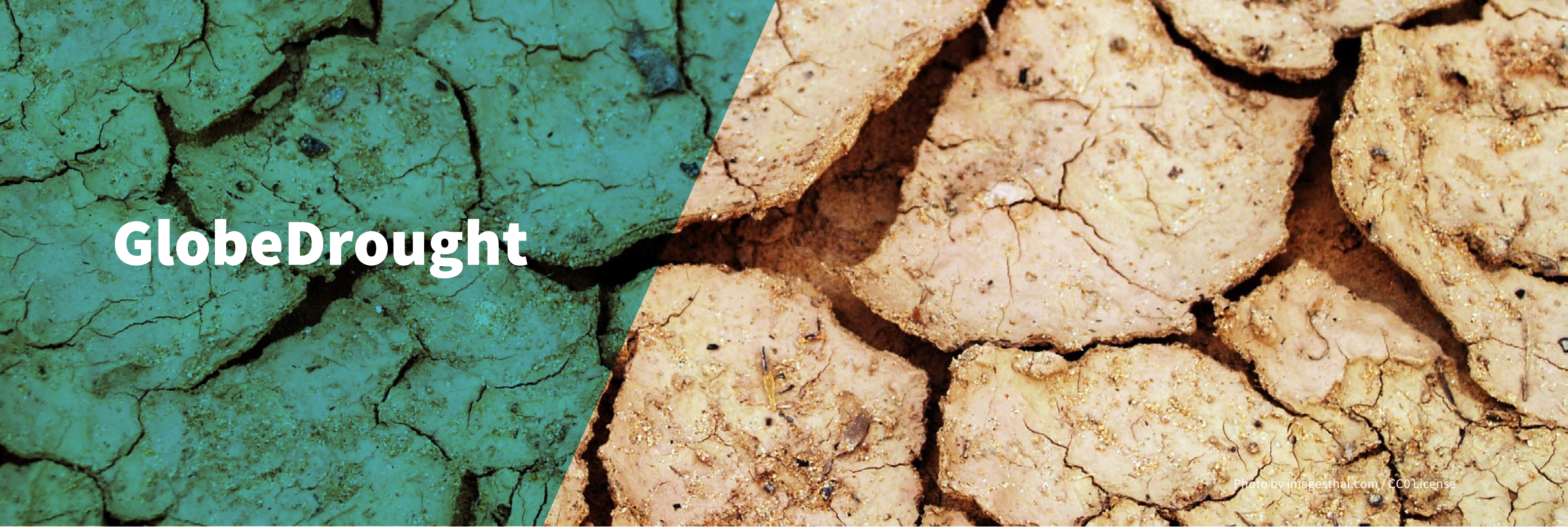
GlobeDrought

A global-scale tool for characterizing droughts and quantifying their impact on water resources

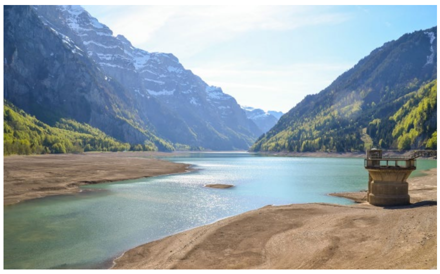
Summary

The aim of the 3-year GlobeDrought project (2017-2020) is to develop a web-based information system for comprehensively characterizing drought events and associated risks. The project will produce a spatially explicit description of drought risks by considering three components: (i) drought hazard, (ii) exposure, and (iii) vulnerability. It will investigate how droughts impact agricultural systems and public water supply. In terms of methodology, the project aims to link satellite-based remote sensing of vegetation conditions and analyses of precipitation data with hydrological modeling and crop modeling. This will produce indicators for characterizing meteorological, hydrological and soil moisture droughts, which will make it possible to quantify drought hazards as an important driver of risk. Analyses of socioeconomic, governance-related and environmental data will provide the basis for quantifying exposure and vulnerability of social-ecological systems. Within the framework of a co-design process, potential users and stakeholders will help to shape the content and technical design of the drought risk information system. The global-scale analyses planned for the project which focuses on drought impacts on agricultural systems and water supply will be supplemented by detailed analyses for regions heavily affected by droughts such as Southern Africa (incl. South Africa and Zimbabwe), Eastern Brazil, Western India, and the Missouri River Basin of the United States.



