ZEF

Sustainable Development of Research Capacity based on GLOWA Volta

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TRAINING WORKSHOP REPORT

Training Workshop at the Direction of Meteorology

Ouagadougou - Burkina Faso

From Monday 15th to Friday 19th February 2010

Family picture of participants and authorities after the opening ceremony

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1. Introduction

The goal of this workshop was the training of existing methodologies and tools for predicting the onset of the rainy season for agricultural management.

The training included the following topics:

- The programming environment *Matlab*
- The physically-based crop model *CropSyst*
- A statistical method to estimate the onset of the rainy season in West Africa
- Statistical models for predicting the onset of the rainy season
- The procedure how to estimate the impact of climate change on crop productivity in West Africa

For the training communicators important workshop outcomes were:

- Discussion with local stakeholder about priority research needs within the region

2. Location and period of the workshop

The workshop was held at the Direction of Meteorology (Ouagadougou, Burkina Faso) from Monday 15th to Friday 19th February 2010.

3. Attendance

The invited institutions, which are listed below are mainly from research and data gathering institutes, apart from some exceptions belonging to water management or regulating bodies.

1	Direction de la Météorologie
2	CROCO Burkina
3	Université de Ouagadougou / IGEDD
4	INERA
5	GREENHANDS Organization
6	IGEDD
7	CERPINEDD
8	IUCN/PACO
9	DRAHRH -Centre
10	IDR/UPB
11	IGB
12	DGRE

4. Opening

The overall goal of the training workshop was to introduce participants to existing methods for estimating the onset of the rainy season under agricultural meaningful aspects in West Africa. Additionally, the training gave insight in estimating the impacts of the expected climate change on future agricultural productivity. The persons in charge were Dr. Patrick Laux and Greta Jäckel.
The training workshop was opened at 9:30 a.m. with a welcome statement by the Director of Meteorology, Mr. Garane Ali, followed by the statement of GVP Coordinator Prof. Dr. Karl Harmsen and an opening speech held by the General Director of Civil Aviation and Meteorology.

Afterwards Prof. Karl Harmsen thanked GVP for organizing the workshops. He mentioned the importance of estimating onset of the rainy season especially for arid and semi-arid parts of Burkina Faso. Finally he wished all participants a good and successful training workshop.

The workshop was hosted by Dr. Patrick Laux and Greta Jäckel (both from the Institute for Meteorology and Climate Research, IMK-IFU, Karlsruhe Institute of Technology, Germany), supported by Dr. Benjamin Kofi Nyarko and Theophile Mbakop.

5. Workshop Sessions and Discussion

MONDAY, FEBRUARY 15TH:

Patrick Laux introduced the participants of the workshop into the topic of the estimation of the onset of the rainy season (ORS) and methods for its prediction by showing the results of his PhD Thesis. Some highlights of his presentation were:

- the definition of Onset Of Rainy Season (ORS)
- statistical tools for predicting the ORS, i.e. linear discriminant analysis and linear regression analysis
- assessing the impacts of climate change on ORS dates

The following topics have been introduced to the participants during the Day 1

1. **Onset of the rainy season (ORS) approach**
   - ORS definition in the context of agriculture (planting date)
   - Literature: Approach of *Stern et al.*, 1982
2. **Fuzzy logic–based approach** (modified version of Stern et al., 1981)
3. **Important questions**:
   - Comparison of „traditional“ methods with „scientific“ methods (What can we learn (implement) from farmers?)
     Including/Translating farmers‘ criteria (e.g. flowering of trees, movement of bats and ants) into computer-based expert system
     Improvement of more specific modeling
   - How can we validate the calculated ORS dates?
   - How can we find the optimal criterions for estimating the ORS dates?

Discussion Day 1:

Question: *What was the motivation of your PhD thesis?*

Answer: Since the 1980s farmers have been realizing a higher variability of rainfall. This also affects the onset of the rainy season. The motivation basically was to help farmers to decide when to plant in order to reduce crop yield losses.

Question: *Did the cessation of the rainy season play an important role in your PhD thesis*?

Answer: Yes, we also analyzed the cessation of the rains for the past and the future. For the future, for instance, we found that it is likely that the ORS dates will strongly delay, but the cessation dates won't delay that much. Consequently, the length of the rainy season will decrease.

