HI-AWARE Working Paper 10

HI-AWARE
Himalayan Adaptation, Water and Resilience Research

CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

Critical Climate-Stress Moments and their Assessment in the Hindu Kush Himalaya

Conceptualization and assessment methods

Consortium members

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About HI-AWARE Working Papers

This series is based on the work of the Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) with financial support from the UK Government's Department for International Development and the International Development Research Centre, Ottawa, Canada. CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The programme supports collaborative research to inform adaptation policy and practice.

HI-AWARE aims to enhance the adaptive capacities and climate resilience of the poor and vulnerable women, men, and children living in the mountains and flood plains of the Indus, Ganges, and Brahmaputra river basins. It seeks to do this through the development of robust evidence to inform people-centred and gender-inclusive climate change adaptation policies and practices for improving livelihoods.

The HI-AWARE consortium is led by the International Centre for Integrated Mountain Development (ICIMOD). The other consortium members are the Bangladesh Centre for Advanced Studies (BCAS), The Energy and Resources Institute (TERI), the Climate Change, Alternative Energy, and Water Resources Institute of the Pakistan Agricultural Research Council (CAEWRI-PARC) and Alterra-Wageningen University and Research Centre (Alterra-WUR). For more details see www.hi-aware.org.

Titles in this series are intended to share initial findings and lessons from research studies commissioned by HI-AWARE. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the HI-AWARE consortium, they have only undergone an internal review process.

Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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Critical Climate-Stress Moments and their Assessment in the Hindu Kush Himalaya

Conceptualization and Assessment Methods

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Contents

Executive Summary

This document discusses and provides a rationale behind the concept of 'critical climate-stress moments' in the context of weather variability and climate change (hereafter: critical moments). It also describes a 'critical-moments assessment' methodology. It further serves as a guide to implement a critical-moments assessment in HI-AWARE study areas. Users of this guide would include HI-AWARE consortium members and partners, but it will also be of interest to others working in the field of climate-change adaptation and decision-making. Sections up to 3.3 target a broad audience. After section 3.3 the report is specific to the HI-AWARE initiative. The detailed description of methods and research questions are likely to be of use to HI-AWARE partners mainly.

'Critical climate-stress moments' are defined as those moments when households, communities, and the livelihood systems they depend on, are especially vulnerable to climate and weather-related risks and hazards. These include events at different spatial and temporal scales (such as heat waves, cold spells, floods, droughts, and hail. In other words, critical moments are a combination of (context-) specific present and past conditions, in which climate stresses are particularly likely to be risky and adverse to a particular household or community and the livelihood system they depend on. A 'moment' refers to a time period shorter than a year. A 'moment' may be days, weeks, or even months.

A critical-moments assessment aims to support community members and adaptation planners in the development of more tailored, climate-change adaptation responses by identifying:

1. The specific climate conditions under which a critical moment occurs: how are such occurrences perceived by those experiencing them? What are their temporal and spatial scales, and how do these relate to climate trends? All this as analysed in the HI-AWARE Research Component 1 (RC1) on biophysical drivers and conditions leading to vulnerability and climate change effect. The information on weather and climate variability, climate change, and specific thresholds associated with critical moments can be used to tailor the analysis of climate-change models and to inform, tune, and interpret the outputs of the hydrological effect model.

2. The socio-economic and political drivers of vulnerabilities giving rise to critical moments, as experienced and perceived by the most vulnerable and by a range of stakeholders at local level. This analysis is conducted in close collaboration with HI-AWARE Research Component 2 (RC2) on socio-economic, governance, and gender-based drivers and conditions leading to vulnerability.

3. The effectiveness of current coping strategies to overcome critical moments.

Chapter 1 introduces the objectives and target groups of the guide. Chapter 2 discusses the background and rationale of critical moments. The use of critical moments is introduced as an approach to vulnerability, aiming at overcoming some bottlenecks of recent research, particularly when it comes to bridging science and policy-making. Chapter 3 highlights the role of critical moments assessment in HI-AWARE and presents the methodology to implement a critical-moments assessment in HI-AWARE study areas.

The methodology has been developed on the basis of key research questions and a set of sub-questions, which are to be addressed in all study areas.

The key research questions of a critical-moments assessment are:

At what times in the year are people in the HKH region particularly vulnerable to climate hazards and weather conditions with respect to achieving their livelihood goals? What climatic conditions and other biophysical and socio-economic factors cause these periods of stress?

For operationalization, these key questions may be subdivided into the following research sub-questions:

1. At what times in the year are people's lives most affected by climate hazards? How do these periods of stresses vary across different social groups and socio-political contexts as also within households?
2. What specific climatic conditions and other drivers (such as biophysical and socio-economic circumstances) cause these periods of stress? How are such conditions experienced by the most vulnerable?
3. What is the effect of these periods of climatic stress on people's livelihoods? How does the effect vary across different social and ethnic groups and within households?
4. What strategies have people adopted to cope with critical moments? To what extent do people perceive these strategies as being effective? What would they like to do, ideally?
5. How are critical moments likely to evolve in future climate-change scenarios?

These sub-questions guide the selection of research methods, tools, and activities. For each research sub-question, examples of guiding questions and methods that could be used to answer these questions, are described in Chapter 3 and elaborated in Annex 1. Each research sub-question will be further operationalized and tailored to the specific conditions of a study area.

Chapter 4 gives a future outlook and discusses forthcoming work to put the critical-moments assessment into practice. The chapter underlines the need for monitoring the fieldwork at critical moments. Learning about the concept of critical moments is crucial to define its characteristics further and to draw conclusions about its added value to existing vulnerability assessments and the extent to which it supports adaptation decision-making better.

1. Introduction: Why Look at 'Critical Moments'?

This HI-AWARE paper discusses and provides a rationale behind the concept of critical moments. It also describes a critical-moments assessment methodology to add value to vulnerability assessments, by specifically providing a different analysis to understand exposure and sensitivity and by evaluating needs for adapting to future climate change and its variability. Critical moments form part of the work under Research Component (RC) 4 of HI-AWARE. This RC aims to deepen understanding of people's vulnerability, particularly the exposure and sensitivity in climate-stress moments, to help them with tailor-made adaptation strategies.

So far, according to the IPCC dominant framework (IPCC, 2007; IPCC, 2014), the triad of Vulnerability, Adaptive Capacity, and Resilience has guided most of the research revolving around adaptation. In particular, policy-oriented science in the field of adaptation to climate change usually starts with vulnerability assessments that offer a 'snapshot' of the present situation at a given scale, typically at local level. These vulnerability studies tend to focus on 'what' (like infrastructures, sectors) and 'who' will be most vulnerable to climate change under different climate scenarios. Such analysis is then followed by an identification and assessment of on-going and potential adaptive measures at different temporal scales – immediate, mid-term, and long-term. Relatively less attention is given to the 'when' question: when are people particularly vulnerable to climate change. The concept of critical moments is designed as an attempt to overcome some of the bottlenecks that vulnerability research has encountered over the last years. This has been especially so when it comes to articulating the temporal dynamism and the complexities associated with vulnerability to weather and climate risks.

In addition, a critical-moments perspective addresses the challenge of better linking vulnerability assessments with adaptation policy. The concept of critical moments has emerged from an acknowledgement that the contribution of vulnerability analyses to policy has been peripheral at best.

Literature has identified broadly three sets of reasons why vulnerability assessments so far have largely failed in bridging the gap between science and policy. Mustafa et al. (2011) mentioned three shortcomings. First, there is the question of spatial scale. Policy-makers are generally concerned with aggregate populations at meso and macro-national scales, while vulnerability research is interested in household and community differentiation at micro scale.

Second, there is the issue of the need for a context-specific or generalized (one-that-fits-all) solution. Most policy-makers need simple, generalized, actionable, and preferably quantitative information as inputs into the policy process (Dewulf et al., 2005). On their part, the work of most vulnerability analysts has resulted in spatially and temporally nuanced, complex, and usually qualitative information directed to understanding root causes rather than prescribing actions. The third issue deals with what type of change is looked for, incremental or transformative adaptation. Many vulnerability analysts are concerned with systematic change and fundamental inequities in the prevailing political and economic structures that policy-makers may often represent and reproduce (Wisner et al., 2004).

Increased understanding about stress moments of vulnerable households in terms of timing and context-specific climatic, socio-economic, and biophysical causes may improve tailoring and prioritization of adaptation measures to increase resilience to climate variability and climate change. In particular, it is crucial to address the issue of temporal scales in vulnerability research supporting immediate, mid-term and long-term adaptation.

Inspired by these notions, HI-AWARE aims to develop present vulnerability approaches by incorporating concepts such as critical moments. HI-AWARE covers three main time-specific axes. RC4 looks at a current vulnerability situation and puts it into a dynamic relation with 1) the past, as it is driven by its study of root causes and structural factors leading to the present vulnerability; and 2) the future, which is addressed by looking into adaptation turning points and pathways.

'Critical climate-stress moments' are defined as those moments when households, communities, and the livelihood systems they depend on, are especially vulnerable to climate and weather-related risks and hazards. These include events at different spatial and temporal scales such as heat waves, cold spells, floods, droughts, and hail. In other words, critical moments are a combination of (context-) specific present and past conditions, in which climate-stresses are particularly likely to be risky and adverse to a particular household or community and the system they depend on. A 'moment' refers to a time period shorter than a year. A 'moment' may be days, weeks or even months, depending on the driver.

The concept of 'critical moments' and a critical-moments assessment methodology are discussed in the next chapters.

Chapter 2 presents a background and rationale for critical moments as a concept. By discussing commonalities and differences in recent thinking about vulnerability, vulnerability assessment, and adaptation decision-making, we formalize and solidify our approach to collect information for people-centred and gender-responsive policies and practices to enhance adaptive capacities and climate resilience of people in the Hindu Kush Himalayan region. Chapter 3 discusses a research methodology to implement a critical-moments assessment. The methodology has been developed on the basis of key research questions and research sub-questions to understand and address critical moments better. The chapter describes research activities and the people who these activities will be carried out with to put a critical moment assessment into practice. Chapter 3 also presents a basket of tools from which a user may select the most appropriate to get answers to research sub-questions. Chapter 4 gives a future outlook and discusses forthcoming work. It also gives suggestions for learning from experiences with the use of 'critical moments'.

Annex 1 outlines a more detailed description of tools for a critical-moments assessment. Annex 2 lists the elements of a critical-moments assessment report as one of the tangible outcomes of a critical-moments assessment.

Users of this guide include HI-AWARE consortium members and partners, but the document will also be of interest to others working in the field of climate-change adaptation and decision-making. Sections up to 3.3 target a broad audience. After section 3.3 the report is specific to the HI-AWARE initiative. The detailed description of methods and research questions are likely to be of use to HI-AWARE partners mainly. The paper encourages standardization of the use of a critical-moments assessment. In that way it may facilitate practical applicability as much as scientific rigour.

2. The Concept of Critical Moments: Theoretical Base and Challenges

2.1. Context Analysis: Vulnerability and Vulnerability Assessments

To further our understanding of vulnerability and adaptive responses, we found a growing number of literature reviews comparing frameworks, concepts, and the operationalization of vulnerability (Füssel, 2007; O'Brien et al., 2007; Carter and Mäkinen, 2011; Morgan, 2011; Delaney et al., 2014).

The most often reported and fully defined frameworks of vulnerability are found in IPCC, 'Patterns of Smallholder Vulnerability' and 'Vulnerability as Expected Poverty' (Delaney et al., 2014). Comparative analysis has found substantial heterogeneity in frameworks, concepts, and operationalization (Füssel ,2007), making it difficult to identify climate vulnerability indicators and determinants with a robust empirical support (Hinkel, 2011).

Different fields of research have developed their own approaches to vulnerability, often heavily influenced by their topical and disciplinary foci (Füssel, 2007; O'Brien et al., 2007; Gaillard, 2010; Sumner and Mallett, 2013). This has created multiple frameworks for understanding vulnerability to climate change and its subsequent classification (Luers, 2005; Adger, 2006; Gallopin, 2006; Vincent, 2007).

A reductionist-exposure perspective has been abandoned for hazards research. The latter has come a long way from its initial focus on engineering structural interventions to controlling the physical risk of hazards. Since the 1970s, research on vulnerability has broadened the temporal and spatial scales of analysis of disasters. In this process, emphasis shifted to including deeply embedded social characteristics (Sen, 1981; Turner et al., 2003; Wisner et al., 2004) and recognizing individual and collective perceptions of risk, and the ways in which those perceptions affect hazard-related behaviour. Work by Hewitt (1983) and Blaikie and Brookfield (1987) changed the direction of hazards research, emphasizing the influence of social structural factors on differential access to resources, and hence on differential susceptibility to environmental extremes. Political ecologists were more concerned with issues of class, type of economic development, international dependency, gender, and deeper social structures, in explaining the causal chain of vulnerability (Watts and Bohle, 1993; Wisner, 1993; Blaikie et al., 1994; Enarson and Morrow, 1998; Mustafa, 1998).

