Risk Supplement to the Vulnerability Sourcebook

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Risk Supplement to the Vulnerability Sourcebook

Guidance on how to apply the Vulnerability Sourcebook's approach with the new IPCC AR5 concept of climate risk

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Quick tour guide

- This Risk Supplement provides guidance on how to apply the Vulnerability Sourcebook's approach with the new IPCC AR5 concept of climate risk.
- It is not a stand-alone publication, but should be read together with the Vulnerability Sourcebook, which is available online at: http://www.adaptationcommunity.net/vulnerability-assessment/vulnerability-sourcebook/
- The structure of this Risk Supplement mirrors the structure of the Vulnerability Sourcebook consisting of the conceptual framework, the core guidelines with eight modules and individual steps within each module, and a brief chapter on monitoring and evaluation.
- The objective of each module is summarised under the headline 'What will you learn in this module?', quoting the respective paragraph from the Vulnerability Sourcebook. Modifications ***are highlighted.***

The following icons further help you navigate through the Risk Supplement:

The **leaf** summarises the **major changes** compared with the respective section of the Vulnerability Sourcebook.

Boxes labelled with the **expert** provide further **theoretical background information.**

The **arrow** points to **major definitions** of the new conceptual framework.

The **question mark** highlights **guiding questions** that can assist you in developing your impact chains.

For ease of reference, the **hand** refers to the **relevant page(s) of the Sourcebook**.

I. Introduction

Why a Risk Supplement?

The GIZ Vulnerability Sourcebook offers a concept and step-by-step guidelines for standardised assessments of vulnerability to climate change. Published in 2014, it has since been widely put to use for vulnerability assessments in the framework of climate change adaptation planning from the local to the national level.

In its methodology, the Vulnerability Sourcebook follows the concept of climate change vulnerability as described in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) (☞p. 20). Yet, in the latest Fifth Assessment Report (AR5) of the IPCC Working Group II (WGII), this concept has been replaced by the concept of **risk of climate change impacts.** This risk concept has been adopted from the approach and practices of risk assessment in the disaster risk reduction community. By embracing the risk concept, the IPCC

- accounts for the fact that a large proportion of interrelated impacts are triggered by hazardous events, which is more appropriately addressed by the risk concept;
- encourages the climate research community to strengthen its efforts to determine the likelihoods of potential consequences as part of the risk assessment; and
- contributes to an integration of the two research realms of climate change adaptation (CCA) and disaster risk reduction (DRR).

Therefore, the AR5 risk concept does not only introduce new terms and new definitions for old terms, but it follows a different underlying philosophy. As a consequence, basing applications of the Vulnerability Sourcebook on the AR5 risk concept needs more than merely re-naming key terms. It requires clarifying potential inconsistencies, highlighting ambiguities and providing solutions for its operational use.

Adaptation practitioners from both developed and developing countries interested in applying the Vulnerability Sourcebook's methodology have expressed the wish to make use of the new risk concept. In addition, some current applications of the Vulnerability Sourcebook are already using the AR5 definitions. However, to date there exists no detailed guidance on how to integrate the AR5 concept into the Vulnerability Sourcebook's approach. This Risk Supplement intends to fill this gap.

What are the objective and background?

The objective of this Risk Supplement is to provide **practical guidance on how to apply the Vulnerability Sourcebook's approach using the AR5 risk concept**. Going beyond the comparison already presented in the Vulnerability Sourcebook (☞p. 31–33), it introduces the terminology of the AR5 risk concept to the CCA community and clarifies its implications for the Vulnerability Sourcebook methodology. Although there are a number of significant modifications, the **general step-by-step approach** of the Vulnerability Sourcebook remains unchanged.

The Risk Supplement follows the risk concept as defined in WGII AR5. It describes **one possible way** to make practical use of this concept, since the WGII does not provide directions or guidelines as to how it can be operationalised for a climate risk assessment. Also, there are still several open questions about translating the concept of risk analysis from the DRR realm to a climate change context.

The main text contains all the crucial information needed to apply the AR5 risk concept in practice. In addition, throughout the Risk Supplement, impact chains illustrate the individual steps for a simplified example from the agricultural sector. Readers who are interested in background information and in the details of the conceptual changes will find further background information in the expert boxes.

In order to provide a consistent guidance for the application of the AR5 risk concept, some key strategic decisions had to be made, the approach had to be simplified and the methodology needed to be tested against several real world cases. Thus, the document was developed jointly by a group of experts from Eurac Research and GIZ. The work was supported by inputs from an extended group of vulnerability and risk experts through a series of workshops, structured interviews, and an analysis of real world examples. Slightly simplified impact chains of two of these examples developed during an expert workshop can be found in the Annex.

How to use this Risk Supplement and when to choose the new AR5 risk concept?

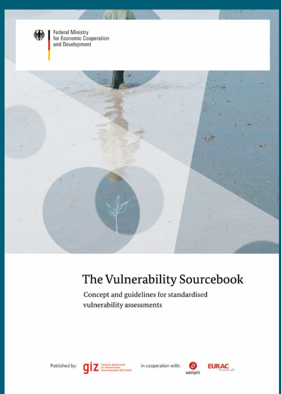
Being a supplement to the Vulnerability Sourcebook, this publication does not work as a stand-alone document, but **should be read alongside the Vulnerability Sourcebook**. Solely the conceptual framework and Module 2 can be read independently since here significant changes apply. The structure of the Risk Supplement mirrors the structure of the Vulnerability Sourcebook with its eight modules and individual working steps within each module. For each module the necessary changes in the approach are explained. All relevant figures in the Vulnerability Sourcebook have been modified according to the AR5 risk concept. We suggest that you first check the major changes summarised at the beginning of each module and then go through the single steps in each module reading both documents in parallel.

Since the AR5 concept corresponds with the most recent IPCC report and is more consistent with other risk concepts, such as disaster risk, we **generally recommend using the new AR5 concept.**

In the following two cases, however, we recommend to use the AR4 concept:

- **Monitoring and Evaluation:** If you have already applied the Vulnerability Sourcebook and intend to directly compare, monitor or evaluate this baseline assessment.
- **Familiarity or preference:** If the commissioner or end-users of the assessment have a clear preference for the AR4 concept or if the key experts to conduct and support the study are more familiar with the AR4 concept.

THE VULNERABILITY SOURCEBOOK



The Vulnerability Sourcebook provides step-by-step guidelines to conduct robust vulnerability assessments. Published in 2014, it has since been widely put to use for vulnerability assessments in the framework of climate change adaptation planning from the local to the national level. To download the Vulnerability Sourcebook in English, French and Spanish please visit: http://www.adaptationcommunity.net/vulnerability-assessment/vulnerability-sourcebook/

II. Conceptual framework: the IPCC AR5 risk concept (☞p. 17)

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- The AR5 risk concept focuses on assessing the risk of specific consequences or impacts that may harm a system. The vulnerability of the system is now one of three components of the risk.
- Consequently, the assessment is called 'climate risk assessment' instead of 'climate change vulnerability assessment'. The definitions of terms have changed. In particular 'exposure' and 'vulnerability' have now very different meanings. This may require additional considerations in the communication and interaction with stakeholders.

The IPCC provides definitions of the key terms used in the climate risk concept, which are being presented in this chapter[1]. Following each definition, you find some key aspects relevant for the application of your climate risk assessment. Expert box 1 provides further information on risk definition in other contexts as well as a differentiation between hazardous events and trends.

The latest IPCC assessment report (AR5), published in 2014, has introduced a new concept which aims to identify and evaluate the risk of impacts from climate change. It was adopted from the concepts and practices of carrying out risk assessments in the DRR community. Thus, it greatly overlaps with the way in which scientists and practitioners address natural hazards such as earthquakes, floods or landslides.

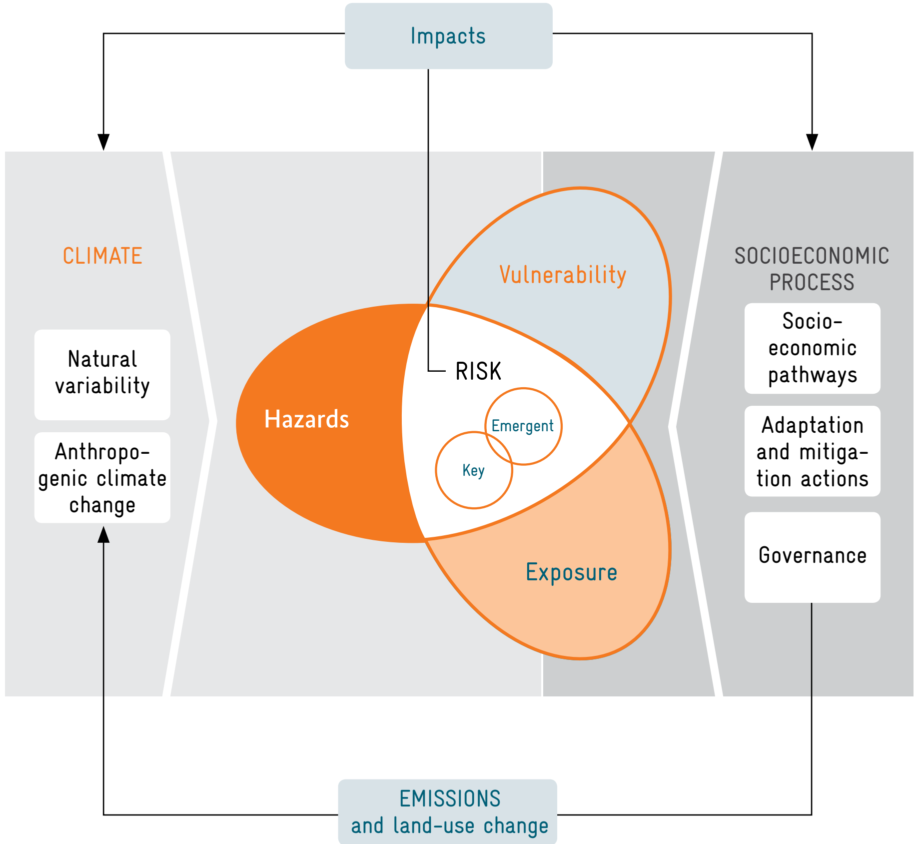
[1] If not tagged otherwise, the citations in quotation marks are from the IPCC AR5 glossary (IPCC 2014, page 1757 - 1776).

The IPCC climate risk concept is based on the definition and the understanding of risk and its contributing components as used by the DRR community. Some of the terms used in this concept are newly introduced to the CCA community; others are now defined differently.

The implications for the Vulnerability Sourcebook

The IPCC AR5 risk concept has been developed around the central term ‘**risk**’. In this concept, risk is a result of the interaction of **vulnerability**, **exposure**, and **hazard** (see Figure 1). (☞p. 32)

Figure 1: Illustration of the core concepts of the IPCC WGII AR5. The risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems



Source: IPCC 2014, p. 1046

Risk

DEFINITION RISK

*'The **potential for consequences** [= impacts] where something of **value** is at stake and where the outcome is **uncertain** (…). Risk results from the interaction of **vulnerability, exposure, and hazard** (…).'*

Important implications for the Vulnerability Sourcebook:

- A climate risk is the potential for specific, climate-related consequences (climate impacts) for something of **value** (= assets, people, ecosystem, culture, …). Typically, your system will be affected by more than one climate risk. When starting your climate risk assessment, you thus need to specify the risks your study focuses on. You need to identify the type of hazards and climate impacts that lead to the risks and who or what is at risk. Examples for risks are:
  - risk of water scarcity for smallholder farmers (water scarcity as a potential consequence of climate impacts, smallholder farmers are at risk);
  - risk of food insecurity for rural population;
  - risk of species extinction for biodiversity.

- Risk is something where the 'outcome is **uncertain**'. In a risk assessment, this uncertainty can be addressed in different ways. An explicit evaluation of the likelihood for specific consequences based on an event of defined magnitude, as it is common in a risk assessment on discrete hazardous events (e.g. Hurricane category 4), is hardly feasible for the risks related to the manifold potential changes of future climate conditions. However, we propose to make the likelihood explicit wherever possible, especially in the selection of hazard indicators. For a more in depth discussion of uncertainty, likelihood and how to address it in the risk approach see Expert Box 2 and Module 3.

Hazard

DEFINITION 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.**'*

1 EXPERT

A broader look at the term 'risk'

Risk definition in other contexts – ISO 31000 and disaster risk

The general concepts of risk, risk assessment and risk management are well established in many fields, from technical applications (e.g. industrial plants, airports), to project management, finance industry or civil protection.

ISO Norm 31000 (ISO 2009), which defines risk as the '**effect of uncertainty on objectives**' is the most accepted and broadest definition. The ISO Norm further specifies: 'Risk is often characterised by reference to **potential events and consequences [impacts]**, or a combination of these', and 'risk is often expressed in terms of a **combination** of the **consequences** of an event (including changes in circumstances) and the associated **likelihood**.'

The **United Nations International Strategy for Disaster Reduction (UNISDR)** defines **disaster risk** as: 'The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period' (UNISDR 2009).

The IPCC definition of risk is based on those two definitions, thus facilitating an integration of climate risks into existing risk management strategies in policy and decision-making. However, accounting for the complexity of climate impacts, it is broader in its scope by considering not only (hazardous) events (see below) and by being less focused on quantifying the likelihood of causes and effects.

Hazardous events versus trends

The concept of climate risk was adopted from the field of DRR. In DRR, the focus is on sudden hazardous events of a certain magnitude and with the potential to have immediate consequences, e.g. a flood event with impacts on humans or assets (such as death, injury or significant crop losses). In addition to sudden hazardous events, however, climate risks also comprise a broad range of trends steadily evolving over a longer time frame. The adverse consequences of these trends manifest themselves in slowly increasing pressure on the environment and livelihoods rather than in immediate impacts. Examples for such trends and their consequences include an increase in pests and diseases in the agricultural sector due to a warmer and more humid climate or the loss of arable land due to slowly increasing saltwater intrusion.

In order to grasp all relevant impacts of climate change on the system of concern, climate risk assessments therefore need to consider both sudden hazardous events and slowly evolving trends. This has certain implications on the way how likelihoods are determined and reflected in assessment (see Expert Box 2).

Important implications for the Vulnerability Sourcebook:

- A hazard is related to one specific risk for a specific socio-ecological system or parts thereof (exposed elements, see below).
- A hazard may be a climate event (e.g. a heavy rain event), but it can also be a **direct physical impact** (e.g. a flood).
- A hazard is not necessarily an extreme weather event (e.g. tropical storm, flooding), but can also be a slow onset **trend** (e.g. less water from snow melt, increase in average temperature, sea-level rise).
- If possible, the **probability** of a specific hazardous event or trend should be estimated. This can be done by defining hazards as critical climate events or critical physical impacts (e.g. 'heavy rain events' instead of 'rain' or 'heat days' instead of 'temperature'). Later in the assessment this will be further specified by setting thresholds and identifying frequencies (e.g. number of days with more than 50 mm rainfall – see also the discussion of likelihood, probability and frequency in Expert Box 2 and in Module 3).
- In the context of a climate risk assessment, it is assumed that a hazard represents an **external climate signal**, which does not depend on exposure or vulnerability and can per se not be influenced by adaptation or other measures seeking to deal with climate-related loss and damage.

