environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

National Climate Risk & Vulnerability (CRV) Assessment Framework

Version 1, April 2020

Proposed citation:

Department of Environment, Forestry and Fisheries, 2020. National Climate Risk and Vulnerability (CRV) Assessment Framework summary document, Pretoria: South Africa.

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

ACKNOWLEDGEMENTS

Framework development led by Waagsaether, K. L., Taylor, A. and Ziervogel, G. from the Climate System Analysis Group (CSAG) at the University of Cape Town, and funded by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Initial thoughts on the project were discussed at well attended stakeholder meetings. Feedback helped to strengthen the framework and a near final version was presented for comment. It is hoped that CRV assessments based on this framework can add to the work of various government departments and their long-term planning, and also inform adaptation interventions.

FOREWORD

The impacts of global climate change are increasingly being felt around the world. Changing rainfall and temperature patterns are affecting ecosystems and human societies in different ways. While climate change is expected to create new opportunities in some parts of the world, it is also expected to cause considerable distress in other parts. The extent of the impact depends on the magnitude of climatic changes affecting system (exposure), the characteristics of the system (sensitivity), and the ability of people and ecosystems to deal with the resulting effects (adaptive capacities of the system). These impacts and vulnerabilities manifest themselves at varying degrees from local to provincial level and require actions and support to respond. Assessing vulnerability to climate change is important for defining the risks posed by climate change and provides information for identifying measures to adapt to climate change impacts. It enables practitioners and decision-makers to identify the most vulnerable areas, sectors and communities.

South Africa has also experienced climate change impacts, and the evidence clearly emphasises the need for the country to build resilience and adaptive capacity to understand and respond to climate change risk and vulnerability. Climate Risk and Vulnerability Assessments have increasingly been used for adaptation actions, development planning at local, national and regional levels and for the identification of climate change hotspots. However, dealing more comprehensively and consistently with climate change impacts is a global challenge, both for developing and developed countries. The need for vulnerability assessments has become more and more important over the years and addressing potential harm imposed by climate change is gaining relevance for all kind of organizations.

As part of achieving this objective, the country through its National Determined Contributions (NDCs) to the Paris Agreement, has committed to the development of a Vulnerability Assessment and Adaptation Needs Framework to support continuous presentation of adaptation needs. Furthermore, the National Climate Change Response Policy (NCCRP, 2011) outlines the importance for each vulnerable sector to identify its climate risks and develop response strategies to address climate impacts. However, the complexity of assessing vulnerability involved defining and measuring the various geographical, spatial, temporal and social dimensions of vulnerability has resulted in a multitude of methodologies for assessing and understanding vulnerability. Therefore, there is generally a lack of consensus regarding the appropriate frameworks and best methodologies for assessing vulnerability. In South Africa, there is no standard approach or best practise guidelines for measuring vulnerability. This makes monitoring of vulnerability and the evaluation of adaptation measures considerably challenging and precludes comparing different sectors or localities as well as assessing vulnerability over time.

Given the circumstances, the development of any one-size-fits-all solution for assessing vulnerability to climate change is problematic. However, the National Climate Risk and Vulnerability Assessment Framework will provide methodologies and tools to be used to assess the components of vulnerability to climate change at different levels. It will further provide guidance in designing a suitable combination of different methods and tools for the climate change vulnerability assessment. Government departments, private sector and other organisations have developed vulnerability assessment reports and sectoral response strategies. In most cases, the level of vulnerabilities was determined using the IPCC endorsed framework (Exposure + sensitivity = Potential Impact + Adaptive capacity = Vulnerability) which eventually led to the ranking of each sector vulnerability using the scale of low/medium/high. However, several assessment methodologies and tools have emerged and understanding climate risk is crucial for effective adaptation action. It is very important to understand individual components in climate risk and vulnerability assessments looking at the conceptual approaches to vulnerability, exposure used, if current or future risks were assessed, and if and how changes over time (i.e. dynamics) were considered. The framework will further provide guidance on how to use different sets of methodologies and tools to undertake the risk and vulnerability assessment for specific circumstances.

There is growing demand among stakeholders internationally across public and private institutions for spatially-explicit information regarding vulnerability to climate change at the national and local scale and a call for a standardized approach on conducting risk and vulnerability assessment. However, the challenges associated with mapping the geography of climate change vulnerability are huge, both conceptually and technically, suggesting the need for more critical evaluation of this practice and the development of a common approach on conducting risk and vulnerability assessment. At present, there are already numerous approaches to vulnerability assessments that can be used to examine different types of climatic trends, threats and impacts caused by climate change and what is missing, however, is a need for a uniform approach that allows different actors to proceed consistently based on internationally agreed procedures. Hence the proposal to develop the National Risk and Vulnerability Framework (NRVF).

This Framework is intended to provide an overarching approach and guidance towards undertaking risk and vulnerability assessment using a suite of available methodologies and tools. It intends to provide stakeholders/decision makers with an integrated diagnostic framework that can assist to analyse if and how the dynamics of climate risk is addressed in practical assessment cases, and to also enhance a common approach/ a shared responsibility approach in conducting climate risk assessments across all sectors. Provide decision makers with a selection of methods and tools to assess the different components that contribute to key questions such as the type of planning required for a vulnerability assessment, which tool to use and how to carry out a vulnerability assessment. It will also offer a step-by-step guidance for designing and implementing a vulnerability assessment which covers the entire life cycle of adaptation interventions, using consistent methods proven on the ground. This holistic focus on the full spectrum of adaptation measures, plans and strategies constitutes a new approach to vulnerability assessments.

CONTENTS

LIST OF ABBREVIATIONS

CRV	Climate Risk & Vulnerability
DEFF	Department of Environment, Forestry and Fisheries
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

Climate variability and climate change (see box 1) have damaging and costly impacts across much of the world, and South Africa is no exception. The impacts of droughts, floods, cyclones and heatwaves are often the most widely reported, but gradual changes in temperature and rainfall that affect patterns of food production, diseases, species populations (especially key pollinators) among others are also being observed and pose significant threats to the functioning of society. As the climate continues to change so these impacts are projected to worsen, unless significant adaptive action is taken to reduce risks and vulnerabilities. Impacts are not experienced equally, even where the same climate event or climate pattern occurs. In order to design and implement effective adaptation interventions it is necessary to assess where, to what extent and by whom these climate impacts are being felt (i.e. current risks and vulnerabilities), why the patterns are as they are, and how this might change into the future. A better understanding of climate risks and vulnerabilities is also critical in advancing the climate change mitigation agenda, strengthening the case for investing in large-scale and widespread measures to reduce greenhouse gas emissions, nationally and globally, to avoid the worst of the projected climate impacts.

The need for this framework stems from the mounting set of demands for various public, private and non-governmental organisations to undertake climate risk and vulnerability (CRV) assessments for policy, planning, funding, insurance and compliance reasons. These include requirements under the National Climate Change Response Policy (2011), the draft Climate Change Bill, the draft National Climate Change Adaptation Strategy and the Disaster Management Amendment Act 16 of 2015, as well as international funding processes and reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

Numerous climate vulnerability and/or climate risk assessments have been done over the last two decades, however these are patchy in their coverage and use a variety of different approaches, methods and data. This variety has proved problematic for evaluating assessments and for aggregating across them to inform planning and decision making at larger scales and higher levels of governance. Consequently, South Africa's national government, like many other international, national and regional authorities around the world (for example the German and Indian governments), have undertaken to establish a common framework to guide the development and review of such assessments to enable a more integrated approach to climate adaptation. The intention is to provide guidance on how the many assessments that are taking place might align, and, where possible, enable comparison between, and aggregation of, assessments. The custodian of the CRV Framework is the Department of Environment, Forestry and Fisheries (DEFF), the National Department responsible for guiding and coordinating the implementation of activities to ensure that South Africa (our society, economy and ecosystems) becomes progressively more climate resilient and less carbon intensive. The Framework is aimed at any actor in South Africa setting out to assess Climate Risk and Vulnerability (CRV). It provides a flexible yet structured sequence of steps and set of options that ensures that, whichever CRV assessment context, scale or focus, a standard set of concepts and questions have been taken into consideration.

The framework provides three practical steps, namely 1) Scoping, 2) Planning and 3) Assessing, provided in chapter 3. It is important to first read chapter 2, making sense of the conceptual framing and definitions, before working through the practical steps of the framework.

Box 1: Climate variability and climate change[1]

Climate is defined as the average weather, or the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The relevant quantities are mostly surface variables such as temperature, precipitation and wind. The standard period for averaging these variables is 30 years, as defined by the World Meteorological Organisation. Climate in a wider sense is the state of the climate system.

The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere, and the interactions between them. The climate system evolves in time under the influence of internal dynamics and because of external forcings such as volcanic eruptions, solar variations and human-caused changes in the composition of the atmosphere (such as increasing concentrations of carbon dioxide, methane and other greenhouse gases) and land-use (e.g. removing forests for farming and settlements).

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system, or to variations in natural or human caused external forcing.

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent human-caused changes to the atmosphere and land-cover.

Note that the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that is additional to natural climate variability observed over comparable time periods, thereby making a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. This policy usage differs slightly from the scientific use of the same terms as defined above, which causes confusion, so use and interpret them with awareness and clarity.

For the purposes of assessing climate risk and vulnerability it is often not necessary to distinguish what risk or amount of risk is attributable to human-induced climate change from risk that is considered to be present as a result of natural climate variability and change (i.e. what the climate would be without human influences). However, there are some specific funding sources that require this differentiation to be made as their mandate is only to find the 'additional' component associated with reducing the risks of anthropogenic climate change. This differentiation and attribution is an ongoing source of tensions and difficulties, so do not get caught up in these technicalities unnecessarily. Simply focus on assessing the risks and vulnerabilities associated with the climate and how it is changing as a result of the combination of natural and human processes.

[1] The text in this box is adapted from the glossary of the IPCC AR5 2014 report Mitigation of Climate Change, URL: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-i.pdf

2. Understanding Climate Risk and Vulnerability Assessments – Conceptual framing and definitions

Climate risk and vulnerability is a diverse and dynamic field of research and practice. People from numerous disciplines and professional fields are contributing to the development of these concepts and finding different ways to conduct assessments and manage interventions. As a result, there are many different definitions and methodologies that have developed over a number of decades, as weaknesses, gaps and inconsistencies between preceding definitions and frameworks are identified and attempts are made to integrate and improve them (see boxes 2 and 3).

Box 2: Conceptual lineages

While in the past many in the disaster management field have called climate change adaptation interventions ‘protection’ (with a strong emphasis on hard infrastructure interventions like building seawalls and drainage networks), there has been a move to talk of ‘risk mitigation’ and ‘risk reduction’, which aligns with the language and tools of economists, financiers and business people and includes more socio-economic and behavioural responses. ‘Mitigation’ has been a source of confusion because disaster managers use it to mean any measures to reduce the risk of a disaster occurring, while climate specialists use it to refer specifically to the reduction of GHG emissions and land use changes that drive changes in the climate. Those working in the climate field talk mainly of ‘adaptation’ when referring to efforts at reducing climate impacts, although increasingly many are now talking of ways to build ‘resilience’. These terms have different histories, applications, and draw attention to slightly different ways of thinking and acting. But ultimately all of them ascribe to an ideal that if we can understand what poses a threat then we can proactively take measures to avoid the worst of the consequences.

The Intergovernmental Panel on Climate Change (IPCC) is an authority on climate issues at the international scale. The IPCC involves hundreds of academics (and now some practitioners too) from around the world who spend years collating all the latest research relating to climate change and produce a series of reports assessing the current state of global knowledge on climate-related matters. While recognising that there is no one right way to conceptualise climate risk and vulnerability, this CRV framework adopts the latest IPCC conceptual framing. This aligns the framework with the latest in global thinking and means that assessments using this framework will have a consistent conceptual approach, which enables some comparability between them and possible aggregation.

The latest IPCC conceptual framing comes from the IPCC’s Fifth Assessment Report from (AR5) (2014), where risk is a core concept, and vulnerability a component of risk. Here the risk associated with experiencing climate impacts is defined as resulting from the interaction of climate hazards, exposure and vulnerability. The vulnerability component of risk focuses on the sensitivity and adaptive capacity of those or that exposed to certain climate hazards. Vulnerability is defined as an internal pre-condition of the system being assessed in relation to the risk of experiencing climate impacts.

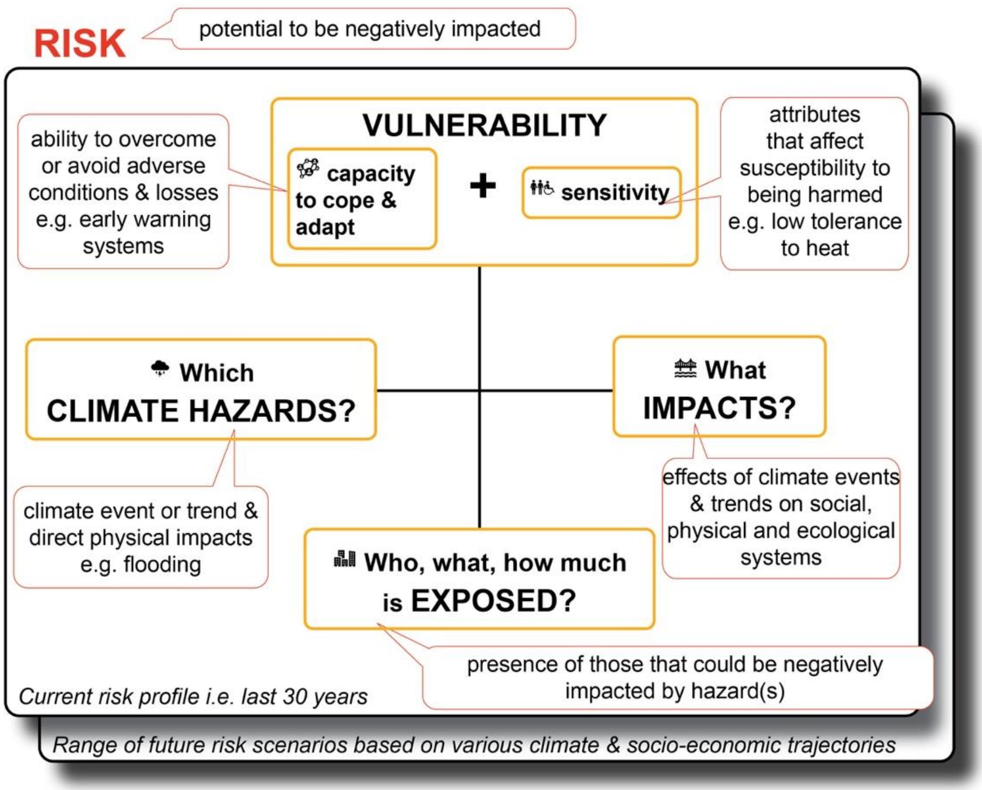


Figure 1 The component of climate vulnerability and climate risk, adapted from IPCC AR5 (source: GIZ, 2017a, p.17).

This conceptual framing brings into focus the climate hazards or stresses that are being considered in the assessment. Hazard does not only refer to the climate signal (whether an extreme event or a trend), but also climate-related direct physical impacts such as floods, erosion and landslides. It provides the opportunity for the assessment of the likelihood of potential impacts as part of understanding risk (although recognising that probabilistic approaches are not well suited to most climate risks because information about magnitude, frequency and associated damages is often not available). The key step in understanding risk is identifying who and what is exposed to the climate hazards and might therefore be potentially impacted or harmed, including groups of people, animal and plant species, pieces of built infrastructure (like houses, roads, factories, water treatment plants and power stations) and ecological infrastructure (like wetlands, streams, forests, stretches of coastline, etc.) that could be adversely affected. Climate vulnerability is a component of climate risk and explains why when equally exposed to a climate hazard, like a drought or coastal inundation, some are impacted worse than others. So two districts might have the same level of climate risk associated with flooding. One district has high exposure based on many households living in the

1-in-100 year flood zone but low vulnerability as they have the infrastructure and financial mechanisms to cope and adapt, and their livelihoods are based on employment outside of the flood zone. The other district has low exposure because few people live in the flood zone but they are highly vulnerable because they have no insurance or money to repair their homes and replace lost items, the floods damage the crops they rely on for an income, as well as damaging the bridges and roads they use to access schools and hospitals.

The conceptual framework provided by the IPCC AR5 tells us that to adapt, or reduce climate risk, interventions should either reduce vulnerability, by reducing sensitivity (e.g. build on raised or floating platforms in a flood zone) and/or increasing capacity (e.g. increase access to home insurance, or provide skills training to those living informally in flood risk areas in how to construct dwellings on stilts), and/or reduce exposure (e.g. move out of a flood zone). When assessing risk it is important to think through the problem from both 'ends', i.e. considering climate hazards, exposure to those hazards, vulnerability to experiencing the impacts of those hazards and thereby the resulting impacts, as well identifying impacts or negative outcomes and then working backwards to figure out vulnerability factors, exposure and thereby hazards. Leading with hazards is a useful way of identifying new or rare climate threats, while leading with impacts surfaces how climate conditions drive or exacerbate existing development, conservation or business concerns.

