Integrating the concept of limits in adaptation planning for the sector of agriculture

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Integrating the concept of limits in adaptation planning for the sector of agriculture

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Abstract: This report outlines how the concept of limits to adaptation can be integrated into plans of the sector of agriculture.

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1. Why are limits to adaptation relevant for adaptation planning?

In the PROVIDE project (Paris Agreement Overshooting: Reversibility, Climate Impacts and Adaptation Needs), we look at what a temporary global increase above 1.5°C, namely an overshoot, means both for mitigation and adaptation measures.

In this report, we focus on how limits to adaptation can be integrated into sectoral plans under potential overshoot scenarios, specifically the sector of agriculture. Alongside this report, we have released two additional reports: one that looks into how limits to adaptation can be integrated into plans for the sector of infrastructure under overshoot and another one that discusses the importance of overshoot proofing adaptation plans and policies more broadly.

Adaptation to climate change has progressed in recent years but gaps between the levels of implementation and risks and impacts remain prominent[1]. Adaptation processes face numerous constraints and limits which hinder effective risk reduction. One of the concepts that is rarely considered in adaptation planning are limits to adaptation. The IPCC defines them as the points at which actors' and systems' needs can no longer be secured from intolerable risks[2]. Limits can be either soft (can temporarily not be overcome) or hard (will never be overcome).

Limits to adaptation are hard to identify, both due to their contextual nature and to the lack of scientific information available. Limits can be determined by biophysical characteristics but can also be set by decision-makers, for the limits that are closely linked to socio-economic aspects. For example, trees that have been planted in a city to cool specific streets but that cannot withstand the higher temperatures experienced due to global warming and therefore no longer cool the streets are an example of a biophysical limit. A socio-economic limit would occur when policy-makers are no longer able to invest in the construction of sea walls protecting a coastal city due to their high cost.

Limits to adaptation are relevant already today, as the IPCC reports that hard limits have been reached in some ecosystems and that soft limits are mainly caused by finance and governance constraints. They will be increasingly important to consider as global warming progresses and further limits are reached. When potential overshoot scenarios are taken into account in adaptation planning processes and risk assessments, it is essential to look into when limits to adaptation may be reached to adequately time the implementation of adaptation measures required in a changing climate. For this, adaptation pathways can be used, defined by the IPCC as "a series of adaptation choices involving trade-offs between short-term and long-term goals and values"[2]. They are seen as processes allowing to identify solutions that avoid potential maladaptation and are meaningful in specific contexts. In this report, we exemplify how this can be done below.

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[1] UNEP Adaptation Gap Report, 2023: https://unepccc.org/adaptation-gap-report-as-climate-impacts-accelerate-finance-gap-for-adaptation-efforts-at-least-50-bigger-than-thought/

[2] IPCC glossary: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Annex-II.pdf

2. Limits to adaptation in the sector of agriculture

The remainder of this report focuses on the sector of agriculture, more precisely on the adaptation of farmed cattle to heat stress.

Due to the lack of precise scientific information and the novelty of these concepts for adaptation planners and practitioners, we focus on illustrative examples that are not backed by quantitative numbers.

2.1. Adaptation of cattle to heat stress

Similarly to humans, animals and thus cattle are increasingly exposed to heat stress with rising global temperatures. Heat stress for cattle tends to occur when temperatures reach above 25°C, as this is when cattle step out of their 'thermoneutral' zone[3]. Cattle remain a major source of global food production and livelihoods of farmers currently are being impacted by climate change. In the EU, cattle farming is a highly relevant economic sector.

Based on our desk-research of documents available online, the main EU recommendations for this topic focus on the transport of cattle during extreme temperatures[4]. The Transport Guide for Extreme Temperatures highlights that the thermal conditions tolerated by the cattle varies with the types and ages of the animals and provides recommendations on how to manage heat during transportation. Nevertheless, it also states that the transportation of cattle is not allowed if the forecasted outside temperature along the route is > 30°C.

In this example, we look at outdoor cattle farming and what potential limits might be reached in the face of climate change.

2.2. Potential limits to adaptation

Through a published review on adaptation of animals to heat stress[5], we identify the negative impacts that climate change could have on livestock production. We argue that these negative impacts can also be framed as limits to adaptation and threaten the livelihoods of cattle farmers. The table below presents a non-exhaustive list of these potential limits.