Impact

In times of drought, water resources are insufficient. These water shortages often have negative effects on agricultural productivity and on associated socioeconomic factors. They can cause reduced income, food shortages and even famines. Operational early warning systems for droughts try to address the problem. However, they are mostly only capable of characterizing the status quo, or offer limited forecasts for droughts in the near future – e.g., the next three to six months. These early warning systems generally do not sufficiently integrate variables and drought indicators. In particular, they do not adequately describe causal links in the formation and development of droughts, connections between the various types of droughts (meteorological, hydrological and soil moisture), and socioeconomic factors. The project intends to fill this gap by developing an **integrated drought (risk) information system**. With its planned experimental early warning system, the project aims to reduce the time between satellite-based data collection, identification of a drought risk and the implementation of countermeasures by political decision-makers and those involved in international humanitarian aid.



Partners in Southern Africa

SOUTH AFRICA

Prof. em. Andries Jordaan, University of the Free State (UFS), Faculty of Natural and Agricultural Sciences

National Disaster Management Centre (NDMC)

South African Weather Service

ZIMBABWE

Prof. Sara Feresu, University of Zimbabwe, Institute for Environmental Studies (IES)

Welthungerhilfe regional staff & collaborators

Expected outcome

The **Drought Information System** comprises of a global component and components providing more specific regional analyses for the Republic of South Africa and Zimbabwe. The experimental early warning system will provide data, maps and tools for near real time drought monitoring. In addition, a projection of the development of droughts within the next year will be provided, based on ensembles of historical climate data as replacement of climatic data for the future. Probabilities will be calculated to quantify how likely it is that a drought becomes more severe, remains similar, becomes less severe or disappears within the projected time period.

The **regional drought risk assessments** are being adapted in a co-design process to the requirements of partners and stakeholders in the region. In contrast, the global information system facilitates comparisons of drought impacts, drought risks and drought conditions across the globe.