Box 3: Resilience versus vulnerability and risk

The concepts of vulnerability and risk focus on differentiating between who or what is exposed to climate hazards and why they are impacted in different ways and to varying degrees. Resilience places a stronger focus on whole systems and their combined capacity to function and change in the face of climate hazards, pressures or disturbances. Reducing the climate vulnerability and risks of various communities, businesses, sectors and jurisdictions contribute to increasing the resilience of South Africa's social, economic, and environmental systems.

Box 4 below provides a list of definitions for each term, as stated in the IPCC AR5 glossary, and are used as the primary point of departure for this National CRV Assessment Framework. Together these concepts give us the components needed to understand how the climate poses a threat, and to identify possible interventions to adapt to risk of climate impacts.

The framework ensures that all the above concepts of IPCC's conceptual framework are included in the assessment, to varying depths depending on whether an initial screening, a mid-range or an in-depth assessment is undertaken.

Box 4: Key definitions from the IPCC AR5 glossary of Working Group 2 (IPCC 2014, pages 1757-1776)

Risk: The potential for consequences [= impacts] where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard.

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In [the IPCC] report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability: The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

Sensitivity: Factors that directly affect the consequences of a hazard. Sensitivity may include physical attributes of a system (e.g. building material of houses, type of soil on agriculture fields), social, economic and cultural attributes (e.g. age structure, income structure).

Coping capacity: The ability of people, institutions, organisations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term (e.g. early warning systems in place).

Adaptive capacity: The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (e.g. knowledge of alternative farming methods).

Impacts: Effects on natural and human systems. In the [IPCC] report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

3. Framework for Assessing Climate Risk & Vulnerability

The CRV Assessment Framework is structured around three separate yet interlinked steps, moving from (1) **Scoping**: *Unpacking the purpose and context*, into (2) **Planning:** *Deciding on the depth of assessment*, into (3) **Assessing**: *The components of conducting an assessment*.

(1) Scoping - Unpacking purpose and context

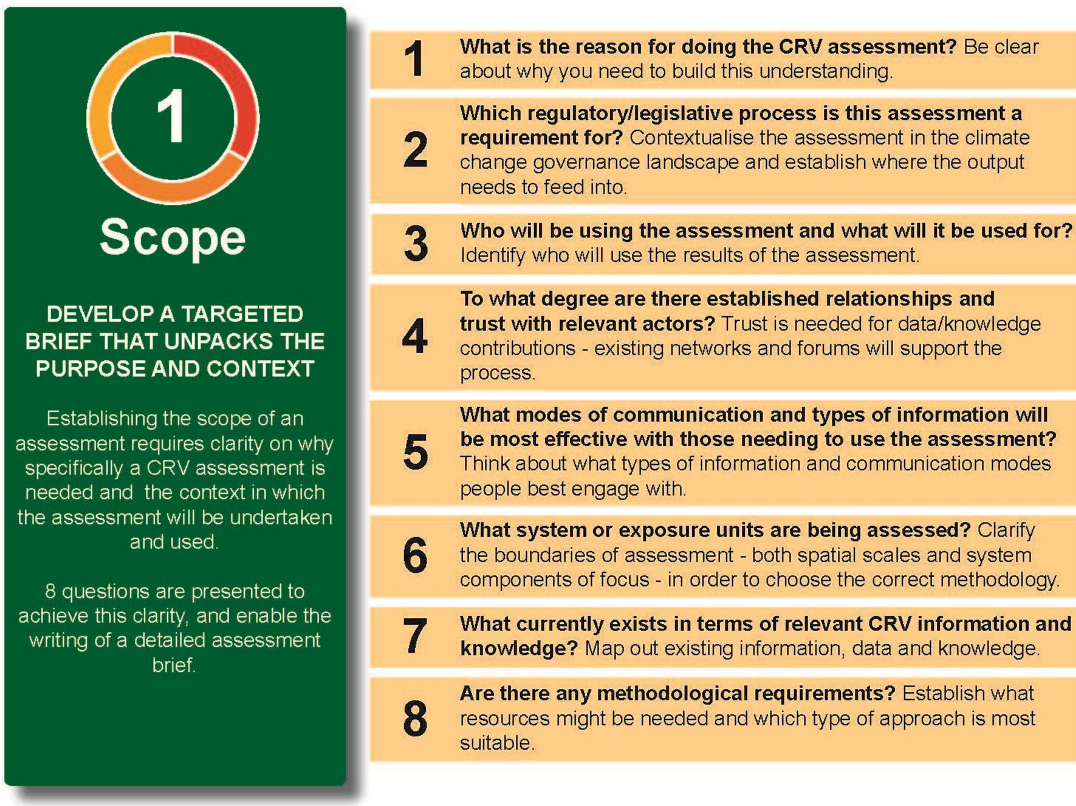


Figure 2 Scoping questions – work your way from 1 to 8.

The aim of the first step is to think deeply about and develop clarity on why there is a need to assess climate risk and vulnerability, and to unpack the context in which an assessment is being conducted. This will help to guide the choices around the depth of assessment and the methodology to use. Eight questions are presented that are central to understanding the assessment purpose and context. These are presented in figure 2 above. Working through these questions informs the writing of a brief (which may become the basis for a terms of reference and/or the introduction of the assessment report) outlining what the assessment sets out to do and the context in which it operates.

Each question is shown in figures 3 through 10 below, with potential answers to prompt thinking, as well as a short paragraph on *why* this question has been included, and a reflection question (see thought bubbles) that is intended to prompt thinking about what the answer to the question implies for the assessment and the way forward.

Start by skimming through the questions in figure 2, then systematically engage each question in more detail by working through figures 3 to 10 below. The questions will not all apply to every context. Also, in some cases several options / answers, rather than one branch, may fit, or in other cases maybe none will be a good fit. Every assessment and context is different. By answering these questions, and documenting the answers clearly, those not directly involved in the assessment will be able to better understand and utilise the findings.

Application examples

As a way of illustrating the scoping step, we draw on two examples of existing vulnerability assessments that have been undertaken in South Africa. These include a climate risk and vulnerability assessment for the City of Cape Town from 2019 (referred to as **City of Cape Town**), and a fisheries focused, community-based socio-ecological vulnerability assessment from 2015 (Raemaekers and Sowman) (referred to as **fisher communities and surrounding waters**).

These examples are applied to each of the eight questions. The resulting briefs are provided at the end of this step 1 section, illustrating how CRV assessments are based on different needs and starting points.

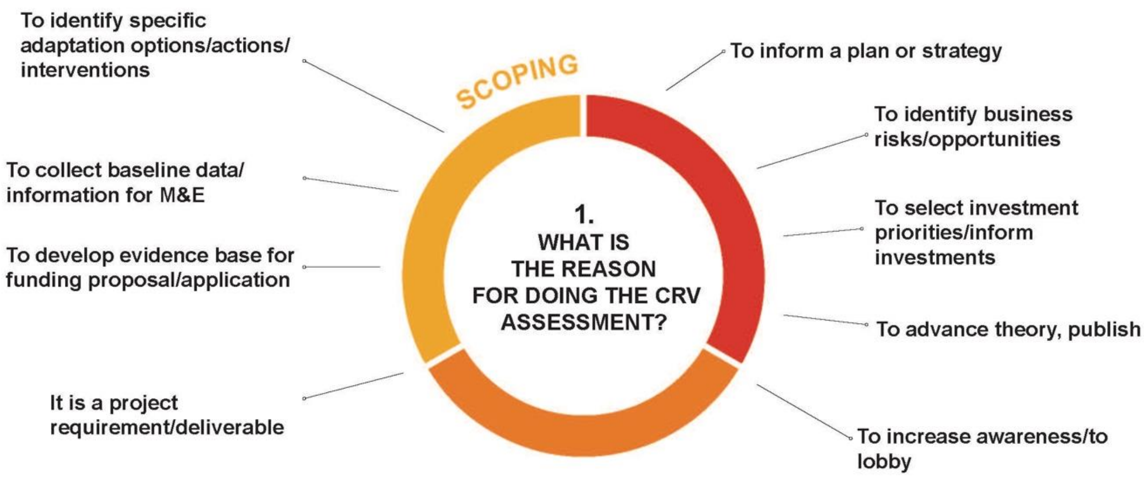


Figure 3

Although it can generally be seen as important to understand the risk and vulnerability of a system, it is very important to be clear about why, towards what purpose, one wants to build this understanding.

What does it mean if there are multiple reasons for doing an assessment, and which is the most important reason?

Application examples

Fisher communities and surrounding waters

- It is a project requirement/deliverable
- To develop an evidence base for [future] funding proposals/applications
- To identify specific adaptation options/actions/interventions
- To advance theory/publish

City of Cape Town

- To identify specific adaptation options/actions/interventions
- To inform a plan or strategy [the Spatial Development Framework (SDF), Build Environment Performance Plan (BEPP), Integrated Development Plan (IDP) and budget documents]
- To select investment priorities/inform investments

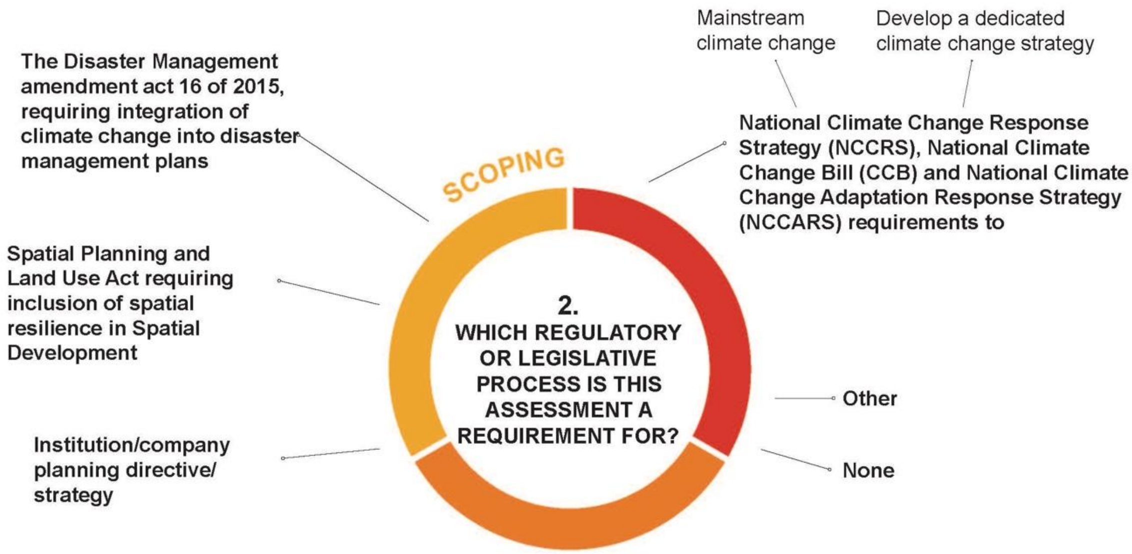


Figure 4

Making explicit any regulatory or legislative process requirement highlights another reason that underpins the assessment. It is important to explicitly state this in order to contextualise it in the climate change governance landscape, and make it clear what the output needs to be designed to feed into.

Does the requirement give power of legitimacy to the outcome of the assessment, and what does it mean for the assessment process and output?

Application examples

Fisher communities and surrounding waters

- None

City of Cape Town

- National Climate Change Response Strategy, National Climate Change Bill and National Climate Change Adaptation Response Strategy requirements – to mainstream climate change
- Disaster Management amendment act o16 of 2015, requiring integration of climate change into disaster management plans
- Spatial Planning and Land Use Act requiring inclusion of spatial resilience in Spatial Development Framework

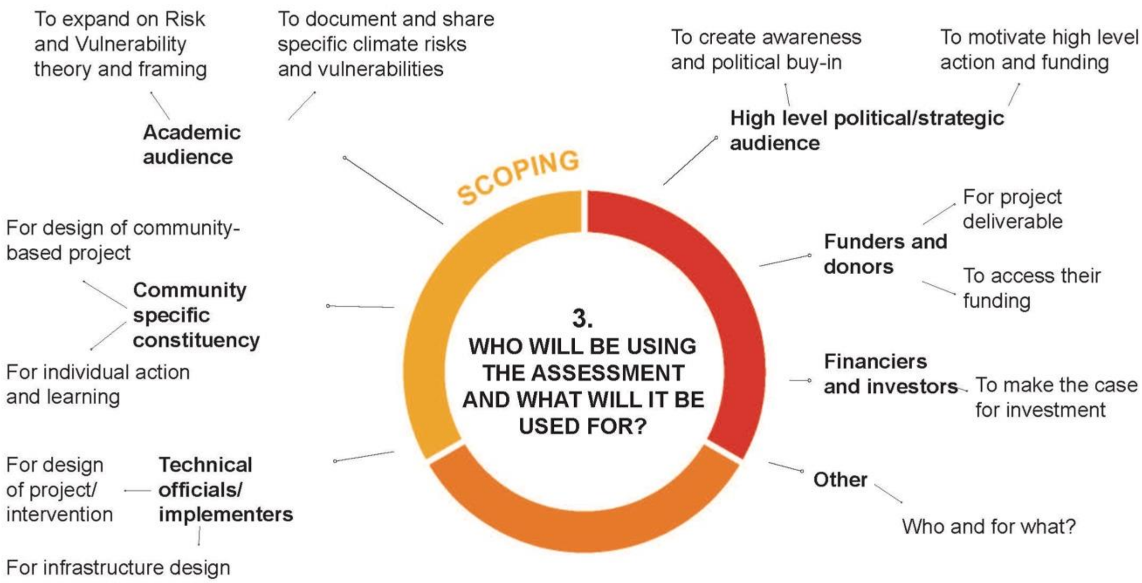


Figure 5

It is important to identify who will be using the results of the assessment, and what for, as this will shape the choice of method and what the assessment output needs to look like.

Did the intended users themselves identify the need for the assessment and are they part of designing and conducting the assessment – what do these aspects mean for your assessment process and output?

Application examples

Fisher communities and surrounding waters

- Community specific constituency – for individual action and learning [fishers]
- Academic audience – to share specific climate risks and vulnerabilities
- Funders and donors – for project deliverable and to access their funding [the Global Environment Facility, the Food and Agriculture Organisation]

City of Cape Town

- Technical officials/implementers – for infrastructure design and for design of project intervention [spatial planners and urban designers and the IDP team]
- High level political/strategic audience – to motivate high level action and funding [the Mayoral Committee to consider in their decision-making]
- Funders and donors – to access their funding
- Financiers and investors – to make the case for investment

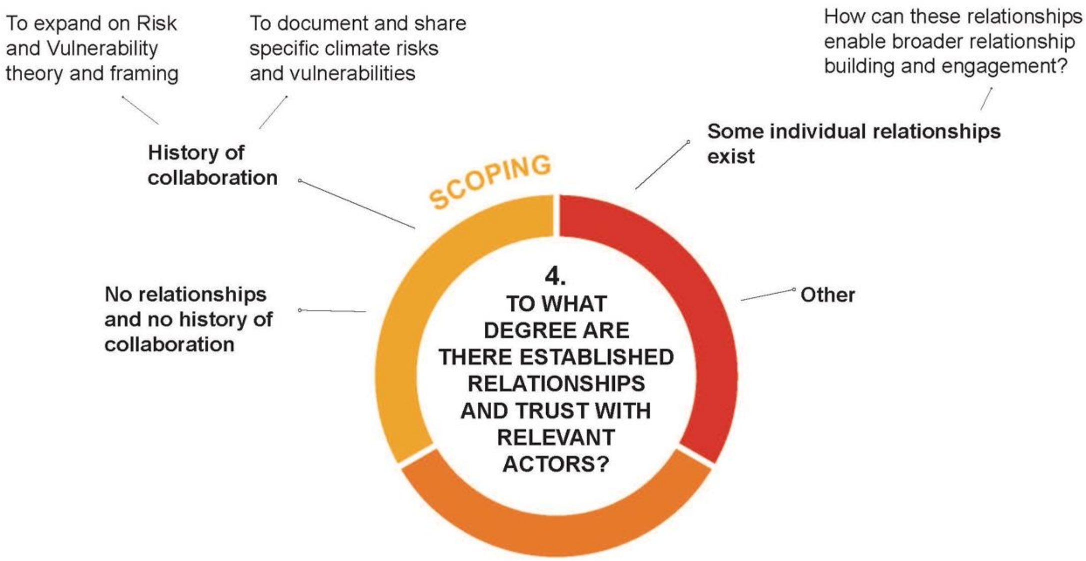


Figure 6

Network and relationship building, and the building of trust, is usually necessary for contributing data and knowledge to the assessment. It is also important for ensuring that the assessment output is relevant and understood by those who may use it. Relationship and trust building takes time, and the extent to which such has already been established will have an impact on timelines and the nature of engagements. Existing relevant forums or platforms can support and speed up this process.

