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Trends and the Future of Livestock Production Systems under a Changing Climate in Africa

Figure 1: Grazing herd. Source: CCAFS, 2019

KEY MESSAGES

1. **There are diverse livestock production systems in Africa.**
2. **Livestock production has the greatest potential to meet food needs, maintain ecosystem health and abate negative impacts of climate change in the African drylands.**
3. **Expected climate scenarios including increased temperature, rainfall uncertainties and more extreme weather events will have far reaching implications on livestock production systems and therefore food security in Africa.**
4. **Advancements in breeding, nutrition and animal health will have significant influence on livestock sector transformation.**
5. **Gender plays important role in the livestock sector across the continent and will need to be addressed when transforming the livestock systems.**

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Introduction

Livestock production plays a crucial role in providing employment, ensuring food supply and as a source of foreign exchange earning in many countries in Africa. It contributes 20 to 50% of the agricultural GDP across countries, with a continental average of 26%. About 60% of Africa's land surface is classified as drylands, with low and highly variable annual rainfall and high temperatures. This makes livestock production in the form of pastoral and agro-pastoral systems a major land use and source of livelihood for over 270 million people in the continent's drylands. It accounts for about 30% of the gross value of agricultural production in Africa, of which 92% comes from production of beef cattle, dairy cattle, goats, sheep and chicken (IUCN, 2010).

The livestock sector in Africa is fast changing, owing to the effects of climate change and the growing demand for livestock products. The current and projected changes in climatic systems are expected to have direct and significant effects on the livestock systems. These projections, for instance have indicated that smallholder mixed crop-livestock systems are, and will remain, the main producers of ruminant products to 2050, under all scenarios (Herrero *et al.*, 2014).

Overview of major livestock systems in Africa

Livestock production occurs under diverse systems across the continent, influenced mainly by climate, landscape and socioeconomic factors. Broad categories of the production systems are: grazing systems, mixed farming systems and industrial systems. (FAO, 2009) (Figure 1). It is estimated that 70% of livestock production in Africa occurs in smallholder systems, and are characterized by large animal numbers and low inputs and outputs. Climate change affects these systems differently.

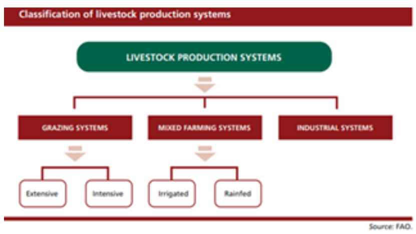

Figure 2: Classification of Livestock Production systems. Source: FAO (2009)

Extensive grazing systems cover most of the dry areas of Africa that are marginal for crop production. Such

areas tend to be sparsely populated. These systems are characterized by ruminants (e.g. cattle, sheep, goats and camels) grazing mainly on grasses and other herbaceous plants, often on communal or open-access areas and often in a mobile fashion (Pastoralism). **Intensive grazing systems** applies more advanced pasture management practices, including the rotation of cattle in several smaller paddocks instead of continuously grazing one or two large paddocks. A **mix of livestock production systems** bears great potential to meet the subsistence needs of people, maintain ecosystem health and minimize the negative impacts of climate change. Traditional pastoral and agro-pastoral systems and industrialized systems have different capacities to adapt to climate change. Pastoral systems have often been defined by their adaptive capacity and can only have survived in highly uncertain and climatically extreme environments by being very adaptive. Figure 3 indicates the distribution of the livestock production systems across Africa.

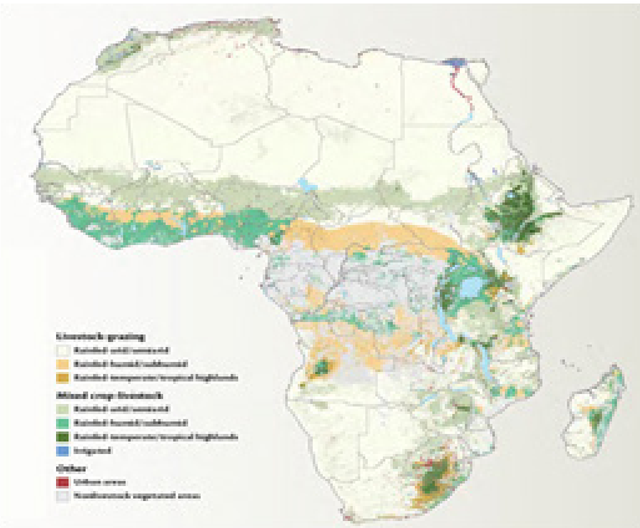

Figure 3: Livestock production systems in Africa by climate zone. Source: Robinson et al., (2011)

Climate change and livestock sector in Africa

The rangelands, where livestock production is a major land use practice and source of livelihood are increasingly facing population pressure and resource competition, resulting in further constraints on grazing resources and already stressed ecosystems.

