

Modelling Impact of Climate Change on Agricultural Food Production in sub-Saharan Africa and Measures of Mitigation

CHRISTIAN FOLBERTH¹, HONG YANG¹, KARIM ABBASPOUR¹, RAINER SCHULIN²

¹*Swiss Federal Institute of Aquatic Science and Technology (Eawag), System Analysis, Integrated Assessment and Modelling, Switzerland*

²*ETH Zurich, Institute of Terrestrial Ecology, Switzerland*

Several recently published studies have shown that climate change will very likely have a significant impact on the global agricultural production. While an increase in agricultural yields is expected in temperate zones, crop yields are supposed to decrease even further from already low levels in (sub-)tropic and (semi-)arid regions of sub-Saharan Africa. Our study makes use of a regionalised large-scale crop growth model based on the GIS-Environmental Productivity Integrated Climate (GEPIC) model. The regionalisation can provide more precise estimations of future yield change than global models with very general parameter setups. For this, global soil data will be adapted to more realistic conditions and local agricultural practice will be taken into account as far as possible. A global circulation model (GCM) ensemble consisting of 4–5 GCMs will be applied to assess the likeliness of decreases and increases in yields.

Preliminary results from the model without regionalisation have shown that yields of the staple foods maize, wheat, and rice will be affected to different extents. For maize an increase in yields can be expected along the east African coast, southern Africa, and the Gulf of Guinea. This can be attributed to the heat tolerance of the crop, increasing CO₂ concentrations in the atmosphere, and local increases in precipitation. In the Sahel zone and Central Africa, losses are very likely, though. Wheat and rice will mostly be negatively affected, while the most severe losses can be expected for wheat in the Sahel countries.

Besides the sole assessment of climate change impact on agricultural production, different strategies for climate change mitigation will also be tested using the same model. Thereby, investment intensive technologies like irrigation and industrial fertilisers will be compared with low-cost techniques like rain water harvesting and ecologic sanitation. Also crop suitability under current and future environmental conditions will be an objective of the study.

Keywords: Climate change mitigation, crop growth modelling, food security, GEPIC

Contact Address: Christian Folberth, Swiss Federal Institute of Aquatic Science and Technology (Eawag), System Analysis, Integrated Assessment and Modelling, Ueberlandstr. 133, 8600 Duebendorf, Switzerland, e-mail: christian.folberth@eawag.ch

Securing Food Supply by Adapting Millet Growing to Climate Variability: Decision Making Rules of Fulani Agro-pastoralists in Mopti Region, Mali

MAGDALENA WERNER¹, LASSINE DIARRA², CHRISTIAN HÜLSEBUSCH¹,
BRIGITTE KAUFMANN¹

¹*German Institute of Tropical and Subtropical Agriculture (DITSL), Germany*

²*Institut d'Economie Rurale (IER), Mali*

Climate data show that the Sahel region and its neighbouring regions are exposed to reduction of precipitation and an increase of climate variability that might result from climate change. In the Mopti region, former pastoralists of the Fulani ethnic group have settled after the severe droughts in the 80th of last century. Besides livestock keeping, they increasingly depend on crop production. In both production lines, they have to cope with a high climate variability that is characteristic for this region and have developed strategies to manage their production system in this environment. The study examines production strategies of Fulani agro-pastoralists and their ways of adaptation to climate variability. Four villages in two different ecological zones (Séno and Niger delta) were chosen in order to study the production strategies of the Fulani agro-pastoralists. Data collection had a focus on qualitative methods. The research team lived for two weeks in each of the villages and conducted seasonal calendars (n=8), pairwise ranking (n=2) and open in-depth interviews (n=12). All data collection sessions were recorded with a voice recorder. The interviews were transcribed. The data were first analysed using content analysis. The information provided on management was analysed using a cybernetic analysis tool.

Decision making rules could be identified, including routine action rules, problem solving rules and selection rules. This is shown using the example of sowing millet. The producers make their decisions which variety to sow when and where according to rainfall patterns, soil characteristics, crop rotation schemes, cereal stock, labour and plough availability, and other environmental and individual factors. Problems frequently encountered are interruption of rainfall, high spatial fluctuations in precipitation, and fluctuations in the duration of rainfall which causes high variability in the length of the vegetation period. The results show high flexibility and complexity in management decisions taken by the agro-pastoralist producers. It can be shown that the agro-pastoralists perform their production strategies in order to balance between the objectives of achieving high yields, secure yields and sustain soil fertility.

Keywords: Adaptation, agro-pastoralists, climate variability, food security, Fulani, Mali, millet, Mopti, Peulh, risk management

Measuring Water Footprints in Dairy Farms Worldwide: Implications for Food Security

NADIRA SULTANA¹, MOHAMMAD MOHI UDDIN², OTHMAN ALQAISI¹, OGHAIKI
ASAAH NDAMBI¹, TORSTEN HEMME¹

¹*University of Kiel, IFCN Dairy Research Center, Germany*

²*Humboldt Universität zu Berlin, Dept. Animal Breeding in the Tropics and Subtropics,
Germany*

The increasing trend of worldwide water availability risk issues in dairying are becoming burgeoning important. In 2050, water availability is expected to decrease by 19–35 % due to climatic change and by 67 % due to the expanding population. The water crisis around the world is a potential threat toward achieving a Millennium Development Goal to cut the hunger people to a half in 2015. In order to ensure food security, it is necessary to ensure the optimum use of water in dairying. Measuring water footprint might be the option for efficient water use in dairying. So far, there is very little effort made in the calculation of water footprint for dairy production. The aim of this study is to develop a method for calculating water footprint in dairying worldwide.