> **What does this mean for your timeline, what does it mean for the nature of your engagements?**

Application examples

Fisher communities and surrounding waters

- History of collaboration and well established relationships – with no existing forums or platforms

City of Cape Town

- History of collaboration and well established relationships – between city departments and between some departments and funders and financiers

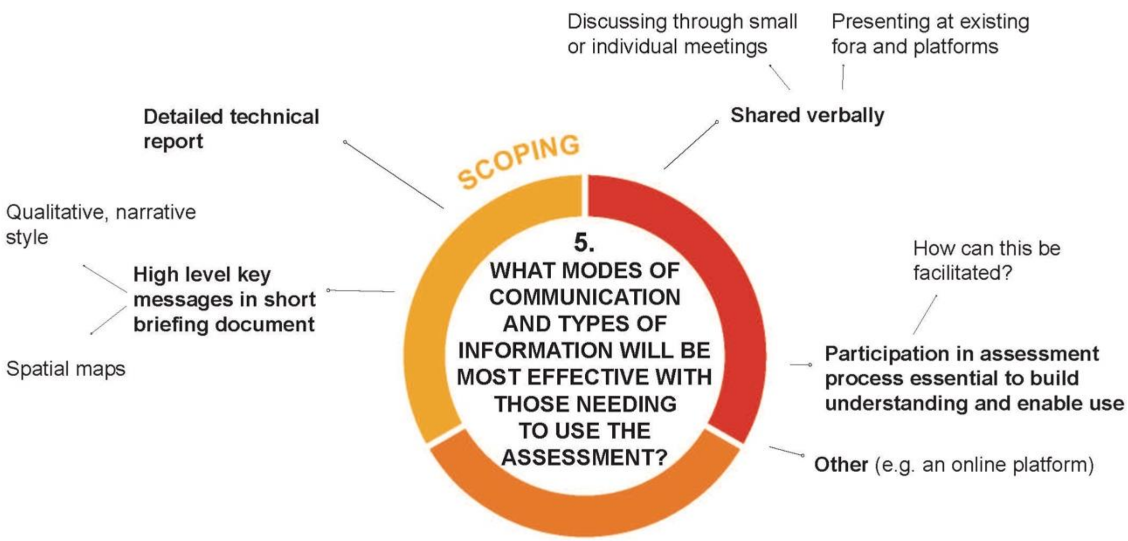


Figure 7

It is important to give some thought to the types of information and communication modes that the relevant people best engage with. This helps ensure that the approach taken is aligned with an assessment output that the relevant actors can and want to engage with.

What does it mean for your assessment and your budget if a variety of communication modes are needed to be effective?

Application examples

Fisher communities and surrounding waters

- Participation in assessment process essential to build understanding and use [with community specific constituency]
- Shared verbally [with community specific constituency]
- Detailed technical report [for funders and donors, and academic audiences]

City of Cape Town

- Detailed technical report [Funders and donors, financiers, technical officials/implementers]
- Shared verbally – presenting at committee meetings [High level political/strategic audience] and technical workshops [Technical officials/implementers]
- High level key messages in short briefing document – through maps and quantitative statements [High level political/strategic audience]

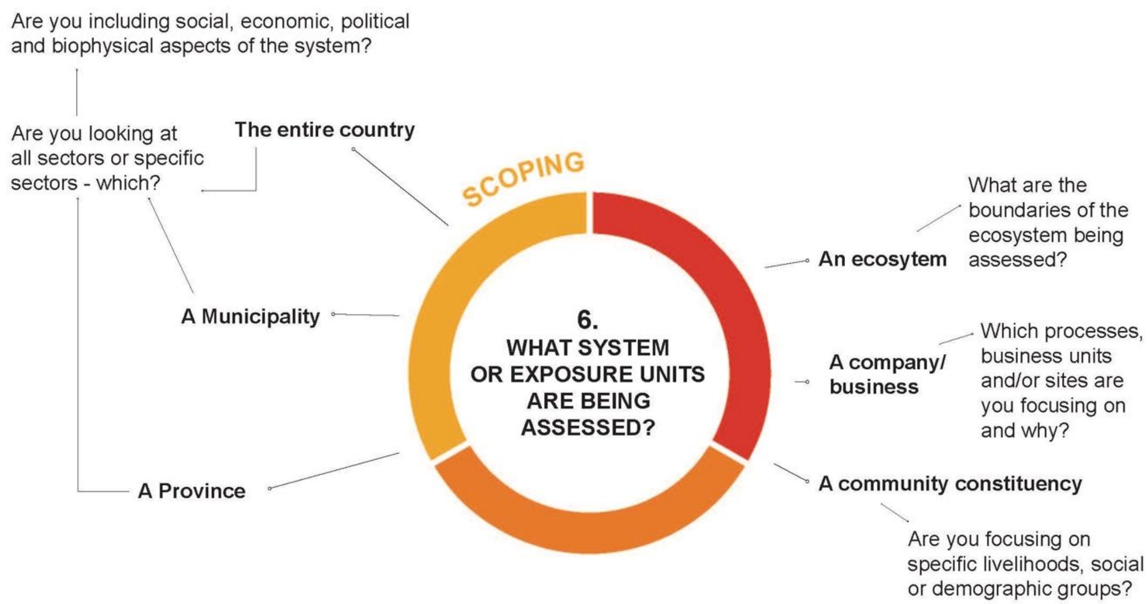


Figure 8

It is important to be clear about the boundaries of an assessment, both in terms of the spatial scales and the system components of focus, in order to choose the appropriate methodology.

Are there any important system assumptions?

Application examples

Fisher communities and surrounding waters

- A community – [focusing on fisheries and aquaculture as a livelihood, however also including other livelihood activities]
- An ecosystem – fishing waters surrounding communities and the Benguela Current Large Marine Ecosystem

City of Cape Town

- A metropolitan municipality – [including all words/suburbs]

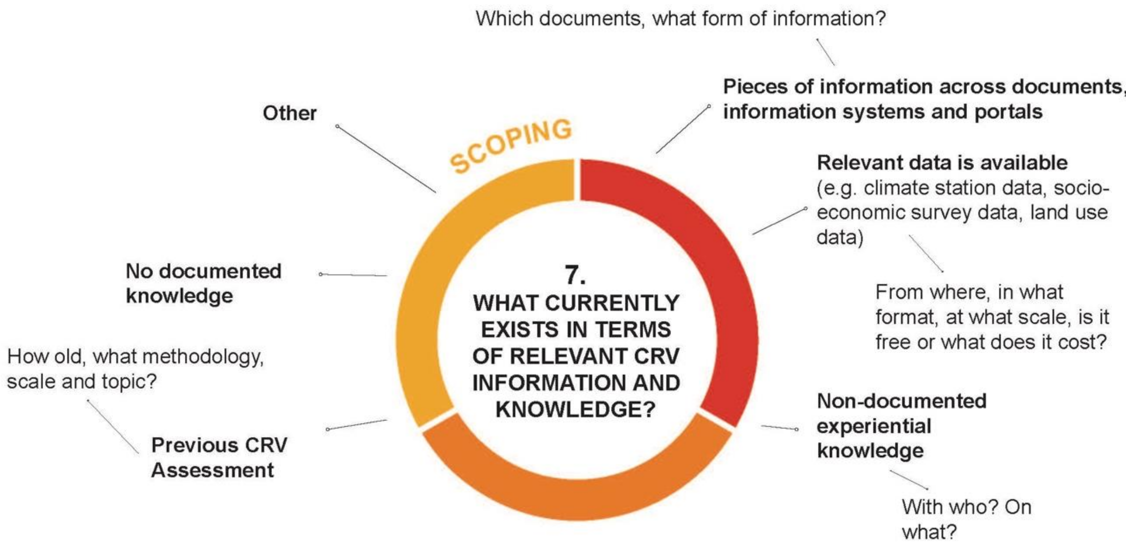


Figure 9

Mapping out the existing information, data and knowledge provides a starting point for the assessment. Making use of and building on existing sources avoids duplication, while it is also important for relevant stakeholders to feel that the work that is already done is recognised and included.

How can one deal with lack of information, such as lack of historical climate records or recent socio-economic data?

Application examples

Fisher communities and surrounding waters

- No documented knowledge
- Non-documented experiential knowledge – [among fishers]

City of Cape Town

- Previous CRV Assessment
- Pieces of information across documents, information systems and portals
- Relevant raw data is available – held by various line departments and in the City's data portal, as well as third party sources
- Non-documented experiential knowledge – held by officials

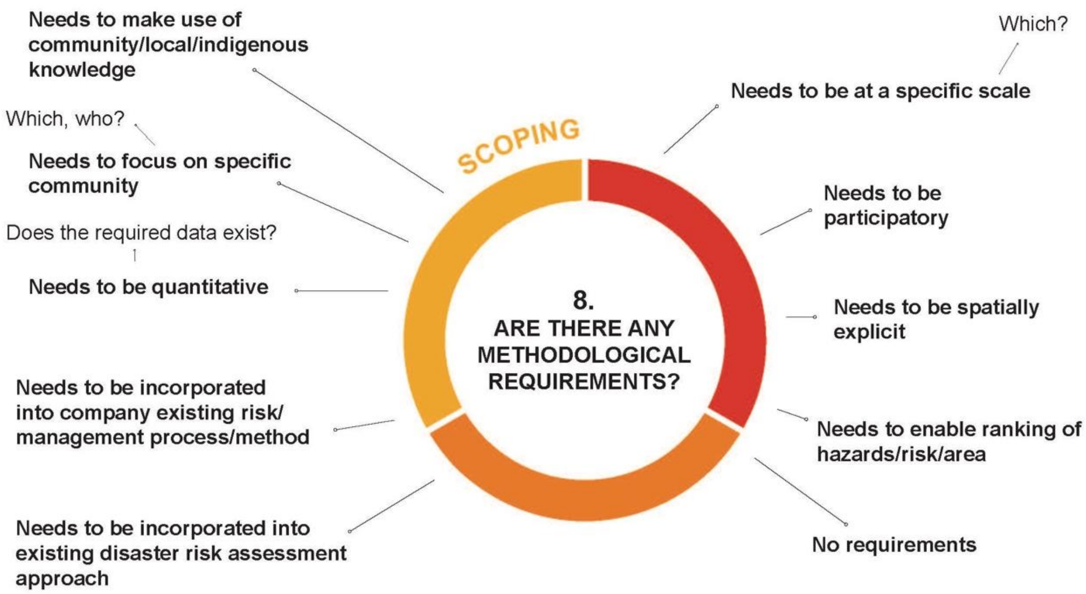


Figure 10

It is important to unpack any methodological requirements as this helps to establish what resources might be needed and the type of approach that would be most suitable.

What do these requirements mean for your choice of method?

Application examples

Fisher communities and surrounding waters

- Needs to be participatory
- Needs to focus on specific community – [fisheries/aquaculture communities]
- Needs to make use of community/local/indigenous knowledge
- Needs to be at a specific spatial scale – [community scale]
- Needs to enable ranking of hazards/risks/area [stressors]

City of Cape Town

- Needs to be at a specific spatial scale – [suburbs]
- Needs to be quantitative – [indicators]
- Needs to enable ranking of hazards/risks/area

Based on the answers above, reflect on whether a risk and vulnerability assessment is truly needed. If there is a lot of existing information, or no clarity on who or what the assessment is for, then moving ahead may not be the best course of action and use of resources.

If there is indeed a clear need for a risk and vulnerability assessment, then write a targeted brief drawing on what came up when moving through the questions, outlining the purpose and context of the intended CRV assessment. Writing the brief is about developing clarity and articulating it for others who are not directly involved, rather than to tick boxes.

Getting to grips with *the why, the who* and *the what* is key for designing and undertaking a relevant and useful assessment. A study looking to advance the academic literature related to the climate risk of certain bird species will have a very different process and output from an assessment aiming to put climate change on the map amongst high level provincial government officials, or an assessment aimed at enabling the incorporation of climate risk into a manufacturing company's safety practices.

Box 5: Example briefs

Fisher communities and surrounding waters

As part of a Food and Agricultural Organisation (FAO) project there is a need to assess community-level socio-ecological vulnerability in the **Benguela Current Large Marine Ecosystem**, **both as part of the project deliverables and in order to create the evidence base for future funding calls, as well as to advance the CRV theory.** The assessment is for: FAO, building further understanding and knowledge; for the project team to create a justification for future work (funding); for the fishers community, building understanding for individual action and learning; and for an academic audience, contributing to advancing the socio-economic aspects of understanding of marine and fisheries systems.

The assessment needs to use participatory methods at a community scale, because it needs to draw on indigenous knowledge, and as per project design and funding it needs to be undertaken in multiple locations – with two days available at each location.

The assessment, being participatory, **requires an interest amongst community members to participate and engage**. Such interest exists, based on the **history of collaboration and well established relationships** amongst researchers and community members. While there is no documented CRV information for these specific communities, there is the expectation that community members hold experiential knowledge relevant to CRV.

The assessment output needs to **enable the identification and ranking of stresses**, including management/governance, socio-economic and ecological stresses, and must create an evidence base for future intervention and action. For the assessment outputs to be communicated most effectively to community members who may apply some of the learning, **verbal communication** as well as **participation in the assessment process** itself is essential. For funders and donors, as well as academic audiences, **detailed technical reports** will be required.

City of Cape Town

A climate risk and vulnerability assessment is needed as a basis for informing decision-making around climate resilience, and as a step towards **selecting investment priorities** (e.g. choices such as when to invest in raising a seawall or protect the groundwater recharge of an aquifer). The intention is thus to influence urban spatial and development planning, creating the evidence base to further **mainstream climate change into the Spatial Development Framework (SDF), Sector Plans, Integrated Development Plan (IDP), Disaster Risk Management Plan and budget processes.** It is **intended to influence the decisions made by senior City officials and politicians, as well as funders**.

It must be a **quantitative spatial analysis** at the sub-city scale that enables comparison between local areas and various climate hazards and thereby the prioritising of adaptation actions for investment. It must draw together relevant data held by the City, as well as climate data from other sources.

CRV is a recognised priority amongst some of the stakeholders, and willingness to engage with CRV varies between City Departments and senior leaders. It is expected that there is a lot of non-documented experiential knowledge held by technical officials, as well as disparate data sources.

Relevant Portfolio Committees and the Executive Management Team (the City Manager and all Executive Directors) will be the space into which the overarching findings will be reported, however for the actual assessments meetings and workshops will need to be organised independently and draw on technical expertise from within relevant departments.

(2) Planning - Deciding on the depth of assessment

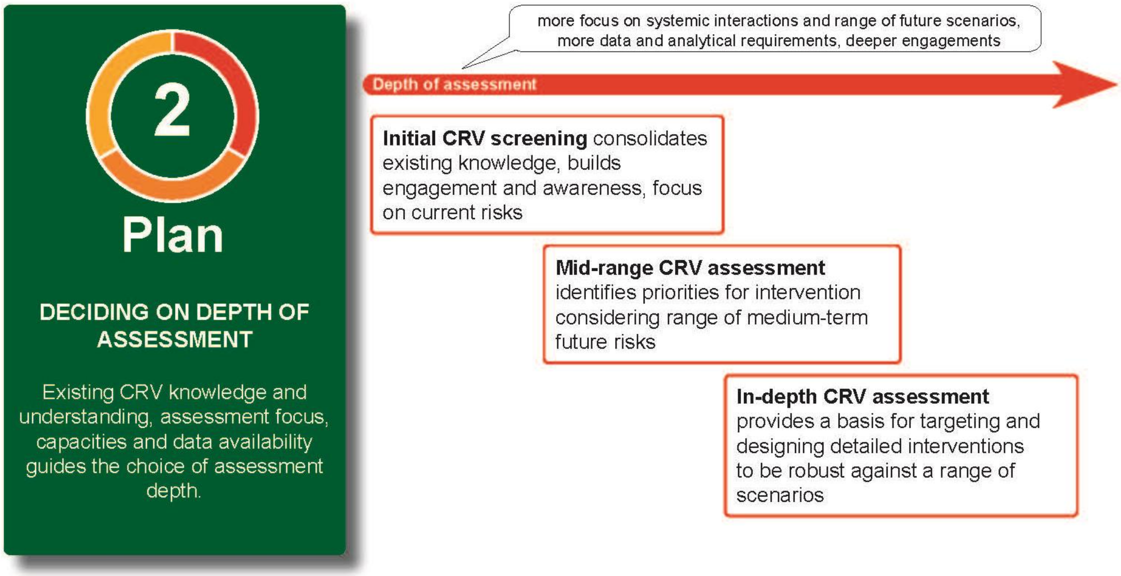


Figure 11 Decide on the depth of assessment.

The second step provides another set of questions, this time to guide towards a choice of assessment depth. The framework suggests three possible depths of assessment: an initial CRV screening; a mid-range CRV assessment; and an in-depth CRV assessment.

This differentiation between various depths of assessment is based on the principle that climate risk and vulnerability assessments need to be an iterative process, starting with broad assessments based on existing available information to raise awareness and identify areas of concern for further investigation. Having engaged with relevant stakeholders and scoped a wide range of possible climate concerns, vulnerable groups, places, species, processes or assets can be identified that warrant further investigation. Only when and where there are particular climate-sensitive decisions to be made, such as revising set-back lines along rivers and coastlines or designing new water treatment works, does it make sense to invest in highly detailed assessments. However, as further discussed below, the three depths of assessment are not really mutually exclusive. They are presented as distinct for the purposes of structuring a set of guidelines, but in real terms there is a continuum of assessment depth and any assessment undertaken may apply different depths to different elements to meet the specific needs of the context.