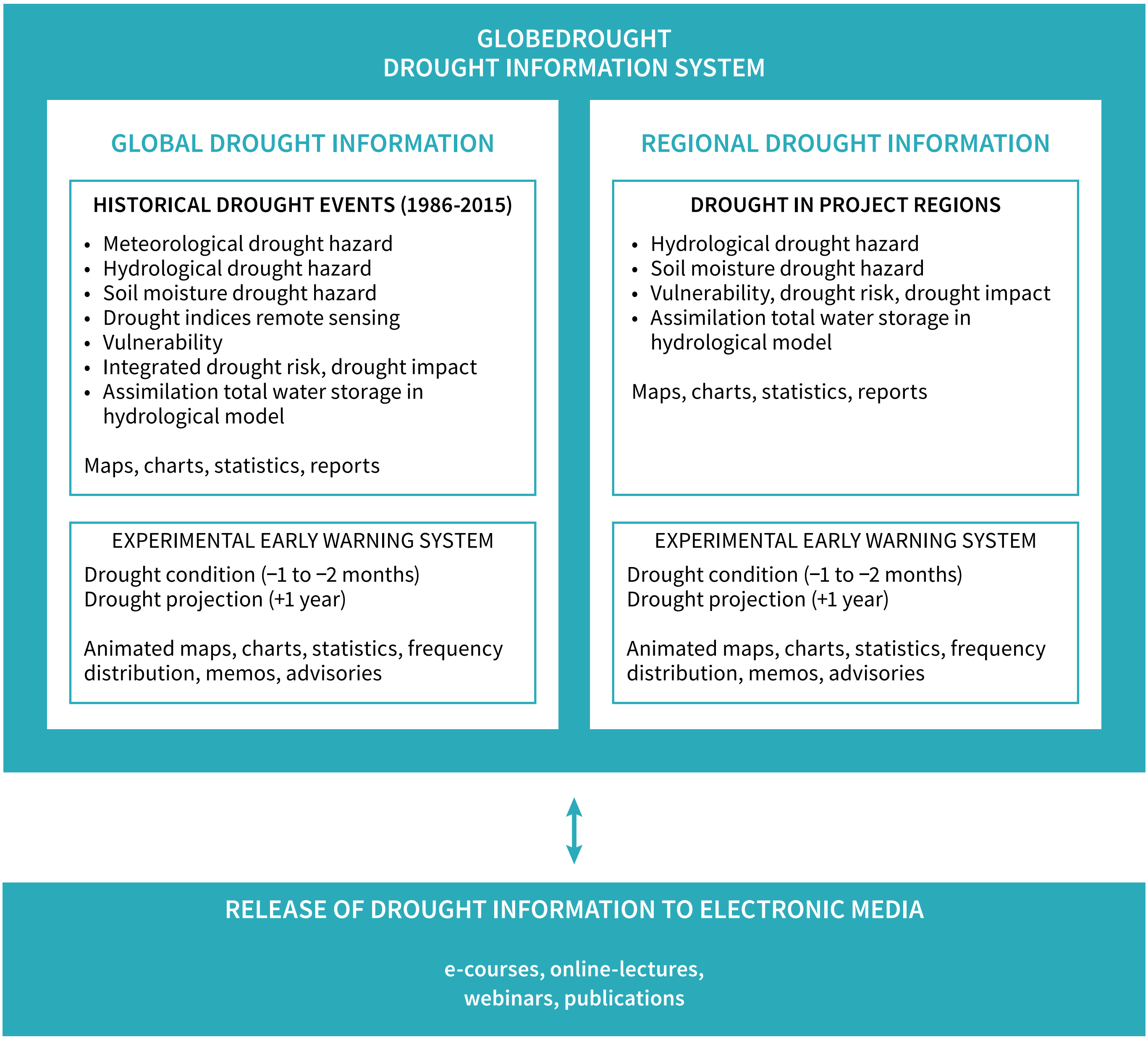


Fig. 1: Products to be developed in specific work packages contributing to the Drought Information System (source: project proposal)