Acknowledging how risk is perceived and handled by those experiencing it, the critical- moments concept aims at building on and improving what Tschakert (2007) calls 'second- generation vulnerability assessment'. The critical-moments assessment moves forward from engineering-dominated, effect-driven sectoral adaptation research (supported by most programmes). The critical-moments assessment also shows the flaws of such a sectoral approach by highlighting the need to recognize non-climatic factors that (re)produce vulnerability in the first place. These include, among others, poverty, control over assets, access to resources, institutional and social networks, education, gender, and ethnicity. (Pelling and High, 2005; Paavola and Adger, 2006; Reid and Vogel, 2006; Mustafa et al., 2010).

Accordingly, in HI-AWARE, we understand 'vulnerability' to mean susceptibility to suffer damage from environmental hazards due to one's social situation and relative inability to recover from that damage (Cutter et al., 2003; Adger, 2006; Sumner and Mallett, 2013). Vulnerability is embedded in everyday power relations and political economy, shaped by social capital (Pelling and High, 2005; Turner, 2016), gender (Sultana, 2014; Morchain et al., 2015), and ethnicity (Bolin, 2007) – among other factors. In this sense, vulnerability describes a set of conditions of people that are derived from historical and contemporary cultural, social, environmental, political, and economic contexts.

The critical-moments perspective works with the acknowledgement that climate change is an 'elusive hazard' (Kates, 1985) and 'cumulative, diffuse, slow-acting and insidious' (Hood et al., 1992). Climate-change effects are cumulative and compounding, incremental, unstable, and dynamic through relatively long historical time-scales over large spatial scales (IPCC, 2012). 'Effects occur abruptly, nonlinearly and manifest at local scales' (Wrathall et al., 2015). Since climate change is a process, and vulnerability assessments are a snapshot of the present, past, and future, they should be comprehensive to see dynamism at different temporal and spatial scales.

Another way to appreciate different perspectives on vulnerability is to distinguish between a scientific framing and a human-security framing, labelled as 'outcome vulnerability' and 'contextual vulnerability' respectively (O'Brien et al., 2007).

A third, often referred to categorization is to differentiate between 'top-down assessments' (also called 'predict-then-act', derived from climate-effect science, typically using a modelling approach) and 'bottom up assessments' (starting from a decision context and contextual factors adding to vulnerability) (Dessai and Hulme, 2004; Dessai et al., 2009; Ranger et al., 2010; Brown, 2011).

Driven by the purpose and experience of the involved analysts, vulnerability assessments may also be seen to fall into two broad classes:

- Based on long-term climatic data analysis and projection of vulnerability (typical for long- term planning and international climate negotiations); and
- Based on local analysis and characteristics, trends and current climate variability, and climate effects.

There has been a blending of the above perspectives on vulnerability, in which an assessment is based on both aspects, that of a hazard as well as the social structures that respond. Yet, the distinctions listed here perpetuate in many vulnerability assessments. Vulnerable groups are not only at risk because they are exposed to a hazard but also as a result of marginality, of everyday patterns of social interaction and organization, and access to resources. That is to say, the effects of a disaster on any particular household result from a complex set of drivers and interacting conditions (Gerlitz et al., 2015; HI-AWARE, 2016).

2.2. Challenges for Vulnerability Assessments to Support Climate Change Adaptation

With climate change affecting livelihoods, the need for adaptation has become increasingly recognized. Affected and concerned people ask for information about whether current practices are able to cope with climate change and increased climate variability, or whether alternative strategies are needed. Although the amount of information available on climate change effects, vulnerability, and adaptation options, is increasing, a number of challenges have emerged for the uptake and practical use of this information.

These challenges include:

- To tailor information to the realities of people (Turner, 2016). There is a gap in literature on micro-level effects of climate-change associated risks on household assets, livelihoods, and well-being. That is, problem identification and interventions tend to focus on direct risks and direct effects of climate change with insufficient attention to indirect risks and effects at household level (Heltberg, Siegel, and Jorgensen, 2009);
- To draw attention to the drivers of vulnerability, including taking into account the effects of other on-going global changes (O'Brien et al., 2004) and drivers of change in HI-AWARE sites, such as globalization, urbanization, modernization, technological, and demographic changes as well as post-colonial relations. Many vulnerability approaches are index-based and look at vulnerability as a state of being to be made visible through the compilation of static indicators, missing an analysis of people's agency in dealing with climate stresses. This is significant because this approach looks at rural society as an analytical object that awaits external intervention, whether by policy or technology transfer, rather than viewing actors in rural society as dynamic partners to engage with. Further, using such static household-level analyses as a

foundation for interventions risks directing attention to addressing symptoms (indicators) of vulnerability rather than addressing root causes (drivers) (Delaney et al., 2014)

- To address vulnerabilities by specific adaptation options rather than by a more general list of options. Most work on adaptation options and coping strategies[1] is generalized and focused on direct effects of hazards and risks associated with climate change scenarios. The interaction of the hazards and the factors, which determine vulnerability has been less studied (Scherr, Shames, and Friedman, 2012). The complexity of determining the vulnerability context of communities often makes intervention and prioritization very difficult (Adger 2006). The needs and priorities of people and communities in developing countries in particular are numerous. Identifying which are urgent and related to climate-change adaptation is necessary to avoid fragmentation and diversion of climate-change resources for general development-oriented activities due to a lack of clarity. Yet, it also carries the risk of leading to conflict, delays in implementation, and a lack of strategic focus (Regmi et al., 2015) ;
- To assess the long-term trends in temperature and rainfall, seasonal variability, and frequency of extremes as part of climate change effects (Wassmann et al., 2009); and
- To bring together the world of models, people's realities, and policy decisions and to match specific local vulnerabilities with parameters chosen in climate projections (Lempert, 2013; Wise et al., 2014)

Most of past social vulnerability research has been based on qualitative research presented as narratives to capture the nuances, complexities, and inter-linkages of factors contributing to differential patterns of damage (Cutter, Mitchell, and Scott, 2000; Halvorson, 2003; Collins and Bolin, 2009). In the policy world, however, it is very rare for textual material to be the basis for action (Aalst, Cannon, and Burton, 2008). Most decision-makers are looking for concise and preferably quantitative information, which is generalizable over larger populations and can help rank and prioritize target populations and activities respectively. At the same time, as Hinkel (2011) argues, vulnerability assessments are more appropriately

Most of past social vulnerability research has been based on qualitative research presented as narratives to capture the nuances, complexities, and inter-linkages of factors contributing to differential patterns of damage (Cutter, Mitchell, and Scott 2000; Halvorson 2003; Collins and Bolin 2009). In the policy world, however, it is very rare for textual material to be the basis for action (Aalst, Cannon, and Burton 2008). Most decision-makers are looking for concise and preferably quantitative information, which is generalizable over larger populations and can help rank and prioritize target populations and activities respectively. At the same time, as Hinkel (2011) argues, vulnerability assessments are more appropriately done at local scales, where systems can be narrowly defined and fewer variables applied, and where context-specific important drivers can be factored in.

In summary, to add value to vulnerability assessments we propose an approach that applies a mix of qualitative and quantitative methods - 1) to triangulate our data (RC2-RC4 and RC1-RC4) and understand the complexity of critical moments at various scales better; 2) to reach out better to the policy community ('science into use', Work Package 2), and, ultimately, 3) to benefit vulnerable communities and help prioritize effective adaptation options.

In summary, to add value to vulnerability assessments we propose an approach that applies a mix of qualitative and quantitative methods - 1) to triangulate our scientific data (Work package 1) and understand the complexity of critical moments at various scales better; 2) to reach out better to the policy community ('science into use', Work Package 2), and, ultimately, 3) to benefit vulnerable communities and help prioritize effective adaptation options[2].

1 We differentiate between coping and adaptation strategies. Coping strategies are seen as short-term, immediate, and oriented to survival, whereas adaptation strategies are more sustained and oriented to longer-term livelihood security. Coping strategies are mainly motivated by crisis and are reactive, whereas adaptation involves planning.
(https://www.weadapt.org/knowledge-base/adaptation-decision-making/adaptation-versus-coping)

2 HI-AWARE consists of three inter-related Work Packages: Work Package 1, or Generating Knowledge, consisting of five interlinked Research Components (RC 1-5), focuses on knowledge generation on climate change impacts, the causes that lead to vulnerability, and adaptation practices and policies; Work Package 2, or Research into Use, systematically promotes the uptake of knowledge and adaptation practices at various scales by practitioners and policymakers, and Work Package 3, or Strengthening Expertise, builds the capacity of researchers, students, and science and policy stakeholder networks to do interdisciplinary research on climate change vulnerability, resilience, and adaptation (http//www.hi-aware.org)

2.3. Overcoming Barriers – Towards Actionable Information

There are advances to overcome the challenges listed in the previous section:

- Recognizing that local level vulnerability is substantially shaped by extra-local, social phenomena. For example, new climate information services, development of national policies, and shifts in international development agendas work across multiple-effect pathways (see the 'nested vulnerability' framework in Eakin and Wehbe (2009);
- Paying attention to the timing of critical climate events in relation to local vulnerabilities. This includes assessing critical temperature levels, critical months, and thresholds for specific crops (Wassmann et al. 2009; Regmi et al., 2010; Schaap et al., 2013)
- Assessments starting from the objectives of actors and assessing what changes in the social and ecological systems society perceives as unacceptable (Kwadijk et al., 2010; Werners et al., 2013) and when the performance of current management practices drops below a critical level (Werners et al., 2015)
- Studying cause and effect chains to identify moments in time for which new coping strategies and adaptation need to be developed (Kwadijk et al., 2010)
- Focussing on the timing of adaptation by asking what needs to be done when and incorporating adaptation options in adaptation pathways (Haasnoot et al., 2012; Jeuken et al., 2014)
- Approaches that provide systematic information on attributes of climate-related decisions (Pyke et al., 2007; Lempert, 2013; Wise et al., 2014)
- Approaches to understand existing agricultural challenges and benefits of climate-smart agriculture (see Climate Smart Agriculture Rapid Appraisal (Winowiecki et al., 2015). Targeting field and farm-scale practices to diversify land use in an interactive way at landscape scale further is a key feature in climate-smart and resilience agriculture (Scherr et al., 2012)
- Approaches assessing perceptions from the vulnerable, factoring in various time dimensions, layers of hazards, and dynamism (Hewitt, 1983; Watts and Bohle, 1992; Wisner et al., 2005)
- Community-based vulnerability assessments paying attention to the period of stress at household and community level at which people suffer particularly (see Table 2.1)

One element found common in these advances is that they look at when specific climate-stresses occur and what are the drivers. This offers an additional perspective to asking who and what is exposed or affected by climate change, and where vulnerable people and their livelihoods are located. These are the questions typically emphasized within a framework for vulnerability analysis and impact assessment (Füssel, 2007; Hinkel, 2011).

Notably few of the reviews discussed in Section 2.1 were found to pay particular attention to the timing or the duration of vulnerability. For example, time considerations had not been used as a discriminator by Paudyal (2010) or Delaney et al., (2014). Although the time horizon of an assessment is used as a criterion in some reviews (Downing and Patwardhan, 2004; Füssel, 2007), it refers to the scope of the assessment (historical, present, or specific projection period) rather than a characteristic of the vulnerability itself.

In the context of HI-AWARE, community-based vulnerability assessments deserve special attention. They include methods, approaches, and tools that focus on assessing a period of stresses at household and community levels, when people suffer most. One objective of such an assessment is to identify what is causing stress (weather and climatic parameters including hazards), when stress occurs (the months or time of year when people are at most risk, including the probability of an event), how it affects people and the resources they depend on, and the degree of response at different levels (coping and adaptation).