Exposure

DEFINITION 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.'

Important implications for the Vulnerability Sourcebook:

- The use of the term 'exposure' in IPCC AR5 differs from the way it is used in the IPCC AR4 concept and in the original version of the Vulnerability Sourcebook.
- Exposure is related to specific **exposed elements** (or **elements at risk**), e.g. people, infrastructure, ecosystems.
- The **degree of exposure** can be expressed by absolute numbers, densities or proportions etc. of the elements at risk (e.g. population density in an area affected by drought).
- A change in exposure over time (e.g. change of number of people living in drought-prone areas) can significantly increase or decrease risk.

Vulnerability

DEFINITION 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.**'*

Important implications for the Vulnerability Sourcebook:

- The use of the term 'vulnerability' also differs from the way it is used in the IPCC AR4 concept and in the original version of the Vulnerability Sourcebook.
- Vulnerability addresses those relevant attributes of the exposed elements and of the system in which they are embedded (e.g. the vulnerability of the population and their direct surroundings in a village located in a drought-prone area) that may increase (or decrease) the potential consequences of a specific climate hazard.
- Vulnerability has two relevant elements:
  - **Sensitivity** is determined by those 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). Thus, the understanding of sensitivity largely remains unchanged from the AR4 concept.
  - **Capacity** in the context of climate risk assessments refers to the ability of societies and communities to prepare for and respond to current and future climate impacts. It comprises:

    Coping capacity: 'The ability of people, institutions, organizations, 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 to introduce new farming methods). This type of capacity has already been applied in the AR4 concept and is thus described in the Vulnerability Sourcebook.

Impacts

DEFINITION IMPACTS

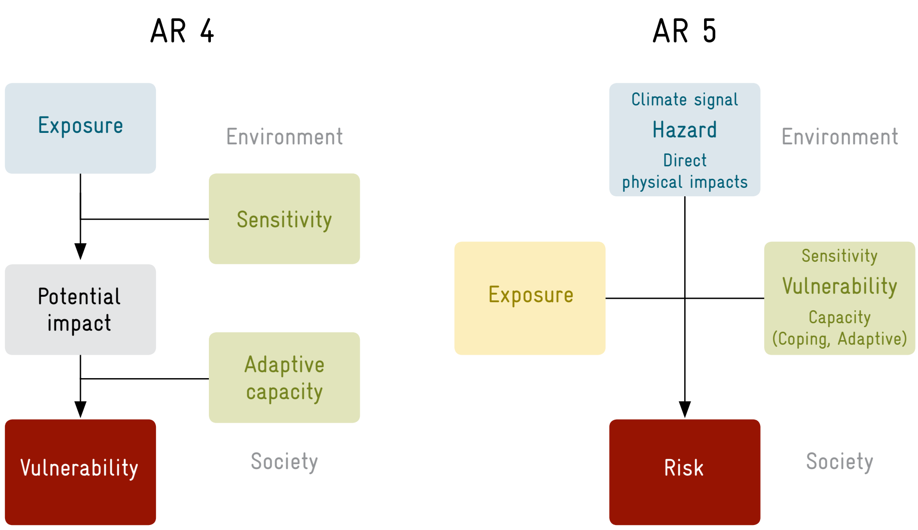
'Effects on natural and human systems. In [the IPCC] report, the term impacts is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, 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****.'*

Important implications for the Vulnerability Sourcebook:

- 'Impact' is the most general term to describe consequences, ranging from direct physical impacts of a hazard to indirect consequences for the society (so-called **social impacts**), which are finally leading to a risk.
- Impacts are the basic building blocks of the cause-effect chains (impact chains) used in the Vulnerability Sourcebook.

Comparison: implications of the IPCC AR4 and AR5 concepts

Figure 2: Comparison of the components of climate change vulnerability (AR4)[2] and climate risk (AR5)



[2] The colours have been adapted to the colours used for the AR5 concept to facilitate comparability and application.

Both the IPCC AR4 and AR5 concept identify components leading to negative consequences caused by the effects of climate change and climate-related extremes on natural or social systems (see Figure 2). Both concepts distinguish **external climate-related causes** (in AR4 ›exposure‹ and in AR5 ›hazard‹) from system attributes. These internal, i.e. system inherent, aspects of the socio-ecological systems at stake consist of vulnerability, sensitivity and capacity. Further, the AR5 concept explicitly considers the **presence and relevance of exposed elements** as an additional component (in AR4 only implicitly included in sensitivity). Both in AR4 and in AR5, only the combination of all components allows to draw a complete picture leading to the **final outcome**: ›vulnerability‹ in AR4 and ›risk‹ in AR5.

Table 1 provides an overview of the different meanings of the key terms in the two concepts explained further by means of an example.

Table 1: Comparison of the meaning of key terms in AR4 and in AR5

	Example	AR 4	AR 5
External climate signal	Lack of precipitation	Exposure	Hazard (Climate signal)
Direct physical impact	Drought	Potential impact	Hazard (Direct physical impact)
Internal attributes: Sensitivity	Crop type	Sensitivity	Vulnerability (Sensitivity)
Internal attributes: Capacity	Knowledge on water management	Adaptive capacity	Vulnerability (Capacity)
Presence and relevance of exposed elements	Relevance of small-holder farming in the region	Implicitly included in sensitivity	Exposure
Final outcome	Water scarcity for smallholder farmers	Vulnerability	Risk

In summary, the major differences and new aspects in the IPCC AR5 concept compared to AR4 are:

- The combination of hazard, vulnerability and exposure defines the risk of potential consequences.
- ›Hazard‹ does not only refer to the climate signal, but also climate-related direct physical impacts such as floods.

- The concept of exposure is introduced as an explicit expression of the presence and relevance of exposed elements.
- Likelihood or uncertainty is explicitly addressed.

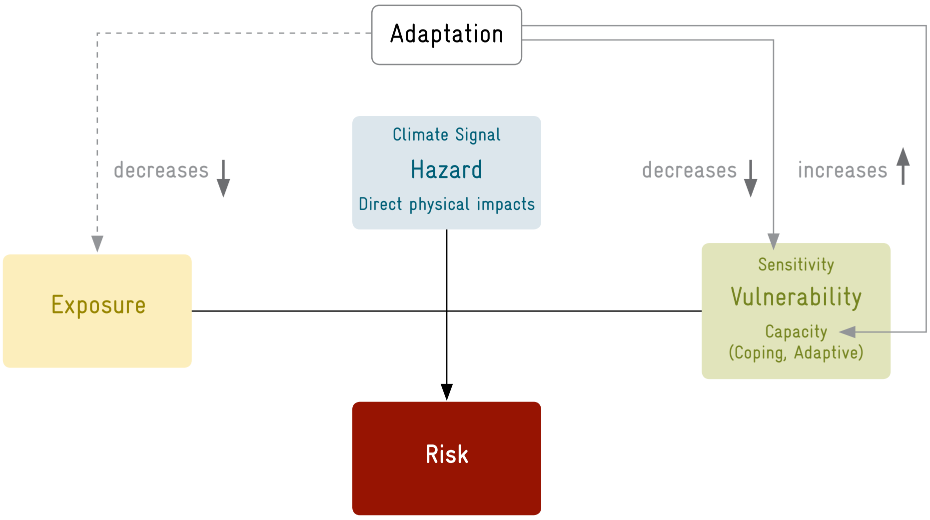
Reducing risk through adaptation

DEFINITION ADAPTATION

'The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities.'

Similar to the IPCC AR4 concept, the AR5 risk concept allows to attribute the effects of adaptation measures to risk reduction.[3] Generally, adaptation measures can reduce the risk by reducing **vulnerability** and in certain cases also **exposure** (see Figure 3). Vulnerability can be reduced either by **decreasing sensitivity** or by **increasing capacity**. For instance, the introduction of water saving irrigation techniques reduces sensitivity while fostering knowledge on water management techniques increases capacity (see also Step 5 in Module 2). In principal, adaptation measures may also focus on reducing exposure, e.g. by relocating farmers to an area that is not drought-prone. However, these measures are oftentimes politically sensitive and not always a viable option. It is therefore recommended to focus on adaptation measures targeting the sensitivity and/or capacity analysed within the impact chain.

Figure 3: Adaptation can reduce the risk by reducing the vulnerability and sometimes the exposure



[3] In order to avoid additional conceptual complexity, this supplement does not differentiate between adaptation measures and other climate risk management measures, e.g. the necessity to deal with climate-related loss and damage.

2 EXPERT

Dealing with uncertainty in climate risk assessments

Key terms

Uncertainty according to the ISO 31000 standard is 'the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood.'[4] Climate risk assessments are subject to various sources of uncertainty, which need to be carefully addressed. In the framework of these assessments, uncertainty can be regarded in terms of confidence and likelihood. (☞p. 19, Expert Box1)

Confidence is a qualitative measure for the uncertainty of knowledge and information and the validity introduced by the IPCC. It is a combination of the level of evidence of a finding and the agreement (e.g. between experts or models).[5] Confidence could be used in a risk assessment to give an indication on the validity of a statement such as in 'high risk for food insecurity in 2020 (medium confidence)'

Likelihood in the risk assessment context is the chance of a specific adverse event (hazard) or consequence (impact) occuring. According to ISO 31000, likelihood can be determined objectively or subjectively, qualitatively or quantitatively, and described in general terms or mathematically (such as a **probability** or a **frequency** over a given time period). **Probability** is one possible measure for likelihood, expressed as a number between 0 and 1, where 0 is impossibility and 1 is absolute certainty.

Options on how to address uncertainty and likelihood in a risk assessment

The probabilistic risk approach

A commonly applied approach in disaster risk assessment is to identify a specific risk scenario for a defined event with a defined magnitude and/or frequency, e.g. a 120 km/h storm, which may damage buildings in a settlement. The risk is then assessed as a function of the probability of consequences to occur (e.g. damage) and the magnitude of the potential consequences (e.g. number of potential victims, potential financial damage). As a guideline for such an approach in the field of disaster risk assessment we recommend the 'Method of Risk Analysis for Civil Protection' by the German Federal Office for Civil Protection and Disaster Assessment (Federal Office of Civil Protection and Disaster Assistance 2011). A probabilistic approach is particularly appropriate for a risk assessment of a specific event with defined dimensions (magnitude and/or frequency).

Applicability for climate risks

With the exception of assessments of very specific climate risks for the present or the near future in situations where sufficient information and expertise is available, probabilistic risk approaches are hardly applicable for climate risk assessments. This is due to the fact that these are typically more explorative in nature[6] and also reflected in the fact that the IPCC in its WGII AR5 report does not specify likelihoods in its analysis of key risks.

The intention of a climate risk assessment is usually not to assess the likelihood of a specific well-defined risk event, but to understand the risk resulting from multiple threats with multiple intensities. Furthermore, even for single events the likelihood of future hazards can scarcely be assessed. Thus, in particular with an indicator-based approach as proposed in the Vulnerability Sourcebook, a probabilistic risk assessment is hardly possible.

Recommended approaches for applications of the Vulnerability Sourcebook

For the application of the indicator-based approach as proposed in the Vulnerability Sourcebook we recommend a more pragmatic and implicit way to address likelihoods. We suggest using critical thresholds and frequencies in the hazard assessment wherever possible (e.g. number of hot days with > 30°C). However, in other cases, it is more appropriate to assess the intensity of a hazard (e.g. sea level rise in cm), as critical thresholds and frequencies cannot be determined or do not apply. In line with the IPCC definition, risk is then assessed as a combination of hazard, vulnerability and exposure. The resulting risk does not represent a probability of a specific event to occur, but rather an integrated assessment of risk classified from low to high considering multiple factors including factors which contribute to the severity of the impact as well as frequencies and likelihoods.

Furthermore, we recommend using different climate scenarios to assess potential future climate impacts. The use of scenarios is a common approach when future consequences are uncertain and likelihood cannot be properly determined. Climate scenarios may be complemented with adaptation scenarios (with additional adaptation vs. without additional adaptation[7]), or, if estimates are feasible, by socio-economic scenarios (e.g. population growth, economic development).

[4] For a detailed description see IPCC WGII AR5 Page 41 Box TS.3 | Communication of the Degree of Certainty in Assessment Findings.

[5] For a detailed description see IPCC WGII AR5 Page 41 Box TS.3 | Communication of the Degree of Certainty in Assessment Findings.

[6] See the section on ‘Focused vs. explorative vulnerability assessments’ in the Vulnerability Sourcebook on page 28.

[7] See for instance the ‘Assessment Box SPM.2 Table 1 | Key regional risks from climate change and the potential for reducing risks through adaptation and mitigation’ in IPCC WGII AR5, Page 21.

III.

Guidelines (☞ p. 35)

Module 1: (☞ p. 39)
Preparing the risk assessment

What will you learn in this Module?

'This module outlines the essential steps for preparing your ***risk*** assessment. It shows you how to assess the initial situation of your analysis, define objectives and make key decisions on the topic and scope of the assessment. Module 1 also helps you estimate time and resources needed and avoid known pitfalls in the early planning phase of a ***risk*** assessment.'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- The term 'risk' is used instead of 'vulnerability' and consequently the term 'risk assessment' instead of 'vulnerability assessment'.
- Risks related to extreme events can and should be considered as well as risks related to slow onset trends.
- If feasible, scenarios for other drivers of risk (e.g. population growth) can be included as part of vulnerability or exposure.

Step 1
Understand the context of the risk assessment

No changes necessary.

Step 2
Identify objectives and expected outcomes

No changes necessary.

Step 3
Determine the scope of the risk assessment

The AR5 risk concept can help you focus the scoping process by responding in particular to the following questions:

- What exactly is your risk assessment about?
  - Which topics (sector, groups) should the risk assessment cover?
  - Are you considering particular social groups?
  - Will the assessment focus on just one subject, or on combined subjects (for example the climate risk on the agriculture production of crops and livestock)?
  - What are the exposed elements you are focusing your risk assessment on (e.g. farmers, paddy fields, buildings, ...)?

- What climate-related risks do you intend to assess? (Consider risks related to hazardous events, such as a flood, as well as risks related to trends, such as increasing temperatures.)
  - What climate risks and impacts occurred in the past?
  - Which known risks and impacts may be relevant for the future?