Results

HIGH DROUGHT RISK CALCULATED FOR SOUTHERN AFRICA BY THE GLOBAL COMPONENT OF THE INFORMATION SYSTEM

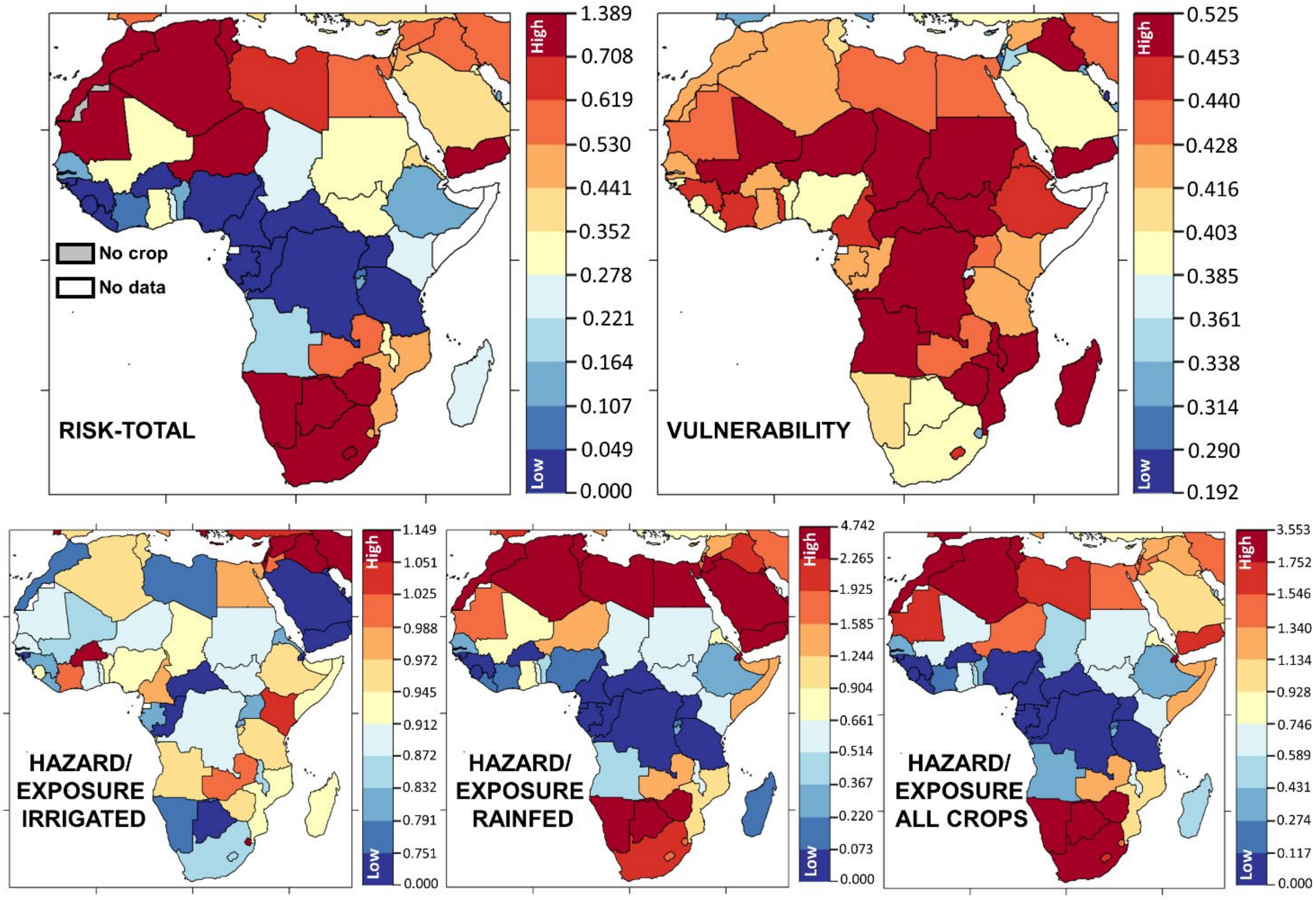


Fig. 2: Drought risk, vulnerability, hazard/exposure of irrigated, rainfed, and the whole crop production sector. The legends were defined by assigning the median of the value distribution to the yellow color in the center, the 90th percentile to the deepest red color, the 10th percentile to the deepest blue color and by determining the class ranges of the other colors by linear interpolation. Risk was calculated by multiplying hazard/exposure with vulnerability.

Source: Meza, I., Siebert, S., Döll, P., Kusche, J., Herbert, C., Eyshi Rezaei, E., Nouri, H., Gerdener, H., Popat, E., Frischen, J., Naumann, G., Vogt, J. V., Walz, Y., Sebesvari, Z., Hagenlocher, M. (2020). Global-scale drought risk assessment for agricultural systems. *Natural Hazards and Earth System Sciences 20*, 695–71.