Having developed the purpose and context brief in step 1 (Scoping), go through the questions and answers below in order to select a suitable depth of assessment:

	Initial CRV screening	*Mid-range CRV assessment*	*In-depth CRV assessment*
Is this	A starting point, to raise awareness and highlight priority risks		
		The basis for strategy development and high-level planning, through the identification of priorities for intervention	
			For targeting and designing complex and costly interventions
Is the focus	Highlighting risks and vulnerabilities		
		Identifying or comparing levels of risk and vulnerabilities for some form of prioritisation	
			Detailed unpacking of the context and drivers, and quantification of risk and vulnerability
Are human and financial capacities	Limited; 3-6 months		
		Modest; 6 months - 1 year	
			Substantial; 1-2+ years
Will the assessment rely on	Easily available, existing data and information; workshops and surveys		
		Getting some new data and information; workshops and expert inputs	
			Extensive new data collection and analysis

It is not advisable to jump straight into an in-depth assessment without some form of scoping or mid-range assessment, as this may lead to wasteful expenditure if an in-depth assessment is poorly targeted because it does not build on initial stakeholder engagement and risk screening. It may however be the case that elements of a screening assessment are included as a first component of a mid-range assessment, or aspects of a mid-range assessment are undertaken as the scoping component to target an in-depth assessment. In effect fine-scale, focused assessments that are needed for concrete planning should build upon more broad, sectoral, scoping assessments that establish strategic priorities based on widespread engagement. The table below gives a brief overview of the key similarities and differences between the three depths of assessment, for which greater details are provided in the next section, step 3.

Table 1 Overview of similarities and differences between the three assessment depths.

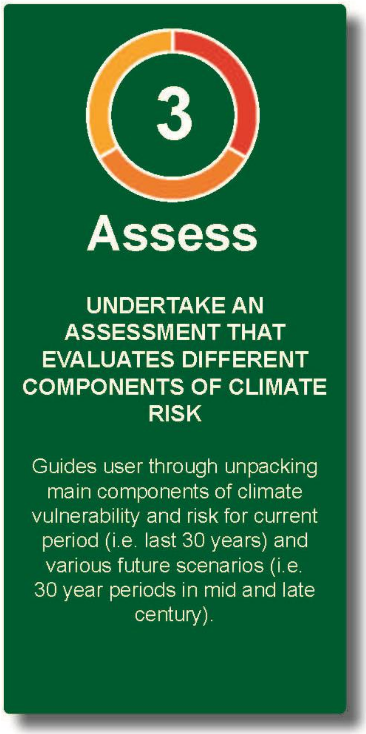
Elements	Initial CRV screening	Mid-range CRV assessment	In-depth CRV assessment
Aim	Begin engagement, raise awareness, minimal capacity and time and data requirements	Build climate risk management agenda, identify priorities for intervention	Target key risks, design complex interventions, requires considerable capacity and data
Specify system of concern	Likely to be broad e.g. whole organisation / jurisdiction area / sector	Priority sub-systems of concern	Focus on fine scale (e.g. piece of infrastructure, specific species, livelihood strategy or

			business operation) long-lived (10+ years) high impact decisions
Identify past (last 30 years) hazards and impacts	Desktop review of existing knowledge and information; participatory brainstorming with key stakeholders	Estimate impact of previous hazards (qualitative or quantitative scale)	Quantify hazard-related damages and losses
Establish baseline risk and vulnerability	Cluster and set-aside risks & impacts primarily influenced by non-climatic factors; gather available information on who / what was impacted how, and how often the hazards have occurred, and any indications of frequency or severity having changed over the last 30 years	Identify causal relationships, develop impacts chains including sensitivity factors and capacities to cope and adapt; investigate co-occurrence of climate hazards and how climate hazards exacerbate non-climatic hazards (e.g. insect infestations or viral epidemics)	Select indicators and quantify exposure, sensitivity and adaptive capacity to establish a formal vulnerability and risk rating for three suitable time-slices
Decide on future time periods and scenarios	None (i.e. focus only on current and historical climate risk and vulnerability); OR mid-century, high emissions scenario (i.e. business-as-usual with minimal mitigation)	Mid century, high and low end scenarios to consider range over 30-40 years; for near future (5-10years) assume current climate range (i.e. observed averages and extremes) but consider how trends in sensitivity and capacity factors change risk profile	Mid century and end century, extreme high end and low end scenarios (RCP 8.5 and 4.5) to establish possible range over 80-100 years using outputs from multiple models to account adequately for uncertainties; socio-economic scenarios should also be considered
Assess future climate risks and vulnerabilities	Stakeholder engagement and review published sources to establish high, increasing and new climate risks due to changing hazards, exposure and/or vulnerability factors to prioritise no-regrets risk reduction measures and further investigations	Estimate range of future climate risk in light of scenarios; establish risk evaluation criteria / benchmarks to identify unacceptable levels to target interventions and/or further investigation	Normalise, weight and aggregate indicators to calculate vulnerability and risk ratings, factoring in secondary impacts and inter-dependencies; undertake model-based stress testing evaluating exceedance and co-exceedance of specified thresholds; convene experts and stakeholders to assess risk acceptability / tolerance
Output	Report drawing together existing information and key stakeholder views to describe the extent of and trends in current climate risks and highlight priority concerns	Set of impact chains showing causal linkages between hazards and differential impacts and description of future, medium-term risk trajectory under business-as-usual emission scenario	Narrative description of key risks. Database of indicators; set of risk ratings under high and low emissions scenarios for medium- and long-term future; impact model; monitoring system to track changes and identify when tolerable limits are exceeded

The guidance here is to address all the elements listed in the assessment tables, to support conceptual standardisation. It is however likely that the mandate of the assessment, or the areas of primary concern and intervention, will shape the depth to which the various elements are assessed. For example, an organisation that is largely concerned with social justice is likely to focus more on unpacking the social and economic aspects of the sensitivity and adaptive capacity elements of risk and vulnerability. Whereas, those concerned with disaster management are likely to place a stronger focus on understanding the nature and frequency of hazards, levels of exposure and related impacts. Whether these assessments were considered to be screening, mid-range or in-depth, the assessment's mandate or primary areas of concern and intervention would thus likely lead to looking at some elements more thoroughly than others.

Once there is clarity and consensus on what depth(s) of assessment make sense and can feasibly be undertaken, the next step provides more detailed guidance on each of the elements of the assessment. Building on these findings, decisions can then be made about what the next steps are for the climate adaptation and risk management process.

(3) Assessing - the components of conducting an assessment



MAIN COMPONENTS OF CLIMATE RISK AND VULNERABILITY ASSESSMENT

	SCREENING	MID-RANGE	IN-DEPTH
Hazards	Consider all for system of concern	Combinations; mid-range scenario; sub-systems	Full range of projections; target decision
Exposure	Descriptive - areas, sectors, groups	Specify factors and timeframes	Select indicators for range of scenarios
Sensitivity	Descriptive - focus on most impacted	Specify factors and timeframes	Select indicators for range of scenarios
Impacts	List historical and expected, based on available information	Establish causal linkages	Quanitfy costs and damages
Capacity	Capacity to prepare for, endure, recover and improve after being impacted	Specify factors and timeframes	Disaggregate and verify - select indicators
Integrate	Pull together in a story	Depict impact chains	Normalize, weight, index and map

Figure 12 Decide on the depth of assessment.

In line with the conceptual framework provided by the IPCC AR5 report and the guidelines provided by the draft ISO 14091[2], the CRV framework guides the user through unpacking the main components of climate vulnerability and risk, namely:

- the climate hazards or stimuli;
- the exposure of the system to climate hazards / stimuli;
- the sensitivity of the exposed elements of the system to climate hazards / stimuli;
- the subsequent (potential) direct and secondary climate impacts;
- and the capacity (or lack thereof) of those / that which are exposed to the climate hazards / stimuli within the system, to prepare for, cope with and adapt to the (potential) climate impacts.

Based on these components, first consider the current and historical impacts and levels of risk associated with climate conditions and events, including if and how these have changed over the last 30 years. The next step is to engage with scenario-based information about possible future states to evaluate anticipated changes in climate risks and vulnerabilities. This serves as

[2] A Working Group of the Technical Committee on Greenhouse gas management and related activities of the International Organisation for Standardisation, i.e. ISO/TC 207/SC 7/WG 11, is developing a new standard on assessing climate change vulnerability, impacts and risk. The new standard is ISO 14091. It describes how to understand vulnerability and how to develop and implement a sound risk assessment for assessing both present and future climate change risks. A draft of this international standard is currently available for review.

a basis for prioritising interventions as part of a long-term, iterative climate adaptation process. It is important to recognise that there will be trade-offs when deciding on which adaptation responses to implement. A thorough assessment of climate risk and vulnerability can help to ensure that these trade-offs are carefully considered and investments / budget allocations are well justified.

As the depth of the assessment increases, the focus narrows to target particular decision needs (the type of decision depends on who the assessment is for and will vary greatly if it is for a national government department, a community-based organisation, a conservation agency, a manufacturer or local retailer, an industry body or someone else). The focus on decision needs is based on a recognition that the complexity and costs of doing highly detailed assessments across broad areas or sectors is usually not warranted. The main challenge this framework grapples with is how to integrate information on the magnitude and frequency of climate hazards and the damages from or costs associated with impacts, which is often quantitative information, with information on social dimensions of sensitivity and capacity to prepare for and respond to climate hazards and associated impacts, which are often best captured as qualitative information, all within a context of severe data scarcity and limited analytical capacities.

The tables below present the various components to be included in each of the three assessment depths, or maybe better understood as phases in an iterative process of developing a deeper understanding of the sources of climate risks and vulnerabilities to guide adaptation planning and implementation. These three depths of assessment get progressively more targeted in focus (i.e. prioritising risks to concentrate on) and more detailed in terms of gathering both quantitative and qualitative data and engaging more deeply with stakeholders in creating composite scores to enable comparison between places and over time (i.e. how has the risk rating for a given place changed over a period of five or ten years). The idea is that, through steps 1 and 2, the user can determine where to enter and exit the assessment process for the current iteration of the assessment, which may involve combining elements from different depths of assessment. This decision should be based on how much has already been done, how much existing information is readily available for the various components, what capacity and resources are available for undertaking the assessment, and what level of assessment will suffice for the planning and decision needs driving the assessment.

This third step of the framework is designed to:

- provide guidance on how to design an assessment, including filling gaps in previous assessments (together with chapter 4);
- guide assessors to make use of qualitative and quantitative data and information to develop a rich understanding of what drives climate risk and vulnerability;
- progress from risk awareness and sensitisation of relevant stakeholders to generate detailed information needed to target interventions as part of a climate adaptation programme of work (as the depth of the assessment undertaken increases);
- identify where there is a need to expand the climate risk and vulnerability monitoring system (linking to chapter 5) and;

- ensure that relevant stakeholders and decision makers are involved at critical steps throughout the assessment process, to ensure that the results adequately reflect the experiences of affected parties, and to streamline implementation.

The tables below set out the elements to include in an assessment, or series of assessments, based on the needs of the organisation that is using the assessment and how far along they are in understanding and addressing climate risks and vulnerabilities. The intention is to provide some flexibility to meet different user needs, while also creating enough standardisation to enable the evaluation and aggregation of assessments at the national scale. Instead of insisting on a common set of methods and data, the framework provides a common set of concepts and elements to structure the assessment. The intention is that users of this guidance framework work through each row or element relating to the depth of assessment they have decided to undertake and ensure that the output(s) they produce from the assessment clearly provide information on each of the elements. Suggestions for specific methods, tools and data sources that can be used to undertake various elements of the assessment are provided in the next chapter and in appendix one.

Initial CRV screening

Table 2 Initial CRV screening table.

Level of assessment	To begin engagement, raise awareness and identify priority risks with limited capacity, time and data
Skills and time required	Moderate knowledge of climate issues and basic research and stakeholder engagement skills required to find, assess and integrate existing sources of information and convene relevant stakeholders; approximately 3 to 6 months to complete
Specify system of concern	Likely to be broad e.g. org / jurisdiction area / sector; the focus and bounds of the assessment should have been specified as part of step 1; now describe the system being assessed in a bit more detail - what are the main economic activities, prevalent and threatened species, key water and energy sources, primary food crops, core business processes, critical supply chains, etc.
Identify past (last 30 years) hazards and impacts	Start with a desktop review of historical climate impacts and risks based on existing knowledge sources (e.g. previous assessments, SA Risk and Vulnerability Atlas, new articles, NGO reports, etc). Document known impacts and risks affecting the system of concern. Take the list from desktop review into a participatory brainstorming session with key stakeholders to expand / refine the list. Structure into simple impact chains showing what impacts link with what hazards.
Establish baseline risk and vulnerability	Cluster the impacts and hazards from the review and brainstorming into groups (e.g. 'erosion and land degradation', 'water scarcity', 'food insecurity'). Do a plausibility check to set-aside any impacts and risks which are primarily influenced by factors unrelated to the climate (these will be revisited in a mid-range and in-depth assessment to see if climate stresses further exacerbate these other hazards, like poaching or the spread of HIV/AIDS for example). While multi-hazard assessments are valuable, they are not the main focus of this climate risk framework.

Exposure - the presence of something of value in the system of concern (AR5 definition)	List who / what is impacted and if possible identify spatially where they are located. This usually requires strong stakeholder engagement and inputs from a variety of knowledge holders. In the case of assessments focussed on an ecosystem, an infrastructure network, an industrial process or alike, inputs from technical experts with context-specific knowledge and experience will be essential.
Sensitivity or magnitude of impacts	Collect statements regarding the severity of past climate impacts: percentage of vegetation cover or species population lost; number of human deaths; monetary value of material losses / damages; lost earnings; number of electricity outages and traffic incidents reported. Collect statements on why some are worse affected than others: e.g. building materials of houses; encroachment of alien species; irrigation; early warning; incidence health complications; youthful demographic; etc.
Coping and adaptive capacity	Identify the strategies that are in place and the resources available to those that are least affected (i.e. those most able to cope and adapt), e.g. insurance, catchment rehabilitation programmes, remittances, protected areas, buffer zones, etc. Assess the ability to reduce the impacts of the hazard at the household/local and community/larger scale.
Hazard frequency and duration	Gather available information on how regularly and/or over what period each climate hazard has occurred historically, considering both extreme events and trends: most years; at least every 5 years; at least every 10 years; more than 10 years. What about co-occurrence: are there two or more hazards that sometimes happen together, or in quick succession, that compound the impacts and therefore pose an even bigger risk? If this information is not readily available note that to be the case, as this may indicate a need for further investigation.
Historical trends	Gather and review available information on how the incidence of hazards, exposure, sensitivities and capacities have changed over the last 30 years (e.g. change in frequency of storm surges, change of number of people living in drought-prone areas or on land that has flooded)
Decide on future time periods and scenarios	Mid century, high emissions scenario (i.e. business-as-usual with minimal mitigation) - see box 6 below for details OR: if no relevant information exists (or is accessible) about future climate projections at a scale suitable for system of concern, note that in the assessment and focus on current / historical risks and vulnerabilities
Assess future climate risks and vulnerabilities	Through expert inputs and reviewing published sources, establish the presence or absence and increase or decrease of future climate hazards for the system of concern. Are there any opportunities presented by future climate scenarios that should be leveraged?
Consolidate assessment	Identify priority climate risks (currently high and worsening) for further investigation (can be through a voting exercise or expert assessment), i.e. which issues affect the system of concern most, described according to the impact (risk of what), the hazard (impact from what) and the exposed elements (what or who is at risk), e.g. risk of water scarcity (impact) due to droughts (hazard) for commercial wheat farmers (exposure). The priorities should reflect the knowledge of as many stakeholders as possible (i.e. those affected and those who need to be involved in addressing the risks). The information and data collected through this process can be used as the basis for M&E to track changes (positive and negative) on an ongoing basis.
Output minimum requirements	The output of a screening assessment should be a report that at a minimum contains a description of the system of concern, the climate hazards currently facing the system (a description of how these might change into the future is desirable), who / what / where is currently most exposed, what factors make them sensitive to experiencing climate impacts, what these impacts are, what capacities exist to reduce these impacts, and a statement about what climate risks are considered of priority concern, to investigate further and to invest in

	no-regret risk reduction measures (i.e. a clear need already exists, without requiring any additional assessment). The uploading of assessment outputs to the National Climate Change Information System (NCCIS) is encouraged as this contributes to the national M&E system tracking the national transition to a climate resilient economy and society.
Next steps	Undertake a mid-range assessment focusing on priority risks

Remember, while the three depths of assessment are shown as separate, it may well be that an assessment best suited to a particular set of contextual needs (as elaborated in step 1) includes elements from across more than one depth of assessment. So elements of a screening assessment could be included as a first component in a mid-range assessment, or aspects of a mid-range assessment are undertaken as the scoping component to target an in-depth assessment.

Box 6: What climate scenarios and climate models or model outputs should be used to assess future climate risk?

