Climate Change Impact Under Climate Scenarios on Maize Yield in Ghana

A.K. Srivastava; C.M. Mboh; G. Zhao; T. Gaiser; F. Ewert

Introduction

Africa as a whole is one of the most vulnerable continents in the face of climate change due to its high exposure and low adaptive capacity. In the coming decades, global climate change will have an impact on all sectors of the global economy. But most impacts will fall on the agricultural sector, creating food insecurity and heightened water stress, most especially in the developing world. Detailed climate change impact assessment studies on maize are scarce for the tropical humid forest zone of Central Ghana, constituting a major maize production area in the country (Figure 1). In view of this background, the objective of this study was set to make an impact assessment of climate change scenarios on potential productivity of maize using crop growth model based on three General Circulation Models (GCM), two Representative Concentration Pathways (RCP_s) for two time scenarios (near future and end century) under A1B emission scenario in central Ghana which is regarded as a major maize producing area in the country. A1B emission scenario proposed by the Special Report on Emissions Scenarios (SRES) was chosen as one of the most impacting due to a rise in temperature; hence this evaluates the potential impact of one of the most critical possible future climates.

Materials and Methods

A gridded data set was built; covering the two major maize producing regions of Ghana namely, Ashanti and Brong-Ahafo. In this study the time-slices 2000, 2030 and 2080 were chosen to represent the baseline and future climate, respectively. Future climate scenario analysis was based on reference time slice of 2000 (based on thirty years daily data of 1971-2000). Projections of future climate were obtained using CMIP5 and the RCP_s for carbon emissions currently in use by the IPCC Fifth Assessment Report. Future climate projections were created using the 'delta' method, in which the mean monthly changes (from baseline) for RCP_s 4.5 and 8.5 for near future and End century time slices centred around 2030 and 2080, respectively, were applied to the daily baseline weather series. The GCMs used in this study are i) GFDL-ESM2M; ii) GISS-E2-H; and iii) HadGEM2-ES. Within the SIMPLACE modelling framework, a combination of the LINTUL5 crop model with a detailed soil water balance model (SLIM) was used to simulate the yield of dominant maize, a long-cycle variety ('obatanpa'), with prevailing agri-management practices comprising of low fertilizer application rate and no irrigation.

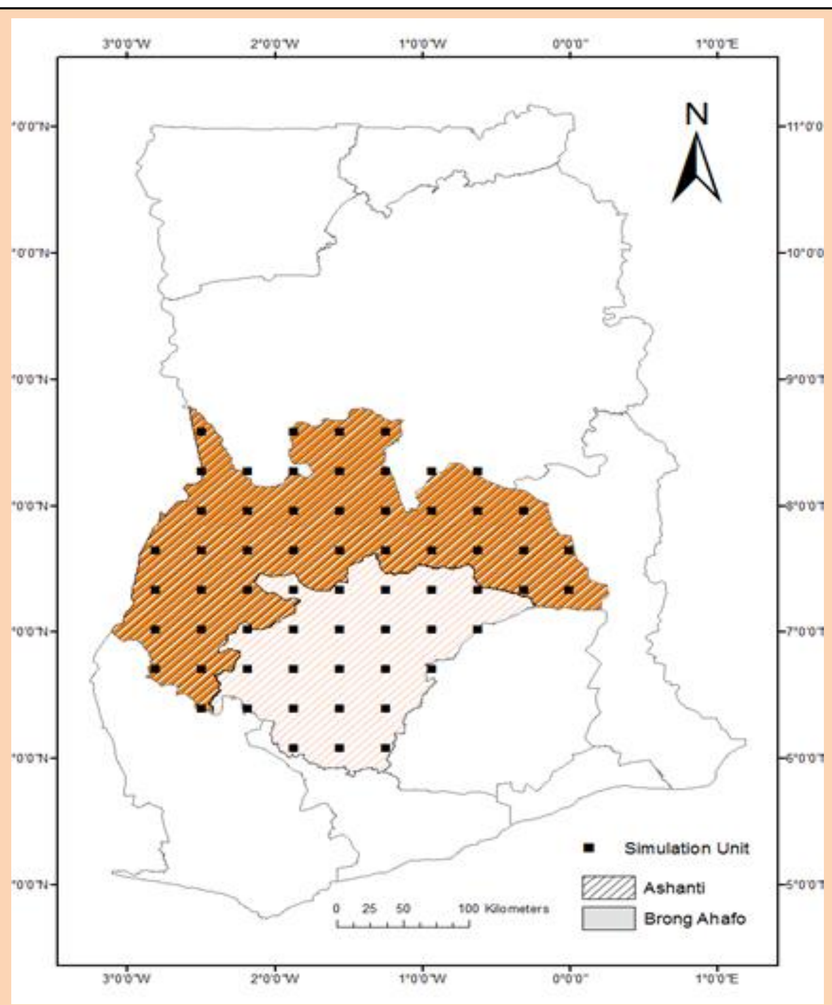

Figure 1: Study area in Ghana.