MAIZE YIELD SIMULATED FOR FOUR PROVINCES IN SOUTH AFRICA BY A CROP MODEL ASSIMILATING SOWING DATES FROM REMOTE SENSING

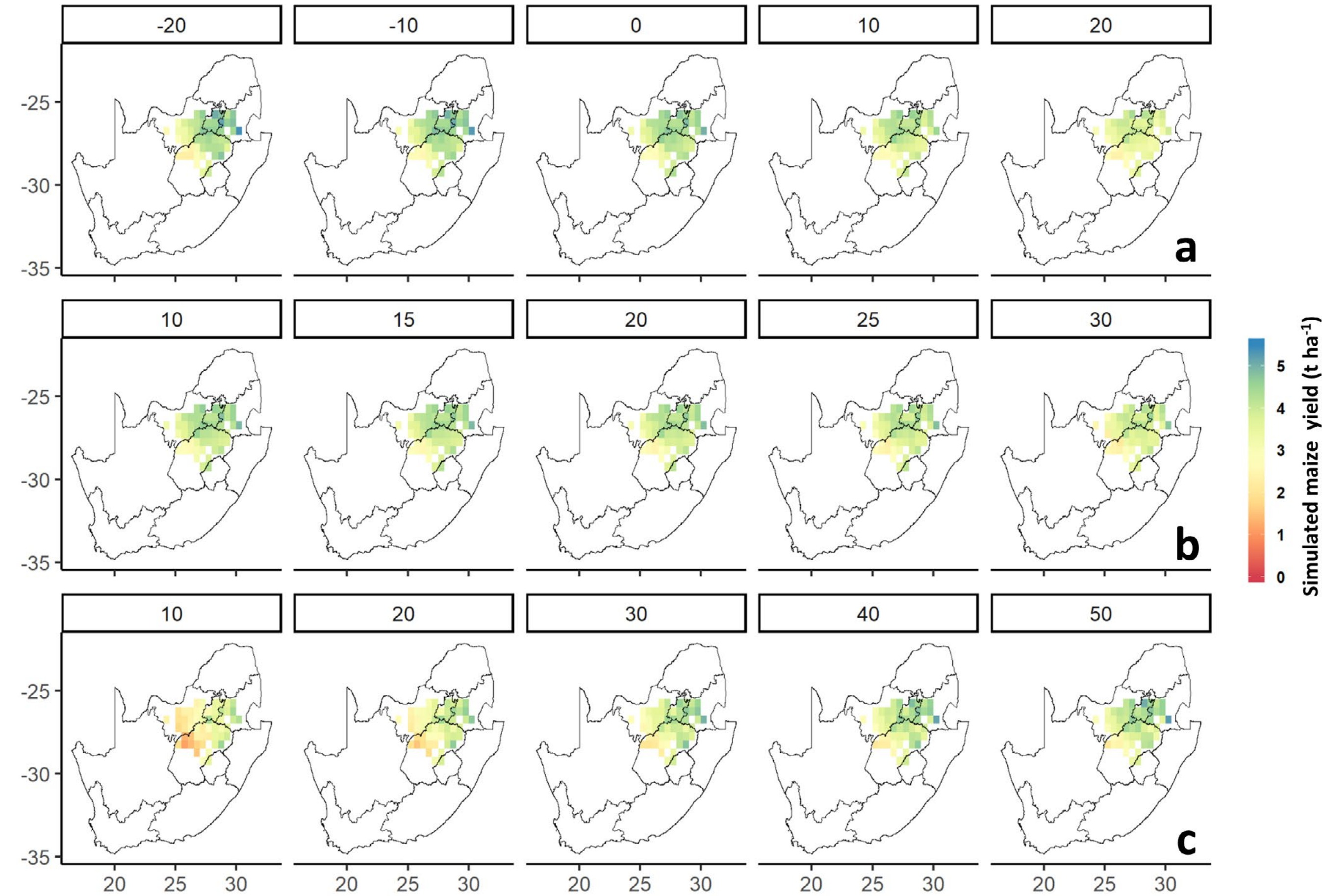
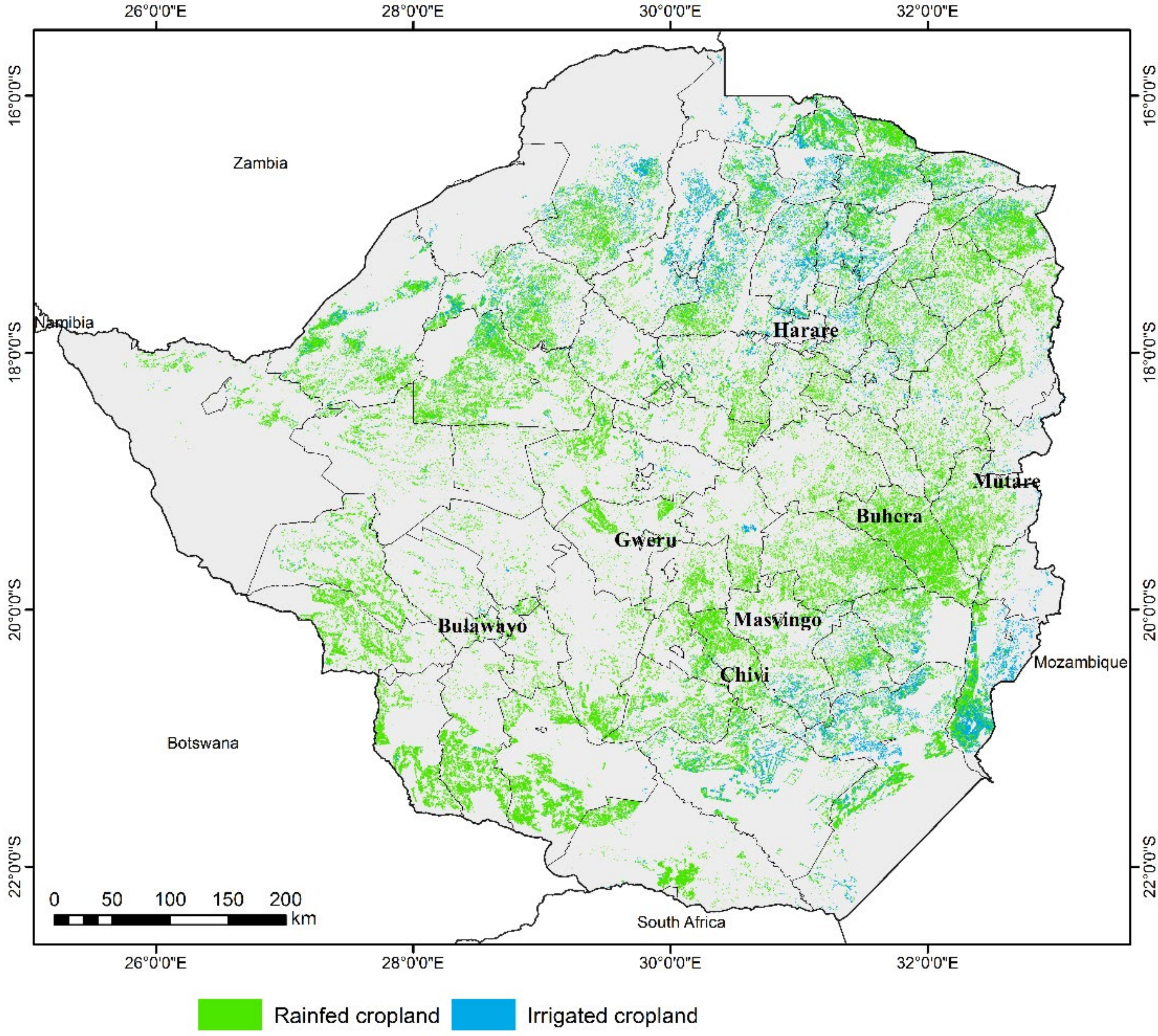