- What major non-climatic drivers influence these risks?
  For an assessment of future risks, you need to consider possible future developments. Future climate risks will not only depend on the future climate, but also on future socio-economic conditions. Try to understand which are the major drivers besides the climate that could influence current and future climate-related risks. These factors have an effect on the exposure (e.g. population growth in urban areas may influence the number of people exposed to a potential impact) or the vulnerability (e.g. increase in per-capita income may decrease the vulnerability). Evaluate what is feasible and which scenarios can be included to determine these factors.

- What is the concrete geographical scope of your assessment?
  Will it cover a specific community, district/province or country? Or will it focus on specific entities such as a clearly definable ecosystem (e.g. a river delta or protected natural area)? Moreover, are you focusing on a single spatial unit (e.g. one district) or are you comparing areas (e.g. two or more districts)?

- What is the time period of the assessment?
  A clear time reference (current risk, future risk) is one of the advantages of the AR5 risk concept. The Vulnerability Sourcebook already proposed to work with specific time slices. The new concept allows being very specific regarding the time reference. For instance:
  - current climate risks related to impacts from current climate variability, climate extremes and recent changes of climate conditions, e.g. 1986 – 2015;
  - future climate risks related to impacts due to future climate variability, climate extremes, and future climate change, e.g. 2021 – 2050.

Step 4
Prepare an implementation plan

No changes necessary.

Module 2:
Developing impact chains (☞p. 55)

Impact chains form the core of the Vulnerability Sourcebook's approach, and they lay the foundation for the entire risk assessment. Module 2 proposes an approach on how to develop impact chains according to the AR5 concept. Further details are given in the single steps.

In order to simplify the application, this module (unlike the others) is written as a stand-alone chapter: you do not need to refer to the Sourcebook to work through it.

What will you learn in this Module?

'This module will show you how to define the ***risks*** addressed in your ***risk*** assessment and develop an impact chain using it as a starting point. Impact chains can help you better understand the cause-and-effect relationship determining the ***risks*** in the system of ***concern***. This in turn will help you identify indicators which you will use later in your assessment.'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- The IPCC AR5 risk concept entails major modifications in Module 2.
- Key terms are applied as described in the Conceptual Framework. Their meaning has either changed (exposure, vulnerability) or they have been newly introduced (hazard, risk).
- As a consequence, the components of the impact chain and their relationships also differ from the approach in the Vulnerability Sourcebook.
- Relevant factors need to be phrased as critical states (e.g. 'lack of precipitation') in order to facilitate the risk assessment. A neutral expression of these factors (e.g. 'precipitation') should be avoided.
- The entire impact chain will be based on the question: What is contributing to the risk?

The proposed new sequence of working steps is as follows.

Step 1
Identify climate impacts and risks

Which major climate impacts and risks do affect your system of concern?

Step 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?

Step 3
Determine vulnerability

Which attributes of the system contribute to the risk?

Step 4
Determine exposure

Which factors determine exposure?

Step 5
Brainstorm adaptation measures (optional)

What measures could help decrease vulnerability and / or exposure within the system of concern?

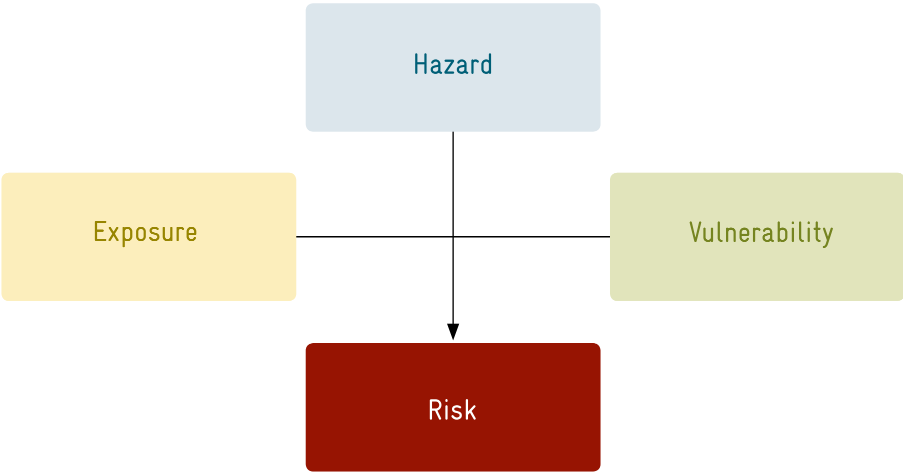
What is an impact chain?

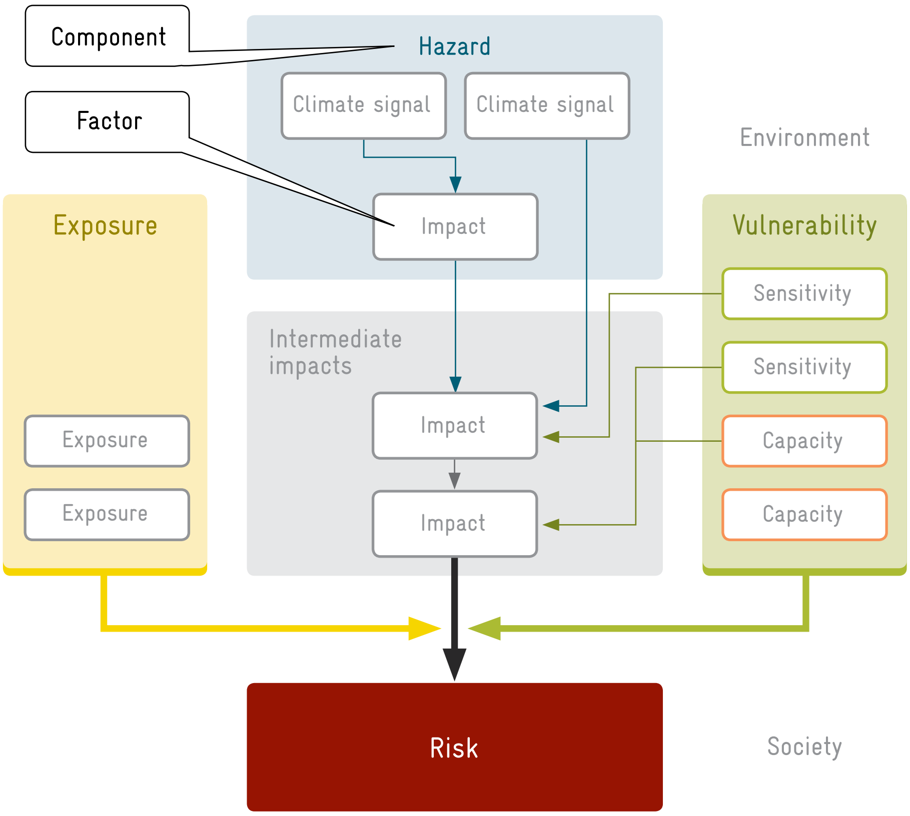
An impact chain is an analytical tool that helps you better understand, systemise and prioritise the factors that drive risk in the system of concern. The structure of the impact chain developed according to the IPCC AR5 approach is based on the understanding of risk and its components (see Figure 4). For detailed information on these components refer to the Conceptual Framework of this document.

In accordance with the IPCC AR5 definitions, we understand 'impacts' as the basic building blocks of cause-effect chains from hazard to risk (see Figure 4, below).

A climate signal, e.g. a heavy rain event, may lead to a **direct physical impact**, e.g. a flood, causing a sequence of **intermediate impacts**, which finally lead to the **risk**.

Figure 4: Structure of an impact chain according to the IPCC AR5 approach. General overview of the concept (above) and detailed structure (below)





A chain is composed of **risk components** (hazard, vulnerability, exposure) (see coloured containers in Figure 4) and underlying **factors** (white boxes). The hazard component includes factors related to the climate signal and direct physical impact. The vulnerability component consists of sensitivity and capacity factors. The exposure component is comprised by one or more exposure factors (no subdivision within this component). For simplicity, the relationships from all factors directly leading to the risk without relationships to other factors are summarized by bold arrows on the bottom of the respective components.

In contrast to these three components, **intermediate impacts** are not a risk component by themselves but merely an auxiliary tool to fully grasp the cause-effect chain leading to the risk. By definition, they are a function of both hazard and vulnerability factors, which means that all impacts identified which do not only depend on the climate signal but also on one or several vulnerability factors need to be placed here.

There are a number of principles to consider when collecting the various factors to generate an impact chain. The step-by-step guidance and the examples shown in Figures 5 – 8 will help you understand the following principles:

- To avoid double counting a factor needs to be allocated to one risk component only.
- The factors allocated to one component (be it hazard, vulnerability or exposure) should be – at least predominantly – independent of factors of other components. Factors which are influenced by other factors of at least two different components should be treated as intermediate impacts.

  Example: As shown in Figure 8 the following factors are independent from each other and can be allocated to the different components as follows: too low precipitation (→ hazard), low efficiency of irrigation system (→ vulnerability), number of smallholder farmers (→ exposure). However, 'insufficient water supply for crops' is influenced by factors from two different components (hazard and vulnerability) and therefore needs to be considered as an intermediate impact.

- Factors representing potentially hazardous events can either be allocated to the hazard component or can be classified as intermediate impacts. This decision needs to be based on the question whether the specific factor can be influenced by measures or activities taken within the system you are focusing on.

  Example: If you look at the risk of soil erosion in agriculture, you may identify '100-year flood events' as relevant for your assessment. In case the area you are considering is located in the lowlands downstream of the area where the flood originates, it is not possible to directly influence these flood events; thus you would allocate the factor to the component hazard. In case this area is located upstream in the mountains, it may be possible to reduce surface runoff; thus the vulnerability of the system plays a role, and you would describe the factor as an intermediate impact.

These principles are pragmatic rules that are necessary to keep the risk assessment consistent and manageable. Moreover, for developing impact chains, expert knowledge and a sound understanding of the system at the heart of the risk assessment are indispensable. We recommend the following breakdown of steps:

- Prepare the process within the project team with the help of external experts where necessary (review of known impacts and cause-and-effect relationships).
- Use participatory methods such as workshops involving key institutions and experts as well as representatives of affected sectors or communities to broaden knowledge, create a common concept and encourage ownership (brainstorming additional impacts, prioritisation of impacts, drafting impact chains).
- Finalise the process within the project team with the help of external experts where necessary (fine-tuning and finalisation of impact chains).

Building an impact chain is an iterative process. New aspects can arise throughout the process. You can always return to previous steps.

Step 1
Identify climate impacts and risks

GUIDING QUESTION

'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 topic (addressing the sectors agriculture and health, for instance) you will need to develop discrete impact chains for each topic, 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 choice down to one or more risks according to the focus of your assessment.

Review the results of Module 1

Start with a desktop review of climate impacts and risks based on the knowledge sources you identified in Module 1. Document known impacts and risks for each of the topics you identified.

Brainstorm potential impacts and risks

Take the impacts and risks you collected during the review and use a brainstorming session with key stakeholders to complete the list. Make sure that you stay within the system of concern as defined in Module 1 (e.g. risk of water scarcity for smallholder farmers).

TIP

Brainstorming can best be done by conducting a participative workshop with experts and key stakeholders. Use pin boards and cards to collect and arrange impacts and risks identified with the participants.

If your risk assessment addresses more than one topic or sector (e.g. agriculture and health), examine them separately. Key questions in identifying relevant impacts and risks include:

- How have weather phenomena and extreme climate events impacted your system in the past?
- Have you observed any new trends or recent events (e.g. in the last decade)?
- What socio-economic impacts have you observed in the past as a result of these climate events (e.g. loss in yields, increase in disease)?

Cluster the impacts and risks

After collecting impacts and risks from the review and brainstorming, cluster them into larger groups united by similar topics, giving each cluster a unique title (e.g. 'erosion and land degradation', 'water scarcity', 'food insecurity').

TIP

Make sure you have captured all relevant impacts and risks affecting your system of interest for each cluster. Therefore, once you are done compiling impacts and risks by their subject take a second look if you miss any relevant aspects.

Prioritise and select key clusters

The next step is to discuss how many clusters you wish to use in order to prioritise one or more as the focus of your assessment. The key question here is: in your opinion, which issues affect your system the most?

One method of prioritisation is to give each workshop participant a number of 'votes' (in the form of sticker dots, for instance) in order to distribute them to the clusters he or she regards as most important.

Arrange impacts and risks within clusters

Once you have identified your priority clusters, take a closer look at the impacts and risks within each cluster, which resulted from the brainstorming session. If some of the identified impacts and risks seem to occur as a consequence of others in your cluster (e.g. 'risk of loss in crop yield' and 'risk of income losses due to lower crop yields') visually highlight these causal relationships so as to narrow down the focus of the assessment. Next, you need to do a plausibility check to identify your impacts and risks to focus your risk assessment on. For that purpose, discard any impacts and risks which are significantly influenced by factors unrelated to climate change, retaining only those impacts and risks clearly related to climate as your starting point. Let this task be guided by questions such as:

- Which other factors (such as forest degradation, groundwater exploitation, etc.) affect the impact or risk?
- Are these or are climate factors dominating?

In case you have difficulties answering these questions, consult experts to gain further guidance.

As a result, you will have one (or a set of) impacts and risks (e.g. water scarcity) to focus your assessment on. The final wording of the risk can be composed of the impact (risk of what), the hazard (impact from what) and the exposed elements (what or who is at risk), for instance, 'risk of water scarcity (impact) due to droughts (hazard) for smallholder farmers (exposure)'.