Scenarios are descriptions of how the future could evolve based on an understanding of how the world works and what drives change. A **climate scenario** is a plausible, simplified representation of the future climate, based on a set of climatological relationships. Climate projections often serve as the raw material for constructing climate scenarios that are used for impact modelling, but climate scenarios usually require additional information such as the observed current climate[3]. A **climate projection** is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, which is in turn based on assumptions concerning, for example, future socioeconomic, demographic and technological developments that may or may not be realised. Concentration scenarios, derived from emission scenarios, are used as input to a climate model to compute climate projections.

A **climate model** is a numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. The climate system can be and is represented by models of varying complexity. Coupled Atmosphere-Ocean General Circulation Models (AOGCMs) provide a representation of the climate system that is near the most comprehensive end of the spectrum currently available. Climate models are applied as a research tool to study and simulate the climate, and for operational purposes to generate climate projections[4]. There are over 60 global climate models that have been developed and refined by teams of scientists around the world to simulate how the global climate works and what that means for the climate experienced in different regions and sub-regions. These computer models are run to simulate the past (which can be compared to the available records of what was actually observed in various locations) and are run to simulate projections of the future. One of the major variables in generating future climate scenarios is what the concentration of greenhouse gases in the atmosphere will be, which in turn is based on how much will have been emitted (and thereby the extent to which climate change mitigation actions are implemented around the world).

When assessing future climate risk and vulnerability one has to make choices about which climate scenario or scenarios to use as the basis for assessment. This means choosing between the results of different climate models, various possible time periods of the future (commonly a 20 year period in the middle of the 21st century another at the end of the 21st century), and different GHG emissions or concentration scenarios. Four concentration scenarios, called Representative Concentration Pathways (RCPs), were selected for use in the Fifth IPCC Assessment, RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5. The numbers indicate the level of radiative forcing

[3] For a detailed explanation of how climate change scenarios are developed visit: https://www.climatescenarios.org/primer/

[4] For more on how climate models work, how they can be used in planning and how to understand and interpret global climate model results see the Future Climate for Africa (FCFA) Guides: https://futureclimateafrica.org/wp-content/uploads/2017/01/fcfa_climate_models_web.pdf and https://futureclimateafrica.org/wp-content/uploads/2017/09/fcfa_gcm-guide-web.pdf

(in Watts per square meter at the top of the atmosphere) by the year 2100. As such RCP 2.6 represents a future with very significant reduction in global emissions. RCP 8.5 represents a scenario with an ongoing rise in emissions. The other two are middle grounds, where some mitigation efforts are implemented. Because there are so many factors influencing what the future global emissions levels, and thereby climate conditions, will be and because different models simulate different aspects of the climate system more or less well (i.e. there is no one best model[5]), the broad recommendation is to use / consider as many model outputs and scenarios as possible and feasible in your assessment, so that you can understand the range of potential risk and avoid making decisions that are tied to one scenario of the future, when another scenario might be equally possible. A more targeted recommendation is to use climate scenarios based on RCP 8.5 (minimal effective mitigation) and RCP 4.5 (strong mitigation). These are considered to be the most likely upper and lower bounds of global emissions given current trends and international agreements.

Mid-range CRV assessment

Table 3 Mid-range CRV assessment table.

Level of assessment	To develop a strategy and high-level plan, identify priorities for intervention.
Skills and time required	Solid knowledge of climate issues and system dynamics, strong stakeholder engagement skills, and skills in integrating qualitative and quantitative information; 6 months to 1 year to complete.
Specify system of concern	Specify the target / priority sub-systems of concern for the assessment - based on outcomes of screening and further stakeholder engagement - describing the boundaries and core characteristics.
Identify past (last 30 years) hazards and impacts	Define a scale on which to estimate the impact of previous hazards (qualitative e.g. insignificant, moderate, high, extreme, or quantitative e.g. 1-10)
Establish baseline risk and vulnerability	Identify causal relationships between risks and impacts: Develop impacts chains that show cause-and-effect relations between damages/loses/disruptions experienced and the climate hazards or stimuli. For example, wheat crop losses relate to flowering times of different cultivars, sowing times, soil moisture, heat stress, high evapotranspiration, low seasonal rainfall, and high temperatures (exceedance of 30 deg C) especially in grain filling period.
Exposure - the presence of something of value in the system of concern (AR5 definition)	Add more specificity to identifying what is exposed, expressing the relevance of the exposed elements in the system of concern, e.g. land area under wheat production and number of people employed in jobs reliant on wheat through the whole supply chain within the district or province being assessed.
Sensitivity/magnitude	Identify sensitivity factors that constitute vulnerability. For example late sowing practices, slow maturing varieties, no irrigation, unfavorable soil conditions, high levels of equipment theft, declining water allocations due to growing urban demands. Consider women, children, youth, elderly, disabled and chronically ill when identifying sensitivity factors.

[5] For more on climate model evaluation see Eyring et al, 2019. Taking climate model evaluation to the next level. Nature Climate Change, 9, 102–110.

Coping & adaptive capacity	Identify lack of capacities to cope and adapt that constitute vulnerability. For example, low efficiency irrigation systems, insufficient water storage and/or pumping capacity, weak agricultural extension services, lack of fertilizer subsidies, unaffordability of insurance. Consider women, children, youth, elderly, disabled and chronically ill when identifying capacity factors.
Hazard frequency, duration and intensity	Gather further information on how often, how long and with what intensity each climate hazard has occurred historically: most years; at least every 5 years; at least every 10 years; more than 10 years; lasting for days, weeks, months, years; with low, medium or high intensity.
Interactions between hazards	Have any hazards occurred at the same time or in quick succession in the area being assessed? Revisit the impact scoring and the impact chains, how do these change when considering two or more hazards happening together? I.e. First develop an impact chain for each hazard, then show relationships between them.
Historical trends	Gather further information on how the incidence of hazards, exposure, sensitivities and capacities have changed over the last 30 years? (e.g. change of number of people living in drought-prone areas or on land that has flooded)
Decide on future time periods and scenarios	Mid century, high and low end scenarios to consider range (see box 6 above for details)
Assess future climate risks and vulnerabilities	Acquire basic scenario data (likely to be monthly data at 50-100km resolution from global climate models but make sure NOT to only use data from a single model, rather consider at a range) and commission experts to assess likelihood and magnitude of consequences of projected risks, accounting for the capacity to cope and adapt, to establish a future risk rating range; identify and describe sources of sensitivities and adaptive capacity. Are there any opportunities presented by future climate scenarios that should be leveraged?
Consolidate assessment	Establish risk and vulnerability evaluation criteria / benchmarks with broad stakeholder inputs; identify unacceptable levels (i.e. what are the thresholds beyond which a risk is considered unacceptably high by relevant stakeholders, or against an international benchmark, and thereby requires / justifies allocating resources to reduce the risk as a matter of priority) to be targeted for intervention and/or further investigation. The information and data collected through this process can be used as the basis for M&E and to track changes (positive and negative) on an ongoing basis.
Output minimum requirements	The output of a mid-range assessment should be a report that at a minimum contains a description of the system of concern, a description and visual representation of the cause and effect relationships for each key risk between impacts, exposure and sensitivity factors and climate hazard, then showing consideration of interactions between hazards. The report must contain information about how the risks are expected to change into the future, based on climate scenarios (and if possible socio-economic and demographic scenarios affecting exposure, sensitivity and adaptive capacity) from more than 1 model and more than 1 emissions scenario. The report must reflect deliberation over what constitutes tolerable / acceptable levels of risk and where such risk thresholds are already being breached or are expected to be breached soon. The uploading of assessment outputs to the National Climate Change Information System (NCCIS) is encouraged as this contributes to the national M&E system tracking the national transition to a climate resilient economy and society.
Next steps	Undertake an in-depth assessment that goes deeper to include more nuanced quantitative and qualitative data on the various elements that make up climate risk, both current and future, to inform specific policy, planning, investment

	decisions.

As indicated earlier, it is not advisable to jump straight into an in-depth assessment without some form of scoping or mid-range assessment, as this may lead to wasteful expenditure if an in-depth assessment is poorly targeted. However, it may be the case that elements of a screening and mid-range assessment are undertaken as the scoping component to target an in-depth assessment.

In-depth CRV assessment

Table 4 In-depth CRV assessment table.

Level of assessment	Detailed assessment of risks as one informant for targeting and designing complex interventions; a resource and capacity intensive undertaking.
Skills and time required	Advanced understanding of climate issues and significant expertise in both quantitative and qualitative data analysis and facilitating participatory processes; 1 to 2 years up to 4 years to complete depending on amount of data to collect, process and analyse.
Specify system of concern	Focus on long-lived infrastructure or investment decision like investing in alternative crops, switching livelihood strategies or establishing new biodiversity conservation areas - based on outcomes of mid-range assessment and decision needs.
Identify past (last 30 years) hazards and impacts	Quantitative estimates of hazard-related losses and gather qualitative descriptions of impacts and responses to historical events / episodes by digging deeper into local knowledge through interviews and focus groups.
Establish baseline risk and vulnerability	Acquire / collect data of suitable temporal and spatial resolution and include local knowledge to quantify exposure, sensitivity and adaptive capacity to establish a formal vulnerability rating in addition to the risk rating (target interventions with risk and vulnerability ratings which are both high based on a threshold agreed by relevant stakeholders or set by national or international standards)
Exposure - the presence of something of value in the system of concern (AR5 definition)	Guided by the factors identified in the mid-range assessment, quantify exposure through the use of relevant indicators. e.g. how much has been impacted by a given hazard quantified in numbers of people, financial value of assets, surface area of land, distance of network infrastructure, number of pieces of infrastructure or equipment damaged - it is essential that the selection of indicators is guided by in-depth stakeholder engagement, over and above the availability of data.
Sensitivity/magnitude	Guided by the factors identified in the mid-range assessment, quantify sensitivity factors (e.g. % of area equipped with irrigation): select potential indicators (carefully considering the spatial coverage required, the unit of measurement or spatial resolution required, the temporal coverage required), procure data, revise indicators based on data availability and quality, noting new needs for monitoring programmes to provide missing data for the next iteration of the assessment - it is essential that the selection of indicators is guided by in-depth stakeholder engagement, over and above the availability of data

Coping & adaptive capacity	Guided by the factors identified in the mid-range assessment, quantify capacity factors (e.g. % of income available for investment into new crop types): select potential indicators, procure data, revise indicators based on data availability and quality, noting new needs for monitoring programmes to provide missing data for the next iteration of the assessment - it is essential that the selection of indicators is guided by in-depth stakeholder engagement, over and above the availability of data
Historical trends	Create a time series of hazard, exposure, sensitivity and capacity factors to analyse how they have changed over time
Decide on future time periods and scenarios	Mid century and end century, extreme high end climate scenarios (stress testing) and low end scenarios to establish full range, i.e. based on the RCP 8.5 and 2.6 emissions scenarios respectively (or RCP 6 if RCP 2.5 that sees global net emissions declining after 2040 is deemed too unrealistic) - see box 5 for details. If needing to narrow even further, focus on RCP 8.5 only but consider the 15th and 85th percentile of an ensemble to express the range of uncertainty. Socio-economic and demographic scenarios should also be considered to explore how exposure, sensitivity and adaptive capacity is likely to change.
Assess future climate risks and vulnerabilities	Acquire data (may require daily or hourly data for some variables if available and a finer spatial scale) and deeper engagement with local knowledge on future evolution of hazards, exposure, sensitivity and capacity, including secondary impacts and inter-dependencies, to establish quantified risk and vulnerability ratings, as well as rich narratives explaining the reasons for the ratings. Are there any opportunities presented by future climate scenarios that should be leveraged? It is often not possible or desirable to perform a full indicator based assessment, so the data analysis should run alongside expert workshops, gathering insights in a qualitative, narrative way.
Consolidate assessment	Transform (normalise) different indicator data sets into values with a common scale based on meaningful thresholds in the given context of the assessment; weight the indicators selected to describe the exposure, sensitivity and adaptive capacity components according to which have greater influence on a vulnerability component than others; aggregate individual indicators of the three vulnerability components to combine the information from different indicators into a composite indicator representing a single vulnerability component; aggregate the risk components hazard, vulnerability and exposure into a composite risk indicator (target interventions where both risk and vulnerability ratings high). Are there any opportunities presented by future climate scenarios that should be leveraged? *It is imperative that the identification of thresholds, the weighting of indicators, the interpretation of resulting scores and identification of potential opportunities are guided by in-depth stakeholder engagement and qualitative expert inputs.* The information and data collected through this process can be used as the basis for M&E and to track changes (positive and negative) on an ongoing basis.
Output minimum requirements	The output of an in-depth assessment should be a narrative report describing key risks supported by data and indicators that, at a minimum, contains maps of where climate risks are calculated to be highest, now and under a range of future scenarios. These maps should be accompanied by rich narratives that unpack the reasons behind the scores, highlighting what combinations of exposure, sensitivity and capacity factors give rise to areas or groups with the highest risk scores, or scores exceeding a threshold deemed unacceptable by stakeholders and/or international standards. The uploading of assessment outputs to the National Climate Change Information System (NCCIS) is encouraged as this contributes to the national M&E system tracking the national transition to a climate resilient economy and society.

Next steps	Consider using an integrated assessment model to stress test the system of concern, evaluating exceedance and co-exceedance of specified thresholds (intolerable risks), interdependencies and technical requirements for interventions; establish a monitoring system to track changes and identify when tolerable limits are reached (i.e. trigger additional / alternative adaptation measures), and where possible input such into the NCCIS.

The next chapter gives an overview of the types of methods and tools that can be used to undertake the various components of each assessment. When communicating the outcomes of the assessment, consider the objectives of the assessment and the target audience (i.e. policy makers, scientists, local community, farmers) to determine the level of detail, style and language of presenting the findings.

4. Undertaking assessment in practice - guidance on methods and tools

There are a whole variety of data and information portals, guidelines, methods and tools that are used in assessing climate risk and vulnerability to gather and analyse data and information and to visualise and communicate the results. Examples of these have been captured in Appendix One: Resources for Assessments where they are linked directly to the assessment elements. Some are more quantitative in nature, others are more qualitative; some are designed to be participatory and include social processes, while others are more technical and expert-oriented. Each comes with different strengths and weaknesses or blind spots. For that reason, combining different data and information portals, guidelines, methods and tools gives a richer picture and understanding of climate risk and vulnerability from which to make decisions about what to prioritise. Although collecting data is important and necessary, it is important to remember that the analysis of the data is critical as it is needed to identify the nature of risk and vulnerability and identify potential ways to reduce risk and adapt to climate change.

There is no neat way to package the variety of methods and tools used for risk and vulnerability assessments. One can broadly distinguish those methods and tools focused on enabling broad participation and those aimed at creating climate risk and vulnerability indices. However, there are many other approaches and methods that can also provide useful inputs. These include methods such as systems mapping and governance assessments as examples. Integrated assessment modelling is one approach used to pull together models that cover the biophysical and social system and capture both mitigation and adaptation aspects of the climate change problem. This approach requires significant resources and capacity and is not widely used in South Africa.

An area of methodological innovation that is emerging is around integrating participatory approaches and more quantitative approaches. Participatory approaches tend to gather primary data direct from those impacted or affected by climate hazards, whereas indicator-based approaches rely more on secondary data but use participatory processes to evaluate the indicators. Integrating the two approaches is hard because they often rely on different worldviews and frameworks. The impact chain methodology (GIZ, 2017a) is increasingly being used for climate risk and vulnerability, in part because of its ability to pull together the different elements and the different methodological approaches and data input.

Impact chains as a way to integrate data

The method of developing impact chains is gaining prominence in international practices and guidelines. An impact chain is an analytical method that helps to systematically understand, visualise and prioritise factors that drive climate vulnerability in the system under assessment. Impact chains provide a means to think through, discuss and communicate the linkages between climate hazards, direct and secondary impacts, and the social, economic and biophysical factors that play a role in generating or reducing these impacts. Developing impact chains requires the integration of inputs from scientists, professionals, government officials, and representatives from affected sectors and communities. Details of the tools and associated data that can be fed into the impact chains are presented in Appendix One: Resources for Assessments.

