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Integrated approaches to understanding and reducing drought impact on food security across scales

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Understanding the cross-scale linkages between drought and food security is vital to developing tools to reduce drought impacts and support decision making. This study reviews how drought hazards transfer to food insecurity through changes in physical processes and socio-environmental systems across a wide range of spatial and temporal scales. We propose a multi-scale, integrated framework leveraging modeling advances (e.g. drought and crop monitoring, water-food-energy nexus, decision making) and increased data availability (e.g. satellite remote sensing, food trade) through the lens of the coupled human–natural system to support multidisciplinary approaches and avoid potential policy spillover effects. We discuss current scale-dependent challenges in tackling drought-induced food security whilst minimizing water use conflicts and environmental impacts.

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Introduction

Recent decades have witnessed substantial strides in increasing global food production. Yet we still face challenges to feed 9.8 billion people by 2050, especially over drought-prone and dry areas of the developing world. For example, in sub-Saharan Africa, food crises are periodically triggered by droughts, and could be further exacerbated by other compounding factors (e.g. heat waves, floods, conflict). Over the last five decades, food production shocks (i.e. sudden losses) have become more frequent across all regions and all food sectors [2•]. Half of these shocks are caused by extreme weather [2•] with disproportionate effects on countries with low coping capacity, such as the ability of farmers to diversify food production or the ability of governments to import food or provide insurance. For instance, the 2017 Kenya drought led to a national emergency and left 2.5 million people facing food insecurity [3]. With more effective adaptation strategies and actions, the impact of elevated drought risk due to climate change [4,5] can be reduced and help facilitate progress towards hitting the second United Nations Sustainable Development Goal (SDG) (i.e. zero hunger). Synchronous challenges are emerging if multiple inter-related SDG goals are to be achieved simultaneously (e.g. SDG2 to ensure food security, SDG6 to ensure water security, SDG13 to foster resilience), as they interact across a range of spatial and temporal scales, leading to diverse trade-offs, synergies and even competing policy responses with impacts that are also scale-dependent [6••]. Understanding such cross-scale interactions is key for policymakers and stakeholders to develop adaptation policies that can effectively reduce the impacts of drought on agricultural production, and to increase societal resilience to future drought-induced emergencies, while still meeting competing demands and enhancing environmental sustainability.

Figure 1 conceptualizes a range of potential food security outcomes, for the example of Zambia, driven by cross-scale interactions of a range of plausible physical and socio-economic scenarios. The effect of drought (or other hazards) on individuals and communities depends on both the direct impact of the drought on local food production and the response of trade networks and institutions to drought occurrences (e.g. aid/relief organizations), which are reliant upon domestic infrastructure to move food resources. The impacts of droughts are also