Step 2
Determine hazard and intermediate impacts

GUIDING QUESTIONS

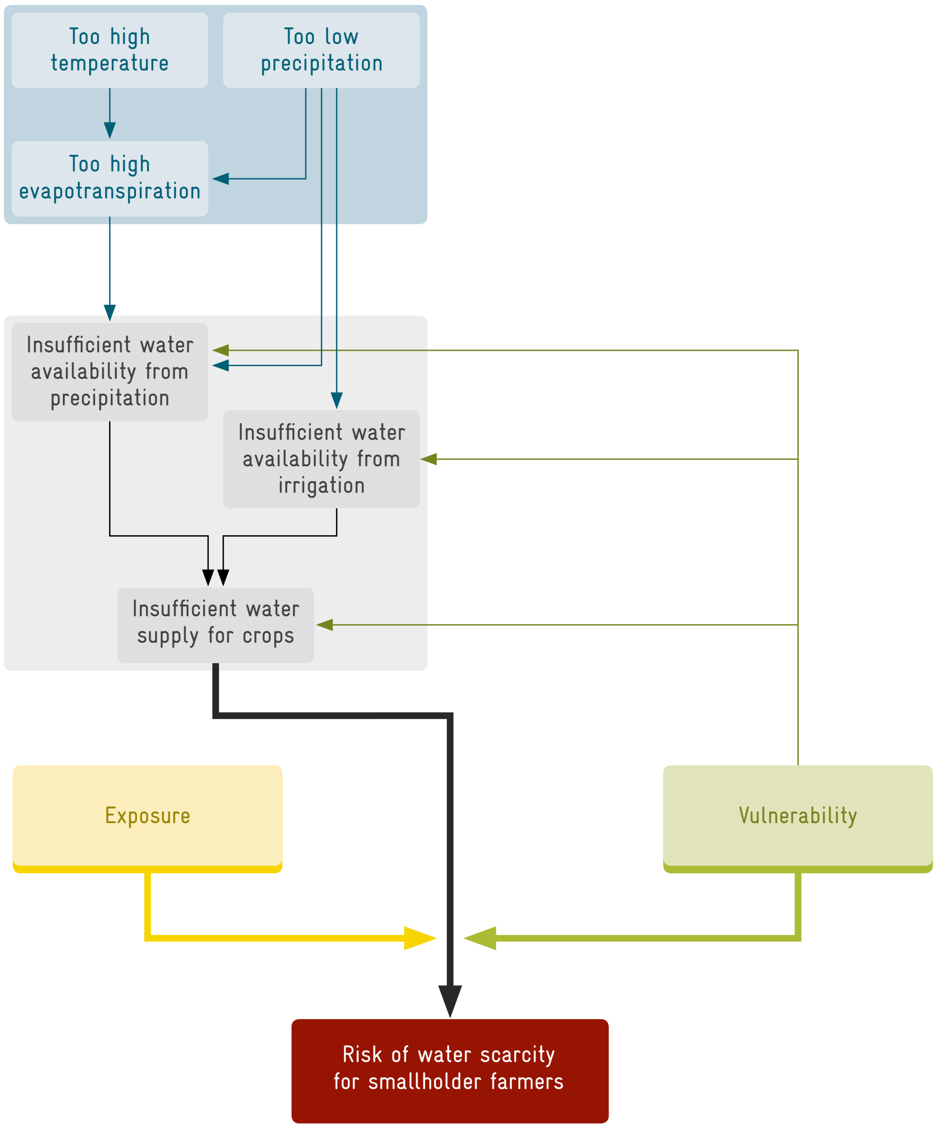
'Which climate-related hazardous events or trends and their direct physical impacts pose a risk to your system of concern?'
'Which intermediate impacts link the hazard and the risk?'

The component hazard consists of two parts: climate signal and direct physical impact. To identify the relevant climate signal(s), start with your selected risk, and then work from the bottom up by identifying related intermediate impacts that lead to your risk until you have reached the hazard (direct physical impacts or climate signals).

Figure 5 is an example of an impact chain for the 'risk of water scarcity for smallholder farmers'.

As you can see, climate-related factors usually follow a sequence which leads from readily measurable factors, such as temperature and precipitation, to more complex factors such as evapotranspiration and water availability. 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 factors of both hazard and vulnerability should be treated as intermediate impacts (e.g. 'insufficient water supply for crops',

Figure 5: Hazard and intermediate impact factors for the risk 'Risk of water scarcity for smallholder farmers'



as shown in Figure 6). The question whether the specific factor can be influenced by measures or activities taken within the system of concern helps you to distinguish.

For all hazard and intermediate impact factors we recommend a wording that implies a critical state, e.g. 'too high temperatures' rather than 'temperature', following the guiding question: 'What are the major contributing factors leading to the risk?'

With hazard factors and intermediate impacts identified, you now have a good basis for determining relevant vulnerability factors.

Step 3
Determine vulnerability

GUIDING QUESTION

'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. However, an unambiguous allocation of the individual factors to either the sub-component sensitivity or capacity is often not possible. This is unproblematic since the factors of both sub-components will later on be aggregated into the component vulnerability.

Please consider to link vulnerability factors with the related intermediate impacts, if possible (e.g. the intermediate impact 'insufficient water availability from irrigation' is related to the sensitivity factor 'low efficiency of irrigation system').

Also for factors of vulnerability we recommend a wording that implies a critical state, e.g. 'unfavourable soil conditions', instead of 'soil type' or 'insufficient know-how about irrigation systems' rather than 'knowledge about irrigation'.

Sensitivity

GUIDING QUESTION

'Which attributes make the system vulnerable to potential negative impacts of the hazard(s) under consideration?

Sensitivity includes the physical environment as well as socio-economic or cultural aspects such as soil condition, irrigation systems or land use patterns. When looking at water scarcity in agriculture, think of questions like: is the water demand of crop types an important factor here?

Figure 6: Sensitivity factors (green outline) for the risk 'Risk of water scarcity for smallholder farmers'

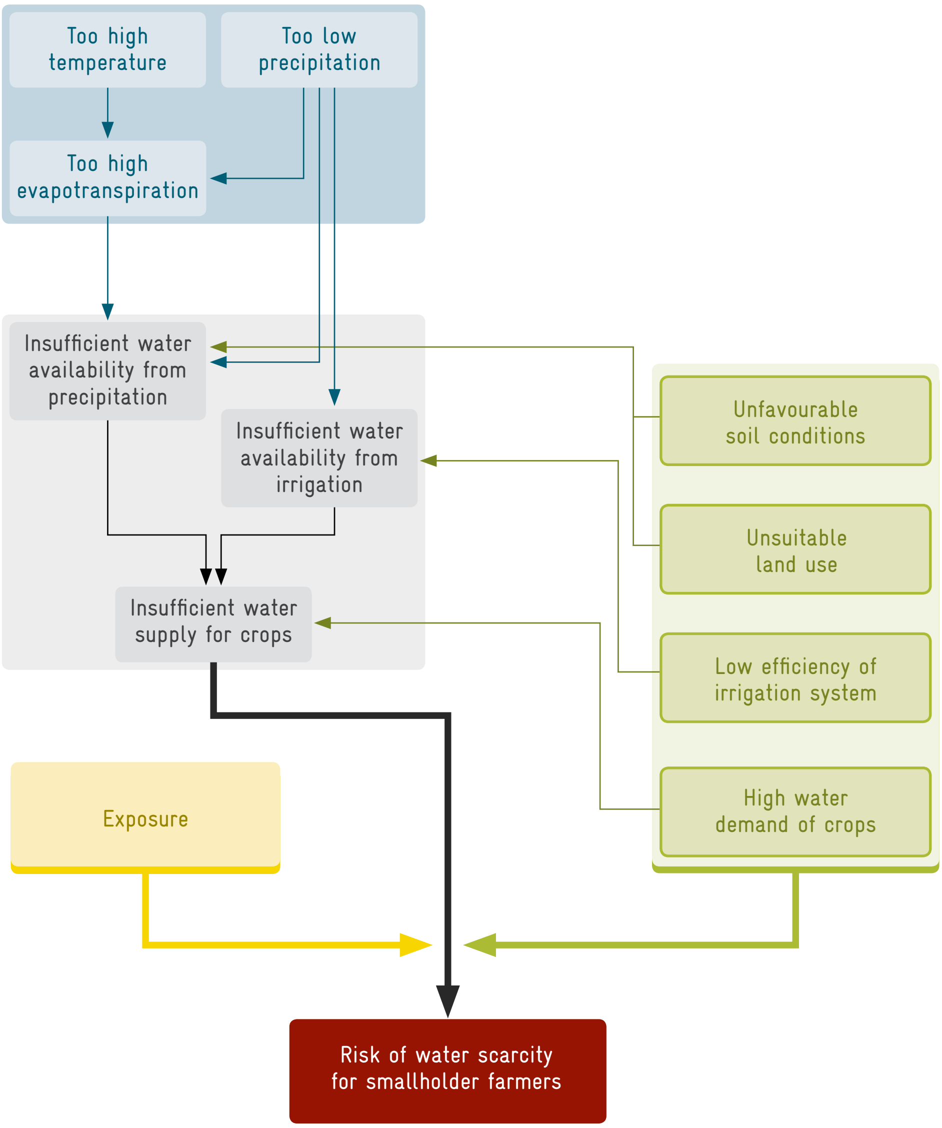


Figure 6 shows a practical example of adding sensitivity factors to the impact chain.

Capacity

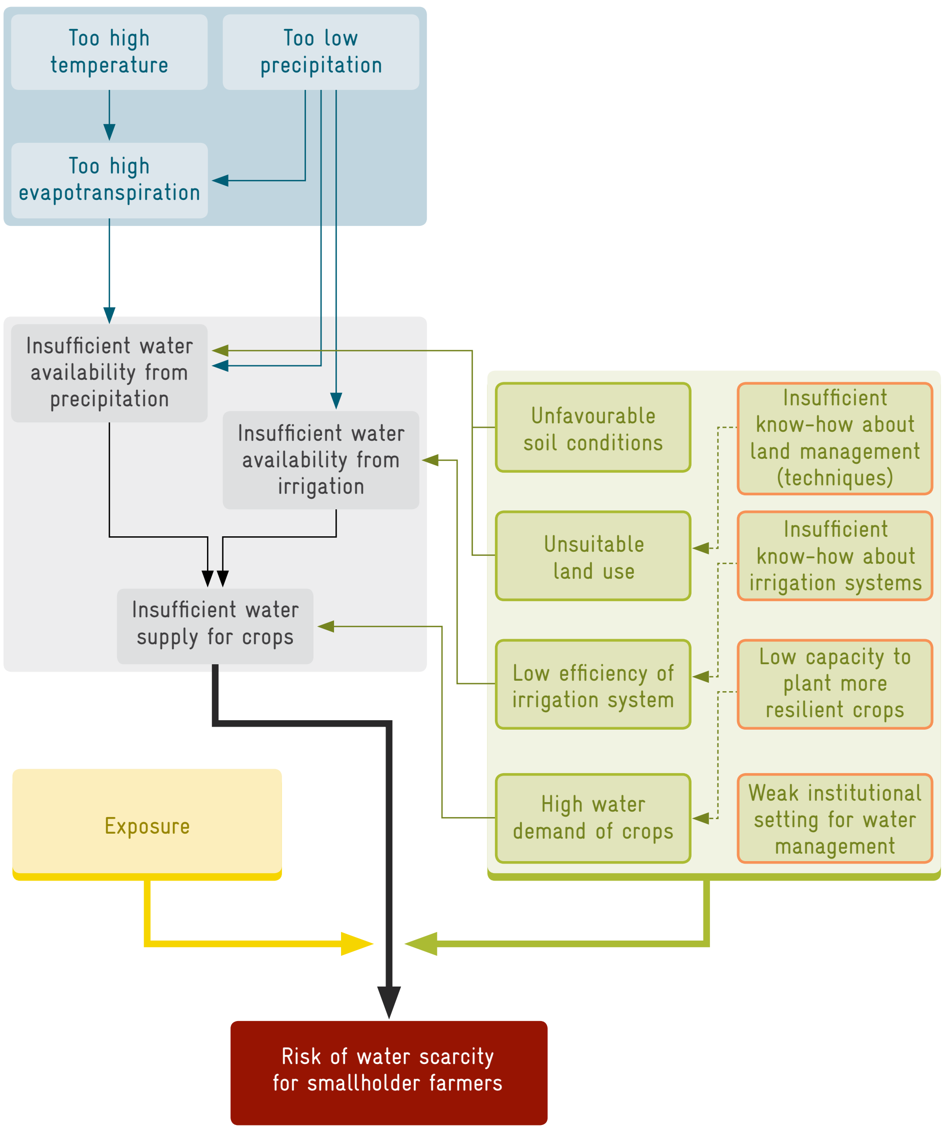
GUIDING QUESTION

'Which abilities of the societal system are in place or missing to reduce the risk of concern – now and in future?'

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 (see definition of coping capacity and adaptive capacity in chapter II). In order to identify (lacking) capacities, consider aspects directly linked to the risk as well as more generic issues. You may find it helpful to keep the four dimensions of adaptive capacity in mind:

- **Knowledge**: is there knowledge or expertise available or missing which might aid adaptation?
- **Technology**: are there technical options available or missing which could enhance capacity?
- **Institutions**: how does the institutional environment contribute to capacity?
- **Economy**: which economic and financial resources are available or missing for enhancing capacity or implementing adaptation measures?

Figure 7: Capacity factors (orange outline) for the risk 'Risk of water scarcity for smallholder farmers'



Identifying factors as a lack of capacity helps you to brainstorm on possibilities and entry points to enhance capacities.

Figure 7 shows how capacity can be added to the impact chain. Factors describing the (lack of) capacity are shown as green boxes with orange outlines.

Step 4
Determine exposure

GUIDING QUESTION

'Which factors determine exposure?'

The term 'exposure' has a new meaning in the IPCC AR5 concept. It now refers to the **presence** of something of value in the system of concern. While the scoping in Module 1 already provided initial ideas about the exposed elements in question, this now needs to be further specified. We recommend formulating this component in a way that expresses the relevance of the exposed elements in the system of concern, e.g. 'the land covered by smallholder farming' or 'number of smallholder farmers' could be suitable factors.

For instance, the higher the share of smallholder farmers of the total population in that region, the higher the related risk. See Figure 8 for the sample impact chain including exposure. In most cases, the exposure component will consist of considerably less factors than hazard or vulnerability and, in fact, oftentimes one exposure factor might be enough to express the relevance.