[1]Simpkin P, Cramer L, Ericksen P, Thornton P. 2020. Current situation and plausible future scenarios for livestock management systems under climate change in Africa. CCAFS Working Paper no. 307. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Climate change and livestock production influence one another both directly and indirectly (Figure 4). It is therefore imperative to understand the inter-relationship impacts on each other, particularly in the context of Africa.

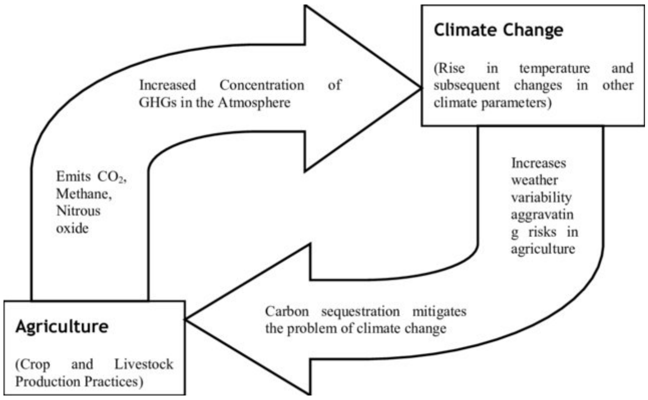

Figure 4: Inter-linkages between agriculture and climate change. Source: Krishna Pant (2009)

i. Impact of climate change on livestock production

Temperatures rise, shifts in rainfall patterns, increase in extreme weather events and reduced water availability are expected to increasingly affect livestock production systems. Occurrence of livestock and zoonotic diseases is likely to increase with climate change resulting to alteration in the abundance, spread and transmission of animal pathogens (FAO, 2018) (Table 1).

	Grazing systems	Non-grazing systems
Direct impacts of climate change	- increased frequency of extreme weather events - increased frequency and magnitude of droughts and floods - productivity losses resulting from physiological stress due to higher temperatures - change in water availability, which may increase or decrease depending on the region	- change in water availability, which may increase or decrease depending on the region - increased frequency of extreme weather events, with impact being less acute than for extensive systems
Indirect impacts of climate change	- Agro-ecological changes and ecosystem shifts leading to: - alteration in fodder quality and quantity - change in host-pathogen interaction resulting in an increased incidence of emerging diseases - disease epidemics	- increased resource prices (e.g. feed, water and energy) - disease epidemics - increased cost of animal housing (e.g. cooling systems)

Impacts of livestock production on climate change

The livestock sector contributes significantly to climate change through emission of greenhouse gases, including carbon dioxide (CO2), methane and nitrous oxide. Estimates show that livestock sector in Africa contributes over 70% of the total GHG emissions, mainly due to methane and nitrous oxide emissions, two particularly potent GHGs, predominantly from cattle and their manure. This contribution occurs either: **directly** through (i) enteric fermentation from ruminants and on-farm fossil fuel use and (ii) manure management from methane and nitrous oxide or **indirectly** through

(i) land use and land-use change (CO_2 emitted from the replacement of forest and grasslands) (ii) feed production (CO_2 emissions from fossil fuels used in manufacturing chemical fertilizer and pesticides).

These adverse interactions between climate change and livestock production exacerbate complications in the livestock sector considering the increasing demand for livestock products (Herrero *et al.*, 2014). This further raises the question on how to maintain a balance between productivity, household food security and environmental conservation.