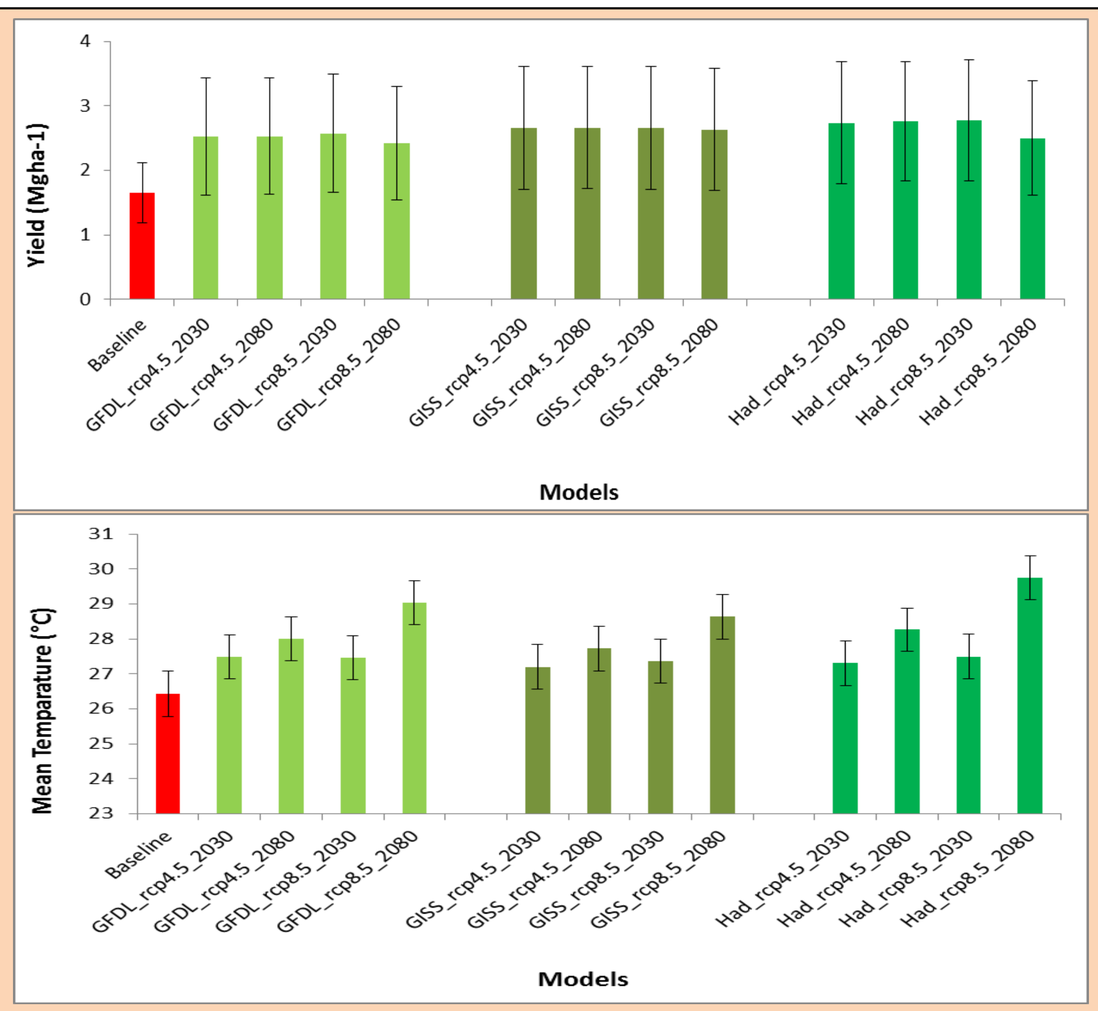

Figure 2: Comparison of Yield (Mg ha-1) (upper graph) and Mean temperature (°C) (Lower graph) across the models and scenarios analyzed.

Results and Discussion

As per the output of the climate models, there is a tendency of improvement in maize yields in the study region within the time slice of 2030 and 2080. The variation in yield increase ranges from 31.4 to 40.2 % depending on the climate model and the RCPs analysed (Figure 2). However, the increase in yield is more pronounced with the output of HadGEM2-ES which anticipates highest increase in temperature (by more than 3°C) compared to baseline. Simulations indicate delay of the maturity date, consequently elongating the growth periods under increased air temperatures leading to increased grain filling period and higher yield. There was no water stress in the crop growing period across the climate models and scenarios simulated, suggesting that in the future time period by 2080, there would be enough precipitation amount to support maize production under rain-fed conditions.

Conclusion

This study concludes that the impact of climate change under A1B IPCC SRES scenarios on maize production in the central Ghana is significant and positive. There is an increase in maize yield ranging from 31- 40% across all the GCMs and RCPs analyzed.

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Contact: **Dr. Amit Kumar Srivastava.**
E-mail: amit@uni-bonn.de
Phone: +49 228 732876; **Fax:** +49 228 732870
Institute of Crop Science and Resource Conservation,
University of Bonn, Katzenburgweg 5, D 53115 Bonn, Germany.

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