Table 2.1: Overview of types of community-based vulnerability assessments and their attention to periods of climate related stress (applied in the HKH region). The table also highlights how temporality is addressed in HI-AWARE Research Component 2

Community-based vulnerability assessments and rapid appraisal	Attention to period of stress at the household and community level when people suffer most	Methods, approaches and tools offered	Aims to identify indicators or drivers of particular vulnerability
Climate vulnerability and capacity analysis of CARE) (Dazé, Ambrose, and Ehrhart, 2009)	Field guides 3 and 4 mention identification of period of stress; the tool seasonal calendar includes identification of periods of stress.	Field guide with 6 tools. Notable seasonal calendar and historic timeline'.	Primarily oriented to identifying drivers of vulnerability.
Participatory climate risk vulnerability and capacity assessment (PCR-VCA) of Practical Action (Regmi et al., 2010)	Questions about difficult period(s) or when vulnerability is highest are not explicitly asked can be integrated with other tools.	Provides tools for assessing (i) community's risk context through disaster prioritization matrix, hazards, seasonal calendar, disaster trends, production trends and coping strategies, and gender roles; (ii) livelihood assets base; (iii) enabling environment for implementing coping and adaptation strategies.	Primarily oriented to identifying drivers of vulnerability and indicators.
Participatory tools of UKAID and LPF (Regmi et al., 2010)	The question what is the most difficult period or when vulnerability is highest is not asked presently. It could be added or included into some of the tools presented, though.	13 tools presented. Of particular interest are tool 2 Hazard mapping, which looks into periods of stress, and tool 4 Climate hazard effect assessment.	Mixed. Mapping and ranking of effects, hazards, and vulnerable groups. Facilitates exploration of drivers of vulnerability.
Framework for community-based climate vulnerability and capacity assessments in mountain Areas. ICIMOD (Macchi, 2011).	The document notes that key vulnerabilities can be identified and discussed in a merger of seasonal calendar and livelihood seasonal-monitoring calendar. It also suggests identifying cyclical periods and significant events that occur during a year influencing the life of a community.	Offers participatory rapid appraisal (PRA) tools. Time aspect addressed in interviews or focus group discussions; includes community historical timeline, Seasonal calendar, and Livelihood seasonal monitoring calendar.	Drivers, focus on 'how'.
Community based vulnerability assessment tools and methodologies and risk mapping (MoEST 2012) + Review of community based vulnerability assessment methods and tools (Paudyal, 2010).	Attention to assessment questions, yet gives no specific weight in assessing components of vulnerability (exposure, sensitivity, vulnerability). Interesting inclusion into adaptive capacity (asking: are resources adequate to the community for use at the time of climate effects based on the past experiences?).	Selection of PRA tools such as seasonal calendar of different climate events, Historical trend line, Climate change hazard, Historic timeline and trend analysis. Resources mapping includes a question on resources adequate at time of climate effects.	Oriented towards qualitative assessment of vulnerability. Attention is paid to cause - effect relationships, yet mostly with the objective of classification.

VACA: An approach to measure vulnerability and adaptation to climate change in the Hindu Kush Himalayas (Gerlitz et al., 2015).	Paper mentions the role of 'periodically unavailable livelihood resources', yet not included in assessment.	Vulnerability and adaptive capacity assessment (VACA) consisting of settlement and household questionnaire, based on exposure, sensitivity, adaptive capacity.	Indicators
Climate change, poverty and livelihoods: adaptation practices by rural mountain communities in Nepal (Gentle and Maraseni, 2012).	Attention to period of stress in seasonal calendars. No explicit attention to time/ periodicity in determining vulnerability.	Climate vulnerability and capacity analysis (CVCA) process, participatory social research methods, including Seasonal calendars and Historical timeline.	Indicators? Focus on how climate change is affecting the livelihood of communities.
Review of specific methods (as suggested in ICIMOD RC2) 'Source: HI-AWARE (2016b)'			
Mapping climate stresses	Included in last step. Offers scope to be included in earlier steps e.g. ethnographic research and hazard mapping and prioritization. Current questions address frequency, intensity, and effects of climatic hazards.	Community profiling, ethnographic research, transect walk, physical and hazard mapping + prioritization, climate trend analysis, seasonality of climate ddisasters and crop calendar.	Questions predominantly toward mapping of indicator values of hazards and social conditions. Prioritization of hazards and identification of what is affected .
Mapping socio-economic stress and drivers	Seasonality is included in livelihood analysis (not linked to climate hazards). Scope for inclusion in other tools.	Social ranking with poverty lens, livelihood analysis and calendar, socio-economic stressors, vulnerability matrix with gender lens, Life history (narratives).	Focus on indicators. Questions towards setting criteria, listing, and categorization. Drivers of social / economic activity addressed in mapping of socio-economic stressor. Drivers of vulnerability addressed in narratives.
Adaptation needs and priorities	Questions about seasonality of effects in focus groups. Could be included in interviews.	Focus group discussion, Key informant interview.	Focus on mapping drivers, conditions, and different vulnerabilities. Drivers of adaptation explored in interview questions.

In summary, considering the challenges and advances in vulnerability studies as described in the previous sections and the focus of community-based vulnerability assessments and rapid appraisals in the HKH region (Table 2.1) there is scope for further improvement of the following aspects:

- Knowledge on underlying drivers and other complexities that cause local vulnerabilities including the interplay between climate, biophysical and socio economic factors now and in the future;
- Knowledge on critical temperature levels and hydrological thresholds for specific crops, energy production and human health in periods in which climate related vulnerability is the highest;
- Climate model information and climate scenarios tailored to the realities of people e.g. to those periods they are most vulnerable;

- Identification of specific adaptation strategies that address people's vulnerabilities in the periods they suffer most; and
- Communities' responses to reduce vulnerability.

The critical moments perspective and its related methodology 'critical moments assessment' show good potentials to realise these improvements.

2.4. Characteristics of Critical Moments

Based on the review of vulnerability assessment in the previous paragraphs, we propose to look into the dynamics of the exposure and sensitivity of households and communities in the HKH region to climate change as well as into their adaptive capacity. We also would identify when they are particularly vulnerable to climate stress and how it impacts their livelihood

To facilitate conceptualization and operationalization of our work, we call these time periods 'critical climate-stress moments'. Their added value to vulnerability assessment and adaptation is to enable a deeper understanding of the stress period, the complex interaction of drivers resulting in such a critical moment, how it impacts people's livelihood and how people are (and could be) responding. In addition, with the use of tailored climate scenarios we assume that looking at critical moments will allow the design of tailored adaptation interventions.

'Critical climate-stress moments' are defined as those moments when households, communities, and the livelihood systems they depend on are particularly vulnerable to climate and weather-related risks and hazards. Critical moments are a combination of specific present and past conditions (context-specific), in which climate-stresses are particularly likely to be risky and adverse for a particular household or community and the system they depend on. Therefore, a critical-moments assessment combines identifying and analysing:

1. Specific climate conditions under which a critical moment occurs. How are such occurrences perceived by those experiencing the effects? What are the temporal and spatial scales? How do these relate to climate trends as analysed in HI-AWARE's Research Component 1 (RC1)?

2. The socio-economic and political drivers of vulnerabilities giving rise to critical moments, as experienced and perceived by the most vulnerable and by a range of stakeholders at local level. This analysis is conducted in close collaboration with HI-AWARE's Research Component 2 (RC2) on socio-economic, governance, and gender drivers and conditions leading to vulnerability.

In particular, a critical-moments assessment aims at improving our understanding of the following:

- At what time(s) of the year households and/or communities are currently especially exposed and sensitive to climatic change;
- The specific climate parameters that are critical for households (allowing to focus on climate-change modelling and scenario development);
- Conditions under which households and communities are especially vulnerable to climate stresses with respect to their livelihood systems and wellbeing (allowing to focus on adaptation);
- The effectiveness of current coping and adaption strategies to overcome critical moments; AND
- The prioritization and design of tailor-made adaptation interventions.

Applying the concept of 'critical moments' to social dimensions of vulnerability permits analysis across diverse social locations and complex mechanisms of vulnerability creation that combine climatic and non-climatic events. This new knowledge helps identify more tailored adaptation measures, which is important to increase climate resilience and adaptive capacities in the Hindu Kush Himalayan region.

To focus the research in HI-AWARE, we suggest the following initial scope for a critical-moments assessment:

- Critical moments as perceived by households and/or communities within selected livelihood systems. To capture communities' perceptions use may be made of the participatory methods described in Annex 1. Discussions with stakeholders operating at higher decision-making levels (district, state, national) focus on critical moments occurring and affecting the community level;
- Criticality specific to climate and weather-related risks (heat, flood, drought) per region (upstream, downstream) and their impact on the ability of households and communities to achieve their food security and livelihood goals. A critical moment is determined by the interaction of climate and weather-related stresses and the livelihood system characteristics and capability of communities to respond to such risks;
- Current criticality with respect to climate and weather-related risks, in terms of change in seasons and heat intensity, variability in rainfall, and extremes (like floods and droughts), changes in incidence and frequency of snowfall, frost, fog, high wind and wind gusts, and hailstorms. Perceptions of change will be collected at several temporal scales, using various methods (quantitative and qualitative) and addressing different stakeholders (households, key informants, decision-makers);
- Qualitative/quantitative information on weather, climate variability and change, and specific thresholds associated with critical moments will be collected. This information will be used to tailor the analysis of climate-change models (post-processing, downscaling, bias correction), and to inform, tune, and interpret the outputs of a hydrological effect model;
- We keep the definition of 'moment' in critical moments intentionally open-ended and dynamic. This allows to capture both inter and intra-annual criticalities as experienced by those who are vulnerable as well as by key stakeholders and decision-makers. A particular household or community may experience one or more critical moments within a year. The temporal as well as spatial distribution of these moments may change over the years, or interact with other risks (both environmental and socio-economic), and become critical only when several layers of hazards and risks are coupled. Moments may be periods of days, weeks, or even months in year; and
- The criticality of sectors will be assessed by generalizing critical moments experienced by households and/or communities for a particular sector i.e. agriculture, health, and energy production.

Critical moments for agricultural households and communities

Specifically speaking for agriculture households and communities, critical moments are the stages within the production cycle of a crop, when a household or community is affected by climate stresses with respect to losses in food security and livelihood. The reasons for a critical moment may vary at different stages. For instance, during sowing it could be lack of rainfall affecting soil moisture, but during harvesting it could be loss due to heavy precipitation. Critical moments are climate-stress specific and depend on the sensitivity of livelihood activities and the adaptive capacity of farm enterprises. Our work in HI-AWARE will allow us to assess whether critical moments can be classified for different agro-ecological zones and types of farm enterprises and can meaningfully focus adaptation activities.

Following the exploration of vulnerability and adaptation literature and the conceptualization of critical moments, it is important to note that a critical-moments assessment is a proposed addition to the vulnerability assessment family. The assumptions and arguments made earlier for its added value may also be read as hypotheses requiring further research. This will be an important point of attention for HI-AWARE.

3. Critical Moments Assessment Methodology and Its Position in HI-AWARE

3.1. Critical Moments in the Overall Structure of HI-AWARE

In HI-AWARE we use different perspectives to understand people's vulnerability to climate change and variability better (Figure 3-1). In Research Component 2 (RC2) we apply methods to discover root causes and drivers behind vulnerability. As such, RC2 helps to understand how past socio-economic and biophysical processes, gender drivers and climate trends have shaped people's vulnerability.

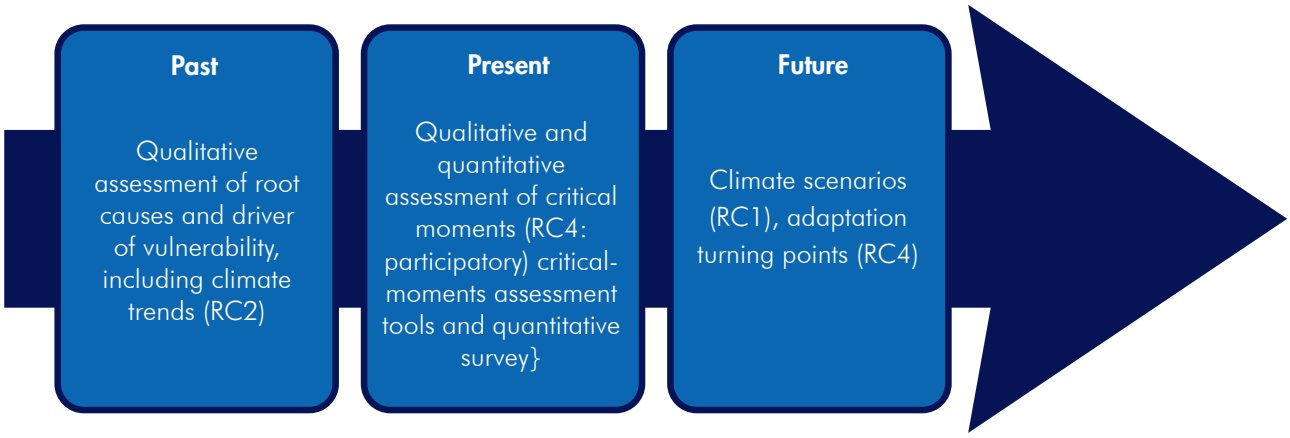

Figure 3.1: Critical moments as one of the perspectives in HI-AWARE to understand people's vulnerability to climate variability and change in the past, present, and future better

In Research Component 4 we use the critical moments concept to learn more about people's vulnerability in the present. The critical moments assessment methodology qualitatively assesses people's perception of the moments in which they feel particularly vulnerable to current climate-stresses with respect to achieving their livelihood goals.

