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THE IMPACT OF CLIMATE CHANGE ON THE AGRICULTURAL SUITABILITY FOR SELECTED CROPS IN THE OKAVANGO CATCHMENT – A GIS-BASED ANALYSIS

INTRODUCTION

The Okavango catchment is characterised by a hot subtropical climate with high annual mean temperatures ranging from 18 °C in the extreme north-west of the catchment to 26 °C in the very south (Weber, 2013). Precipitation in the area shows a gradient from around 1 400 mm in the humid Angolan highlands to less than 500 mm in parts of Namibia and Botswana, where it is a major constraint for agriculture. Recently, the Intergovernmental Panel on Climate Change (IPCC) released its fifth assessment report on climatic changes and their likely impacts. For Africa, particularly the more arid regions, temperature is expected to rise faster than the global land average. Depending on the emission scenario, warming projections of 2 °C to 6 °C by the end of the century have been calculated, alongside decreasing mean precipitation and shorter wet periods in southwestern Africa (Niang *et al*., 2014). This means that already existing stress on water resources will be amplified and in some parts of the Okavango catchment, the suitability for the cultivation of certain crops may be severely reduced as precipitation falls below their tolerance limits. The main crop products grown in the region are maize (*Zea mays*), manioc (*Manihot esculenta*) and millet (*Pennisetum glaucum*) (Domptail *et al*., 2013, Kowalski *et al*., 2013, Grosse *et al*., 2013).

We present the results of a GIS-based analysis comparing the expected climatic changes in the study area with tolerance levels for precipitation (Ecocrop 2014) of the three main crops. The corresponding shifts in suitability are assessed for a medium (rcp4.5) and a worst-case (rcp8.5) emission scenario.

DATA AND METHODS

The analysis uses climate scenarios computed with the regional climate model REMO (Jacob, 2001), forced by the global climate models ERA-Interim and Echam6 (Stevens *et al*., 2013). To achieve a high resolution of one kilometre, the output underwent a regionalisation scheme (Weinzierl *et al*., 2013). We furthermore conducted a simple multiplicative adjustment to account for a slight overestimation of precipitation by the model. Because of the uncertainties inherent in long-term climate change projections, it is customary to work with sufficiently long time spans of 30 years or more. We therefore compared the precipitation simulations for the years 2071 to 2100 with a reference period from 1980 to 2009.

Until the end of the 21st century, the mid-range scenario (rcp4.5) shows a moderate increase in annual mean temperature between 2,2 °C and 2,8 °C accompanied by a precipitation decrease between 3 % and 11 %. For the worst-case scenario (rcp8.5), a temperature increase between 4,8 °C and 5,7 °C is estimated, while the precipitation decrease ranges between 9 % and 32 %. Both scenario runs indicate that the southern part of the basin is likely to be more affected by temperature increase and precipitation decrease than the northern part, while precipitation is already very unevenly distributed.

The effects of the precipitation decrease on the cultivation of crops were analysed using a fuzzy logic approach with the optimal and absolute water requirements shown in Table 1.

Table 1: Annual precipitation requirements (FAO2014) of the main crops of the Okavango catchment

Plant	absolute min	optimal min	optimal max	absolute max
Maize	400 mm	600 mm	1 200 mm	1 800 mm
Millet	200 mm	400 mm	900 mm	1 700 mm

RESULTS AND CONCLUSIONS

We find that until the end of the 21st century, the potential for growing millet will most likely remain high under the mid-range emission scenario. For maize, the suitable zone might even shift a bit southwards. Under the high emission scenario, though, the millet cultivation may experience problems, for example at the margins of the Okavango Delta and in the central areas of Botswana, as well as along

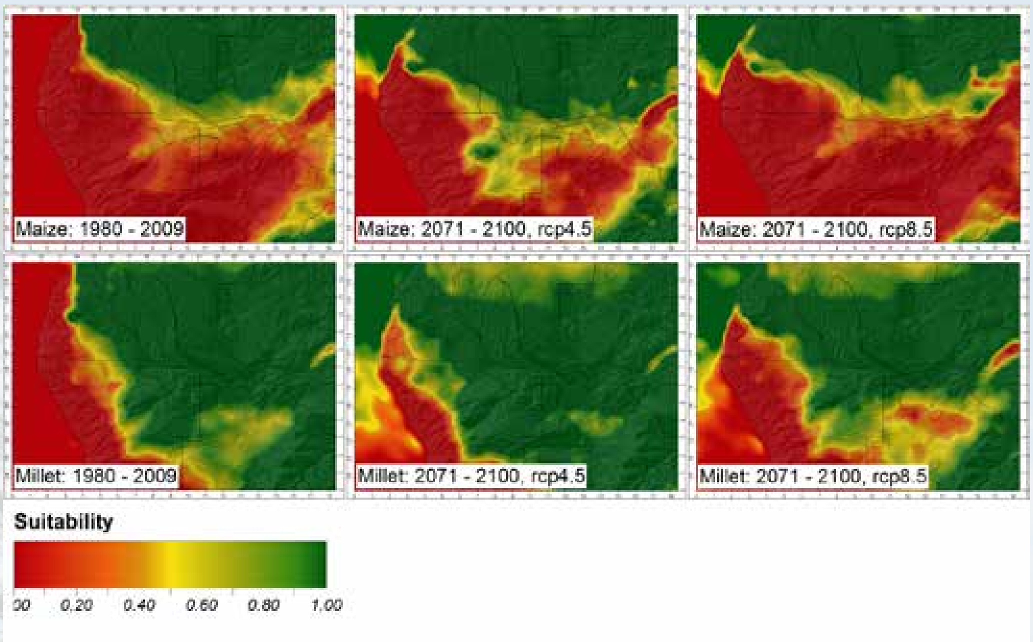

Figure 1: Suitability for maize and millet derived from precipitation reanalysis and climate model scenarios.

the Angolan-Namibian border. The suitable zone for maize cultivation is likely to shift northwards so that growing maize will hardly be feasible without irrigation in the Namibian part of the catchment (see Figure 1).

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