Drivers of transformation in livestock systems

Understanding long-term changes and projections in livestock systems and their drivers and effects on socioeconomic systems is important in informing policy and development actions towards sustainable livestock systems. Some of the key factors that will influence transformation in the livestock systems in Africa include:

i. Increasing demand for livestock products (livestock revolution): Projections indicate that the global population will rise up to about 9.15 billion, with most growth expected in developing countries. Secondly, unprecedented urban growth is expected in Africa, which will have considerable impact on patterns of food consumption, particularly those from livestock. Thirdly, income growth will be accompanied by a rise in expenditures on livestock products. These three factors will continue to create overall increase in livestock products and production systems, commonly referred to as the livestock revolution. FAO projects extra 80% and 200% increase in meat demand in developing countries by 2030 and 2050, respectively under business as usual scenario.

ii. Production response: Growing livestock production is accompanied by substantial land use changes in the area of arable land, pastures and forests. Increase in livestock production will be based on rise in livestock numbers in Africa, particularly ruminants. Large increases expected in Africa will be due to increase in production of maize, sorghum and millet, which provide a key source of feed. Livestock system evolution in the coming decades is inevitably going to involve trade-offs between food security, poverty, equity, environmental sustainability and economic development (Thornton, 2010).

iii. Breeding: Selection of breeds and cross-breeding techniques has been conventionally used to increase livestock productivity. New tools of molecular genetics will have far-reaching impacts on livestock production systems in Africa. Preservation of local animal genetic resources will influence livestock adaptation and systemic changes such as disease prevalence.

iv. Nutrition: Knowledge on science of animal nutrition continues to expand and develop. There are prospects that novel feeds from various sources will be used to provide alternative sources of protein and energy. Mixed crop–livestock smallholder systems are likely to intensify. The need to mitigate GHG emissions through improved feeding practices that reduce methane emissions per unit feed intake will also influence livestock production in Africa.

v. Disease: Livestock and zoonotic diseases generate a wide range of biophysical and socio-economic impacts that may vary spatially. Infectious disease threats are diverse and dynamic, and will be greatly modified by climate change.

Figure 5: Drivers of transformation in the global livestock sector. Source: FAO, 2018

Future Trends, Challenges and Opportunities in the Livestock Sector in Africa

Future trends in livestock production in Africa

Livestock production in Africa is increasing and is to continue due to the surging global demands of

livestock products. Increased livestock production will be achieved through various processes and intensification strategies, supported by technological advancement. However, increasing livestock production is expected to result into higher economic and environmental cost. The conditions for effecting production growth, such as high technological change potential in livestock and crop yields, lower costs, and adequate product prices, vary across the continent. For instance, conditions will be highest for milk production in East and West Africa, for monogastrics in West Africa and for ruminant meat in East Africa (Figure 6).

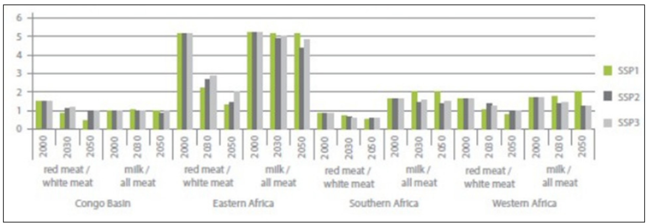

Figure 6: The ratios of red to white meat, and milk to meat consumption by SSA sub-region and SSP scenario to 2030 and 2050. Source: Herrero et al., (2014)

Population increases and relatively lower economic growth would force SSA towards a greater trade dependency to fill demand gaps. Maintaining business as usual trends would lead to a doubling of imports of milk and monogastric products relative to production by 2050 and potentially, to an increase in imports for ruminant meats from about 2% in 2000 to about 16% in 2050 of the shares of production. Any negative deviation from the current trend in terms of production efficiency, prices and GDP growth would make livestock sector in SSA largely uncompetitive, negatively affecting production and consumption (Herrero *et al.*, 2014).

Among the various livestock production systems, the smallholder mixed crop-livestock systems remain the main producers of ruminant products until 2050, under all scenarios. Pastoral and the mixed crop-livestock systems in more humid areas are likely to increase the production of meat and milk by 4 to 8 times relative to 2000 production. This will be due to increased livestock and crop production under these systems as well as a result of expected expansion of grassland and cropland. In the case of monogastrics, most expansion of production in all scenarios will be through industrial production systems. Majority (67%) of monogastric production in Africa still come from smallholder systems. It is projected that industrialization's share will rise from the 33% in 2000 to about 80% by 2050, regardless of the scenario chosen.