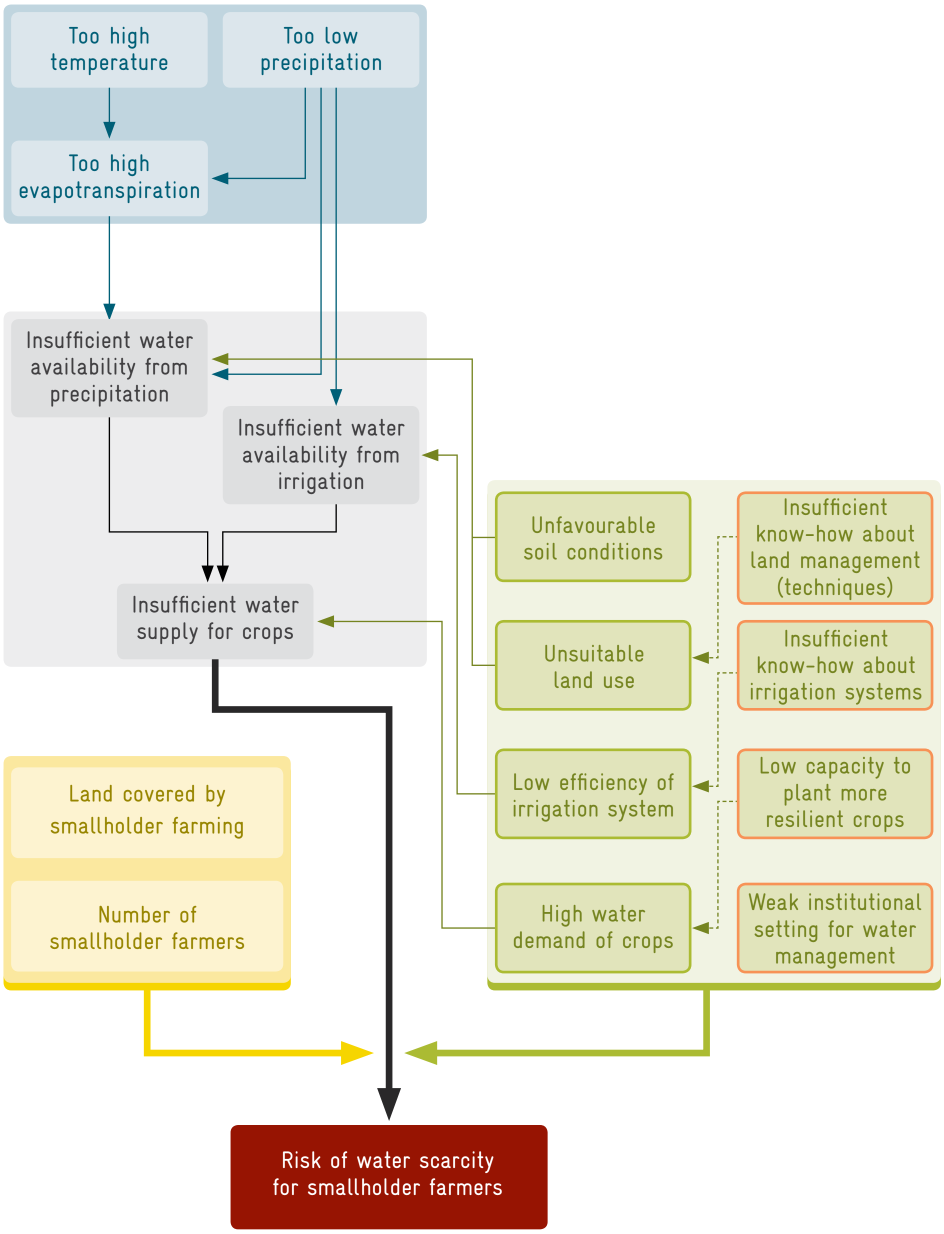
Exposure is easily confused with vulnerability, in particular with the sensitivity sub-component. In order to distinguish these two components, keep the following example in mind: Imagine you have identified the climate-related 'risk of health impacts due to heatwaves' and want to assess it. In order 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).

Step 5
Brainstorm adaptation measures (optional)

GUIDING QUESTION

'What measures could help decrease vulnerability and / or exposure within the system of concern?'

Figure 8: Exposure factors for the risk 'Risk of water scarcity for smallholder farmers'

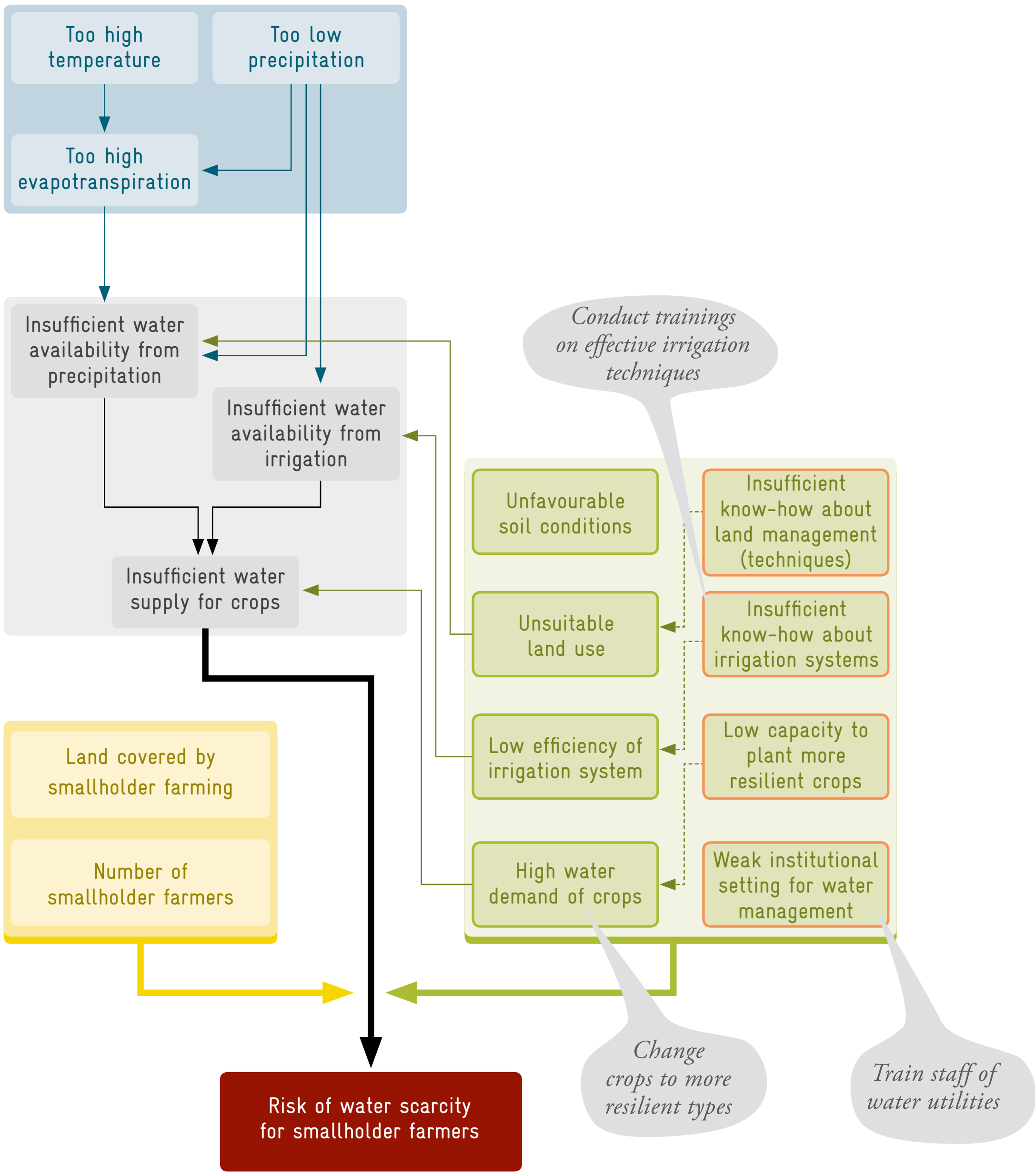


Impact chains do not only provide an understanding of risk that can be operationalised, but can also drive the initial brainstorming session on potential adaptation measures. We particularly recommend this exercise if your risk assessment is designed to support the development and monitoring and evaluation (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?

This is especially helpful if the risk assessment is intended to lay the groundwork for adaptation measures, and it can serve as a useful reality check. Feel encouraged to discuss potential measures beyond the identified vulnerability factors. You may find that the understanding of the causal relationships of the components contributing to vulnerability is incomplete and that the impact chain requires additional elements. Keep in mind that this Risk Supplement refers to adaptation measures in a wider sense including other climate risk management measures, which should not be kept out of the picture during brainstorming.

Figure 9 shows our example impact chain with a few exemplary identified adaptation measures.

Figure 9: Adaptation options for the risk 'Risk of water scarcity for smallholder farmers'



To ensure that your assessment takes gender and disadvantaged groups into account, use the same approach applied in developing impact chains. For each component in the impact chain consider whether there is a dimension specific to women or disadvantaged groups. This can be done for any individual factor except those representing climate signals or direct physical impacts. Most likely, you will find the specific factors related to gender issues or disadvantaged groups amongst the factors of the vulnerability component.

Focussing on gender and disadvantaged groups usually adds another level of detail to your analysis. Consider a dedicated screening for these issues once an impact chain has been developed. It should focus on the following questions:

- Does the identified impact have a particular effect on women or disadvantaged groups?
- Are any of the factors in the impact chain specific to women or disadvantaged groups? How can this influence be described? In which way does it affect women?
- Are there any additional factors that are specific to one gender or a particular societal group that should be included in the assessment?

Another way of including women and disadvantaged groups is to take a gender-neutral impact such as 'water scarcity in small-holding agriculture', and phrase it as, for example, 'water scarcity in small-holding agriculture conducted by women'.

You can also ask: "If there is a specific impact, how does it particularly affect women and disadvantaged groups?" Identify and consider sub-impacts when elaborating sensitivity and capacity.

Figure 10: Including gender in impact chains

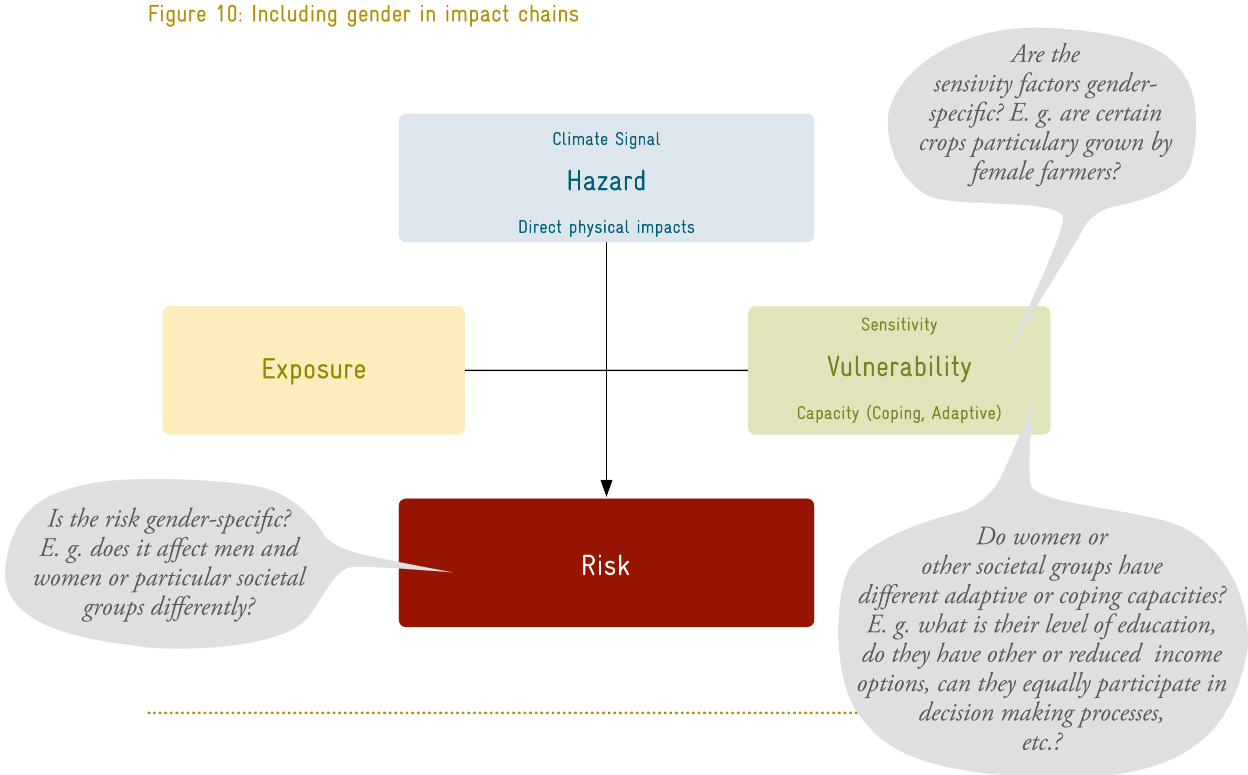
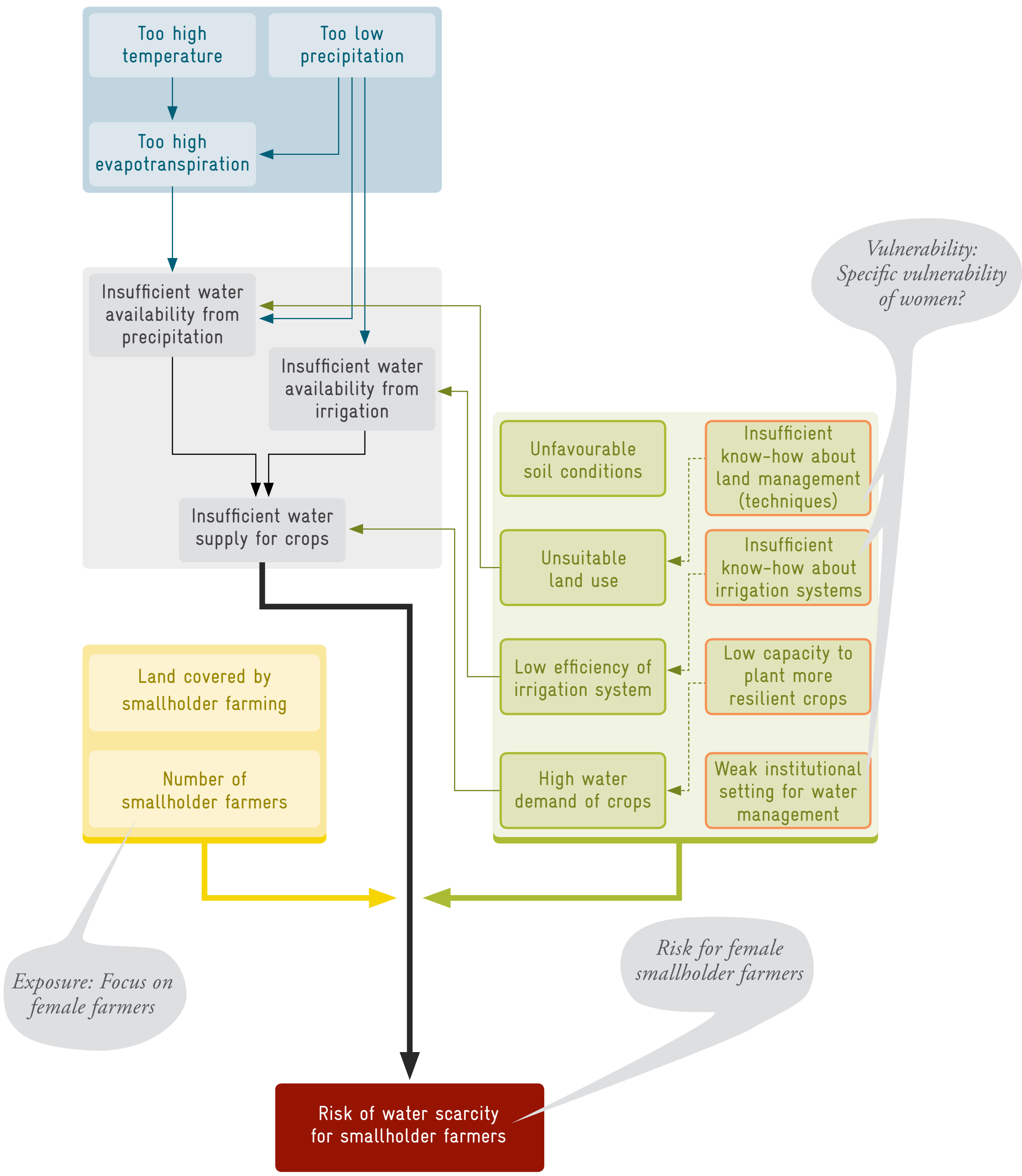


Figure 10 visualises the way in which key questions on how to determine the risk of women or disadvantaged groups can be included into the generic climate risk assessment chain.