Research Components 1,3 and 4 improve our understanding about people's vulnerability in the future. RC1 provides information on the likely occurrence of critical moments in future. Discussions on Adaptation Turning points in RC4 helps to discuss specific situations in which a social-political threshold of concern is likely to be exceeded due to climate change.

The methodology for a critical - moments assessment as part of RC4 is very much linked to other HI-AWARE research components (Figure 3-2). The assessment methodology builds upon the work carried out in RC1 and RC2 and feeds into RC1, RC3, RC 4 and RC5.

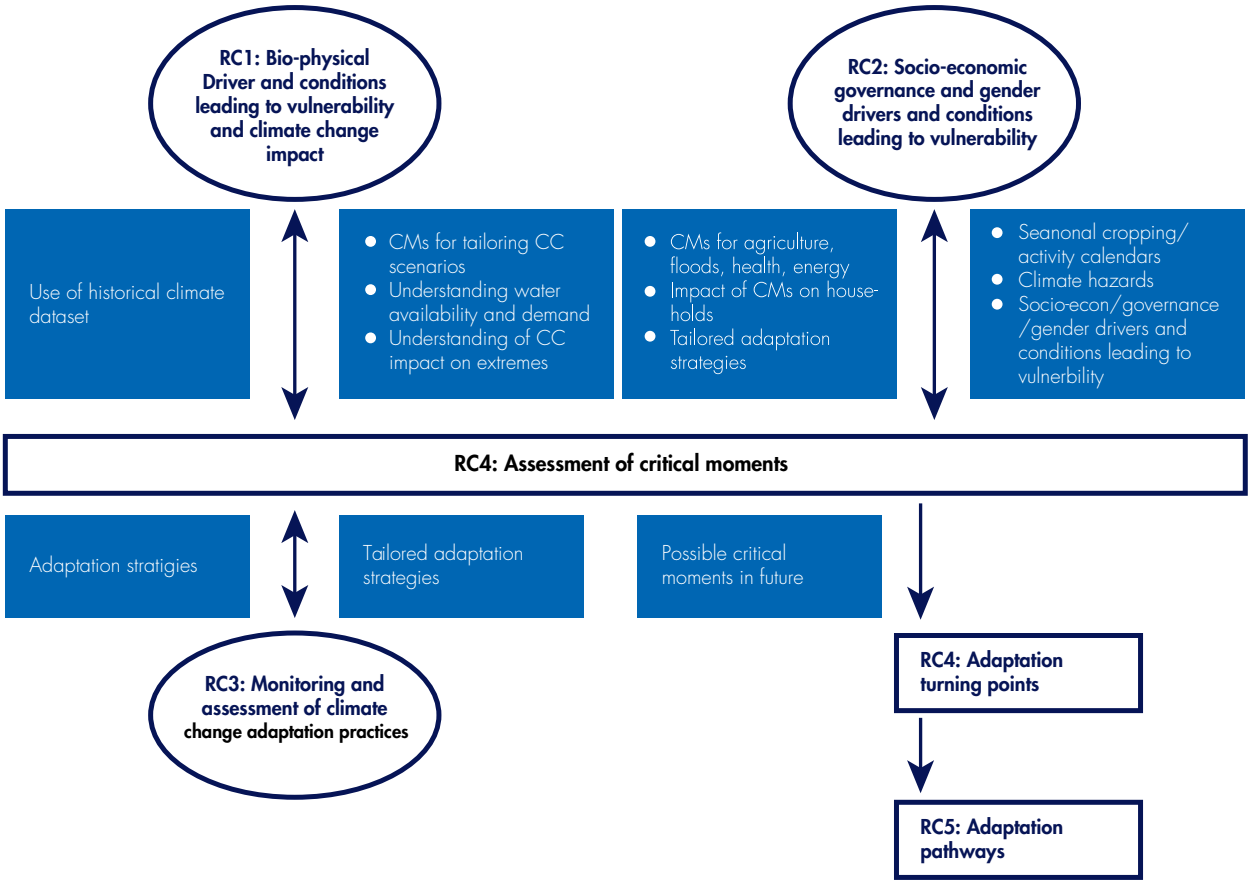

Figure 3.2: Critical moments in the overall structure of HI-AWARE

A critical moment assessment builds upon the insights on the livelihood system, perceived climate stresses and gender, socio-economic and biophysical drivers of vulnerability examined in RC2. A critical moments assessment requires the use of historical climate data on (trends in) precipitation, temperature, flood occurrence, hail storms or snow fall generated in RC1. In turn, insight into thresholds identified in a critical moments assessment will allow for tailoring climate modelling and climate scenarios also carried out in RC1. Climate models tend to provide raw data and general trends on daily precipitation or min/max temperatures and their spatial distribution, and so on. However, farmers or other stakeholders might be interested to know how often the max. air temperature will exceed 35°C in November in future, since 35°C is the temperature threshold for wheat (Figure 3.3).

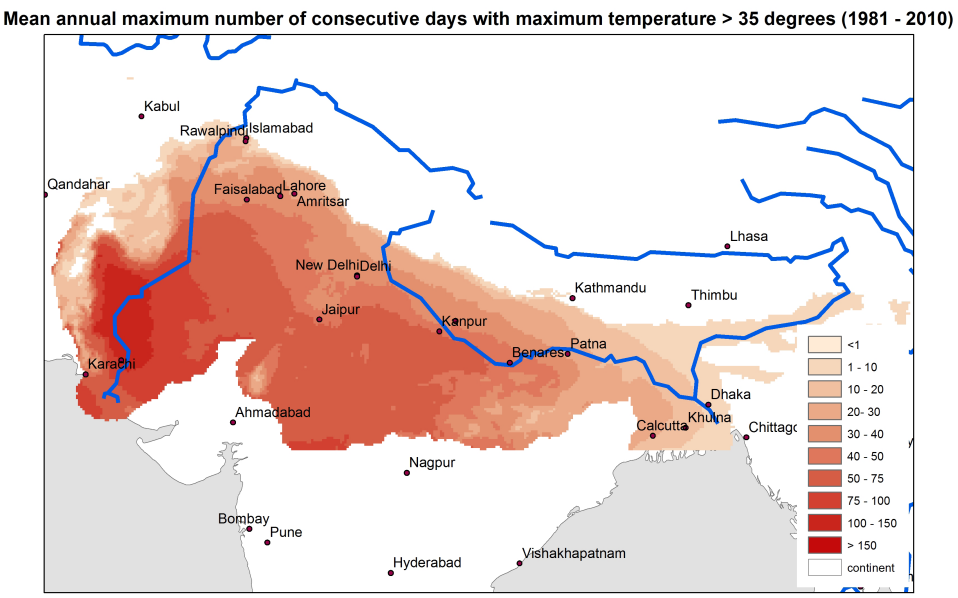

Figure 3.3: Mean annual maximum of number of consecutive days with max temperature > 35C degrees (1981-2010) for the Hindu Kush Himalayan region.

(Source: Biemans, based on Lutz and Immerzeel 2015)

There is also a clear link between a critical moments assessment and work on adaption measures in RC3. Discussions on critical moments will generate insights into the effectiveness of current coping and adaptation strategies to deal with climate-related risks. Understanding the effectiveness of these strategies in view of tailored (future) climate scenarios will form a strong base for the prioritization of adaptation measures in RC3. Insights into potential critical moments in the future will facilitate discussions on adaptation turning points (RC4) and in the end on adaptation pathways (RC5).

Triangulation - sample size - focus

This document describes a participatory critical-moments assessment. For the purpose of scientific quality a triangulation of methods is strived for by combining this mode of assessment with a participatory assessment of root causes (RC2) and an additional quantitative survey of critical moments which is carried out in combination with the participatory critical-moments assessment (HI-AWARE, 2016c).

The participatory critical-moments assessment follows a trans-disciplinary research approach. It combines knowledge of community members and other stakeholders with scientific knowledge and data. The use of climate and weather data as well as existing literature on cropping calendars, yields, thresholds, incomes, and health problems will form an essential part of a critical-moments assessment as much as people's perceptions and experiences. The use of existing quantitative information, through secondary data analysis, is important to prepare and deepen discussions with stakeholders as also to validate findings.

The participatory critical-moments assessment will be implemented in each HI-AWARE study area. Per study area, a minimum of four focus group discussions will be organized, two with men and two with women. The preliminary focus of a critical-moments assessment will be households and communities, and their livelihoods. As agriculture is crucial for earning a livelihood, this assessment will predominantly address this sector. Health issues influenced by climate conditions in combination with other socio-economic and biophysical drivers of vulnerability will be examined as well. Only when relevant, critical moments in hydro-electric power generation or in other livelihood resources such as livestock or forestry will also be assessed.

3.2. Key Research Questions and Research Sub-questions

In line with the methodologies applied in RC2, the critical-moments assessment methodology is designed on the basis of key research questions and research sub-questions. These sub-questions guide the selection of research methods, tools, and activities. For each research sub-question, examples of guiding questions and methods that could be used to answer these questions are described in Annexe 1.1-1.6. Each research sub-question will be further operationalized and tailored to the specific conditions of a study site. This last step is not described in this document, but should be combined with the preparation for RC2 fieldwork and done by the responsible partner institutes themselves. The Annexes also provide tables to facilitate a systematic collection of data and documentation of results.

The key research questions a critical-moments assessment addresses, are:

At what times in the year are people in the HKH region particularly vulnerable to climate hazards and weather conditions with respect to achieving their livelihood goals? What climatic conditions and other biophysical and socio-economic factors cause these periods of stress?

These key research questions may be split into the following research sub-questions:

1. At what times in the year are people's lives most affected by climate hazards? How do these periods of stress vary across social groups and socio-political contexts as also within households?
2. What specific climatic conditions and other drivers (such as biophysical and socio-economic circumstances) cause these periods of stress? How are such conditions experienced by the most vulnerable?

3. What is the effect of these periods of climatic stress on people's livelihoods? How does the effect vary across social and ethnic groups and within households?

4. What strategies have people adopted to cope with critical moments? To what extent do people perceive these strategies as effective? What would they like to do, ideally?

5. How are critical moments likely to evolve in future climate-change scenarios?

The research sub-questions largely follow a logical order. Responses to previous questions give direction to subsequent ones. That is why a critical-moments assessment may be described as a stepwise process.

To ensure scientific rigour and allow comparison of results from different research sites within and across countries, all research teams are to study the same key research questions and research sub-questions. At site level, the guiding questions might differ to meet site-specific conditions. Research sub-questions 1-4 will be discussed with community members and other stakeholders at local and district level. Research sub-question 5 addressing potential, newly emerging critical moments due to climate change will be discussed with (climate) professionals of RC1 and other stakeholders at higher levels only (Figure 3.4).

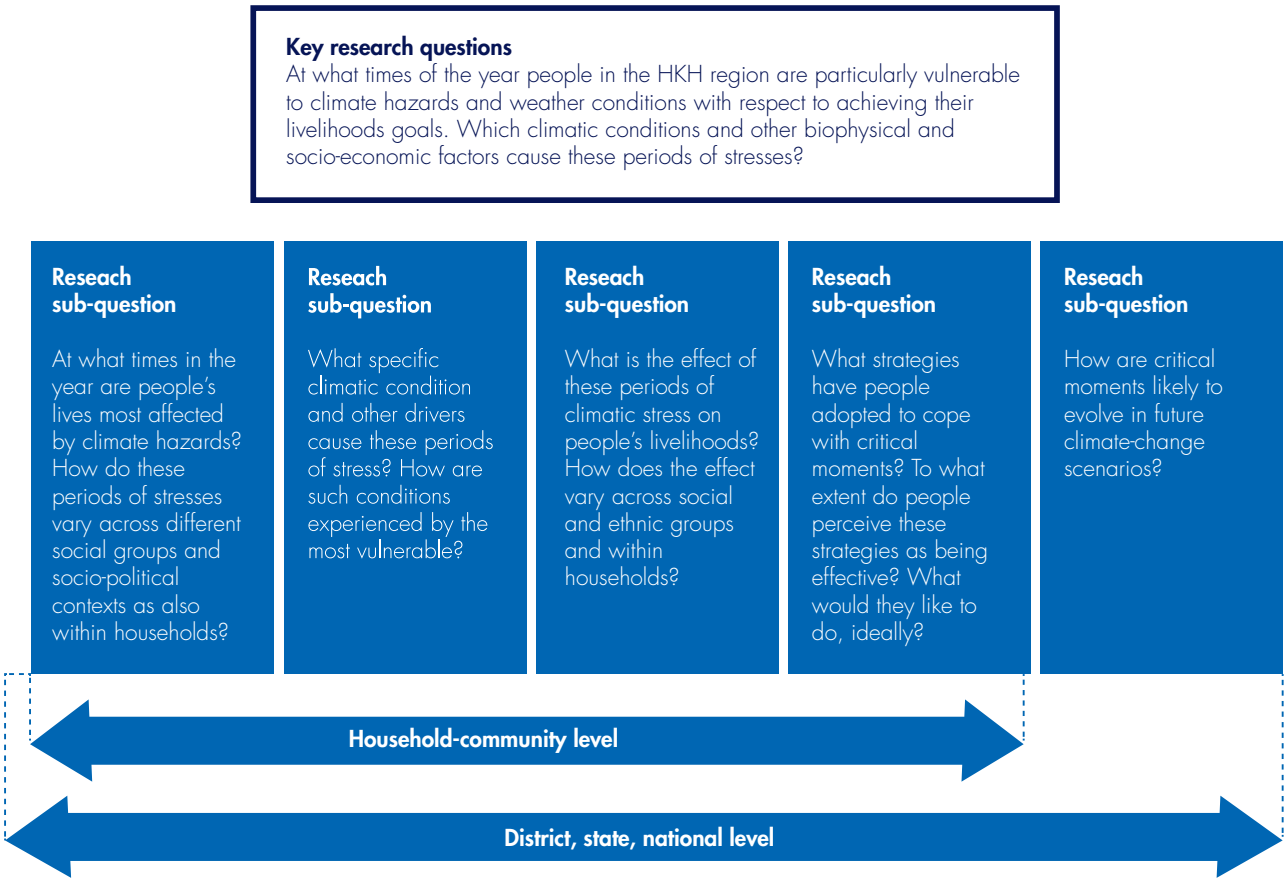

Figure 3.4: Key research questions and research sub-questions guiding the critical-moments assessment methodology