TUESDAY, FEBRUARY 16th:

Patrick made the recap of the presentations of day 1 which was essentially based on how to define the ORS and to use the fuzzy logic-based ORS approach.

The main focus of day 2 was set to:

- The approach of ORS (Emphasizing and more clarification)
- The forecasting and predicting of the ORS
- Linear regression analysis and the ORS regression models for the region.

An introduction to MATLAB was performed by Greta. The MATLAB software (trial version) was handed over to the workshop participants for installation on their computers. First practical exercises were conducted after showing the advantages of using MATLAB and clarifying the algorithm, which should be used for determining the onset of the rainy season.

Discussion Day 2:

Question: *Why do we have to learn how to program with Matlab? Why is it necessary to add other functions?*

Answer: In this workshop we do not show you a nice graphical user interface (GUI). The routines for estimating the ORS are mainly functions. This keeps it more flexible. If you want to use them, or even modify them, you should know how to do that. There is the possibility to insert some other functions and variables for solving specific problems. However, this is not a programming workshop, and you will only learn the basics.

Question: *Has the ORS-model been validated with measured dates of the onset of the rainy season?*

Answer: There is no measured ORS data available. It is also difficult to get the information of the planting dates from the farmers. For this reason, it's impossible to validate the ORS-approach in this way.

But we will show you in this workshop how to perform crop modeling in order to find the optimal planting dates (coinciding with the ORS dates).

Question: *Which information is contained in the term of the effective drought index EDI?*

Answer*:* The drought index indicates water stress to plants based on observed rainfall. The calculation of the effective drought index can be realized by incorporating the effective precipitation and the mean effective precipitation for the whole observation period. Furthermore the amount of the precipitation which is necessary in order to obtain "normal" conditions is important for the calculation of the EDI. With the help of these parameters it's possible to determine deviations from the mean effective rainfall. Positive EDI indicate moist periods, negative EDI indicate dry conditions.

Question: *The approach for calculating the onset of the rainy season is quite important. It's based on different criterions. Are the criterions adjustable or are they conventional?*

Answer: I explained the definition of Stern et al., 1981 to you in my presentation. In this publication they used fixed values for the criteria. At the same time all criterions have to be fulfilled simultaneously. This limits the approach. Therefore, we used a fuzzy logic-based approach to find the optimal solutions for these criteria. They strongly depend on the region (station) and the crops. Using a plant growth model we are able to adjust these criteria operationally. It was possible to optimize the fuzzy logic criteria with the help of a plant physiological model.

Question: *I would like to know, whether this approach (linear regression analysis) is examined?*

Answer: Yes, we validated this approach using jack-knife validation and the results were satisfying. This validation was done with data in a period from 1961 to 2001 for the Volta Basin.

Question: *To what timeframe after 2001 can this approach be applied to?*
Answer: This approach could be applied for each time period you want, depending the availability of precipitation data. However, it should not be used for forecasting purposes. It is recommended to use it for the ongoing season.

Question: *I have a question concerning the regions with similar precipitation. Which relation is between the prediction of the ORS of a station of a certain region, and a station of another region, if the variability of the rainfall is evident? You can see this for example at the stations Bobo and Fada, which are in different regions: there is a significant difference for the ORS of 30 days.*
Answer: It's difficult to answer this question precisely. In order to predict the onset of the rainy season for the Volta Basin I grouped stations with similar temporal rainfall characteristics to 5 different regions I think it's more favorable to use regions instead of stations due to the lower variability of the regions. Theoretically, the LRA approach could be applied for stations, too.

WEDNESDAY, FEBRUARY 17.

At day 3, Patrick started with the recap of day 2.
The recap was followed by an introduction to the crop yield model CropSyst. The following topics were covered:

- Introduction to different modules of CropSyst (Location, Weather, Soil, Management …)
- Exercise: Creation of location file for each Pixel of Upper-East region
- First modeling exercises (manually) for 1979-2001 using different planting dates (as only variable) to estimate impact of planting date on crop yield.