Limits to adaptation for cattle farming
• Reduced cattle growth • Reduced milk production (yield and quality) • Reduced meat production • Increased disease occurrence (e.g. vector-borne diseases) • Economic losses from reduced production • Death of the cattle

[3] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4823286/
[4] https://food.ec.europa.eu/system/files/2019-11/aw_platform_plat-conc_extreme-temp-factsh-cattle.pdf
[5] https://www.sciencedirect.com/science/article/pii/S1751731118001945

2.3. Adaptation options available

The same publication[5] identifies a non-exhaustive list of potential adaptation options available for cattle presented in the table below.

Categories	Examples of adaptation options
Animal housing management	• Shade • Shelter design • Cooling systems • Forced ventilation
Nutritional interventions	• Seasonal specific feeding • Fibre feeding • Feeding fats and concentrates • Vitamin and mineral supplementation • Providing cool drinking water
Genetics and breeding	• Studying genetic diversity • Genetic selection for thermo-tolerance through genomic and proteomic approaches • Embryo transfer • Developing stress- resistant breeds
Animal health management	• Monitoring and control of disease outbreak • Epidemiological surveillance measures • Rapid investigation of outbreaks • Using geographical information system for mapping the disease outbreak • Laboratory/field research to find solution to the climate-associated disease outbreak

2.4. Illustrative adaptation pathways

To design scientifically sound adaptation pathways, the duration of the benefits and effectiveness of adaptation measures must be considered and, consequently, limits to adaptation should be identified. In addition, the lead time needed for full implementation and effectiveness of the measures must be considered when looking at these timelines[6].

In *Figure 1*, we illustrate how Adaptation option 1 (cattle cooling themselves down under the shade from trees and a built shelter) can reach a limit to adaptation based on an identified projected quantitative impact level, for example a maximum number of extreme heat days for which these two measures sufficiently cool the cattle. The graph indicates that this limit (model median) will be reached around 2030, when another more transformational adaptation option should be in place (Adaptation option 2).

In this example, we suggest that farmers could look into introducing a new cattle breed that has higher thermal-tolerance to face increasing heat. The orange dotted line illustrates the planning and implementation time needed before this measure is effective.

[6] https://doi.org/10.1007/s40641-020-00166-8

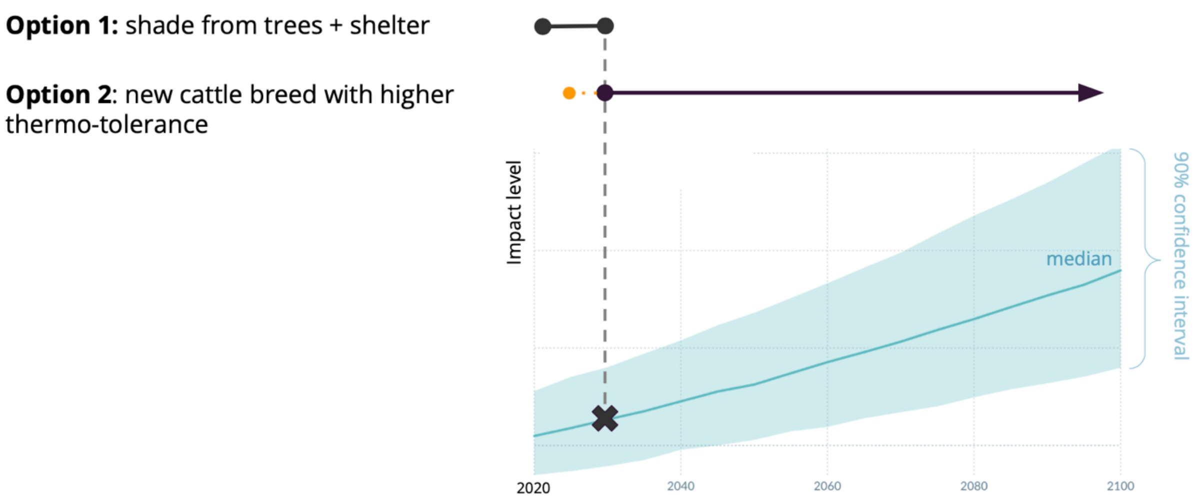

Figure 1: Representation of an illustrative pathway for cattle farming adapting to heat stress

Figure 2 uses the same example as *Figure 1* but additionally highlights the uncertainties arising from impact projections (red dotted line). It shows that not only should the median value be considered (represented by the blue line) but also a range of results provided by the various climate models used to calculate the median value (represented by the light-blue coloured area). Here, the light-blue coloured area shows the 90% confidence interval that illustrates the breadth of model uncertainty.