As per the guidance provided in the GIZ (2017b) Risk Supplement to the Vulnerability Sourcebook, the steps in developing impact chains are as follows:

1. Identify climate impacts and risks: Which major climate impacts and risks do affect your system of concern? The first and most crucial step in developing an impact chain is identifying major climate impacts and risks (e.g. ‘water scarcity’ or ‘risk of water scarcity for smallholder farmers’) to your system. If your risk assessment covers more than one sector (for example agriculture and health) you will need to develop discrete impact chains for each sector, which can later be combined and interlinked. Identifying major climate impacts and risks starts with a broad view, including a review and brainstorming process of climate impacts and risks. Subsequently you can cluster them and narrow your choices down to one or more risks according to the focus of your assessment.
2. Determine hazard and intermediate impacts: Which climate-related hazardous events or trends and their physical impacts pose a risk to your system of concern? Which intermediate impacts link the hazard and the risk? The hazard component consists of both the climate signal and direct physical impact. To identify the relevant climate signal(s), start with your selected impacts and risk identified in step 1, and then work back by identifying related intermediate impacts that lead to your risk until you have reached the hazard (direct physical impacts or climate signals). To distinguish between hazard and intermediate impact, remember two general principles: First, factors can be allocated to one of the three risk components only (hazard, vulnerability, exposure). Second, factors which are influenced by both hazard and vulnerability should be treated as intermediate impacts. The question of whether the specific factor can be influenced by measures or activities taken within the system of concern helps you to distinguish.
3. Determine vulnerability: Which attributes of the system contribute to the risk? The identified factors allocated to the component vulnerability should represent the two aspects of sensitivity and capacity, where capacity covers coping as well as adaptive capacity. Sensitivity includes the physical environment as well as socio-economic or cultural aspects such as soil condition, irrigation systems or land use patterns. The capacity factors comprise those aspects that characterise the ability (or lack of ability) to cope with an adverse situation as well as those aspects that determine the ability (or lack of ability) to adapt to future situations. It may be helpful to keep the four dimensions of adaptive capacity in mind: knowledge to cope and adapt; technologies; institutions to provide assistance; and economic and financial resources to implement options.
4. Determine exposure: Which factors determine exposure? The term ‘exposure’ refers to the presence of something of value in the system of concern. Exposure is easily confused with vulnerability, in particular with the sensitivity sub-component. In order to distinguish these two components, keep the following example in mind: Imagine you have identified the climate-related ‘risk of health impacts due to heatwaves’ and want to assess it. In order to assess it, you may specify the exposed elements as ‘the population’ and express the exposure for instance as ‘population density’. However, characteristics of the exposed population, which contribute to a predisposition to be

stronger affected such as ‘age’, need to be allocated to vulnerability/sensitivity (elderly people are more vulnerable/sensitive to heatwaves than younger people).

5. Brainstorm adaptation measures (optional): What measures could help decrease vulnerability and / or exposure within the system of concern? Impact chains do not only provide an understanding of risk that can be operationalised, but can also drive the initial brainstorming session on potential adaptation measures. We particularly recommend this exercise if your risk assessment is designed to support the development and monitoring and evaluation (M&E) of adaptation interventions. The vulnerability factors you have identified can serve as a starting point for brainstorming, facilitated by questions such as: what is the best way to tackle sensitivity factors and enhance capacities to moderate impact?

See the GIZ (2017b) Risk Supplement, pages 26 to 41, for further details.

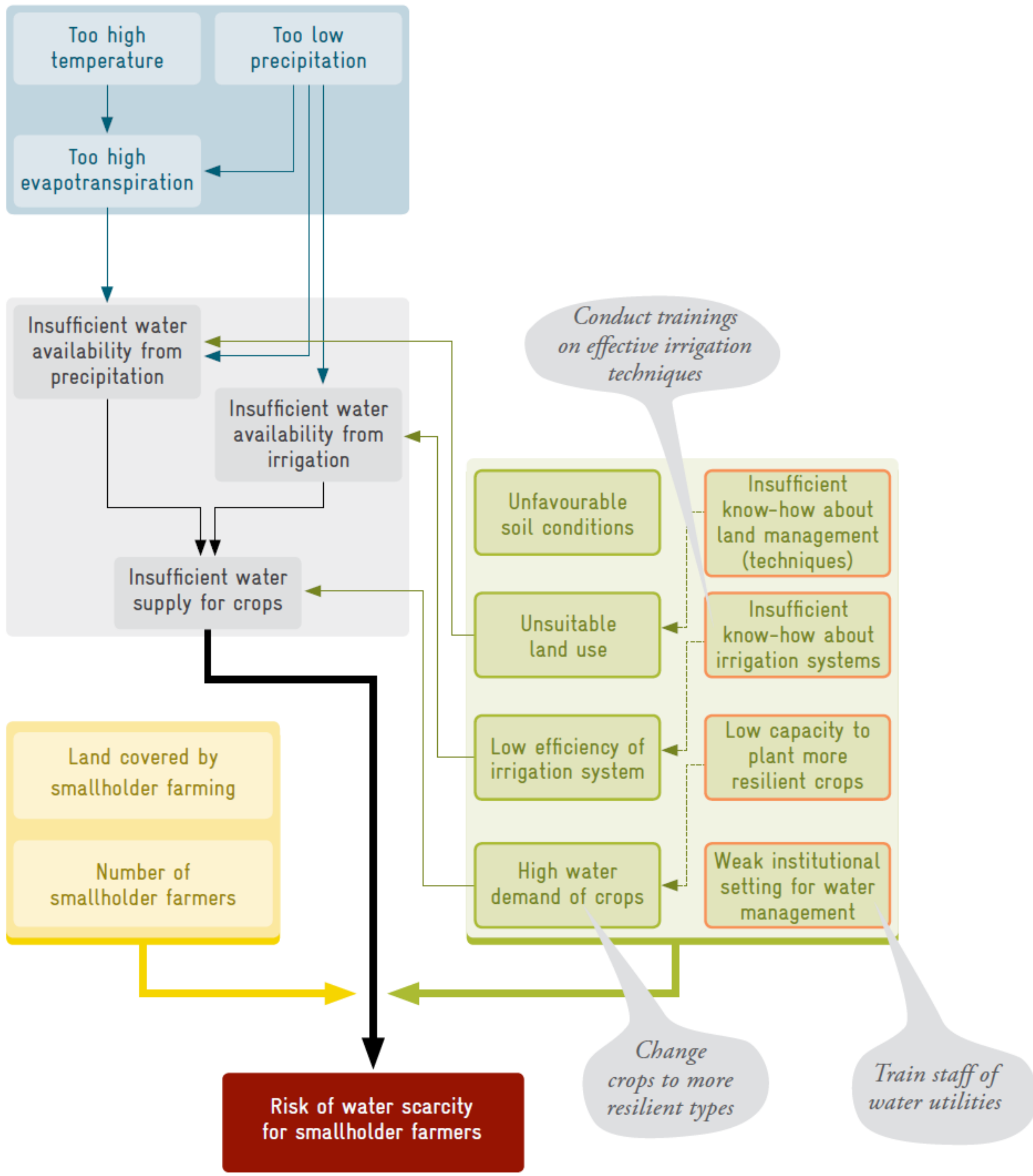


Figure 13 Example of impact chains developed for the risk of water scarcity experienced by smallholder farmers (GIZ Risk Supplement, 2017b, p.39).

Climate risk and vulnerability indices

Indicators are relatively commonly used when assessing climate risk and vulnerability. Indicators can easily be integrated into impact chains. There is no single method or tool for developing a climate risk and/or vulnerability index, but it involves:

- Identifying and selecting indicators;
- Acquiring and/or gathering data;
- Normalising, weighting and aggregating indicators.

Exploring how indicators have been used in vulnerability assessments in practice helps to illustrate what is entailed. The Indian Himalayas Climate Adaptation Programme (IHCAP) - a project of the Swiss Agency for Development and Cooperation (SDC), which is being implemented as a bilateral cooperation programme with the Government of India's Department of Science and Technology (DST) used indicators in their assessment (IIT, 2019). The assessment was undertaken for Districts within 12 Indian Himalayan Region States. The assessment was not hazard specific and so did not contain any climate information. This deviates from the recommendations put forward in this framework. While not being hazard specific, the assessment included indicators of exposure levels e.g. Population density; Percentage area under Horticulture Crops. Sensitivity indicators included were: Percentage of marginal farmers; Percentage of women in the overall workforce; Percentage area irrigated; and Percentage area under open forest (the rationale being that forests provide a major source of livelihoods and vital environmental services in the Himalayan States, degradation of forests indicate higher sensitivity, and large tracts of open forests indicate a higher level of forest disturbance and degradation). Indicators of capacity included: Per Capita Income; Number of Primary Health Centres per 100,000 Households; Percentage crop area insured under all Insurance Schemes; and Road Density. The data was sourced from the Census of India (2011), Agriculture Census, 19th Livestock Census, Press Information Bureau, Dept of Health, Agricultural Statistics at a Glance 2016, Horticultural Statistics at a Glance 2017, State of Forest Report 2017, and various other government sources. A series of stakeholder consultations and workshops were convened to select and weight indicators. The most important criteria for selecting the indicators were the availability of data, which may result in missing critical drivers of vulnerability. The indicators were compiled into a composite index and mapped to identify hotspots.

Indicators are often useful when spatial analysis is required. This was the case for the City of Cape Town, that, with support from the French Development Agency, recently undertook a climate risk assessment using an index approach. The climate hazards assessed were: Average, maximum and minimum temperature; Very hot days; Heat-wave days; High fire-danger days; Rainfall; Extreme rainfall; Windspeed and derived hazards of drought, fires, flooding. Using data from CSIR, StatsSA and the City's own records, indicators were selected for the hazards, sensitivity and capacity. Nine indicators were used to assess hazard exposure (based on the earlier AR4 definition) for three time periods: the current / baseline period (1961-1990); the mid future (2021-2050); and the far future (2070-2099). The data were normalised to a scale of 1 to 9, weighted and combined into a composite exposure score and spatially mapped for each of the suburbs across the municipality, for each of the three time periods.

Slightly different indicator sets were used for the three time periods, notably the mid future exposure includes a sea level risk indicator, while far future does not, and the current exposure index includes a heat island intensity indicator, while the future exposure index does not. A resilience index was then calculated by normalising, weighting and aggregating 35 sensitivity and capacity indicators. The weighting ranged from 1 to 5 for each indicator making up exposure and resilience. These weightings were determined by three key aspects, as informed by the background research and stakeholder engagement: relevance to the region/area; confidence in the accuracy of the data; and the spatial resolution of the data. From these vulnerability scores were calculated by dividing the composite exposure score (current, mid future, far future) by the composite resilience score (current). The results are presented as three maps showing the spatial distribution of vulnerability scores for the three time periods, and a vulnerability scatterplot for current conditions showing major suburbs plotted against exposure and resilience, with bubbles sized by population density.

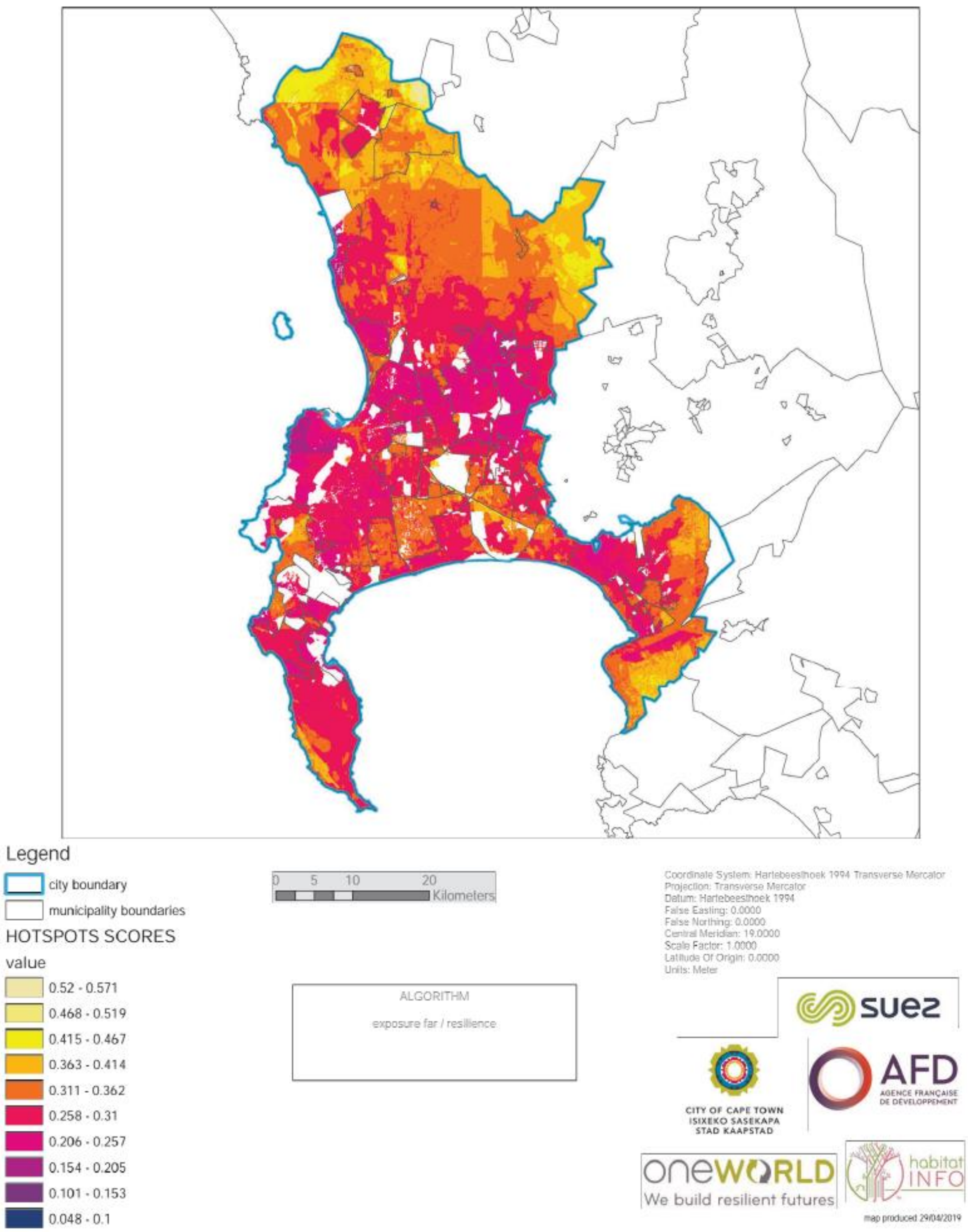


Figure 14 Summary vulnerability map for far future period calculated by dividing current resilience score (based on 35 sensitivity and capacity indicators) by far future composite exposure to multiple climate hazards score (CCT, 2019, p.46).

Participatory climate risk and vulnerability assessments

Integrating information about the local context and socio-economic dimensions of climate change risk and vulnerability is important for many assessments. Qualitative participatory methods are well suited for capturing the lived reality of people and the capacity they might have to respond. Participatory climate vulnerability and risk assessments have been widely and increasingly used over the last two decades.

There are numerous data sources to draw on which include both primary and secondary data. It is important to first determine what data is currently available before considering what additional data you might need to collect. Table 5 presents "types of issues" for consideration which relates to the elements provided in this guidance. It outlines the kinds of data and tools that might provide information for each element or type of issue. Some of the participatory tools are quite in-depth and would be suited to mid-range assessments, while others are quite rapid and might be better suited to initial screening. In CARE's Climate Vulnerability and Capacity Analysis (CVCA) Handbook (2019) (Table 6), they outline examples of participatory tools and the purpose of each one. Examples of two tools are provided in Box 7.

Table 5 Sources of information to explore the key issues (Source: CARE 2019).

		Source(s) of information	
Key issues	**Key points to consider**	**Secondary research**	**Participatory research tools**
Climate context	Extreme weather events affecting the community Observed changes in weather and seasonal patterns Observed changes in temperature, rainfall and extreme weather events Projected changes in temperature, rainfall and extreme weather events	Climate change reports Climate data (localized to the extent that this is available) Reports or assessments from humanitarian/ disaster risk-reduction actors	Hazard map Vulnerability matrix Historical timeline Seasonal calendar
Livelihood context	Primary and secondary livelihood strategies Most important assets needed for the different livelihood strategies Livelihood assets affected by scarcity, and why Opportunities for livelihood diversification	Demographic data Livelihood assessments conducted by government or NGOs Baselines or evaluations for livelihood projects Value chain/market studies	Vulnerability matrix Seasonal calendar Daily clock
Climate impacts	Impacts of climate-related shocks, stresses and uncertainties on: » People's livelihoods » Household and/or community assets » Ecosystems and natural resources Access to services	Climate change and disaster risk assessments Climate change vulnerability assessments for relevant sectors During and post-disaster evaluations	Impact chains
Current responses[3] to climate risks[4]	Responses to climate risks by: » Different social or wealth groups » People with different livelihood strategies Strategies employed to protect household and/or community assets from climate risks Access to climate information for decision-making	Climate change and disaster risk assessments During and post-disaster evaluations	Historical timeline Seasonal calendar Daily clock
Community strategies to increase climate resilience	Community-identified: » Adjustments to livelihood strategies to make them more climate resilient » New livelihood strategies people would like to explore » Strategies to protect assets from climate risks » Changes in household division of labour and decision-making power » Information needed	N/A	Adaptation pathways

Table 6 Participatory tools (Source: CARE 2019).

