Some indicators represent aspects of resilience that could be addressed through DFID and other interventions. Others are not amenable to intervention. |
| Urban resilience (earthquakes) | Asadzadeh, A., Kötter, T., Zebardast, E., 2015. An augmented approach for measurement of disaster resilience using connective factor analysis and analytic network process (F'ANP) | 1.90 | System | Multiple | Disaster resilience index for better understanding of the inherent strengths (resilience) and inherent weakness (vulnerability) or potentially performance of urban regions that could be affected from a major earthquake. Identifies indicators of resilience. Since these indicators are very general, and knowing that better set exist, this reference is classified as an outlier. |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
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| | model. International Journal of Disaster Risk Reduction 14, 504–518. https://doi.org/10.1016/j.ijdrr.2015.10.002 | | | | |
| Hospital disaster resilience (infrastructure) | Zhong, S., Clark, M., Hou, X.-Y., Zang, Y., FitzGerald, G., 2014b. Validation of a Framework for Measuring Hospital Disaster Resilience Using Factor Analysis. International Journal of Environmental Research and Public Health 11, 6335–6353. https://doi.org/10.3390/ijerph110606335 | 1.83 | System | Micro | 8 domains of resilience tested in 42 hospitals in Shandong Province, China, with factor analysis idenfitying a 4-factor structure of hospital resilience: emergency medical response capability, disaster management mechanisms, hospital infrastructural safety, disaster resources. Building on above study. This method is interesting but not for fit for purpose as a standalone method at portfolio level given the scale and the need to collect a lot of primary data through hospital surveys. However, there are a lot of indicators that could be relevant to hospitals in Nepal and this might be folded into wider resilience measure or used as a stand-alone approach for specific programmes/areas. Wider principles might inform Nepal resilience measurement at large. The framework can be regarded as a checklist to evaluate key indicators of hospital vulnerability and to identify priority practices that could better prepare the facilities for future disasters. The methodological framework and some of the agreed indicators may inform the development of indicators of hospital resilience in Nepal and other countries. |
| Food security and DRR | Venton, C.C., 2017. The Economics of Early Response and Resilience | 1.80 | Impact | Micro | Prepostioning of emergency supplies has high CBA. Looks at the economics of investing in food security aspects of DRR to generate cost savings compared to disaster relief. Timeliness of response as a key factor in CBA calculations. |
| Rural Diversity Index (socio-ecological resilience) | Quaranta, G., Salvia, R., 2014. [European Countryside] An Index to Measure Rural Diversity in the Light of Rural Resilience and Rural Development Debate. European Countryside 2, 161–178. https://doi.org/10.2478/euco-2014-0009 | 1.73 | System | Micro | Resilience as diversity - socio-ecological coupling. The RDI is an index that measures the diversity of rural socio-ecological systems on the basis of the three dominant perspectives of rural diversity: 1) agricultural diversification; 2) non-agricultural diversification; 3) diversification of the rural economy as a whole, and four capitals: 1) natural; 2) economic; 3) social and 4) institutional, which make up rural socio ecological systems. This method is interested but not for fit for purpose as a standalone method at portfolio level given the scale and the need to collect a lot of primary data. However, there are a lot of indicators that could be relevant and this might be folded into wider resilience measure or used as a stand-alone approach for specific programmes/areas. |
| Commercial building resilience (infrastructure) | Burroughs, S., 2017. Development of a Tool for Assessing Commercial Building Resilience. Procedia Engineering 180, 1034–1043. https://doi.org/10.1016/j.proeng.2017.04.263 | 1.63 | System | Micro | Broad characterisation of resilience beyond immediate characteristics of buildings that seems relevant to DFID Nepal portfolio context.The scheme adopts resilience as a holistic concept incorporating physical, infrastructural, environmental, economic–social, political–regulatory, and organisational resilience, and is rated according to dimensions, subdimensions, and items scored on a points system. The scheme allows the aspects in which a building is performing well or poorly to be identified as well as give an overall resilience rating. |
| | Chang, S.E., Shinozuka, M., 2004. Measuring Improvements in the Disaster Resilience of Communities. Earthquake Spectra 20, 739–755. https://doi.org/10.1193/1.1775796 | 1.53 | Impact | Meso | Resilience can be conceptualized along four interrelated dimensions: technical, organizational, social, and economic (TOSE). Evaluating community resilience and the degree to which mitigation and preparedness activities further resilience goals requires a multidisciplinary approach and quantitative measures. This paper proposes measures that relate the impacts of potential earthquakes to multi-dimensional performance standards. A resilient system should demonstrate three characteristics: reduced failure probabilities, reduced consequences from failures, and reduced time to recovery. A resilience framework must address the capacity of social units (e.g., individuals, organizations, and communities) to prepare for and respond to disasters. A key challenge is how to measure resilience and resilience improvements. |

| Tool/method name/summary | Reference | Score | Approach | Scale | Reasons for interest |
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| Climate Disaster Resilience Index (urban resilience) | Wan Mohd Rani et al. - 2018 - Measuring Urban Resilience Using Climate Disaster Resilience Index (CDRI)<br>*N.B. Original text not accessible behind paywall: Joerin, J., Shaw, R., Takeuchi, Y., Krishnamurthy, R., 2014. The adoption of a Climate Disaster Resilience Index in Chennai, India. Disasters 38, 540–561. https://doi.org/10.1111/disa.12058* | 1.37 | Impact | Meso | Climate Disaster Resilience Index (CDRI)—*consisting of five dimensions (economic, institutional, natural, physical, and social)*, 25 parameters, and 125 variables.<br>Climate Disaster Resilience Index is a tool aimed at measuring the city's level of resilience. The application to aimed to create awareness of the current and future risk that may pose the city (Joerin & Shaw, 2011; Surjan, Sharma, & Shaw, 2011). Outcome of the assessment is expected to guide in the establishment of a more holistic and comprehensive climate and disaster management plan to address the related issues. Useful for large urban settings e.g. Kathmandu; and baseline CDRI can be re-measured over time to record the impact of resilience investments, using spider web charts with good visuals. |
| Cost-effectiveness analysis (CBA-related) | Lukat, E., 2018. The Use of Non-Monetary Metrics to Assess Adaptation Actions: Cost-Effectiveness Analysis (CEA) [WWW Document]. ECONADAPT/TOOLBOX. URL https://econadapt-toolbox.eu/use-non-monetary-metrics-assess-adaptation-actions-cost-effectiveness-analysis-cea (accessed 11.18.18). | 1.30 | Impact | Multiple | Use of CEA and non-monetary metrics may be better suited to adaptaion investment prioritisation. CEA is also useful when targets are set (e.g. regulatory standards) and authorities are interested to identify the least costly path to achieve that single target. |
| Hospital disaster resilience (infrastructure) | Zhong, S., Clark, M., Hou, X.-Y., Zang, Y.-L., Fitzgerald, G., 2014a. Development of hospital disaster resilience: conceptual framework and potential measurement. Emerg Med J 31, 930–938. https://doi.org/10.1136/emermed-2012-202282 | 0.00 | System | | This article doesn't present an applicable method per se but (1) defines hospital resilience; (2) constructs a conceptual framework (including key domains); (3) proposes comprehensive measures for possible inclusion in an evaluation instrument; and (4) develops a matrix of critical issues to enhance hospital resilience to cope with future disasters. This article provides some relevant insights that might feed into approaches in Nepal and could be relevant to hospitals in Nepal. |