The TIPI-CAL (Technology Impact Policy Impact Calculations model) of the International Farm Comparison Network (IFCN) was used to collect data and calculate variables of water footprint. The method was tested on 12 typical dairy farms from six developed countries: Switzerland, Germany, Spain, Canada, USA and New Zealand and six developing countries: Bangladesh, Pakistan, China, Jordan, Czech Republic and Argentina.

The results show that the milk yield per day varies between 2.6 kg in Bangladesh to 34 kg in USA. The cows have the highest water requirement during lactation period. Cows in Bangladesh use 66 % of their total requirement during lactation period compared to 97 % in Jordan. The water use during dry period for Bangladesh was the highest (33 %) due to very long dry period. The water input per kg milk production varies from 430 liters in USA to 2400 liters in Pakistan. The water used for drinking and washing was 3.5 liters and 56.0 liters for Germany and Pakistan.

The study shows that feed production is the major driver for water use on dairy farms. The greatest challenges were in obtaining coefficients on water input for feed production and water usage in dairy farms. The accurate measurement of water use in dairying can be a step towards achieving more efficient water use which will augment food production and thus ensure food security.

Keywords: Dairying, food security, water footprints

The Sustainability of Bushmeat Hunting in Central Gabon and the Implications for Local Food Security

JUDITH SCHLEICHER

University of Oxford, School of Geography and the Environment, United Kingdom

Bushmeat hunting, the hunting of wildlife for human consumption, is an activity integral to many rural forest communities throughout the humid tropics, often providing a high proportion of household income and protein requirements. However, bushmeat hunting is also considered a major threat to the persistence of biodiversity in tropical forests: in Central Africa alone annual wildlife harvest is estimated to be 1 to 3.4 million tonnes. This raises concern about the survival of hunted species, ecosystem functioning and thus, the future food security of rural communities, especially in the face of expanding human populations and decreasing habitat availability.

Hence, assessing the sustainability of current hunting levels is key to species conservation and people's livelihoods. Unsustainable wildlife harvesting has widely been reported in the literature. However, given the paucity of available biological data and the difficulty in collecting such data, previous sustainability assessments have been based either on (i) models incorporating highly simplistic sustainability indices or (ii) snapshots in time of levels of wildlife offtake. An assessment of sustainability instead requires empirical research on whether and how hunted population levels and/or offtake change over time.

This study therefore investigates bushmeat hunting through interviews and hunter follows in two villages in central Gabon in 2004 and 2010, in particular reporting on the spatial distribution and characteristics of bushmeat catches over time and their contribution to household food intake and income. This talk will outline (i) whether key ecological and socio-economic changes related to hunting took place in the two Gabonese villages during the study period and (ii) the implications for bushmeat hunting sustainability and local food security.

Keywords: Bushmeat, Central Africa, food security, Gabon, hunting, livelihoods

The Influence of Serially Correlated Shocks on the Conservation of Fish Stocks under Open Access Harvesting

MICHELE BAGGIO

ETH Zurich, Professorship for Environmental Policy and Economics, Institute for Environmental Decisions, Switzerland

Renewable resources like fish stocks randomly fluctuate due to the influence of unpredictable environmental variability. Random environmental events can have consequences on the livelihood of fishing communities. Considering that with climate change severe weather events are expected to become more frequent, studying how disturbances affect the dynamics of a natural resource like fish stocks is particularly important. Standard models of renewable resource allocation under uncertainty typically assume that environmental disturbances are identically and independently distributed. When weather patterns impact environmental conditions, shocks may be serially correlated. This serial correlation has implications for the long run conservation of harvested renewable resources. This paper investigates the dynamics of a harvested, open-access renewable resource whose productivity is influenced by serially correlated random environmental disturbances. The main question addressed in the paper is: how does the expected value of stock escapement depend on the parameters that determine the distribution of environmental shocks? In answering this question I also characterise how the maximum and minimum escapement policy functions depend on these parameters. An application of the conceptual framework to the American lobster fishery of Long Island Sound is used to address these issues qualitatively and quantitatively. In the application, the model is parameterised using an econometric model of population dynamics for the Long Island Sound lobster fishery. In this application shocks are negative correlated and transient so a high current productivity shock decreases the probability of high future shocks. The results suggest that conservation is promoted by increases in both the autocorrelation of the random shocks, as well as the variance of the uncorrelated error term. The conclusions provide useful information regarding how serial correlation in environmental disturbances impacts the conservation of open-access renewable resources.

Keywords: Autocorrelated shocks, bioeconomic model, open access

Contact Address: Michele Baggio, ETH Zurich, Professorship for Environmental Policy and Economics, Institute for Environmental Decisions, Universitaetstr. 22 Chn 76.2, 8092 Zurich, Switzerland, e-mail: michele.baggio@env.ethz.ch