Field guide #	Name of tool	Purpose of tool
1	Hazard Map	The Hazard Map provides an introduction to the community, its surroundings and the hazards that affect it. It identifies key livelihood strategies, the resources they require and where they are practised.
2	Historical Timeline	The Historical Timeline provides an overview of important events in the community. It enables analysis of hazard trends and changes based on community perceptions.
3	Seasonal Calendar	The Seasonal Calendar identifies important livelihood activities throughout the year and provides a basis for discussing seasonal changes observed by communities.
4	Daily Clock	The Daily Clock explores gender differences in daily tasks, providing insights into gender-specific roles and responsibilities.
5	Household Decision-Making Pile Sorting	The Pile Sorting exercise explores gender differences in decision-making power in the household. It promotes discussion on the value of joint decision-making.
6	Impact Chains	Impact Chains facilitate assessment of direct and indirect impacts of hazards on livelihoods, providing a basis for discussing how people are currently responding to the impacts.
7	Vulnerability Matrix	The Vulnerability Matrix identifies priority livelihood assets and hazards, both climate-related and other. It also assesses the degree of impact that the hazards have on the livelihood assets.
8	Venn Diagram	The Venn Diagram identifies the institutions that interact with the community members and the services that they provide.
9	Adaptation Pathways	Adaptation Pathways identify options for adaptation and resilience building and assess the opportunities and barriers to putting them in place.

It is important to integrate local data with data from other scales. Taking a multi-leveled approach is therefore important given that many determinants of vulnerability fall outside individuals or communities. Understanding district, national and the international context is often central to understand the feasibility of certain adaptation responses. This can be done through participatory or other methods.

Box 7: Example of two Participatory Vulnerability assessment tools used in the Community-level socio-ecological vulnerability assessments in the Benguela Current Large Marine Ecosystem (Raemakers and Sowman, 2015)

Village Mapping

Participants were divided into small groups and asked to draw a basic map of their community, including the main assets, livelihood and income generating activities as well as relevant institutions that govern people's livelihoods as shown in Figure 13. The facilitator ensured there was a mix of participants in each group. When they had finished drawing their map each group was asked to report back to the plenary. This would be useful in an initial screening to understand potential hazards and the sensitivity of some of the livelihood activities.

Ranking exercise to identify environmental and climate change impacts

The exercise aims to assess the direct and indirect impact of the environmental changes identified on the first day of the workshop. It helps to think through how these changes have contributed to local vulnerabilities and the possible causes of these changes. This exercise was undertaken with the whole group and details of the discussion were captured. Table 7 provides an example of an impacts table from one of the workshops in South Africa.

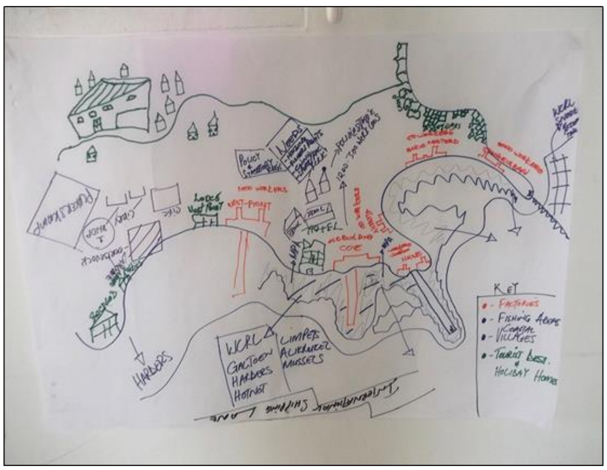


Figure 15 Example of village map developed during the RVA at St Helena Bay.

Table 7 Stressors, impacts and possible causes as identified in St Helena.

Stressor	Impacts	High/ Medium low	What do you think caused the these environmental changes
Seasons changing	Uncertainty – can't plan. Lower quality with season change (snoek).	H	Pollution - factory waste. Shipping lane, tankers in way, keep snoek out. Tankers destroy env/sea bed and banks. Sea conditions better further out -could be cos temp/ changing sea conditions. Excessive pressure by trap fishermen (commercials) fish in area (40-60 traps per boat).
Catches reduced	Less money. Less work opportunities. Break down of social fabric (drugs alcohol etc.). More petrol needed - go out to sea more but get less.	H	Pollution - factory waste. Trawlers catch the food of the snoek (pelagics) trawlers come in closer - allowed to catch sardine and anchovy in closed lobster area.
Resources further out	Quality of fish decreased. More petrol = higher costs and expenses. Fishers die at sea (safety). Need to increase technology and gear, also for safety at sea (GPS)	H	Industry boats fishing inshore area. Fishing industry contributing to global warming (short term vision - they focus on profit) – and broader environmental impacts. Maybe changing seasons and shifts of resources as result of global warming.

5. How to use the assessment for Monitoring and Evaluation (M&E)

In the broadest sense monitoring refers to systematically collecting information to track change and progress (or lack thereof), while evaluations speak to determining the impact, effectiveness, relevance, efficiency and sustainability of interventions. While monitoring is a collation of observations, evaluation looks behind these observations to assess their meaning.

Repeated CRV assessments are one way in which one can monitor how risks and vulnerabilities change through time and whether adaptation interventions have had the desired result. Evaluation, however, entails understanding *why* CRV is changing (or not!). Monitoring through CRVs can act as a *trigger* for evaluations, showing where or what is changing or not changing, so that targeted evaluations can be conducted. For example, say there is a CRV assessment that looks at the spatial hazard risk of an urban municipality, and it is repeated every three years. If after three iterations it shows that a certain section of the city is at increasing risk to impacts of extreme rainfall, this may trigger an evaluation into understanding the underlying drivers of this change.

However, if a CRV assessment informs the development and implementation of adaptation action, then repeat CRV assessments can be used for monitoring and evaluating these actions. Such monitoring and evaluation assumes that adaptation efforts are intended to decrease risk and vulnerabilities, and will shine light on the relevance, efficacy and efficiency of the actions. For example, say there was a CRV assessment that looked at the vulnerability of commercial grain production in a specific region of the country, and which showed a vulnerability to water scarcity and more extreme events such as extreme rainfall. Adaptation actions were then developed to make water use more efficient, and shifting practices to limit crop damage from for example extreme rainfall. If these actions are put into practice, a repeat CRV assessment at a later stage will ideally show a decrease in the vulnerability of commercial grain production. If such is not the case, an evaluation may be necessary to understand why the actions have not been fit for purpose.

If, as in the latter example, the assessment is used for monitoring and evaluating *adaptation action* careful thought needs to be given as to how one deals with a shifting baseline. This refers to the fact that the various elements that inform assessed risk and vulnerability, e.g. adaptive capacity and climate trends, are also shifting through time independent of the adaptation action.

If the intention is for an CRV assessment to contribute to M&E it is essential to ensure that the methodology applied is transparent, clear and repeatable, and that the data incorporated is accessible, as it would entail complete or partial repetition of the assessment at a later stage.

The methodology applied in a CRV assessment also informs the nature of the M&E. If for example an assessment is quantitative with quantitative indicators, this will require quantitative monitoring. It is therefore important to take the M&E requirements of the adaptation intervention into account when one is designing the CRV assessment and choosing the methodological approach.

It is important to be realistic about what is feasible. While repeat CRV assessments may be the intention in many cases there are few examples where the exact same assessment has been repeated several times. Depending on the context of the assessment, M&E needs and requirements, and capacity and timelines it may therefore be necessary to look at picking a few of the assessment components to focus on for repeat assessments, i.e. doing a scaled down version.

The national perspective

Beyond project and area specific M&E there is a great need to come together to contribute towards the national picture of climate risk and vulnerability and how it is changing through time. The evaluation of the effectiveness, relevance, efficiency and sustainability of adaptation actions support this directly. The National Climate Change Information System (NCCIS) (https://ccis.environment.gov.za/#/), beyond being a space that provides various guiding information for assessments (as detailed in appendix one), is the space in which these factors can and will increasingly come together. Information on climate change projects, as well as CRV assessment outputs, can be shared through interactive components of the system.

6. Conclusion

Assessing risk and vulnerability to climate change is not an easy task, but is important for understanding the current situation, how it might evolve under changing conditions into the future, and how to prioritise adaptation interventions. The Climate Risk and Vulnerability (CRV) Assessment Framework presented here aims to guide a broad range of South African users through a structured yet flexible sequence of steps. The intention is to help standardise assessment components and outputs where possible, enabling results to be compiled and aggregated at the national level to assess climate risk and vulnerability across the country and track how it is evolving in light of changing conditions and interventions.

The initial thoughts on the framework were presented and discussed with a wide range of stakeholders at a workshop in August 2019 and a near final framework was presented for deliberation and critical feedback in February 2020. These two workshops were both well attended, with over 50 participants at each, representing a broad range of expertise, sectors, spheres and interests. Through this process a lot of useful feedback was gathered to strengthen the framework and to help think about what is needed going forward. Participants emphasised the importance of finding a variety of ways to share and trial the framework. They noted that it would need to be adapted for different types of assessments and sectors, and that perhaps in trying to standardise approaches you might lose out on some specific contributions. There was concern expressed over making the framework accessible at grassroots level, which would require increased funding and capacity in many instances.

It was felt that if the CRV assessments, based on this framework, were able to feed into the work of different government departments and long-term planning, that would be a sign of success. Given that one of the main aims of undertaking climate risk and vulnerability assessments is to inform adaptation interventions, the implementation of adaptation based on CRV assessments would be another sign of success. However, this will require concerted effort, capacity building and finance for implementation.

References

CARE, 2019. *Climate Vulnerability and Capacity Analysis (CVCA).* CARE Climate Change and Resilience Platform (CCRP). Version 2.0. https://careclimatechange.org/cvca/

City of Cape Town, 2019. *Climate Change Hazard, Vulnerability and Risk Assessment Report*, prepared by One World Consulting.

Eyring, V., Cox, P.M., Flato, G.M., Gleckler, P.J., Abramowitz, G., Caldwell, P., Collins, W.D., Gier, B.K., Hall, A.D., Hoffman, F.M. and Hurtt, G.C., 2019. Taking climate model evaluation to the next level. *Nature Climate Change,* 9(2), pp.102-110.9, 102–110.

GIZ, with EURAC and Adelphi, 2017a. *The Vulnerability Sourcebook: Concepts and guidelines for standardised vulnerability assessments*. Bonn, GIZ https://www.adaptationcommunity.net/?wpfb_dl=203

GIZ, with EURAC, 2017b. *Risk supplement to the Vulnerability Sourcebook*. Bonn, GIZ. https://www.adaptationcommunity.net/wp-content/uploads/2017/10/GIZ-2017_Risk-Supplement-to-the-Vulnerability-Sourcebook.pdf

Indian Institute of Technology (IIT), 2019. *Climate Vulnerability Assessment for the Indian Himalayan Region Using a Common Framework.* The Indian Himalayas Climate Adaptation Programme (IHCAP). http://ihcap.in/reports

IPCC, 2014: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 688.

Raemaekers, S. and Sowman, M. 2015. Community-level socio-ecological vulnerability assessments in the Benguela Current Large Marine Ecosystem. Report prepared for the Food and Agricultural Organisation (FAO) and the Benguela Current Commission (BCC). 144 pp. Cape Town, South Africa.

Appendix One: Resources for Assessments

This Appendix outlines a variety of freely available data and information portals, guidelines, methods and tools. It links a selection of these to the various elements of assessment outlined in step three, noting where and how they apply.

The resources presented below include those that provide raw data for application in an analysis, guides for collecting data, methods for how to analyse data and integrate various sources of information, tools that operationalise methods, and platforms and portals the provide a combination of data, tools and methods.

It is important to distinguish between data collection and data analysis. While a portal may provide you with the data you need, you will likely need to go somewhere else to figure out how to use it for a CRV analysis. And while a guideline may provide you with the process for organising a participatory assessment process, it may not guide you as to how to analyse the variety of information that is shared in the process. Some portals provide a combination of the above, but there is no ‘one stop shop’ that provides all data and methods needed to complete an assessment of any depth. While various efforts continue to be made to provide such a solution, the diversity of needs, approaches and data requirements are too varied across contexts being assessed.

Always apply a critical mind when engaging with a resource, for example: question any underlying assumptions in a proposed data collection process or data analysis methodology; question the method applied to produce a spatial map, and the potential uncertainties therein; question the way in which data was collected, considering data collection biases and how data gaps were addressed.

The resources are first listed below with a brief description and weblink, after which a selection is linked directly to the different elements of an assessment (Table 8).

Data and information platforms and portals

- The **Agricultural Research Council (ARC) and the Department of Agriculture, Forestry and Fisheries (DEFF) GIS Portal** provides access to GIS shapefiles, and static and interactive maps relating to a number of indicators including land use, climate, crops, soil and vegetation. Noting that it does not have all the information for all provinces, that there are no future climate projections and that there is no clear time series to show change over time - http://daffarcgis.nda.agric.za/portal/home
- The **CapeFarmMapper** is a free web-based mapping tool designed to assist with spatial information queries and decision making in agriculture and environmental management. It provides access to spatial databases and web services, including information on where different types of farming is practiced, agricultural land use potential, and historical climate information. It holds a wide variety of detailed agricultural data, and includes many 3rd party integrations. Noting that it is limited to the Western Cape province only, and that it is not specifically aimed at a climate change and variability lens - https://gis.elsenburg.com/apps/cfm/
- The **CSAG Climate Information Portal (CIP)** is an online portal that provides raw and analysed data for historical climate trends and future climate change projections, at a station scale. Noting that the number of stations are limited, and that the downscaling methodology and data is one of many possible approaches - http://cip.csag.uct.ac.za/webclient2/app/
- **DataFirst** is an online platform developed at UCT that provides open access to survey and administrative microdata from South Africa and other African countries. It allows raw data to be downloaded in a variety of formats. Noting that the data largely relates to social, economic and political studies and surveys - https://www.datafirst.uct.ac.za/
- The **Environmental Geographical Information Systems (E-GIS) portal** provides access to baseline environmental geospatial data, map services, printable maps and relevant documents to users of geospatial technology. Quarterly data updates makes it possible to look at changes through time. Noting that access is largely limited to those making use of geospatial (GIS) software, and that in some cases dataset classifications have changed somewhat through time making it hard to do analysis that goes far back in time - https://egis.environment.gov.za/
- The **Frederick S. Pardee Center for International Futures** is the home of the International Futures (IF) model, and hub of long-term forecasting and global trend analysis. It gives access to a large number of variables and projections through an online browser version of the model, as well as forecasts through a google public data explorer. Noting that it requires time and effort to become familiar with the interfaces, and that data forecast limitations and assumptions are not apparent - https://pardee.du.edu/
- The **Gauteng City Region Observatory (GCRO) Quality of Life Survey Viewer and Ward Profile Viewer** are portals providing access to survey data for 2009, 2011 and 2013 Quality of Life surveys, the South African Multidimensional Poverty Index (SAMPI) and census data from StatsSA. The Life Survey Viewer provides graphs for each survey variable, at provincial (Gauteng) or municipal scale, while the Ward Profile Viewer provides a spatial representation of both the survey, StatsSA census data and the SAMPI. Noting that the data is confined to socio-economic aspects, and that it is limited to the Gauteng City Region only - http://gcro1.wits.ac.za/qolviewer/ and https://www.gcro.ac.za/research/project/detail/ward-profile-viewer/
- The **National Climate Change Information System (NCCIS)** offers a number of decision support tools and provides climate trends and projections, as well as national sectoral vulnerability information. Noting that the climate and vulnerability information is mostly taken from the Third

National Communication (2018), and that information is at a national and provincial scale - https://ccis.environment.gov.za/

- The **National Disaster Management Centre** (**NDMC) GIS-porta**l is a portal providing raw data on hazards declared as disasters through a spatial interface, as well as a fire and drought hazard score with vulnerability and capacity score components that can be accessed through an interactive mapping tool. Noting that it is based on Esri GIS mapping software, and that there may be some outdated data components - https://gis-portal.ndmc.gov.za/portal/home/index.html
- The **National OCIMS** is a portal that allows the user access to a variety of oceans and coastal related data, Decision Support Tools and documents - https://www.ocims.gov.za/
- The **SANBI BGIS** is provides interactive maps, with free tools to view and analyse biodiversity related spatial data - http://bgis.sanbi.org/SpatialDataset
- The **SANBI Land Use Decision Support (LUDS**) tool provides the user with the most relevant conservation plan or biodiversity dataset for each land parcel in South Africa. It can list all the biodiversity features occurring on a land area of interest - http://bgis.sanbi.org/LUDS/Home
- The **South African Green Book** is an online portal and tool that includes: story maps that outline the impact of climate change on the economy, on droughts, on urban growth etc; a municipal risk tool that provides social, economic and climatic analysis at the scale of local municipalities; and an adaptation actions section. Noting that the portal requires internet access and that it does not provide access to the underlying data - https://riskprofiles.greenbook.co.za/
- The **South African Risk & Vulnerability Atlas (SARVA)** is a central repository of a wide range of climate and environmental data for South Africa, including a spatial risk profiler (awaiting the imminent launch of the latest version).
- The **Statistics South Africa (StatsSA) Digital Census Atlas** is a portal enabling interactive mapping of pre-processed census data, with underlying data freely available upon request. Noting that use requires downloading the Silverlight software - http://geoinfo.statssa.gov.za/censusdigitalatlas/Default.aspx
- **WeAdapt** is a collaborative platform on climate change adaptation issues. It allows practitioners, researchers and policy-makers to access information and connect with one another. Noting that it is an international website, and that South Africa specific information is limited, and that it is somewhat unstructured and hard to navigate - https://www.weadapt.org/