To a large extent, the guiding questions and methods for discussions with (climate) scientists and stakeholders operating at a higher level are similar to those applied with stakeholders at lower levels. Nevertheless:

- Responses from climate scientists and other stakeholders operating at higher levels are probably less context-specific and of a more quantitative nature than responses from stakeholders at lower levels; and

- Outputs of discussions with stakeholders at community level will be used as input for the interaction with climate scientists and other (climate) professionals for preparing and deepening discussions as well as for validating findings.

3.3. Getting prepared for a critical-moments assessment

In line with the HI-AWARE work plan, fieldwork on critical moments is preceded by a literature review (Task 4.1.2). Its main objective is to identify already known critical moments or potential ones with respect to agriculture, health, energy, and floods. Results of the literature review will be used to guide the discussions with community members and other stakeholders about critical moments.

As mentioned before a critical-moments assessment clearly builds on other HI-AWARE research components. Basic information required from RC1 includes:

- Historical trends in rainfall and (day /night) temperature; and
- Information about changes in the occurrence of floods, heat weaves, hailstorms, and fog.

Basic information required from RC2 includes:

- Village map – resources map
- Major income-generating activities (on/off- farm activities) and the relative importance of agriculture in relation to livestock and off-farm activities;
- Farm types (like rainfed or irrigated agriculture), major crops, cropping system(s) and cropping calendar specified for men and women;
- Critical crop stages;
- Landholding size;
- Climate-stresses / hazards;
- Different social groups;
- Crop production (from agricultural statistics);
- Crop prices;
- Household income (from census);
- Access to markets, credit/finance; and
- Other socio-economic, governance, and biophysical factors giving rise to vulnerability.

It is recommended that RC2 work starts in a particular village. After having collected some basic information, the critical- moments assessment can start. Preferably, the RC2 and RC 4 teams have (partly) the same team members.

Depending on the results of RC2 and heterogeneity of the target community, a critical- moment assessment at village level may take approximately two days. Discussions with experts will require another day. Since critical moments are perceived differently by different people, the diversity of farm types as well as the existence of different social groups should be taken into account for the selection of respondents. To this effect, RC2 provides important information. Annex 1.1 may be used for the identification of respondents.

3.4. Elaboration of Research Sub-questions: Guiding Questions, Methods, and Tools

Research sub-question 1: At what times in the year are people's lives most affected by climate hazards? How do these periods of stresses vary across different social groups and socio-political contexts as also within households? Tool: 'Combined use of livelihood seasonal-monitoring calendar and seasonality of climate disasters' (Annex 1.2)

Research sub-question 1 will probably have already been (partly addressed in RC2. Then it will have provided insights into the key activities of people to earn a livelihood as also into climate stresses faced by people and how these have affected their livelihoods. For agriculture additional questions in the critical moment assessment further specify the crops that are most influenced by climate stresses, critical crop (management) stages, people's perceptions of stress or risks during these critical crop stages and occurrence of these risks. For health additional questions focus on health issues influenced by climate or weather related stresses and these issues are likely to occur and whom are mostly negatively affected. Figure 3.5 shows an example of a discussion on potential critical moments as perceived by man and women farmers in Sindhia village in Dhock Chhan, Pakistan. In this stage of the assessment we talk in terms of potential critical moments as it is still to be examined whether this period is causing the most adverse impact on people's livelihood system.

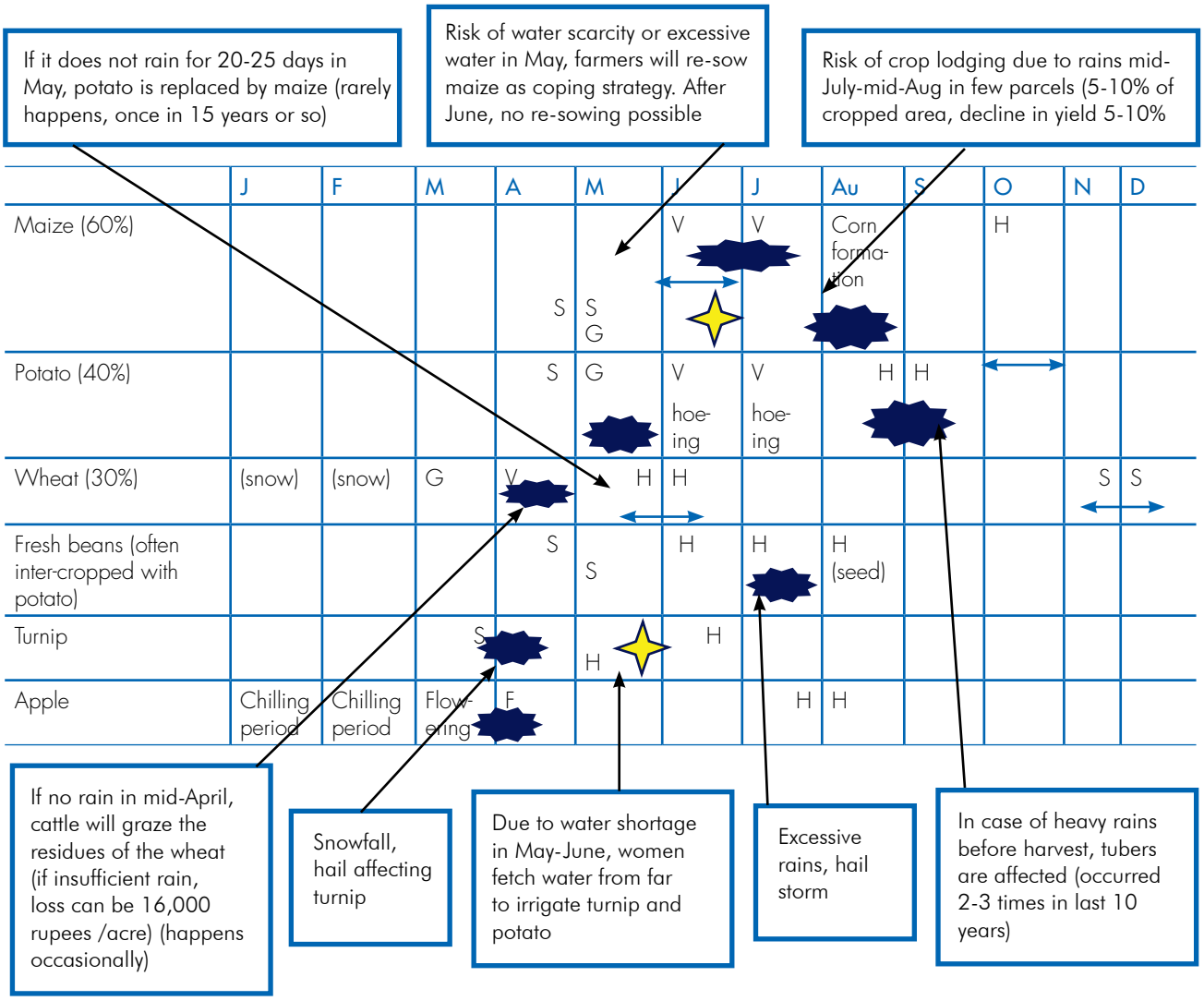

Figure 3.5: Examples of potential critical moments as perceived by men (blue stars) and women (yellow stars) in Sindhia village, Dhock Chhan, Pakistan. S= sowing, G= germination, H= harvesting (Source: HI-AWARE, 2016a)

Methods and tools

In addition to secondary data analysis, methods and tools include:

- Semi-structured interviews and/or focus group discussions; and
- Combined use of livelihood seasonal-monitoring calendar and seasonality of climate disasters (RC2 and Annex 1.2). The tool provides numerous examples of guiding questions for farmers and other stakeholders to find answers to sub-question 1.

Research sub-question 2: What specific climatic conditions and other drivers (such as biophysical and socio-economic circumstances) cause these periods of stress? How are such conditions experienced by the most vulnerable?

Tool 'Quantification of climate factors'

This research question is typical for a critical-moments assessment and focuses on the climatic, biophysical and social-economic drives giving rise to critical moments. It aims to quantify the meteorological factors driving critical moments as well as hydrological and temperature thresholds. Table 3-1 shows the results of a discussion with male farmers and other experts on hydrological thresholds and socio-economic / biophysical factors, which contribute to people's vulnerability in Sindhia village, Dhock Chhan, in Pakistan.

Table 3.1: Hydrological thresholds and socio-economic / biophysical factors, which contribute to people's vulnerability in Sindhia village, Dhock Chhan, Pakistan. (Source: HI-AWARE 2016a)

Crop/ crop stage/ crop management activity prone to climate stresses	Climate related stresses	Hydrological thresholds	Socio-economic factors / biophysical factors contributing to vulnerability	Effect on livelihood high / medium / few losses	Supporting data inputs (interviews, literature study)
Maize -sowing stage	Water shortage	The sowing of maize requires a heavy rain of 1-2 hours in early May.	Small land holding size		Interviews with male farmers, Sindhia village (24-5-2016).
Maize - tillering stage	Water shortage	In June, there is need for a few good rains (1-2 hours good rains every week). One good rain every week during crop growth period.	,,		Interviews with male farmers, Sindhia village (24-5-2016).
Maize - vegetation/ corn formation stage	Water logging	Heavy rains mid-July – mid-August cause crop lodging in parcels/portion of the plot .	,,	Few losses: decline in yield 5-10%	Interviews with male farmers, Sindhia village (24-5-2016).
Potato - after sowing/ planting/ germination	Water shortage	In case of 20-25 days without rains after sowing in May, potato is replaced by another crop + maize (but this rarely happens, once in 15 years).	,,		Interviews with male farmers, Sindhia village (24-5-2016).

Potato	Just before harvesting	In case of heavy rains just before harvesting time (end August / beginning September) tubers become affected, 90% losses (happened 2-3 times over the last years).	,,	High losses If heavy rains end August / beginning September there might be up to 90% losses.	Interviews with male farmers, Sindhia village (24-5-2016).
Wheat -sowing stage	Water shortage	Minimum of 15-20 mm rain (in case of good soil conditions). This minimum requirement is not specific to the Murree region.	,,		Expert meeting 24-5-2016.
Wheat - tillering	Water shortage	Mid-April (there is need for 2-3 hours good rain).	,,	Medium losses. If insufficient rain, loss can be 16.000 rupees / acre).	Interviews with male farmers, Sindhia village (24-5-2016).
Wheat – tillering stage	Water shortage	Need for regular rainfall in Feb, March, need for 15-20 mm in Feb. This minimum requirement is not specific for the Murree region.	,,	If too little rain, risk of 30 % reduction in yield.	Expert meeting 24-5-2016.
Wheat - grain filling stage	Water shortage	Need for at least 25-30 mm rain (risk of 20-25% reduction). This minimum requirement is not specific to the Murree region.	,,	If too little rain, risk of 20-25 % reduction in yield.	Expert meeting 24-5-2016.
Wheat - grain filling stage	Crop logging	Wheat harvest affected (quality and quantity) by heavy rains in June.			Interviews with male farmers, Sindhia village (24-5-2016).