Pastoral and agro-pastoral systems in ASALs are likely to contribute to large increases in milk production. This indicates that it is in those systems that have a low baseline production where significant improvements in productivity, resource-use efficiency and GHG intensities can be made at low cost through improved technology. Under effectively enabling socioeconomic conditions and technology to reduce costs and increase productivity, with modest expansion to guarantee feed sources, pastoral systems in ASALs could triple production of cow's milk and increase small ruminant milk and meat production by a factor of 5 or 6 relative to the production levels of 2000.

Challenges in future livestock production in Africa

The challenges can be grouped into climate change and non-climate change related challenges

i. Non-climate change related challenges

Cultural factors and community involvement, institutional capacity, governance, finance and technology aspects are key barriers or enablers of transformation of livestock sector in Africa. Overall "multiple stressors" in development of livestock sector in Africa include poverty; limited human and economic resources; poor infrastructure; land degradation; limited livelihood diversification and low adaptive capacity; limited technological options; conflict over resources and governance challenges (FAO *et al.*, 2018). Thus, multi-pronged and cross-sectoral approaches may be required to ensure success. (Figure 7).

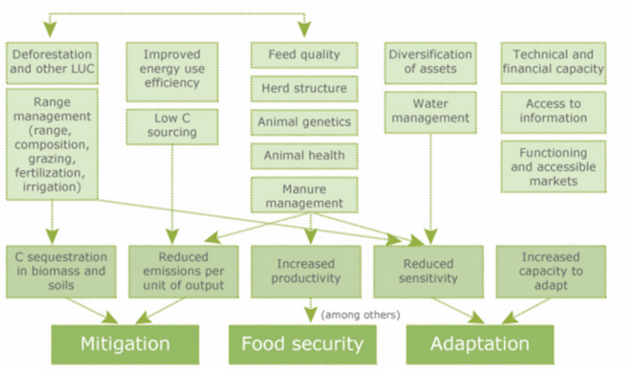

Figure 7: Summary of technical and institutional determinants of climate-smart livestock production. Source: Gerber, 2013

ii. Climate change related challenges:

1. Increasing demand and pressure on pasture and water resources, which are the primary source of feed for grazing systems due to increasing livestock numbers and degradation of natural resources. This will be exacerbated by expected decline in grassland productivity as well as water and heat stress resulting from expected temperature rise.

2. Livestock intensification problems – rising animal products in global diets restricts overall agricultural efficiency gains due to inefficiencies in conversion of agricultural primary production (e.g., crops) in the feed-animal products pathways, offsetting the benefits of improvements in livestock production systems.

3. Increased future risk of zoonotic disease outbreaks, including emerging and re-emerging infectious diseases (EIDs).

4. Significant number of smallholders will increasingly exit the livestock sector and migrate to urban areas searching for employment opportunities.

5. Biodiversity loss including changes in land-use for food production, livestock feed, afforestation, fibre and bioenergy production, carbon storage, biodiversity and other ecosystem services as well as human settlements.

Opportunities in future livestock production systems in Africa

It is clear that there will be shifts in livestock production systems and expansion in livestock markets for livestock keepers and other chain players due to the growing demand for livestock food products. Some of the opportunities that come with this livestock revolution include:

i. Opportunities for supporting industrialization of livestock systems. These include feed and fodder production, improved breeds, feedlots and fattening; abattoir and butchery business; dairying and milk processing; restaurants and catering services; meat and milk retail and wholesale; hides and skins processing and value addition; biogas development; livestock and animal product transport and storage.

ii. Mitigation opportunities – the changes in the livestock sector could mitigate 0.12–0.25 GtCO2-eq yr-1.

iii. Improved market access and off-farm income generation opportunities through certification schemes, price and credit initiatives and the increased use of ICT and digital solutions to reduce transaction costs and improve production efficiencies and financial and market information.

Gender perspectives in livestock production and climate change

Climate change affects men and women disproportionately due to differences in their socially constructed roles and responsibilities. Gender dynamics in Africa are important factors that determine access and use of various resources. The extent of men and women participation in livestock production is largely dependent on the way responsibilities are allocated among men, women and youth. Women and youth are more vulnerable to climate change in agriculture and livestock keeping, as they often have less access to information, markets, credit or insurance, technologies and extension services and grazing resources.