Decision-makers and planners must therefore be aware that there is a likelihood that this specific impact level (that in this example corresponds to an adaptation limit) arises earlier or potentially also later than indicated by the median value (in this case within a range between 2010 and 2060).

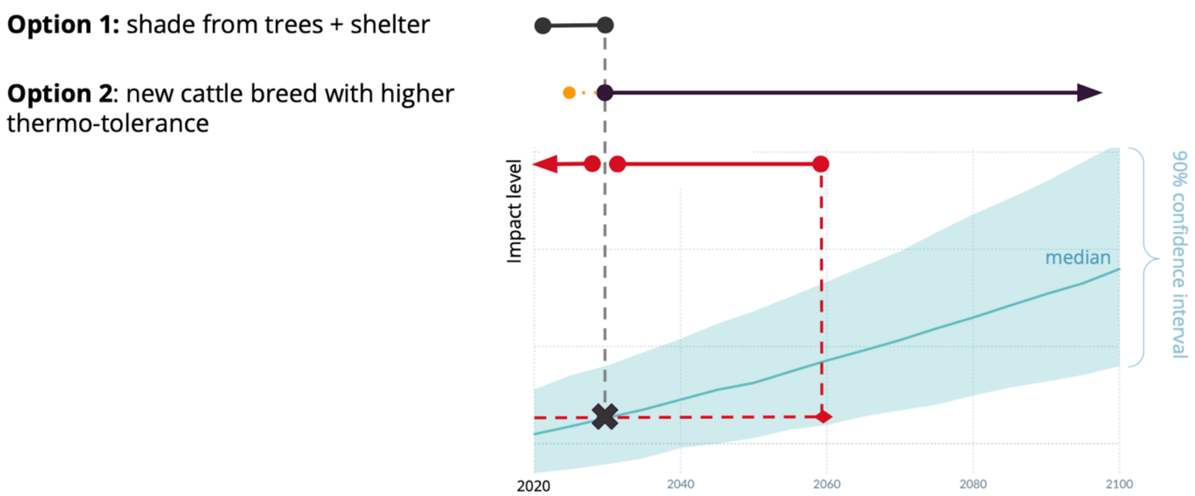

Figure 2: Representation of an illustrative pathway for cattle farming adapting to heat stress, including the uncertainties arising from modelled impact projections

The graph used for illustration purposes in *Figure 1* and *Figure 2* is extracted from the Climate Risk Dashboard, an interactive online platform providing detailed information on different future global warming scenarios and their expected impacts on the climate, natural, and human systems. Relevant scientific information for adaptation planning and designing adaptation pathways can be found through this tool.

3. Key takeaways

In this report, we stress the importance of considering limits to adaptation when planning adaptation projects or policies, in particular under potential scenarios of further increasing global warming such as overshoot scenarios. We also illustrate how adaptation pathways can be used to adequately plan adaptation measures ahead by considering limits to adaptation.

Information on limits to adaptation should be included during the planning phase of projects, when conducting risk assessments or climate stress tests for example. Monitoring and evaluation processes can also provide an opportunity to evaluate the adequacy of the plans and re-design or adjust them if necessary.

Despite the limited scientific information available on limits to adaptation currently, we expect the Climate Risk Dashboard to ease this constraint for a wide range of sectors and contexts. For the agricultural sector, we expect a number of indicators to be particularly relevant, namely: minimum and mean soil moisture content, hot and cold extremes, hottest temperature of the year/month and yield changes relative to selected years for maize, soy, wheat and rice.

Finally, it must be noted that limits to adaptation are just one of the many concepts that must be taken into account for sound adaptation planning that avoids maladaptation.