Figure 11 shows how gender specific aspects of vulnerability and exposure create a specific risk for female smallholder farmers.

Figure 11: Gender specific impact chain



Module 3: Identifying and selecting indicators (☞p. 73)

What will you learn in this Module?

'This module will show you how to select indicators for your assessment. It provides you with the criteria for deciding which indicators are suitable for quantifying the factors determining the *risk* identified in Module 2'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- In accordance with the risk approach, each indicator should be named referring to a critical state. The guiding question here, too, should be: 'What are the major contributing factors leading to the risk?'
- Start with the indicators determining the hazard (including the climate signal), then continue with vulnerability and exposure.

Keep the criteria of good indicators as explained in the Vulnerability Sourcebook in mind:

'[A good indicator] is clear in its direction, i.e. an increase in value is unambiguously positive or negative with relation to the factor and *risk* component.' (☞p. 78)

Thus, try to phrase indicators so that they refer to a critical state or threshold. Use frequencies, numbers etc. to describe the potential occurrence of a hazard and indicate the direction toward a defined event. For the hazard factor 'heavy rain', for instance, this could be 'number of days with more than 50mm precipitation'. Table 2 (replacing Table 6 in the Vulnerability Sourcebook, ☞p. 76) provides examples of good indicators which meet this criterion.

The general steps in the Vulnerability Sourcebook remain valid. (☞p. 78–84)

Please keep in mind, however, that intermediate impacts are not a risk component by themselves but only represent an auxiliary tool to understand the cause-and-effect relationship leading to the risk. For this reason, they will not be

Table 2: Examples of factors and possible indicators

Risk component	Factor	Possible indicator
Hazard (Climate signal)	Heavy precipitation events	Number of days per year with rainfall greater than 50mm
Hazard (Direct physical impact)	Floods	Number of disastrous flood events in one year
Vulnerability (Sensitivity)	Land use prone to erosion	% of land cover classes with a high risk for erosion
	Steep slopes	% of slopes with a gradient greater than 30%
Vulnerability (Capacity)	Poverty	% of people living at less than US$ 2 per day
Exposure	Population density	Number of inhabitants per km^2
	Relevance of rainfed agriculture	% of rain-fed agricultural area within a district

included in the aggregation to the overall risk (see Module 7) and thus do not have to be represented by indicators.

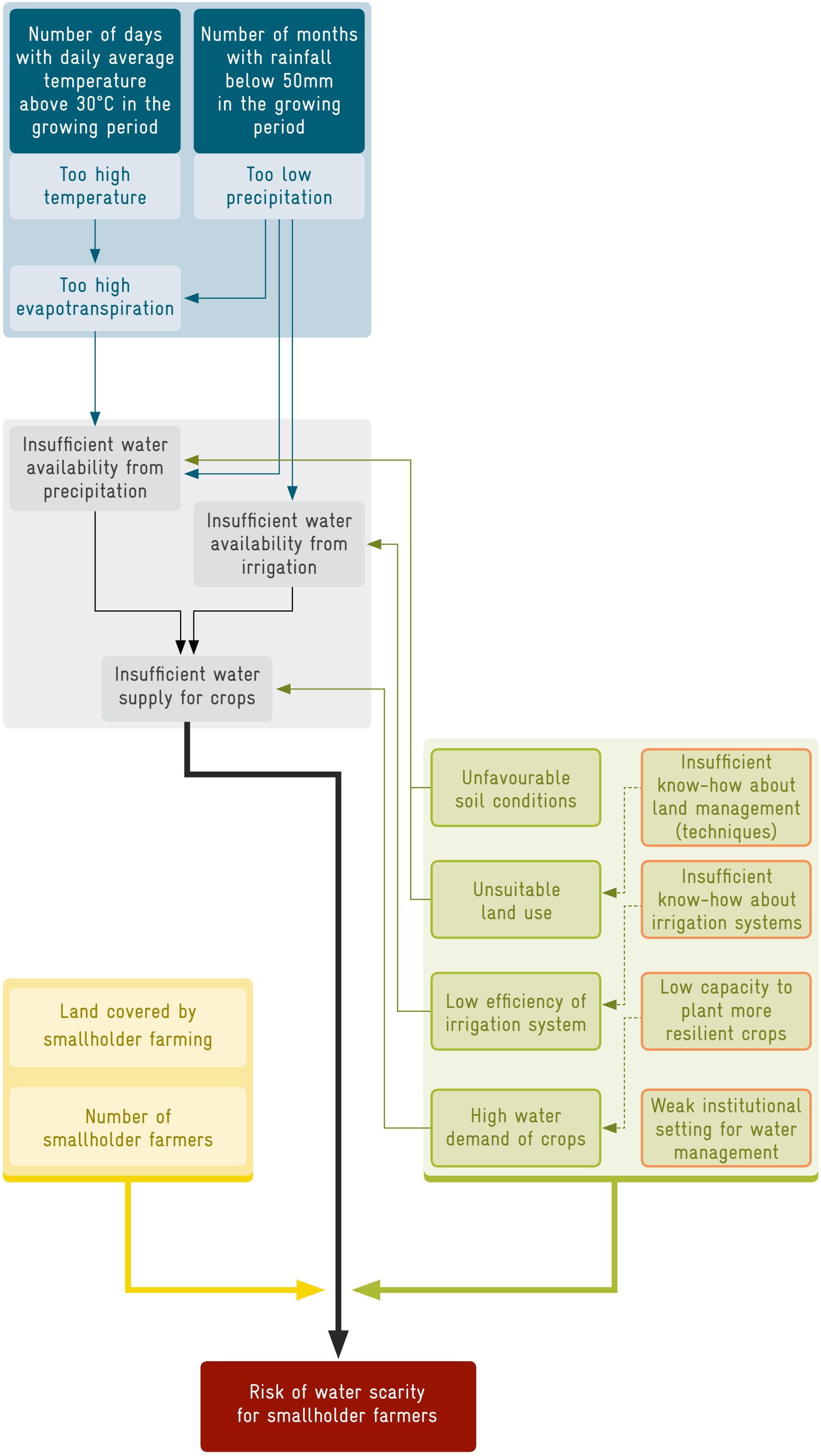
Step 1
Selecting indicators for hazards

Figure 12 illustrates indicators for two hazard factors.

TIP

In your impact chain you may find indicators for a particular hazard factor which also addresses and includes hazard factors above it in the chain. For example, an indicator measuring evapotranspiration will include the factor 'temperature' since this is a crucial element in evapotranspiration. A separate temperature indicator would therefore be redundant and can be left out.

Figure 12: Hazard indicators for the risk 'Risk of water scarcity for smallholder farmers'



Step 2
Selecting indicators for vulnerability and exposure

When selecting sensitivity and capacity indicators it is important to know the direction of each indicator: does a high value represent a high risk or a low risk?

When selecting indicators for the capacity component of vulnerability you need to consider both adaptive and coping capacities.

For exposure, useful indicators are typically numbers, densities or proportions.

Figure 13 shows the example impact chain with example exposure and vulnerability indicators.

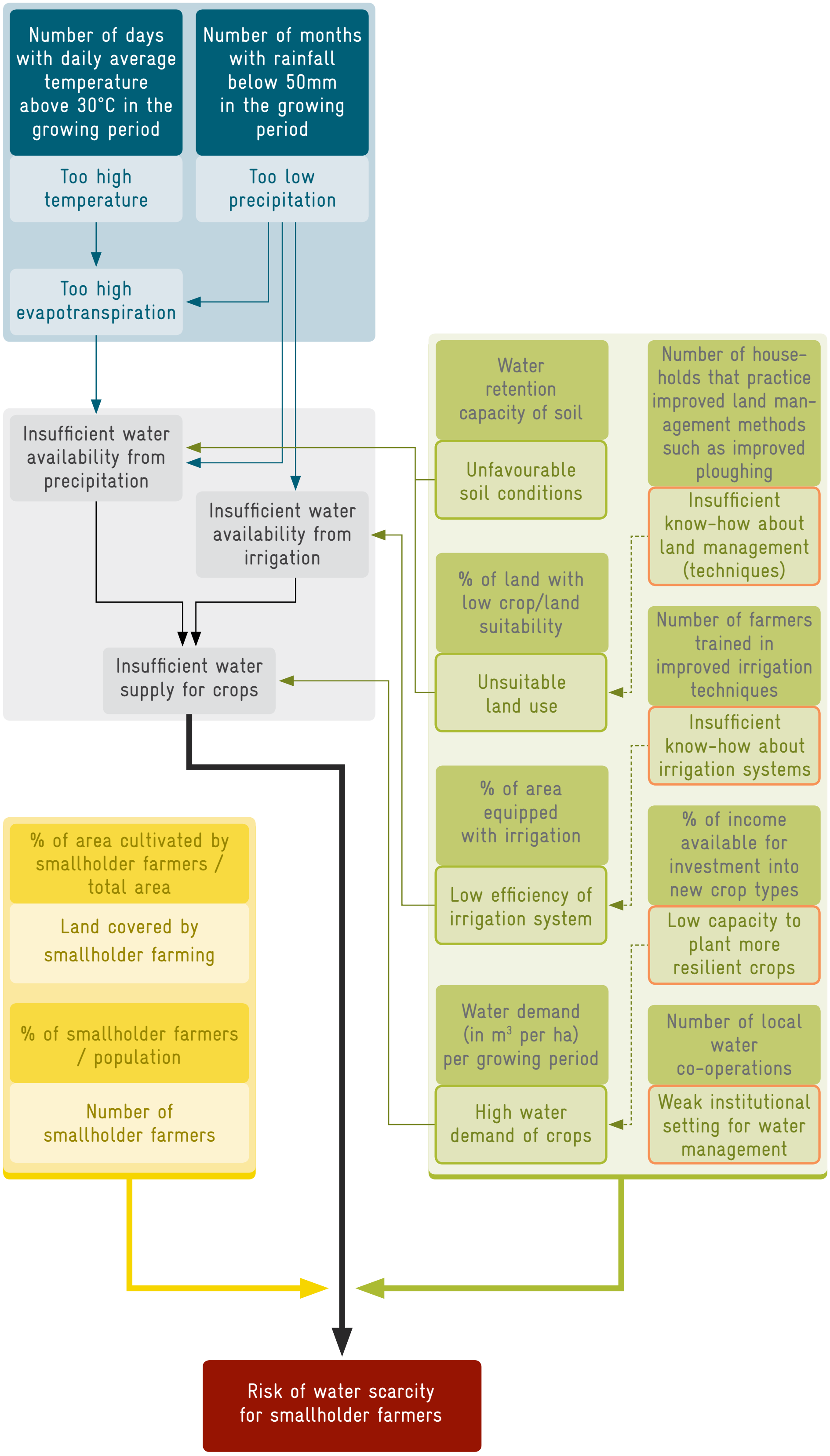
Step 3
Check if your indicators are specific enough

Check again, if your indicator is formulated towards the risk approach: does it have a clear direction and, if possible, an 'event character'?

Step 4
Create a list of provisional indicators for each factor

No major changes needed.

Figure 13: Vulnerability and exposure indicators for the risk 'Risk of water scarcity for smallholder farmers'



Module 4:
Data acquisition and management (☞ p. 87)

What will you learn in this Module?

'This module shows you how to acquire, review and prepare data for your ***risk*** assessment. This includes guidance on data collection, database construction and linking relevant data to your chosen indicators to allow analysis and modelling of ***risk***.'

MAJOR CHANGES
IN RELATION TO THE VULNERABILITY SOURCEBOOK

- There are no major changes in this module.
- The only changes are related to the use of the terms introduced in the revised Conceptual Framework (see chapter II).

Module 5: Normalisation of indicator data (☞p. 105)

What will you learn in this Module?

'This module will show you how to transfer (normalise) your different indicator data sets into unit-less values with a common scale from 0 (optimal, no improvement necessary or possible) to 1 (critical, system no longer functions).'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- There are no major changes in this chapter.
- The only changes are related to the use of the terms introduced in the revised Conceptual Framework (see chapter II) as well as the suggested description of different class values in line with the AR5 risk concept's focus on critical states.

For the risk approach and its focus on critical states it is important to stress that normalisation is not only a mathematical step to transform the data into a common, unit-less, scale ranging from 0 to 1. The following key message from the Vulnerability Sourcebook still holds true:

'A second important aspect of normalisation is to convert numbers into a meaning by evaluating the criticalness of an indicator value. In the Vulnerability Sourcebook, we define "0" as "optimal, no improvement necessary or possible" and "1" as "critical, for the functioning of the system". For instance, an annual precipitation of 600mm/year may be "0 – optimal", while a precipitation of 200 mm may be "1 – critical".' (☞p. 108)

In order to translate numbers into meanings, setting thresholds, as proposed in the Vulnerability Sourcebook on page 114, is still the preferred approach. For a proper assignment of data values to normative values, we propose to use the table on page 115 of the Vulnerability Sourcebook. See Table 3 as an example of how to assign a meaning to the normalised threshold values. As proposed in the Vulnerability Sourcebook (☞p. 118), you can use either a continuous scheme from 0 to 1 or a categorical scheme from 1 to 5. For this normative step, it is highly recommended to involve experts to agree on a suitable evaluation scheme.

Table 3: Class values and description

Metric class value within range of 0 to 1	Categorical class value within the range of 1 to 5	Description
0 – 0.2	1	optimal (no improvement necessary or possible)
› 0.2 – 0.4	2	rather positive
› 0.4 – 0.6	3	neutral
› 0.6 – 0.8	4	rather negative
› 0.8 – 1	5	critical (could lead to severe consequences)

Module 6:
Weighting and aggregating of indicators (☞p. 121)

What will you learn in this Module?

'This module explains the weighting of various indicators selected to describe the ***risk*** components ***hazard***, ***vulnerability*** and ***exposure***. Weighting is applied if some of the indicators are considered to have a greater influence on a ***risk*** component than others.