Research reports and papers

- The **Institute for Security Studies (ISS)** provides a variety of papers with analysis of South African futures, such as South African Futures 2035 (https://issafrica.s3.amazonaws.com/site/uploads/Paper282.pdf), and African futures: Key trends to 2035 (https://issafrica.s3.amazonaws.com/site/uploads/policybrief105.pdf). Tends to make use of projection data by the International Futures (IF) model. Noting that it does not provide underlying data - https://issafrica.org/research/papers
- The **State of Environment Reports** provide information on the status of key aspects of the environment and how these have changed relative to the previous report, highlighting positive and negative trends in the system. For examples see Dube TradePort Corporation -

https://www.dubetradeport.co.za/SiteFiles/111494/DTPC%20State%20of%20the%20Environment%20Report%202015-16.pdf

- **WWF international's Water Risk Filter tool** enables you to explore state-of-the-art water risk maps and reports, along with country profiles and WWF's basin efforts, including 32 annually-updated, peer reviewed data layers along with a site-based operational risk questionnaire, to prioritise water risks - https://waterriskfilter.panda.org/

Guidelines and methods

- **ActionAid international's Participatory Vulnerability Analysis** has a step–by–step guide for field staff - https://www.actionaid.org.uk/sites/default/files/doc_lib/108_1_participatory_vulnerability_analysis_guide.pdf

- The **CARE Climate Vulnerability and Capacity Analysis Handbook** Version 2.0.provides practical tools - https://careclimatechange.org/cvca/

- The **Climate Risk Informed Decision Analysis (CRIDA)** manual provides stepwise planning guidance for water resource planners, managers and engineers to implement robust water management, moving through a bottom-up vulnerability assessment into planning responses. It provides guidance for stakeholder engagement and technical aspects, and minimises the modelling component. Noting that the manual is an international document, and aspects may not all apply to the South African context, and that it is focused on the water sector only - https://agwaguide.org/docs/CRIDA_Sept_2019.pdf

- The **Conservation South Africa (CSA)** methodology considers ecological, socio-economic and institutional vulnerability, applied to the Namakwa District Municipality - https://www.weadapt.org/sites/weadapt.org/files/legacy-new/knowledge-base/files/51c4c23ad02f8final-vulnerability-assessment-full-technical-report-ndm-with-cover.pdf

- The **Health Impact Assessment Framework** is an international framework that provides a framework and procedure for estimating the impact of a proposed programme or policy action on a selected environmental health issue for a defined population - https://www.who.int/heli/impacts/hiabrief/en/

- The **Let's Respond Toolkit** is a toolkit to assist in integrating climate change risks and opportunities into municipal planning, more specifically the Integrated Development Plan (IDP) process. Noting that, over the years since the Toolkit was developed it has become apparent that the IDP may not be the best entry point for integrating climate change into municipal planning, as actions should ideally first be integrated into sector plans- https://www.localclimateaction.org/sites/localclimateaction.org/files/documents/lets_respond_toolkit.pdf

- The **Lets Respond Toolkit Local Government Climate Change Support Vulnerability Assessment Tool** is a tool that provides a step by step participatory process for collecting data, with a related method for analysing that data. Noting that it is aimed directly at district municipalities, and that some of the resources provided are outdated or inappropriate for local scale planning - http://www.letsrespondtoolkit.org/vulnerability-assessment

- **Oxfam's Participatory capacity and vulnerability analysis** a practitioner's guide. An Oxfam Disaster Risk Reduction and Climate Change Adaptation Resource. https://policy-practice.oxfam.org.uk/publications/participatory-capacity-and-vulnerability-analysis-a-practitioners-guide-232411

- The **Spatial Processes in Hydrology (SPHY)** by Future Water is a freely available hydrological modelling tool suitable for a wide range of water resource management applications. Noting that it requires technical skill - http://www.sphy.nl/

- The **Taskforce of Climate-Related Financial Disclosures** helps companies, banks and investors to develop voluntary, consistent climate related financial risk disclosures for their stakeholders - https://www.fsb-tcfd.org/

- **WWF Climate Crowd** is a crowdsourcing initiative that convenes and supports the gathering of data on how climate change is impacting people and nature. A climate crowd partner would be trained by WWF, collect data and submit reports to the crowdsourcing platform, which is fed into country summary reports. Noting that there is no South African summary report to date, that the number of surveys and studies underlying a national summary report is not evident, and that it stands the risk of climate change being used as excuse for all negative impacts as survey participant perceptions are not necessarily validated - https://www.wwfclimatecrowd.org/

Data mapping tools

- **KUMU** is an open source mapping tool that requires the user to import their own data, and that can be used to document, map and show linkages in data. Noting that it requires data input, and should not be seen as a data analysis tool but rather a data presentation tool - https://kumu.io/

Table 8 Overview of select resources and how they speak to the different assessment components [noting that the below resource outlines have not been checked by the resource owners. Slight misrepresentations may thus occur].

Assessment element	Data and information platforms and portals	Guidelines & methods	Research reports & papers
Specify system of concern	**The E-GIS portal** Provides a variety of environmental geospatial data that can show the biophysical aspects of the system of concern (noting that access is largely limited to those making use of geospatial (GIS) software) **ARC and DAFF AGIS Portal** Provides both static and interactive maps, including spatial maps of natural resources, current land use, and agricultural potential for specific crops. **SANBI BGIS**	**CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 1: Hazard mapping, participatory process for identifying areas, livelihoods and resources at risk from climate hazards	Local, regional and national **State of Environment Reports** can provide useful baseline (current / historical) information on various biophysical aspects of a system of concern (e.g. water quality indicators, biodiversity indicators, land cover, etc.) **WWF international's Water Risk Filter tool** Provides maps and reports and data layers related to understanding

	Provides interactive maps, with free tools to view and analyse biodiversity related spatial data. **SANBI LUDS** Provides biodiversity datasets for each land parcel in South Africa, listing all the biodiversity features occurring on a land area of interest. **National OCIMS** Provides access to a variety of oceans and coastal related data. **CapeFarmMapper** Provides access to spatial information on where different types of farming is practiced, agricultural land use potential (limited to the Western Cape province only). **StatsSA Digital Census Atlas** Provides interactive mapping of pre-processed census data, with underlying data freely available upon request. Can support the understanding of overarching socio-economic components of a system (mapping function requires downloading the Silverlight software)		water risks (international and potentially limited South African focus)
Identify past (last 30 years) hazards and impacts	**NDMC GIS-portal** Disaster Atlas, provides historical records of events declared as disasters, to a metro and District Municipality scale (does currently not include impact numbers – people, infrastructure, livestock etc affected) **The South African Green Book** Municipal Risk Tool – Hazards component, historical average frequency/risk (no information on specific events) **CSAG Climate Information Portal (CIP)** historical climate records at station scale, with graphs presenting historical averages. Identification of individual events requiring analysis of raw data – though such analysis has various methodological challenges. (limited to station locations) **The E-GIS portal** Large scale land cover or land use, and changes over time (impacts) can be identified through the processing of environmental geospatial data through time (noting that impact attribution (e.g. whether climate change or other) is a challenge, and that access is largely limited to those making use of geospatial	**CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 1: Hazard mapping, participatory process for identifying hazards spatially – which hazards and where; Field Guide 2: Historical timeline, participatory process for identifying past hazards; Field guide 7: Vulnerability Matrix, participatory process for determining the hazards with the most serious impact.	

	(GIS) software, and that impacts from isolated events cannot be identified) **CapeFarmMapper** provides access to spatial databases, including i historical climate information (limited to the Western Cape province only)		
Establish baseline risk and vulnerability			
Exposure - the presence of something of value in the system of concern (AR5 definition)	**The South African Green Book** Municipal Risk Tool – Resources component **SANBI BGIS** Provides interactive maps, with free tools to view and analyse biodiversity related spatial data. **The NCCIS** Provides generic exposure for national sectors, based on information collated for the Third National Communication (2018) (with exposure broken down to change in climatic drive and potential future consequence, hence somewhat inconsistent with AR5 definition) **National OCIMS** Provides access to a variety of oceans and coastal related data. **SANBI LUDS** Provides biodiversity datasets for each land parcel in South Africa, listing all the biodiversity features occurring on a land area of interest. **The E-GIS portal** Provides a variety of environmental geospatial data that can show the presence of ecosystems and ecosystem services (noting that access is largely limited to those making use of geospatial (GIS) technology) **ARC and DAFF AGIS Portal** Provides both static and interactive maps, including spatial maps of natural resources, current land use, and agricultural potential for specific crops (noting that there is no clear time series to show change over time) **CapeFarmMapper** Provides access to spatial databases that include information on where different types of farming is practiced, agricultural land use potential, and historical climate	**CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 1: Hazard mapping, participatory process for identifying areas, livelihoods and resources at risk from climate hazards; Field guide 7: Vulnerability Matrix, participatory process for determining the resources most important and most impacted. The **Conservation South Africa (CSA)** Provides example of how to incorporate exposure in an assessment (grounded in AR4 definition, strong ecosystems focus). The **Lets Respond Toolkit for Local Government** Provides a step for explicitly identifying exposure (definition based on AR4, and some of the resources provided are outdated or inappropriate for local scale planning)	**WWF international's Water Risk Filter tool** Provides maps and reports and data layers related to understanding water risks (international and potentially limited South African focus)

	information (limited to the Western Cape province only)		
Sensitivity/magnitude	**The South African Green Book** Municipal Risk Tool – Resources component (only covers water supply, agriculture, fisheries & forestry, economy, surface water, ground water) **DataFirst** Provides open access to a large variety of social, economic and political studies and surveys (noting that it includes data for across the continent) **NDMC GIS-portal** Disaster Atlas, provides historical records of events declared as disasters, to a metro and District Municipality scale (does currently not include impact numbers – people, infrastructure, livestock etc affected – but will be useful here once this is added) **National OCIMS** Provides access to a variety of oceans and coastal related data. **ARC and DAFF AGIS Portal** Provides both static and interactive maps, including spatial maps of natural resources, current land use, and agricultural potential for specific crops (noting that there is no clear time series to show change over time) **The NCCIS** Provides generic sensitivities for national sectors, based on information collated for the Third National Communication (2018) (with sensitivity defined as 'stressors to the system') **The GCRO Quality of Life Survey Viewer and Ward Profile Viewer** Provide socio-economic data, through graphs (Life Survey Viewer) and spatially (Ward Profile Viewer). (data is confined to socio-economic aspects, and is limited to the Gauteng City Region only) **StatsSA Digital Census Atlas** Provides census data, for which a number of variables speaks to socio-economic sensitivity (mapping function requires downloading the Silverlight software, and raw data accessible on request) **WeAdapt**	The **Conservation South Africa (CSA)** Provides example of how to incorporate sensitivity in an assessment (grounded in AR4 definition, strong ecosystems focus). **CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 1: Hazard mapping, participatory process for identifying areas and resources at risk from climate hazards; Field guide 7: Vulnerability Matrix, participatory process for determining the resources most impacted The **Lets Respond Toolkit for Local Government** Provides a step for explicitly identifying sensitivity (some of the resources provided are outdated or inappropriate for local scale planning)	**WWF international's Water Risk Filter tool** Provides maps and reports and data layers related to understanding water risks (international and potentially limited South African focus)

	Suggests indicators and links to existing datasets (international website, so South African data is limited) **CapeFarmMapper** Provides access to spatial databases that include information on where different types of farming is practiced, agricultural land use potential, and historical climate information (limited to the Western Cape province only **The E-GIS portal** Provides a variety of environmental geospatial data that can show biophysical attributes of a system (e.g. land cover) that makes it more or less sensitive to hazard impact (noting that access is largely limited to those making use of geospatial (GIS) software) **SANBI BGIS** Provides interactive maps, with free tools to view and analyse biodiversity related spatial data.		
Coping & adaptive capacity	**DataFirst** Provides open access to a large variety of social, economic and political studies and surveys (noting that it includes data for across the continent) **The South African Green Book** Municipal Risk Tool – socio-economic & economic vulnerability and settlement vulnerability (overall score, no detail of why it scores as it does) **The GCRO Quality of Life Survey Viewer and Ward Profile Viewer** Provide socio-economic data, through graphs (Life Survey Viewer) and spatially (Ward Profile Viewer). (data is confined to socio-economic aspects, and is limited to the Gauteng City Region only) **StatsSA Digital Census Atlas** Provides census data, for which a number of variables speaks to adaptive capacity (mapping function requires downloading the Silverlight software, and raw data accessible on request) **CapeFarmMapper** Provides access to spatial databases, including detailed information on agricultural practice (limited to the Western Cape province only) **WeAdapt**	The **Conservation South Africa (CSA)** Provides example of how to incorporate adaptive capacity in an assessment (grounded in AR4 definition, strong ecosystems focus). **CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 3: Seasonal calendar, participatory process for understanding coping strategies (after doing calendar); Field guide 7: Vulnerability Matrix, participatory process identifying current coping strategies (after doing the matrix); Field guide 8: Venn Diagram, participatory process for identify institutions, access to services and social safety nets The **Lets Respond Toolkit for Local Government** Provides a step for explicitly identifying adaptive capacity (definition based on AR4, and some of the resources provided are outdated or inappropriate for local scale planning)	**WWF international's Water Risk Filter tool** Provides maps and reports and data layers related to understanding water risks (international and potentially limited South African focus)

	Suggests indicators and links to existing datasets (international website, so South African data is limited)		
Hazard frequency, duration, intensity	**The South African Green Book** Municipal Risk Tool – Hazards component, historical average frequency/risk **CSAG Climate Information Portal (CIP)** Historical climate records, e.g. total monthly heavy rainfall days (limited to station locations) **NDMC GIS-portal** Disaster Atlas, provides historical records of events declared as disasters, to a metro and District Municipality scale (events covered are only those officially declared as disasters) **ARC and DAFF AGIS Portal** Comprehensive atlas V2: Interactive maps relating to frequency of climate impacts such as frost (in the last 10 years), extreme temperatures Free State fires risk: frequency and risks of fire at fine scale	**CARE Climate Vulnerability and Capacity Analysis Handbook** Field Guide 2: Historical timeline, participatory process for identifying past hazards and their trends and changes over time	
Historical trends	**The South African Green Book** Municipal Risk Tool – Climate component, Spatial maps of historical average temperatures and rainfall **CSAG Climate Information Portal (CIP)** Historical climate records (limited to station locations) **NDMC GIS-portal** Disaster Atlas, provides historical records of events declared as disasters, to a metro and District Municipality scale (events covered are only those officially declared as disasters) **ARC and DAFF AGIS Portal** Comprehensive atlas V2: Interactive maps relating to frequency of climate impacts such as frost (in the last 10 years), extreme temperatures **The NCCIS** Provides national and provincial historical trends, including for average rainfall and temperatures and a variety of extremes, through the Tracking and Evaluation component of the website	**CARE Climate Vulnerability and Capacity Analysis Handbook** Field guide 3: Seasonal calendar, participatory process for identifying hazards and the month in which they appear; Field Guide 4: Historical timeline, participatory process for identifying past hazards and their trends and changes over time (hazard focused)	
Decide on future time	**The South African Green Book** Provides: population projections for 2030 and 2050; growth pressure projections for		

periods and scenarios	2030 and 2050; climate projections for 2021-2040 relative to 1961-1990 (RCP 4.5 AND 8.5), 6 CMIP5 GCMs downscaled to 50km resolution (not clear which downscaling method) **CSAG Climate Information Portal (CIP)** Provides climate projections for 2040-2060 relative to 1980-2000 (RCP 4.5 AND 8.5), 10 CMIP5 GCMs statistically downscaled to station level **The NCCIS** Provides national and provincial projections in the form of spatial maps, from the dynamical downscaling of 6 GCM for the time period 1971-2000 relative to 2021 to 2050 (for RCP 4.5 and 8.5), as well as narratives and key messages based on a broader range of projections		
Assess future climate risks and vulnerabilities	**The Frederick S. Pardee Center for International Futures** is the home of the International Futures (IF) model and provides direct access to long-term forecasting and global and trend analysis relating to social, political and economic dynamics. **The South African Green Book** Municipal Risk Tool – Climate component, projected change average temperature and rainfall, extreme events and very hot days; Hazards component, projected change in hazards; Growth projection Component, projected population estimates; Settlement growth projections component, projected growth in pressure on settlements **CSAG Climate Information Portal (CIP)** African merged stations CMIP5: future climate projections (limited to station locations) **The NCCIS** Provides national and provincial projections, including for average rainfall and temperatures and a variety of extremes, through the Tracking and Evaluation component of the website. Based on information produced for the Third National Communication in 2018, and includes spatial maps, from the dynamical downscaling of 6 GCM for the time period 1971-2000 relative to 2021 to 2050 (for RCP 4.5 and 8.5), as well as narratives and key messages based on a broader range of projections.	**The Local Government Climate Change Support Vulnerability Assessment Tool** Step 2 through 4 provide a participatory process and assessment score sheet for identifying and scoring exposure, sensitivity and adaptive capacity relating to projected climate change (uses the AR4 definitions and framing, and the resources, projections maps etc, are old and at a coarse scale, i.e. not suitable for a local scale assessment)	**The ISS** provides a variety of papers with analysis of South African futures, including projected demographic and economic change (provides analysis and graphs, not underlying data)