The gender-differentiated impacts of climate change indicate variation in their adaptive capacities and exposure to climate risk and changes in access to and management of natural resources. With increasing variation and restructuring of the livestock production systems, men and women will be affected and respond differently to the new norms. However, their collective efforts will make substantial impact in enhancing the overall improvement in the livestock sector.

Empowering women in family farming. Source https://farmingfirst.org/women-iyff14

Case Study 1: Gender aspects in pastoral livestock management

Livestock is key source of livelihood for millions of people in Africa, especially in drylands. Livestock is often one of the few sources of income over which women have complete control, and such smaller livestock can have significant implications for household nutrition, income and health. Women do not have equal access to trainings and other resources for livestock rearing, hindering their effective engagement in livestock production. For example in Niger, CARE's Adaptation Learning Programme (ALP) developed innovative community-based adaptation strategies with pastoralist communities, assessing the implications for women, men, households and community as a whole, in terms of time, labor, resources and social relations. Different roles and responsibilities were then negotiated between women and men in the communities to encourage a more sustainable and equitable division of labor as part of increasing the adaptive capacity of the community as a whole. These interventions worked together to improve women's livelihoods and place in society and built community resilience.

Options to improve livestock management in Africa

Policy interventions

Global, continental, regional and national policies, play an important role in livestock sector development in Africa. They outline the development pathways that enable public and private sector investments and interventions.

Several *continental and regional level* policies and declarations have identified strategies for development of the livestock sector in Africa. For example, the Africa Agenda 2063 (2013-2063) calls for a paradigm shift in development approaches to build on the current positive economic prospects. One of its focus areas is to support modernisation of African agriculture and agri-businesses, including the livestock sector. The Comprehensive Africa Agriculture Development Programme (CAADP) which is the continental policy blueprint for improving agricultural production and productivity in the continent under the African Union Development Agency(AUDA-NEPAD) has identified livestock priority actions under each of its pillars. The Abuja Food Security Declaration (AU, 2006) declared a firm commitment in increasing Intra-African trade including livestock products. Others include: The Malabo Declaration (2014), Continental Programme for Sustainable Development of Livestock in Africa, Policy Framework for Pastoralism in Africa (PFPA) and the Maputo Decleration (2003).

The Sub-regional and national policy interventions include COMESA Regional CAADP Compact and COMESA Regional Livestock Policy framework (2015); EAC Livestock Policy and EAC Regional CAADP; ECCAS/CEMAC Level Agriculture and Livestock Policies; The Strategic Action Plan Development and Transformation of livestock sector in the ECOWAS; IGAD CAADP; IGAD Drought Disaster Resilience and Sustainability Initiative (IDDRSI); SADC Regional Agricultural Policy (2013). Countries have also established various national level climate change policies based on national circumstances. This hampers harmonization at the regional level. Countries are implementing various development and climate risk management projects in the livestock sub-sector.

Technical interventions

Countries and sub-regions are also undertaking various non-policy development programs with a view to build climate resilience in the livestock sector using Climate-Smart Livestock Interventions. Some of the interventions include:

1. Promotion of livestock feed-related climate smart interventions such as forage access and quality improvement through fodder cultivation and conservation and integration of forage legumes into arable crops.

2. Grazing and rangeland management practices have also been promoted to contribute to food security and agricultural productivity. These include controlled grazing by managing stocking rates, rotational grazing to allow rejuvenation of grasses on grazing land, ensuring surface cover and controlling erosion while increasing fodder productivity.

3. Agricultural water management strategies have been promoted to minimize unproductive water losses, increase soil water holding capacity and bridge crop water deficits during dry-spells including rain water harvesting techniques.

4. Livestock production management approaches are also in place to enhance animal productivity, improve feed conversion efficiency and thereby reduce enteric emission intensities.

These include herd management through diversification of their livestock species and transhumance practice, breeding strategies to strengthen local breeds that are well adapted to the local climatic stress and improving local genetics through cross-breeding for more climate resilient breeds.