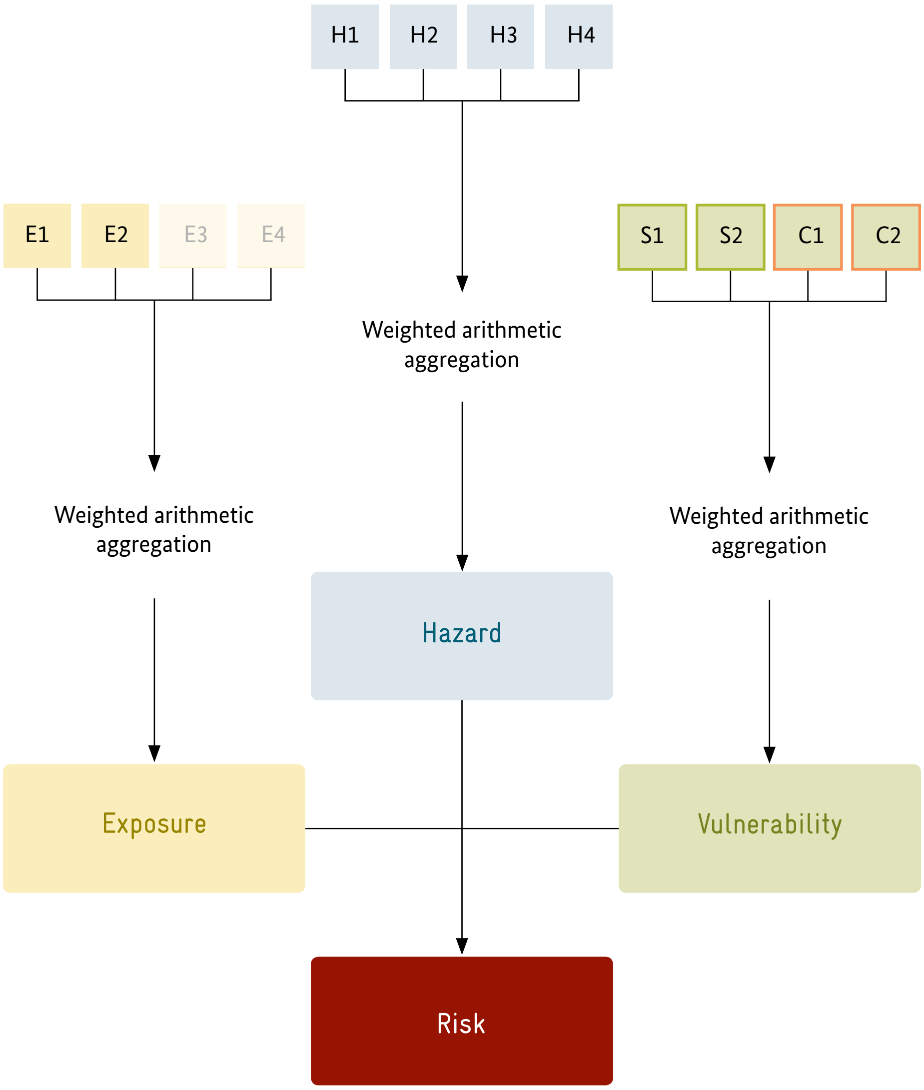
Module 6 also demonstrates how to aggregate individual indicators of the three ***risk*** components. Aggregation is used to combine the information from different indicators into a composite indicator representing a single ***risk*** component.'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

- There are no major changes in this module.
- The only changes are related to the use of the terms introduced in the revised Conceptual Framework (see chapter II).

To weight and aggregate indicators of the various components, you can apply the approach described in the Vulnerability Sourcebook. Figure 14 illustrates this approach, adapted to the AR5 risk concept. (☞p. 130)

Figure 14: Aggregating single factors to risk components



Module 7:
Aggregating risk components to risk (☞p. 133)

What will you learn in this Module?

'This module shows you how to aggregate the ***risk*** components ***hazard, vulnerability and exposure*** into a composite ***risk*** indicator. Finally, Module 7 outlines how to aggregate several ***sub-risks***, for instance of several economic sectors.'

MAJOR CHANGES
IN RELATION TO THE VULNERABILITY SOURCEBOOK

- Aggregating the three risk components to an overall risk is done in one step.

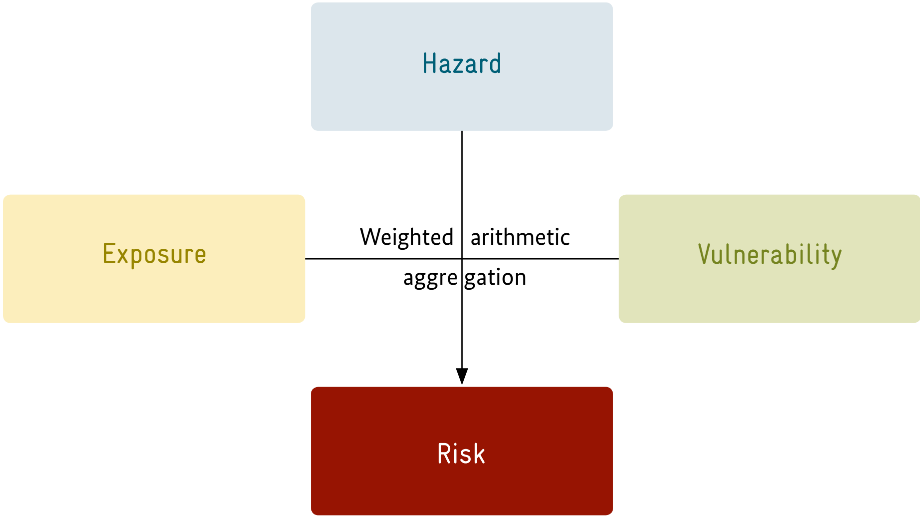
There is not one way only to aggregate the three risk components (hazard, vulnerability and exposure) to one composite risk indicator. We propose a one-step approach which is consistent with the IPCC AR5 risk concept. The advantage of this approach lies in its simplicity. Its disadvantage is a lack of control over combined effects, as well as the possible side effect that one component might compensate another one. Alternative approaches, which provide more control but are also more complex, are discussed in Expert Box 3.

As in the Vulnerability Sourcebook (☞p. 136), we propose to use the weighted arithmetic mean to combine the three components (see Formula 1 below and Figure 15).

Formula 1: Aggregation of risk components

$$\text{Risk} = \frac{(\text{Hazard} * w_H) + (\text{Vulnerability} * w_V) + (\text{Exposure} * w_E)}{w_H + w_V + w_E}$$

Figure 15: Aggregating risk components to a composite risk indicator



Results can be classified as follows (Table 4):

Table 4: Risk classes

Metric risk class value within range of 0 to 1	Risk class value within the range of 1 to 5	Description
0 – 0.2	1	very low
› 0.2 – 0.4	2	low
› 0.4 – 0.6	3	intermediate
› 0.6 – 0.8	4	high
› 0.8 – 1	5	very high

It is still possible to combine sub-risks into an overall risk. This may be useful depending on the context and the aim of your assessment. For an aggregation of sub-risks to an aggregated risk, we recommend to use the same formula (arithmetic mean) as proposed in the Vulnerability Sourcebook for the aggregation of sub-vulnerabilities. (☞ p. 140–141)

3 EXPERT

Alternative approaches for aggregation

A common approach in risk assessments is to combine risk factors with the help of an evaluation matrix. In a probabilistic risk assessment, the two aspects 'probability' and 'consequences' are usually combined in this way. The general advantage of a matrix approach over an arithmetic approach is more control over the aggregation result. The disadvantage is that it can only be applied for categorical values (five classes are common) and that you need to agree on the exact configuration of the matrix. For the IPCC AR5 risk concept, a matrix needs to combine the three risk components (hazard, vulnerability and exposure) as visualised in Figure 16. Here, risk is assessed by combining the degree of hazard (y-axis), vulnerability (lower x-axis) and exposure (upper x-axis) to a risk class (from 1 = very low to 5 = very high).

Figure 16: Example of an evaluation matrix for combining the three components of risk

Vulnerability	1					2					3					4					5				
Hazard \ Exposure	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5	II	III	III	IV	IV	III	III	IV	IV	V	III	IV	IV	V	V	IV	IV	V	V	V	IV	V	V	V	V
4	II	II	III	III	IV	II	III	III	IV	IV	III	III	IV	IV	IV	III	III	IV	IV	V	IV	V	V	V	V
3	II	II	II	III	III	II	II	III	III	IV	II	II	II	IV	IV	II	III	III	IV	IV	III	IV	IV	IV	V
2	I	II	II	II	II	II	II	II	II	III	II	II	II	III	III	II	II	III	III	IV	II	III	III	IV	V
1	I	I	I	I	II	I	I	I	II	II	I	I	II	II	II	I	II	II	II	III	II	II	III	III	III

Risk: I very low; II low; III intermediate; IV high; V very high

Module 8: Presenting the outcomes of your risk assessment (☞p. 143)

What will you learn in this Module?

'This module will show you how best to summarise and present the findings of your assessment.

For this task, you should keep both your objective and your target audience firmly in mind and ask yourself: What was the goal of your *risk* assessment? Which outcomes are vital for subsequent tasks such as adaptation planning or strategy development? What is the best way to present your result to different target audiences? And who should present them?'

MAJOR CHANGES IN RELATION TO THE VULNERABILITY SOURCEBOOK

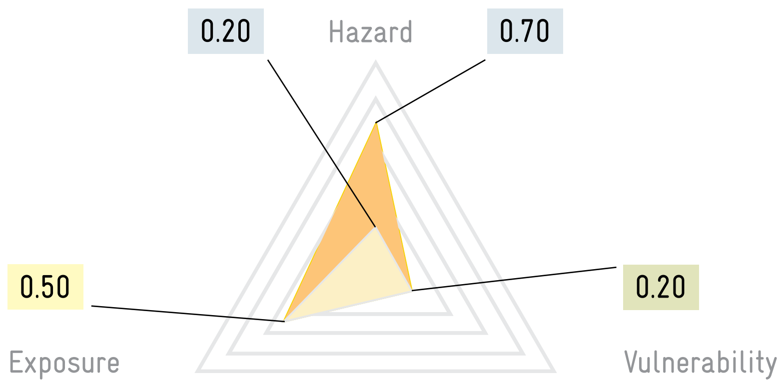
- There are no major changes in this module.
- In addition to maps, we suggest to consider the use of tables and radar diagrams to visualise the results, since they communicate in one picture what each component is contributing to the risk.

The results for the single components of risk, i.e. hazard, vulnerability and exposure, are as important as the overall output, the risk. The presentation of the outcomes should therefore ideally include the results for the three components as well as the composite risk indicator. Consider the examples shown in the Vulnerability Sourcebook (☞p. 152). Figure 17 presents a hypothetical example comparing a specific risk in two communities for two reference time periods in a tabular form and in the form of a radar diagram.

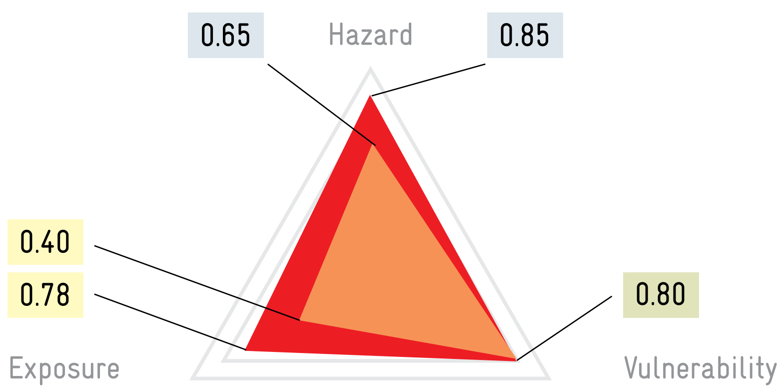
Figure 17: Example of an option to present risk and its components in a tabular form and in form of radar diagrams

		Hazard	Exposure	Vulnerability	Risk	Risk Level
Community A	Today	0.20	0.50	0.20	0.30	low
	2050	0.70	0.50	0.20	0.47	intermediate
Community B	Today	0.65	0.40	0.80	0.62	high
	2050	0.85	0.78	0.80	0.81	very high

Community A – risk level: Today 2050



Community B – risk level: Today 2050



IV.

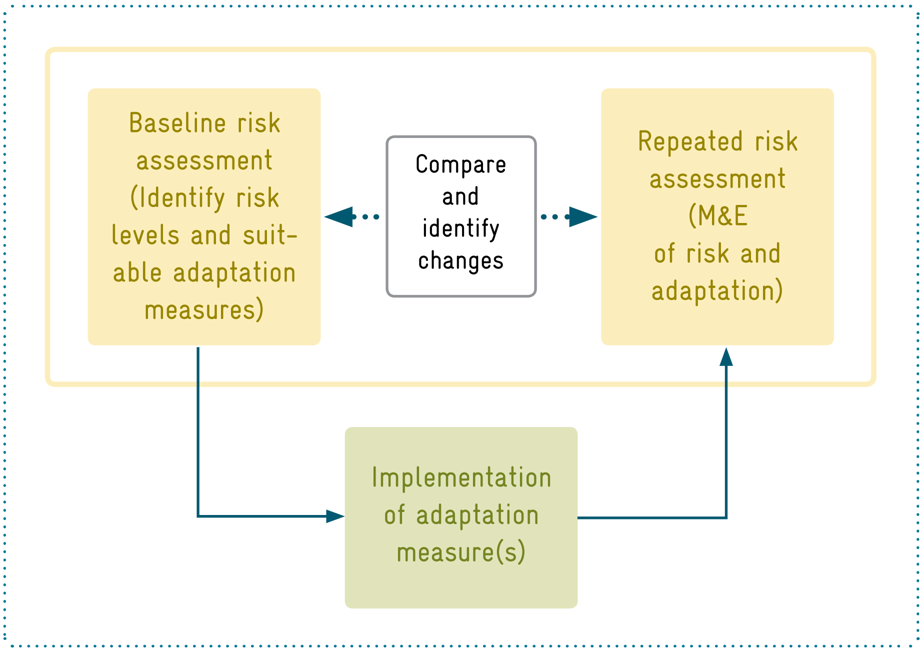
How to use your risk assessment for monitoring and evaluation (☞p. 155)

The Vulnerability Sourcebook's approach to monitoring and evaluation (M&E) is to **repeat** a vulnerability assessment once or several times at defined intervals. The results of the repeated vulnerability assessments are then compared to the initial (=baseline) assessment to identify changes in overall vulnerability, its components or key indicators. Chapter IV of the Vulnerability Sourcebook provides detailed information about this process. (☞p. 155–163)

This general approach also remains valid for the application of the AR5 risk concept and cannot only be used for the M&E of climate risk but also for the M&E of adaptation (see Figure 18). This is based on the **underlying assumption** that every adaptation effort (be it a specific adaptation measure, plan or policy) aims at decreasing vulnerability (through decreasing sensitivity or increasing capacity) or – in very specific circumstances – decreasing exposure.