Methods and tools

In addition to secondary data analysis, methods and tools to address this research question include:

- Semi-structured interviews;
- Focus group discussions; and
- Tool 'Quantification of climate factors' (Annex 1.3). The tool provides numerous examples of guiding questions for farmers and other stakeholders to find answers to sub-question 2.

Secondary data needs

If available, to address this research sub-question it is useful to collect beforehand information on:

- Temperature thresholds for main crops;

- Hydrological threshold for main crops; and
- Indoor and outdoor temperature thresholds for human beings.

Research sub-question 3: What is the effect of these periods of climatic stress on people's livelihoods? How does the effect vary across socia and ethnic groups and within households?

Tool: 'Effect of critical moments' (Annex 1.4)

This research question aims to develop insight into the adverse effects of potential critical moments on people's livelihoods. It estimates losses due to the dynamic interaction between climatic stress factors and socio-economic/ biophysical factors. In addition to secondary data analysis, methods and tools for these guiding questions may include:

- Semi-structured interviews;
- Focus group discussions; and
- Effect of critical moments (Annex 1.4). The tool provides numerous examples of guiding questions for farmers and other stakeholders to find answers to sub-question 3.

Research sub-question 4: What strategies have people adopted to cope with critical moments? To what extent do people perceive these strategies as being effective? What would they like to do, ideally?

This part of the critical- moments assessment builds upon the insights gained from RC3 on adaptation and coping strategies. It also contributes to RC3, particularly where it concerns the prioritization of adaptation options. This sub-question identifies people's coping and adaptation strategies in use and captures their perception of their effectiveness. Table 3-2 shows the results of a first discussion with farmers in Pakistan about coping and adaptation strategies in use to address potential critical moments.

Table 3.2: Current coping strategies practiced by community members in Sindhia village, Dhock Chhan, Pakistan (Source: HI-AWARE 2016a)

Potential critical moments in crop production and climate stress	Coping strategies/ adaptation measures in place to address (potential) critical moments	Effectiveness: + sufficient, - insufficient (Why; if possible differentiate for men/women)	Suggestions for alternative (more effective) adaptation measures
Maize: water shortage in sowing stage (April)	Re-sowing	Sufficient according to male farmers	Not yet discussed
Maize: water shortage in tillering stage (June)	None; if no rain in June, re-sowing no longer possible (male farmers)	?	Not yet discussed
Maize: lodging in vegetative/grain formation stage due to heavy rains with wind	None, (occurs in few parcels in the cropped area; 5-10% loss)	?	Not yet discussed
Potato: water shortage after sowing/germination	Re-sowing with another crop + maize (male farmers)	Less preferred	Not yet discussed
Potato: water logging just before harvesting	Growing potato on ridges, which is already practiced	No other option (male farmers)	

A combined insight into the effect of a climate-related stressful period on the household, the perceived effectiveness of current coping measures, and a true interest in developing more effective adaptation strategies lead to the conclusion whether a stressful period may be considered a critical moment.

Methods and tools

In addition to secondary data analysis, methods and tools for these guiding questions may include:

- Semi-structured interviews;
- Focus group discussion; and
- Adaptation measures addressing critical moments (Annex 1.5). This tool provides numerous examples of guiding questions for farmers and other stakeholders to find answers to sub-question 4.

Secondary data needs

To address this research sub-question it is useful to collect beforehand:

- Current adaptation/ coping strategies to address critical moments (see RC3 output); and
- (Perceived) Cost-effectiveness of coping /adaptation measures.

Research sub-question 5: How are critical moments likely to evolve in future climate-change scenarios?

This question aims to assess how the identified critical moments are likely to evolve due to climate change and if new critical moments are likely to occur. This sub-question will not be discussed by farmers but only with experts and professionals in the field of climate change and/or agriculture, health, or energy. The (potential) critical moments which have been identified with the help of research questions 1-4 are used as the basis for the discussion. This discussion is informed by information on trends in temperature, precipitation, the occurrence of floods, heat waves, snow and hail storms as well as by the tailored projections and scenarios of RC1.

Methods and tools

In addition to secondary data analysis, additional methods and tools for these guiding questions may include:

- Semi-structured interviews;
- Focus group discussions; and
- Future critical moments (Annex 1.6). This tool provides examples of guiding questions for farmers and other stakeholders to find answers to sub-question 5.

Secondary data needs

To address this research sub-question it is useful to collect beforehand:

- (Tentative) Climate projections (HighNoon project, Biemans et al., 2013, HI-AWARE – RC1);
- (Tentative) Hydrological projections (HighNoon project, Biemans et al., 2013, HI-AWARE – RC1);
- (Tentative) Hydrological scenarios (HI-AWARE – RC1);
- Articulated data needs (HI-AWARE – RC1); and
- Climate data: trends in temperature, precipitation, climate hazards, extremes like drought, heat stress, and cold waves (qualitative and quantitative data) (HI-AWARE - RC1).

4. Future Outlook

4.1. Forthcoming Work

To ensure scientific rigour and allow comparison of results from different research sites within and across countries, all research teams need to address the same key research questions and research sub-questions. The guiding questions will differ in order to meet site-specific conditions. Therefore, at the beginning of a critical-moments assessment in the field, HI-AWARE partners are recommended to:

- Operationalize the research sub-questions into guiding questions, which fit the particular conditions of research sites. The example guiding questions described in Chapter 3 and Annex 1.1-1.6 may be used as a source of inspiration;
- Adjust the Tables provided in Annex 1.1 -1.6 according to the researchers' need. Even so, the use of these tables is recommended, because they have been designed to ensure systematic data collection, facilitate documentation, and scientific rigour as such; and
- Collect secondary data to prepare interviews with stakeholders, and validate their responses.

In addition to the collection of data, attention should be paid to reporting and analysis of research results as well, because they determine the quality of research outcomes. Annex 2 outlines recommendations for developing a critical-moments assessment report. Standardization in reporting will facilitate the comparison of results from different research sites within and across countries.

The final results of the participatory critical-moments assessment described in this guide need to be compared and integrated with the quantitative survey on critical moments (HI-AWARE, 206c) to draw scientifically credible conclusions.

4.2. Learning about Critical Moments

Gaining new knowledge on the complexities of vulnerability to climate change, their timing, and possible adaptation measures is important for current and future adaptation. This has been the inspiration for HI-AWARE to introduce the concept of critical moments. Critical-moments assessment is a newly proposed addition to the vulnerability family and the assumptions and arguments made in Chapter 2 to argue for its added value need to be a point of reflection within HI-AWARE. Throughout 2017, the concept of critical moments will be piloted and refined with partners in the Hindu Kush Himalayan region. Learning about the concept of critical moments is crucial to define characteristics further and to conclude about its added value to existing vulnerability assessments and the extent to which it better supports adaptation.

Aspects for monitoring and learning include:

- The extent to which the application of the critical-moments concept generates deeper insight into vulnerability, actionable knowledge, and better tailored adaptation options for communities and adaptation planners;
- Classification of critical moments for types of farm enterprises, social groups, and gender-based divisions, for different agro-ecological zones and / or for different sectors;
- Different perceptions of critical moments. Who should decide what a critical moment is: people experiencing a critical moment or researchers from outside (also)?
- Timing of critical moments: People might experience critical moments at a time that may not coincide with a particular climate stress, like when crops fail some time after a critical frost event earlier in the year. To what extent does the critical - moments assessment methodology applied at that time allow for such discoveries?

- The extent to which a critical-moments assessment is capable of capturing the dynamics and temporal evolution of climate change and how this climate change will affect critical moments; and
- The relationship between critical moments and other concepts in HI-AWARE such as 'adaptation turning points' and 'adaptation pathways'.

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Annex 1: Detailed Description of Methods

Annex 1.1: Selection of Stakeholders and Respondents

This tool assists in identifying stakeholders and respondents to be involved in a critical-moments assessment. The tool helps to check if there is a need to add other stakeholders and respondents than those already contacted to discuss drivers and conditions leading to vulnerability as in RC2.

Objectives

- To identify community members and stakeholders other than those already being involved in RC2 discussions;
- To select farm type(s) the critical assessment will focus on (for agricultural sector only); and
- To select the main crops per farm type.

Time: 1 hour

Step 1: On the basis of results from RC2 on drivers and conditions leading to vulnerability, check if other stakeholders need to be involved in the critical-moments assessment. The guiding questions may help you identify additional respondents to talk to.

Step 2: For agriculture only, discuss the farm type (cash crop, subsistence, other) and size as well as the crops the critical moments analysis will focus on. The selection of crops will be based on the outcomes of the previous steps (from RC2) and criteria such as most important crops for the farmer and region, and most common crops in terms of area. Information in literature on already identified critical moments in the area will be used in the selection of crops as well. Use Table 1.1-1 to document results. Domains not considered relevant may be removed from it.

Guiding questions for all types of stakeholders

- Who may be (or may have been) affected by climate change? (consider different sectors, levels; stratify for gender)
- Who have specialised knowledge of and experience with agriculture, health, and /or hydropower?
- Who have specialised knowledge about climate change and hazards, and their effects?
- Who are relevant stakeholders for adaption strategies to overcome adverse effects of climate (and its changes)?

Table 1.1.1: (New) stakeholders/respondents to be involved in a critical-moments assessment

Agriculture				
Farm type	**Farm type 1: rainfed only**		**Farm type 2: rainfed and irrigated agriculture**	
Main crops/cropping system	Crop 1:	Crop 2:	Crop 1:	Crop 2:
Village level	Name/stakeholder	Name / stakeholder	Name/stakeholder	Name/ stakeholder
Men (elderly, youth, commercial farmers, others…)	Crop1:	Crop 2:	Crop1:	Crop 2:
Women (elderly, youth, commercial farmers, others…)	Crop 1:	Crop 2:	Crop 1:	Crop 2:
District /state/national level (extension workers, researchers, (climate) professionals, NGOs, policy makers				
Men	Names			
Women	Names			
Home garden				
Village level				
Men (elderly, youth)	Names			
Women (elderly, youth)	Names			
Animal husbandry				
Village level				
Men (elderly, youth, commercial farmers, others…)	Names		Names	
Women (elderly, youth, commercial farmers, others…)	Names		Names	
District /state/national level (extension workers, researchers, (climate), professionals, NGOs, policy makers				
Men	Names			
Women	Names			
Other domestic activities/affairs, health issues				
Village level				
Men (elderly, youth, commercial farmers, others…)	Names		Names	
Women (elderly, youth, commercial farmers, others…)	Names		Names	
District, state and national levels (extension workers, researchers, (climate), professionals, NGOs, community workers and others				
Men	Names		Names	
Women	Names		Names	

Annex 1.2: Combined Use of the Tools 'Livelihood Seasonal-monitoring Calendar' and 'Seasonality of Climate Disasters'

The tools 'livelihood seasonal monitoring calendar' and 'seasonality of climate disasters' (adjusted from Macchi 2011) will probably be used in the study of drivers and conditions leading to vulnerability (RC2). The critical-moments assessment builds on the results of these tools. To use both tools for a critical-moments assessment, these are the relevant elements:

Objectives

- To identify the key activities that are most influenced by climate hazards/climate conditions,
- To specify the times in a year when these activities are most influenced by climate hazards/conditions (which months, weeks),
- To assess if people perceive these moments as stressful, that is, as making them more at risk, insecure, and/or vulnerable than other periods in the year,
- To identify who within the household are most affected during stress periods, and
- To identify key activities of local people that are negatively affected by health issues and influenced by climate hazards.

Materials and Preparation

Livelihood seasonal-monitoring calendar prepared in RC2; marker pens to complement the calendar

Time: 1 hour

Step 1: Select the participants who will be invited to participate in the critical-moments assessment. Use may be made of the tool 'selection of stakeholders' (Annex 1.1)

Step 2: If relevant, show participants the Livelihood seasonal-monitoring calendar, which probably has been developed before in RC2 discussions. Briefly discuss the main insights (climate hazards, activities affected by climate hazards).

Step 3: Discuss which key activities are most influenced by climate hazards or climate conditions and focus on the time(s) when these activities are most influenced by them. Specify the months and/or weeks in which the activities are most affected.

Step 4: Assess if people consider these moments stressful, that is, making them more at risk, insecure, and/or vulnerable than in other periods in the year. If so, try to find out the reasons why they perceive these moments as stressful.

Step 5: For the stress moments, try to find out who within the household are most affected during these stress periods, which crops are most affected, and which other household activities are affected?

Please include the number of respondents involved in your field report. Indicate similarities and differences in their perceptions, and stratify by gender.

Examples of guiding questions for stakeholders at household and community level:

- Which of your crops is or are most influenced by climate stresses (like drought, excessive rain, hailstorm)?
- What are critical crop stages for these main crops?
- To what extent do you perceive climate or weather related periods of stress during these critical crop stages?
- Regarding occurrence of these (potential) critical moments: do these periods of stress occur more often than before? How often?