Case study 2: Additive impacts of climate-smart agriculture practices in mixed crop-livestock systems in Burkina Faso

In four farms representative of the area, crop and animal production, income and food security indicators have been simulated, with all combinations of four interventions: i) Optimized crop residue collection; ii) Improved allocation of existing feeds, iii) Crop fertilization; iv) Animal supplementation. The modeling framework used was based on three existing dynamic livestock (Livsim), crop (Apsim) and household (IAT) models. A 99 years current climate series was generated with the climate generator Marksim to assess the impacts of climate variability. The simulations indicated that collection of crop residues improves significantly the food security indicator in one farm because it enables the development of cattle production, whereas the effects were moderate in the three other farms. Low amounts of fertilizer have a significant effect, but the simulations showed decreasing yield returns and the higher downside risk in the bad years. Improved feed allocation strategies with available resources have a positive effect, which is as important as supplementation with additional feeds. The impacts of the tested interventions are additive and synergistic, because increased crop residues production with fertilization creates opportunities for optimized feeding. As a consequence, in the four farms, the highest income and kilocalorie production were obtained with a combination of interventions enhancing synergies between the crop and the livestock systems. The household yearly probabilities to be food secure also increases by up to +26%, suggesting increased resilience toward climate variability. The study concluded that the best options for adapting mixed crop-livestock systems might be found in the synergies between their components, rather than in single interventions. Adapted from: Amole & Ayantunde, 2016

Case Study 3: Eradicating tsetse flies in Zanzibar using the sterile insect technique

In Africa, tsetse flies transmit parasites which cause trypanosomosis, a disease which is deadly for humans and livestock. It is estimated that tsetse flies and trypanosomosis cause over US$1 billion in losses of livestock and US$4-5 billion in lost potential (when animals are weakened by the disease) every year. Drugs and insecticides are of limited success in preventing trypanosomosis in livestock, since drug resistance is increasing and these chemicals are costly. The sterile insect technique (SIT) is a biotechnological tool which has been used with success to combat tsetse flies in Zanzibar. This technique involves producing sterile male insects – usually by irradiation – and introducing them into the environment. The large numbers of sterile males out-compete wild males and mate with wild females who consequently do not produce offspring. Molecular genetics approaches can be used to study the degree of movement of genes between insect pest populations to determine whether or not the populations are isolated. This enables better planning of interventions, since SIT is much more effective in eradicating isolated populations of insects. In Unguja Island, Zanzibar, SIT was used successfully to eradicate tsetse flies in the 1990s. 110 000 sterile males were released each week at the peak of the campaign, which eradicated the tsetse flies in less than three years, and has increased agricultural productivity significantly due to the increased availability of livestock. For example, from 1999 to 2002, there was a 30 percent increase in the average monthly income of farming households, strongly correlated with milk yields and the use of animal power.

Conclusion and Recommendations

Conclusion

Livestock production remains a key land use practice and means of livelihood, particularly in the expansive arid and semi-arid regions in Africa. It is practiced under diverse systems, which are differently influenced and affected by climate change. The livestock sector holds great potential in meeting the food needs which continues to rise across the continent, despite numerous adverse effects of climate change. Climate change will certainly affect livestock production, and significant shifts are expected across the production systems. Several intervention options exist to increase and create effective shifts in future livestock systems. Intensification in production is expected to be the main contributor to bridging the gaps in livestock food needs. All gender groups including men, women and youth have an important role to play in transitioning Africa's livestock sector.

Recommendations

1. **Support breed improvement** in both indigenous and exotic breeds that are driven by socioeconomic and environmental exigencies to improve their productivity and climate resilience.

2. **Enhance integrated livestock systems,** taking into consideration social, economic, health and environmental dimensions.

3. **Enhance water and pasture management** technologies and practices to cushion pastoral and agro-pastoral production systems.

4. **Strengthen models for forecasting climate fluctuations** and extreme weather events, as well as frameworks to increase information access and disease monitoring in the livestock sector to enable informed decisions.

5. **Develop frameworks and models** that will enhance and incentivize financing and private sector investment in the livestock sector.

Further reading

FAO.2018. Shaping the future of livestock sustainably, responsibly, efficiently. Link: http://www.fao.org/3/i8384en/I8384EN.pdf

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IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

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