Chapter IV of the Vulnerability Sourcebook provides detailed information about how exactly to use vulnerability assessments for the purpose of M&E. In addition to these considerations, it is important to keep in mind that applying the AR5 risk concept might not be a sound approach if you have already conducted a vulnerability assessment on the same topic based on the AR4 definitions and would like to use your second assessment for M&E purposes. Therefore, we recommend to **carefully reflect on the application of both concepts** in the given setting prior to making a decision and to involve technical experts in this process advising on the possibilities and limitations of each approach.

Figure 18: The Risk Supplement's approach to M&E: repeated risk assessments



V. Conclusion and outlook

By introducing its new concept of climate risk, the IPCC WGII AR5 report provided a fresh perspective to the climate change debate. However, as described in the beginning, the IPCC did not provide detailed directions or guidelines on how to operationalise the concept for a climate risk assessment.

Systematically analysing and presenting its implications for the methodology of the Vulnerability Sourcebook, this Risk Supplement constitutes a major first step towards a sound application of the AR5 risk concept in practice. While many key questions could be answered in the development of this publication, others still remain open, and new ones have emerged. The Risk Supplement should therefore not be regarded as a rigid and final methodological document. It rather constitutes a sound practical guidance for risk assessments that also seeks to stimulate the on-going discussion between the CCA and DRR communities.

During the development of the Risk Supplement, several researchers and practitioners were consulted and the methodology was applied to real-world examples. Nonetheless, given the highly diverse applications and contexts of risk assessments, we warmly welcome any comments and lessons learned from applying the AR5 risk concept and specifically the Risk Supplement in practice. This feedback will enable us to continuously improve our approach and tailor it to the countries' needs. Please write to adaptation@giz.de.

Thank you!

Annex: practice examples

In order to test and refine the application of the Vulnerability Sourcebook's approach to the AR5 concept, project implementing partners and experts discussed two practice examples on 1) forage scarcity in Algeria and 2) rain-fed lowland rice farming in Thailand during a two-day workshop. As a result, they developed the following simplified impact chains for the respective examples.

Forage scarcity in Algeria

This practice example is linked to a vulnerability assessment carried out on the national level for Algeria. It aims to assess the climate risk of different sectors, including the agriculture sector. The simplified impact chain below developed as part of the Risk Supplement depicts the risk of forage scarcity. See Figure 19.

Rain-fed lowland rice farming in Thailand

In the case of Thailand, both an overarching risk assessment and several sectoral climate risk assessments were conducted. The simplified impact chain below developed as part of the Risk Supplement focuses on the agricultural sector and in particular the risk of low productivity of rain-fed lowland rice. See Figure 20.

Figure 19: Forage scarcity in Algeria

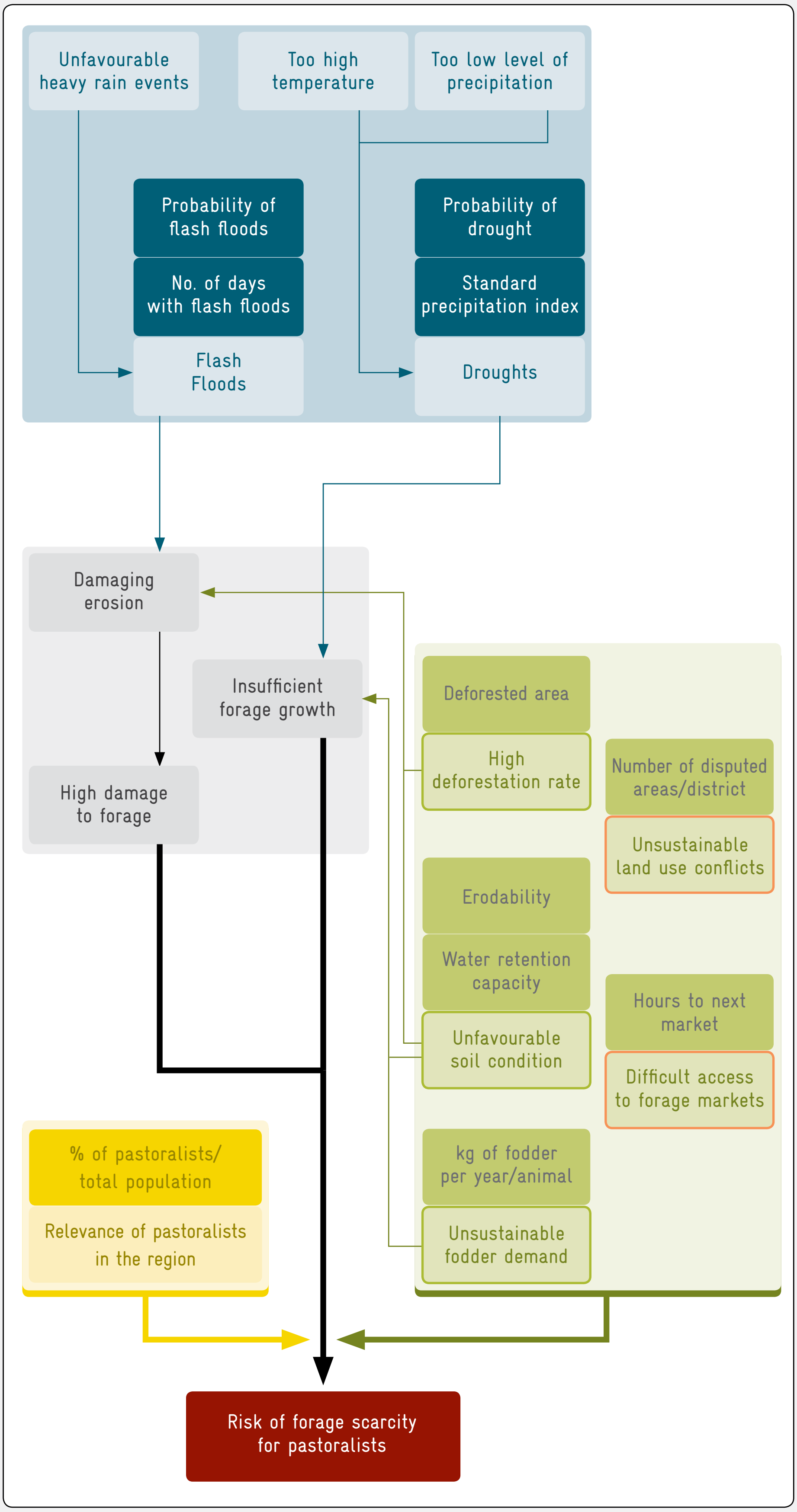
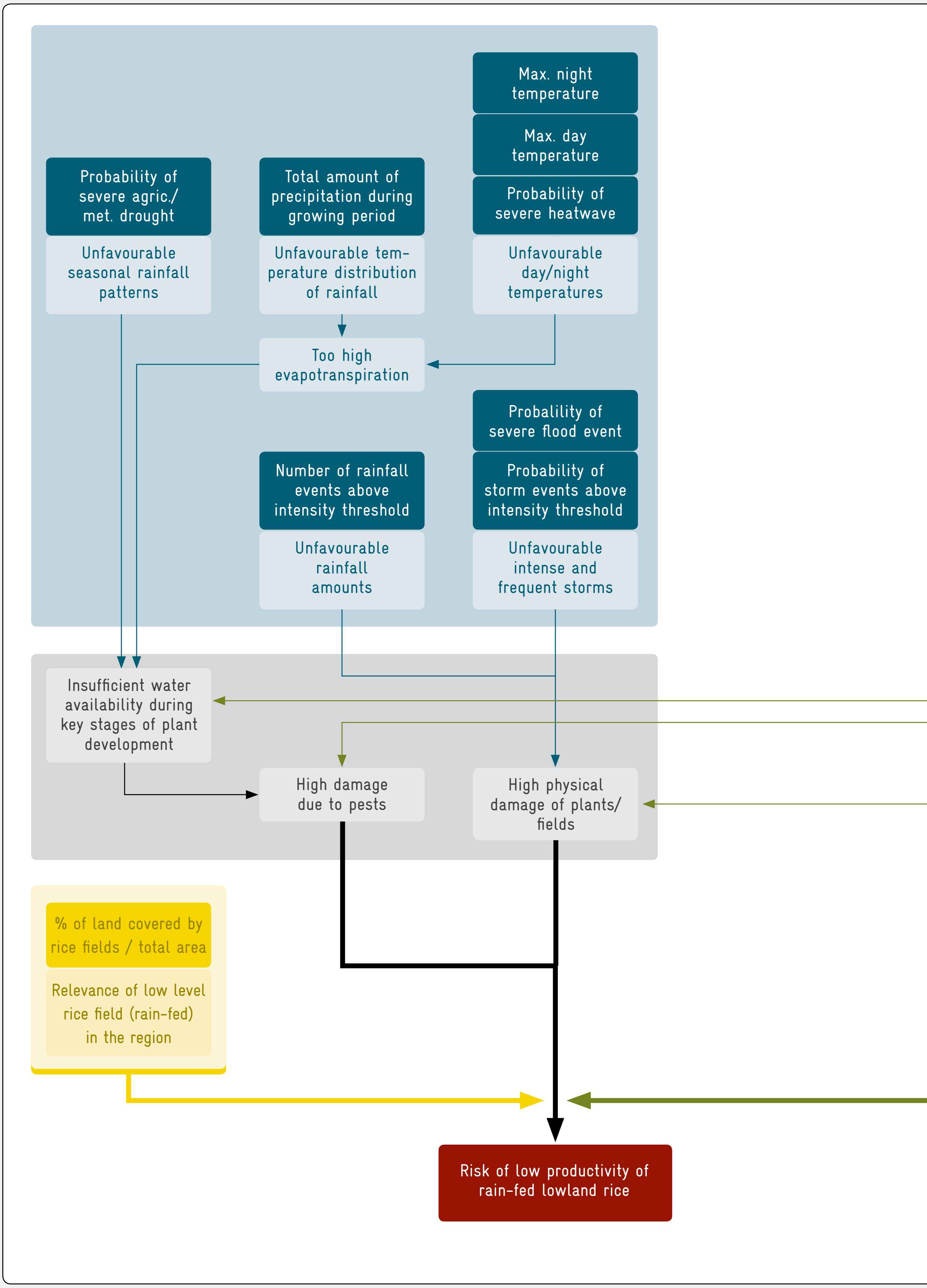
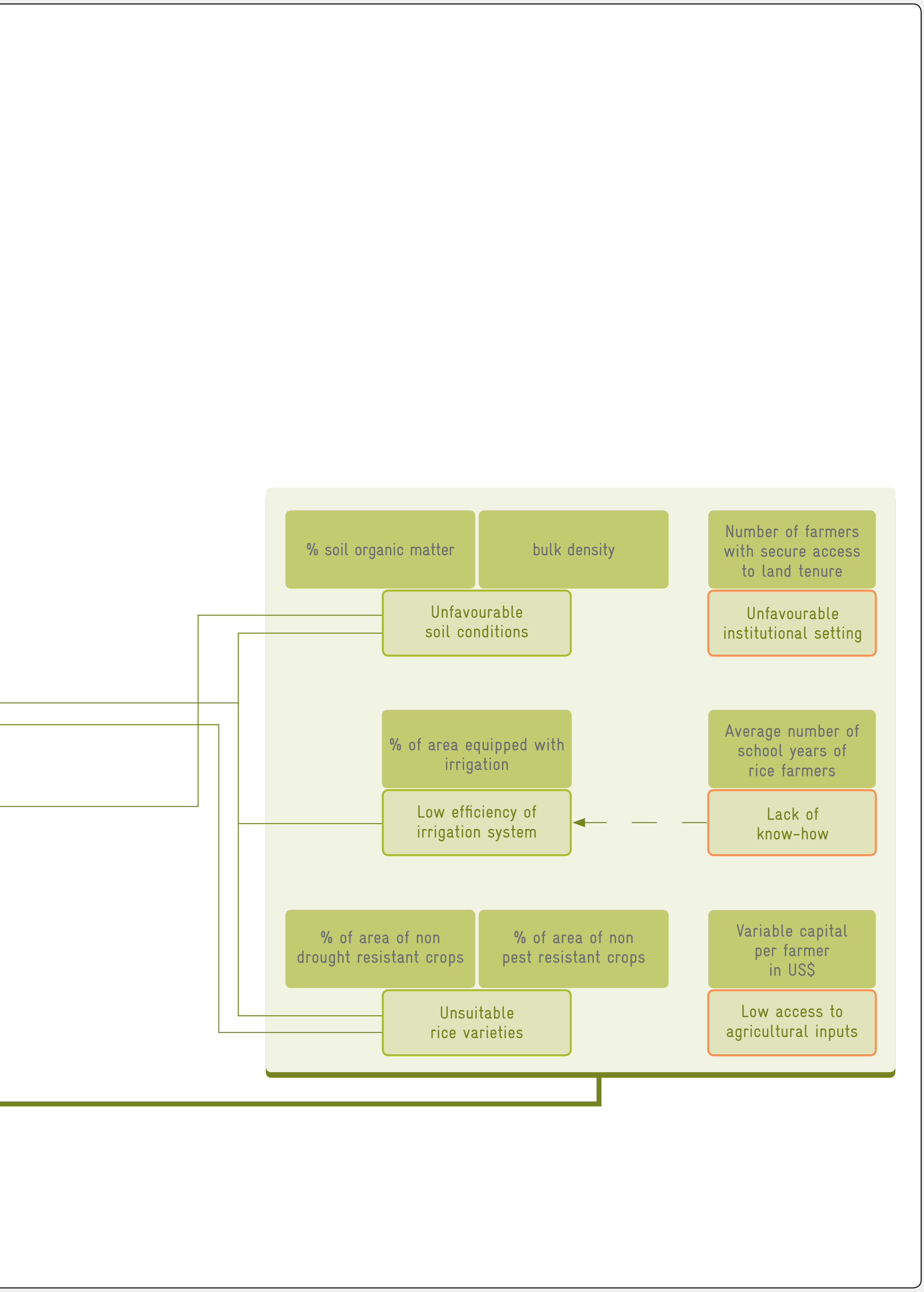


Figure 20: Rain-fed lowland rice farming in Thailand




% soil organic matter
bulk density
Number of farmers with secure access to land tenure
Unfavourable soil conditions
Unfavourable institutional setting
% of area equipped with irrigation
Average number of school years of rice farmers
Low efficiency of irrigation system
Lack of know-how
% of area of non drought resistant crops
% of area of non pest resistant crops
Variable capital per farmer in US$
Unsuitable rice varieties
Low access to agricultural inputs

Literature

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