Fig. 3: Spatial pattern of the mean yield of maize simulated using sensitivity scenarios based on fixed sowing dates (a), sowing dates estimated by the precipitation rule (b) and RS-based sowing dates (c) in the period 2001-2016 across maize growing grids in Free State, Gauteng, Mpumalanga and North West Provinces, South Africa. (The thresholds of cumulative precipitation were defined as 10, 15, 20, 25 and 30 mm. Fixed periods of 10, 20, 30, 40 and 50 days were subtracted from the detected green-up dates as sensitivity scenarios to account for the time gap between sowing and green-up (emergence of leaves), which is when plants become visible to satellites. The fixed sowing date also varied in the range between -20 and +20 days relative to the standard sowing date.)

Source: Eyshi Rezaei, E., Ghazaryan, G., González, J., Cornish, N., Dubovyk, O., Siebert, S. (under review). The use of remote sensing to derive maize sowing dates for large-scale crop yield simulations. *International Journal of Biometeorology*.

MAPPING IRRIGATED AND RAINFED CROP AREAS IN ZIMBABWE BY USING REMOTE SENSING



Source: Landmann, T., Eidmann, D., Cornish, N., Franke, J., Siebert, S. (2019). Optimizing harmonics from Landsat time series data: The case of mapping rainfed and irrigated agriculture in Zimbabwe. *Remote Sensing Letters, 10*(11), 1038-1046.

More information is provided **on our website**:
http://grow-globedrought.net/

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Project partners and tools to be used

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Coordination; Drought impact on crop production and agricultural water demand
Global: GCWM (Siebert and Döll, 2010)
Regional: SIMPLACE <LINTUL5, DRUNIR, CanopyT> (Zhao et al., 2015)

Prof. Dr. Jürgen Kusche
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Drought impact on total water storage change; Analysis of GRACE - gravity data, assimilation of total water storage changes from GRACE into WGHM (Kusche et al., 2016; Schumacher et al., 2016)

Dr. Olena Dubovyk
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Drought impact on vegetation health; Remote sensing of vegetation condition, assimilation of remotely sensed crop parameters into crop models (Dubovyk et al., 2015; Parplies et al., 2016)

Prof. Dr. Petra Döll
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Drought impact on terrestrial hydrology; Hydrological modeling using WaterGAP and WGHM (Döll et al., 2018; Döll et al., 2012), coupling of WGHM with the crop model SIMPLACE <LINTUL5, DRUNIR, CanopyT>

Dr. Michael Hagenlocher
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Indicator-based approaches for spatial vulnerability assessment (agricultural systems, water supply) and integration of drought hazards, exposure and vulnerability into drought risk (Hagenlocher et al., 2018; BEH & UNU-EHS, 2016) at global level and within the case study regions.

Dr. Jonas Franke
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Development, hosting and marketing of the web-based drought information system, remote sensing-based analysis of land use and vegetation anomalies

For a world without hunger

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Vulnerability and risk assessment Zimbabwe and other regions; analysis of trade flows and emergency food aid; assessment of information from own project network

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WATER AS A GLOBAL RESOURCE

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