- Who within your household is or are most affected during these stress periods? You, your wife, your children, others (specify like grandparents or other relatives)?
- Is there any link between (potential) critical moments of risks earlier in the growing season and climate related risks later in the growing season? (For example, delay in sowing due to a lack of rain might adversely affect yield due to rainfall during maturing stage)
- What key activities of people are negatively affected by health issues influenced by climate stresses? When does this happen (which months, weeks, and for how long)? Who within the household is or are most affected then?
- What else is affected (like livestock, seasonal migration by climate stresses) and during which periods in particular?
- What period(s) (weeks/months) may be considered high season and why? (Think of e.g., work load in relation to availability of labour)?
- What period (weeks/months) may be considered low season and why? (Think of work load in relation to availability of labour, for instance)
- Do you face drinking water problems during the summer months? Are these problems more severe in summer than in other months?
- Do you face health problems that are related to heat stress, cold, fog, excessive rains? If yes, in which period(s) of the year do you face these problems?

Examples of guiding questions for stakeholders at district, state, or national level:

- What crops are most affected by climate-stresses and at which growth stage(s)?
- What social groups are most affected by climate conditions during these climate hazard-prone periods?
- To what extent may critical moments earlier in the growing season cause critical moments later in the growing season?
- To what extent are these climate related risks specific to particular farm types and/or agro-ecological zones?
- Which social groups are most affected by climate conditions during these climate hazard-prone periods?
- To what extent do critical moments (related to different crops, key activities) reinforce each other?
- What period (weeks/months) may be considered high season and why? (Think of work load in relation to availability of labour, for instance)
- What activities (other than agriculture related) are prone to climate hazards?
- Do people face drinking water shortage problems due to climate-stresses? In which period(s) of the year is this most likely to happen?
- Do you face health problems which are related to heat stress, cold, fog, excessive rains? If yes, in which period(s) of the year do you face these problems?
- Do people face power/energy failure problems due to climate hazards? In which period(s) of the year is this most likely to happen and how?

Table 1.2.1 may be used to fill in responses.

Table 1.2.1: Example of a Livelihood seasonal-monitoring calendar (adapted from Macchi 2011) (XXX = potential critical moment)

Livelihood activity	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Agriculture												
Rice		n	n 1-10 June stress moment - rice transplantation		p	p	w	w	h			
Wheat	h	h							s	s		
home garden												
Pumpkin	p	p	h		h	h	h					p
Other												
Forestry												
Fodder	c	c	c		c	c	c	c	c	c	c	c
Non-timber forest products	c/s	c/s/	c/s		c/s	c/s	c/s	c/s	c/s	c/s	c/s	c/s
Firewood	c	c	c		c	c	c	c	c	c	c	c
Animal husbandry												
Milk				low production of milk	low production of milk							
Meat												

n - nursery; c - collecting; h - harvesting; p - planting; s - sowing; w - weeding; s selling

Annex 1.3: Quantification of Climatic Conditions

The tool 'quantification of climatic conditions' is typical for a critical-moments assessment and these are the relevant elements:

Objectives

- To deepen understanding about climatic hazards and (quantitative) climatic conditions, which cause stress moments in households and communities with respect to earning their livelihoods; and
- To deepen understanding about the timing of these stress moments.

Time: 1-2 hours

Step 1: Synthesize outcomes of the previous step (tool Annex 1.2.) and identify:

- Activities and crop stages that are severely affected by climatic hazards/conditions and specify most harmful climate conditions;
- Times in the year when these activities/crop stages are most affected by these climate conditions; and
- Write results of the synthesis in the first two columns of Table 1.1-3 on a big sheet, but skip sectors that are not considered relevant.

Step 2: Summarize the main socio-economic drivers and conditions leading to vulnerability from RC2 work.

Step 3: Develop a 'Quantification of climate factors' calendar by discussing:

- The time(s) in the year during which livelihood activities are most prone to climate hazards/conditions;
- Specific meteorological conditions, which cause adverse effects. For identifying these meteorological conditions during potential critical moments, use should be made of secondary data as well; and
- The main socio-economic drivers and conditions leading to vulnerability (RC2 results) and new factors being added, which make such moments even more stressful.

Focus only on relevant activities and domains.

Please include the number of respondents involved in your field report. Indicate similarities and differences in their perceptions and stratify by gender.

Guiding questions for stakeholders at community and district levels

- Say, you still remember a drought of 5 years ago, which caused serious crop failure. Which crops were mostly affected?
- Which crop stages are most drought (or any other climate hazard) prone?
- What happened exactly to the crops during the drought period (think of critical crop stages such as germination of seeds, leaf formation, flowering, and growth)
- What do you mean by drought: no rain, or (how) many days without rain? What is the threshold?
- Does drought occur regularly? (specify)
- Which crops/crop stages are most prone to high temperature?
- What is the temperature threshold for your main crops like rice, wheat, mung bean?
- What happens to drinking water during droughts? (quality and quantity)
- When do drinking water issues occur (after how many days of no rain)? What types of issues occur then?
- What kinds of other health issues are sensitive to drought? When do these issues occur?
- Do people suffer from diseases such as diarrhoea during floods?

- Do floods occur regularly? (specify)
- What indoor temperature(s) at night cause sleep problems for pregnant women? Or in what period(s) in the year do pregnant women face sleeping problems due to high indoor temperature? Or what night temperature and how many consecutive nights of such a high temperature cause sleep problems for pregnant women?
- How many successive days without rain will cause problems for hydropower production?
- Apart from climatic conditions, what other biophysical factors (like declining soil fertility, soil type) and socio-economic factors (such as labour availability, migration) make stress moments the most risky, insecurity, and vulnerability causing moments in the year?

For example, when a household owns a well, a drought during sowing time of wheat does not cause much risk because of the alternative of irrigation.

Guiding questions for (climate) modellers and other (climate) professionals

- What are critical crop stages for the main crops? Which of these stages is or are sensitive to climate hazards? (mention those climate hazards which are considered relevant.) (You can check/use the results of the tool Seasonality of climate disasters and Crop calendar (RC2 results)
- What are temperature thresholds for these critical crop stages (for each main crop)?
- To what extent are these temperature thresholds farm-type specific?
- What are rain thresholds/hydrological thresholds for these critical crop stages (for each main crop)?
- To what extent are these hydrological thresholds specific to farm type?
- How many successive days without rain during the summer season will cause health problems due to a lack of clean drinking water?
- What are indoor and outdoor temperature thresholds for people? (specify for men, women, elderly, children, pregnant women)
- Which specific meteorological conditions cause problems to hydropower production?
- In addition to climate hazards/conditions, what are the main socio-economic factors making stress moments most risky, insecure, and vulnerable moments in a year?

To document responses use may be made of Table 1.3.1.

Table 1.3.1: Quantification of climate factors

Activities severely affected by climate hazards	Climatic hazard(s)/ condition(s)	Stress moments		Support-ing references	Other bio-physical and socio-economic factors leading to vulnera-bility
Agriculture-crop production					
Rice	Drought High tempe-rature	Rice needs to be transplanted from nursery to field 28-30 days after the sowing. Normally the first 2 weeks in June is transplant-ation time.	• Soil should be saturated during trans-plantation • Very high water table needed • No rain fall during the first two weeks of June	Fieldwork, Chitwan, critical-moments assessment training, June 2015	Labour shortage due to migration

Wheat	• Drought • High tempe-rature		Temperature > 35°C during 5 successive days		
Home garden					
Pumpkin	• Drought • High tempe-rature				
Other					
Animal husbandry					
Milk	• Drought • High tempe-rature • (local) Floods				
Butter	• Drought • High tempe-rature • Floods				
Meat					
Wool					
Calves / lambs					
Tourism					
Running lodges / hotels	(local) Floods	June	In India 64.5 mm/day is the threshold above which 'small hydrological disasters' start to occur	Guhatha-kurta et al., 2011	Instable political situation
Guiding, working as porter	(local) Floods	June			Instable political situation
Other domestic activities–health					
(Poor) drinking water availability	• Drought • Weak monsoon in previous years	• End April till the begin-ning of June • End March – end June of year follow-ing weak mon-soon (until reser-voirs fill up again)	Meteoro-logical drought over an area: a situation when the seasonal rainfall received there is less than75% of its long-term average value. Hydrological drought: a period during which the stream flows are inadequate to supply established use of water under a given water management system. Weak monsoon in previous year might cause water scarcity next year, when it starts getting warmer, because water levels of reservoirs and groundwater do not fill up sufficiently	http://www.imd.gov.in/doc/wxfaq.pdf (page 15-16) http://www.skymetweather.com/content/weather-news-and-analysis/poor-monsoon-in-2014-causing-drinking-water-crisis-in-telangana / #sthash.oDtlLXHN.dpuf	
(Poor) drinking water quality	Dry, hot season	March, April, May, September	Dry and hot		

(Low) labour work productivity due to extreme heat	High temperature	April-June	The most commonly used in occupational health is the Wet Bulb Globe Temperature (WBGT). This index takes into account air temperature, radiant temperature, humidity, and air movement, and is the basis for time limitations of work in different heat exposure standards. In wet-bulb –globe temperatures higher than 35°C, the human skin can no longer itself cool down through evaporation. The US military suspends training and physical exercise when this temperature exceeds 32°C .	Roy, 2010 Kjellstrom et al., 2009 Roy et al., 2010	
Dengue		Post- monsoon September-November	India: Very wet monsoon/ heavy monsoon, temperature and relative humidity	Chakravarti and Kumaria 2005	
Diarrhoea	• High temperature • Weak rain • Heavy rain	April – August	In Dhaka, Bangladesh, the number of non-cholera diarrhoea cases per week increased by 5.1% for every 10mm increase above the threshold of 52mm of average rainfall over lags 0-8 weeks. The number of cases also increased by 3.9% for every 10mm decrease below the same threshold of rainfall. For 1 degree increase in average temperature over lags of 0-4 weeks, the number of cases increased by 5.6%	Hashizume et al., 2007 Moors et al., 2013	Poor sanitation facilities

Annex 1.4: Effect of Climate–weather Related Stress Periods

The tool effect of periods of climate –weather related stress is typical for a critical-moments assessment. These are the relevant elements:

Objectives

- To deepen understanding about the effect of stress moments due to a combination of climate conditions and socio-economic factors
- To identify critical moments

Time: 2 hours

Preparation

Copy the columns 'stress moments', 'climatic conditions', and 'socio-economic drivers and conditions leading to vulnerability' of Table 3 (tool 'Quantification of climate factors') and draw a new table (see Table 1.4.1). Skip sectors not considered relevant.

Table 1.4.1: Effects of stress moments

Activities severely affected by climate hazards	Climate -weather related stress moments	Climatic hazard(s)/ Condition(s) causing stress moments	Socio-economic factors causing stress moments	Effect on livelihood -- high losses - losses +- hardly any losses + gains + high gains
Agriculture-crop production				
Rice	First 2 weeks in June –transplant-ation time (drought and shortage of labour)	• Drought • High temperature	Labour shortage due to migration	Sometimes drought causes 50% income reduction
Wheat	November	• Temperature > 35^{0}C during 5 successive days		
Home garden				
Pumpkin		• Drought • High temperature		
Animal husbandry				
Milk	June -July	• Drought • High temperature		
Meat	June-July	• Drought • High temperature		
Tourism				
Running lodges		(local) Flood		(local) Floods will hinder tourists to visit wild parks
Guiding, pottering, other activities		(local) Flood		(local) Floods will hinder tourists to visit wild parks

Domestic activities-health				
Drinking water				
Availability of labour	April-June	High temperature (WB temp above 30-31^{0}C)		100% productivity is not achievable during day time for outdoor workers in peak of hot season
Hydropower production				
Hydro-power production	Beginning of April	(local) Floods		Infrastructure failure

Step 1: Discuss the effect of the stress moments on livelihood goals.

Step 2: Discuss what moments are perceived as climate-weather related periods of stress. That is, what are the times in a year people are particularly vulnerable to climate hazards/conditions with respect to achieving their livelihood goals. In the table you can give these critical moments a different colour.

Please include the number of respondents involved in your field study. Indicate similarities and differences in their perceptions and stratify by gender.

Guiding questions for stakeholders at household and community levels

- What is the effect of exceeding X number of days (threshold) without rain during stress periods (related to plantation, planting, flowering, ripening) for rice/wheat/ beans… on yield?
- What is the effect of exceeding temperature threshold for rice/wheat/ beans… on yield? For example, what is the effect of temperature of higher than 35^{0}C during four successive days on your wheat yield? (– high losses, +- hardly any losses, ++ gains)
- What is the weight of economic loss due to sleep problems for pregnant women in June? (– high losses, +- hardly any losses, ++ gains). Estimate the losses or gains
- What is the weight of economic losses for the household in case of diarrhoea among its members in June? (– high losses, +- hardly any losses, ++gains). Estimate the losses or gains

Guiding questions for (climate) modellers, other (climate) professionals, and stakeholders at higher levels

- What is the effect of exceeding temperature thresholds for rice/wheat/ beans… on yield? For example: What is the effect of temperature of higher than 35°C on your wheat yield (– high losses, +- hardly any losses, ++gains). Estimate the losses or gains
- What is the effect of exceeding rainfall or hydrological thresholds during stress periods (as in plantation, planting, flowering, ripening) for rice/wheat/ beans… on yield? For example: what is the effect of, say, one week without rain during planting time on rice yield? (– high losses, +- hardly any losses, ++ gains). Estimate the losses or gains
- What is the weight of economic loss due to sleep problems for pregnant women in June?
- What is the effect of X weeks without rain during other critical stages on the yield of your crop such as rice/ wheat/maize/bean ….? What is the effect of this on the well-being of the household? (– high losses, +- hardly any losses, ++gains). Estimate the losses or gains
- What is the weight of economic loss due to sleep problems for pregnant women in June (– high losses, +- hardly any losses, ++gains). Estimate the losses or gains
- What is the effect of floods on tourism? What is the weight of economic loss of such an effect?
- What is the effect of X days without rain on hydropower production? What is the weight of economic loss of such an effect?

Table 1.4.2: Coping strategies and adaptation measures to address periods of climate-related stresses

Activities severely affected by climate hazards	Periods of climate-related stresses	Coping strategies/ adaptation measures in place to address these periods of climate-related stresses	Effectiveness + sufficient, - insufficient (Why?)	Suggestions for alternative (more effective) adaptation measures
Agriculture-food production				
Rice	First 2 weeks in June –transplantation time (due to drought and shortage of labour)	Delay transplantation by two weeks	Not sufficient, still losses in yield	Short-duration high-yield variety
Millet				
Other				
Home garden				
Pumpkin				
Animal husbandry				
Milk	June/July due to high temperature/ shortage of drinking water/ fodder	Providing additional concentrates	Yes, but not all households can afford paying concentrates	Not known
Meat	June/July due to high temperature/ shortage of drinking water/ fodder	Providing additional concentrates	Yes, but not all households can afford paying concentrates	Not known
Other domestic activities/affairs – health				
Drinking water availability	April-June, high temperature, WB> 30-31^{0}C			
Hydropower production				
Hydropower production	June, due to floods	No measures in place yet		Embankments

Annex 1.5: Coping-Adaptation Strategies to Address Climate-Weather Related Periods of Stress

Probably people already apply multiple coping strategies to overcome or address climate-weather related periods of stress. The tool Coping – adaptation strategies to overcome/address climate-weather related periods of stress' assists in making these strategies explicit and discussing their effectiveness. On the basis of the perceived effectiveness of a strategy one can decide whether these periods of stress can be seen as a real critical moment or not.

These are the tool's relevant elements:

Objectives

- To assess coping and adaptation strategies that are already in use to overcome/address climate–weather related periods of stress;
- To define critical moment(s); and
- To identify new adaptation strategies, which might be more effective to overcome critical moments.

Time: 2 hours

Step 1: Copy the first three columns of the tool 'Effect of critical moments' on a big sheet, but only for those sectors for which you consider a critical-moments assessment to be relevant. Add two other columns Coping strategies/ adaptation measures in place' to address 'climate - weather related periods of stress' and 'effectiveness' and 'suggestions for alternative (more effective) adaptation measures' (see Table 1.5.1).

Step 2: Ask respondents which coping strategies and adaptation measures they apply to overcome 'climate – weather related periods of stress' in the relevant sectors. Write these strategies/measures in the fourth column.

Step 3: Discuss the effectiveness of the coping strategies/adaptation measures to overcome the climate – weather related periods of stress (think of reasons/criteria related to reduce adverse impact of climate hazards, appropriateness, and feasibility). Write respondents' perception in the fifth column.

Step 4: In case respondents perceive current coping strategies/adaptation measures as not (sufficiently) effective, ask them if they can think of alternative options.

Please include the number of respondents involved in your field study. Indicate similarities and differences in their perceptions and stratify by gender.

Guiding questions for stakeholders at the household–community level

Please address the following questions for all identified climate-related periods of stress:

- What have you done to respond to, say, a delay in the onset of the summer monsoon, exceeding temperature, or hydrological thresholds – floods, droughts?
- Are some of these response strategies typical for women?
- To what extent do you perceive these strategies to be effective to overcome the discussed climate – weather related periods of stress?

Or more specifically:

- Have you done anything to make your rice plants more resistant to droughts during the first two weeks in June? If yes, what?
- Are you satisfied about the degree to which these measures help you make rice plants less prone to droughts?
- If not, why? Can you suggest any other measure(s) that might be more effective?

- Have you done anything to make your wheat crop more resistant to temperatures higher than 35°C? If yes, what?
- Are you satisfied about the degree to which these measures help you make your wheat crop less prone to high temperature?
- If not, why? Can you suggest any other measure(s) that might be more effective?

A similar set of questions may be asked for other critical moments:

- What coping strategies do you put into use to overcome poor quality of drinking water in May, for example? Are you satisfied about the degree to which these measures help you solve the problem?

Guiding questions for (climate) professionals and stakeholders at higher levels:

- What adaptation strategies do you or your organisation apply to respond to the periods of climate-related stresses discussed earlier?
- Are some of these response strategies typical for a specific agro-ecological zone?
- Are some of these response strategies typical for women?
- To what extent do you perceive these strategies to be effective to overcome the periods of climate - related stresses discussed earlier? What other, perhaps more effective adaptation strategies do you propose?

Table 1.5.1: Coping strategies and adaptation measures to address periods of climate-related stresses

Activities severely affected by climate hazards	Periods of climate-related stresses	Coping strategies/ adaptation measures in place to address these periods of climate-related stresses	Effectiveness + sufficient, - insufficient (Why?)	Suggestions for alternative (more effective) adaptation measures
Agriculture-food production				
Rice	First 2 weeks in June –transplantation time (due to drought and shortage of labour)	Delay transplantation by two weeks	Not sufficient, still losses in yield	Short-duration high-yield variety
Millet				
Other				
Home garden				
Pumpkin				
Animal husbandry				
Milk	June/July due to high temperature/ shortage of drinking water/ fodder	Providing additional concentrates	Yes, but not all households can afford paying concentrates	Not known
Meat	June/July due to high temperature/ shortage of drinking water/ fodder	Providing additional concentrates	Yes, but not all households can afford paying concentrates	Not known
Other domestic activities/affairs – health				
Drinking water availability	April-June, high temperature, WB> 30-31°C			
Hydropower production				
Hydropower production	June, due to floods	No measures in place yet		Embankments

Annex 1.6: Future Critical Moments

The occurrence of identified critical moments in future might change due to expected changes in timing, frequency and/or intensity of climate hazards as well as socio-economic changes. Also, new critical moments might emerge.

The tool 'future critical moments' facilitates discussion with professionals operating at higher decision-making levels as well as with RC1 colleagues about critical moments in future.

Objectives

- To discuss if and/or how the occurrence of current critical moments is likely to change due to climate change and /or other changes in the biophysical and/or socio-economic situation; and
- To discuss if new critical moments are likely to emerge due to a combination of climate change and/or other changes in the biophysical and/or socio-economic situation.

Time: 1-2 hours

Step 1: Please make sure you:

- Have listed the identified critical moments per sector for the current situation (results of previous discussions) on A4 paper;
- Bring relevant secondary data on trends in temperature, precipitation, and climate hazards on A4 or A3 paper;
- Bring figures /maps showing (climate) projection outcomes of RC1 on A3 paper; and
- Bring results of the tool 'Effect of critical moments'.

Step 2: Discuss if the respondent sees any trends in temperature, precipitation, and relevant climate hazards. Use the secondary data as input for the discussion. What does this mean for chance of exceeding temperature, rainfall, or hydrological thresholds in future?

What are the consequences for the occurrence of current critical moments? Do you foresee any new critical moments in future?

Step 3: Discuss (climate) projection outcomes for temperature and precipitation of RC1. Do these outcomes correspond with the knowledge of the respondent? What does this mean for the current critical moment in terms of likely change in occurrence?

Step 4: Discuss the question 'what will be the effect on current critical moments, if climate related stresses will increase in frequency and/or intensity?' Do you foresee new critical moments to occur? If yes, when will they occur and for which sectors? Use Table 6 to document your results, but skip those sectors not considered relevant.

Please include the number of respondents involved in your field study. Indicate similarities and differences in their perceptions and stratify by gender.

Guiding questions for (climate) modellers and other (climate) professionals

- If any, which trends do you see in temperature, precipitation, and relevant climate hazards over the last 10 years? What does this mean for the future of current critical moments? (Change in timing, frequency, intensity, and so on.)
- Climate models project an increase in air temperature of 2-40 C in 2050; what does this mean for the current critical moments?
- Women mention that they can't sleep well when the night temperature exceeds 350 C. Three consecutive nights with temperatures higher than 350C reduce their labour effectiveness. What do recent observation data show? How often has the critical threshold of three consecutive nights with a temperature > 350C been reached in the last 10 years? Is its frequency likely to change in the future due to climate change?

- Climate models project a shift in monsoon patterns; what does this mean for the current critical moments? (for agriculture, health, hydropower production particularly?)
- Farmers report that the 2 weeks around the sowing of rice are very critical. They need at least 100 mm of rain during this period. What do recent observation data show? How often has the critical threshold of 100 mm during July been reached in the last 10 years? Is its frequency likely to change in the future due to climate change?

Table 1.6.1: Possible future critical moments

Activities severely affected by climate hazards	Current critical moments	Possible future critical moments (2050)
Agriculture – food production		
Rice	First 2 weeks in June –transplantation time (drought – shortage of labour) (Chitwan, Nepal)	Late arrival of monsoon is likely to happen two times more frequently in 2050 (give reference)
Wheat		
Other		
Home garden		
Pumpkin		
Animal husbandry		
Milk	June/July due to high temperature/ shortage of drinking water/ fodder	Temperature is likely to increase by 4^{0}C in June-July (give reference)
Meat		
Tourism		
Running lodges	June (local flood, roads sensitive to landslides	Uncertain
Guiding, working as porter	June (local flood, roads sensitive to landslides)	Uncertain
Other domestic activities/affairs – health		
Drinking water		Late arrival of monsoon is likely to happen two times more frequently in 2050 (give reference)
Hydropower production		
Production	Beginning of June due to floods	Uncertain

Annex 2: Critical Moments-Assessment Report

Time – venue – research team members

- Indicate date and venue where the critical-moments assessment has taken place
- Mention names of research team members
- Mention the name of the person who recorded the process and results
- Mention the location on the CARIAA website where the report is stored

Pictures

Please add pictures of research site, interview process, effects of critical moments, and so on

Respondents involved

- Indicate number of people involved in the focus group discussions or semi-structured interviews (including number of men, women, elderly, youth) and mention type of stakeholder (community member, NGO, policy maker, climate scientist, and so on) (use Table 1.1.1)

Secondary data used

- List used secondary data sources (full references)

Assessment of critical moments

- Try to quantify qualitative responses by counting similar and different perceptions of respondents. Stratify per gender
- Describe and discuss the potential critical moments for agriculture, health and if relevant for hydropower production. Include Tables 1.2.1, 1.3.1 and 1.4.1
- Describe and discuss the current true critical moments and indicate how these critical moments vary across different social groups, within a household, and across domains and agro-ecological zones. Include Table 1.5.1
- Describe and discuss potential future critical moments and indicate how these critical moments might vary across different social groups, within a household, and across domains and agro-ecological zones. Include Table 1.6.1

Learning

Reflect on process and outcomes and draw conclusions on the following points:

- Classification of critical moments for types of farm enterprises, stratified per gender, for different agro-ecological zones and / or for different sectors;
- The extent to which the application of the critical-moments concept generates deeper insight into vulnerability, actionable knowledge and better tailored adaptation options for communities and adaptation planners;
- Different perceptions of critical moments. Who should decide what a critical moment is (local people experiencing a critical moment or researchers from outside)?

- Timing of critical moments: What if people experience a critical moment at a time that may not coincide with a particular climate stress, like when crops fail some time after a critical frost event earlier in the year; and
- The extent to which a critical-moments assessment is able to capture the dynamics and temporal evolution of climate change and variability and how it will affect critical moments.

The relationship between critical moments and other concepts in HI-AWARE such as 'adaptation turning points' and 'adaptation pathways' (RC5)

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