THURSDAY, FEBRUARY 18th

As usual, day 4 started with the recap of day 3.
Greta Jäckel presented the results of her master thesis with the topic "Impact of the planting date on crop yield – a case study of Cameroon"
She demonstrated that for Cameroon, the application of ORS-approach is favourable in relation to fixed traditional planting dates. She highlighted the effect of agricultural management (planting date) on attainable crop yields.

Discussion Day 4:

Question: *I would like to know whether the results of the simulations are reliable (for the Volta region)?*

Answer: I want to point out that this model is **not** calibrated yet for the Volta Basin. I just want to show you the procedure, that you have the technical background for starting such simulations. The results we showed are valid for Cameroon.

Question: *Is there a correction factor within CropSyst?*

Answer: There is no correction factor, which could be set in the model CropSyst. The data (e.g. precipitation, temperature) has to be corrected before starting the simulations.

Question: *Is it possible to make a forecast within the coupled ORS-algorithm?*

Answer: In order to make a forecast within the coupled ORS-algorithm a 30-day-forecast for the third criterion is necessary. This drought criterion (false start criterion) could be used for the past or ex-post but unfortunately not for the future. A way out of this misery is to leave out this criterion and to consider a-priori values for the false start probabilities (as shown in my PhD thesis).

Question: *Which is the optimal planting date to achieve maximum crop yields according to Gretas assumption?*

Answer: It's not easy to answer this question. The optimal planting date depends on the location and the crop and varies inter-annually. The date depends on the optimal values for the membership functions. In order to get these parameters for the Volta Basin, the crop model has to be calibrated first.

Question: *I think the farmers will be really interested in this approach if the simulated crop yield exceeds their actual yields.*

Answer: Yes, I agree. However, you cannot compare the results of the simulations directly with the actual measured yields. There is a large uncertainty of the measured yields, but also uncertainties due to the crop growth model, the input data, the downscaling approach etc.

Additionally, field studies are necessary to prove if this approach is superior to traditional methods (planting dates). So far, this is just a computer simulation.

Question: *Is there a tool in the model, which considers exogenous factors (e.g. convective rainfall…) and corrects it automatically?*
Answer: No, there are no tools and correction factors within the model structure. The input data has to be corrected before starting the simulations.

Question: *Which should be the best time to implement this approach into field studies?*
Answer: Unfortunately I can't answer to this question. For these decisions an agronomist is necessary.

Question: *Why did you choose the crops maize and groundnut?*
Answer: We chose maize, because of its important role as cash and staple crop in West Africa. Furthermore we decided to choose maize, which is a C4-plant, and groundnut, which is a C3-plant, because we want to analyze the impact of CC and the direct CO2 fertilization effect on different plant photosynthesis types.

Question: *How did you calibrate the crop model?*
Answer: We used AGRISTAT data for the calibration of the model CropSyst for Cameroon. Unfortunately we only had 5 years of actual crop yields
For the Volta Basin this calibration is not yet done. We used for the workshop simulations for Burkina Faso a non-calibrated model. This is why the results of our simulation are not reliable.

Question: *The effects of the climate change (for the components precipitation and temperature) were presented in Gretas presentation for Cameroon. Are there similar effects of the climate change for the Volta Basin possible?*
Answer: This is a very difficult question. It is possible, that the effects of the climate change are similar to the effects simulated for Cameroon, but it's not sure. Precipitation for example is subjected to a high spatial variability. An increasing or decreasing trend is possible. In Greta's presentation you could even realize that the different GCMs predict different signals: one GCM shows an increasing trend, the other shows a decreasing trend of precipitation.

FRIDAY, FEBRUARY 12

Day 5 started with a short recap of day 4 followed by the presentation of **Moussa WAONGO** from the Burkina Faso Met services. His presentation was about the potential applicability of the workshop material in practice.
After his presentation, a discussion was opened. The highlights are listed below:

Discussion Day 5:

Question: *Which are the most important parameters which are integrated in this software DHC?*
Answer: It's possible to calculate the crop yield and to include the vegetation, the soil properties as well as all current trends of the climate change.
But unfortunately it is impossible for us to make simulations or to determine the date based on existing data. This requires collaboration between institutions for better performance in terms of results

Question: *How to get information concerning the actual data of the onset of the rainy season?*
Answer: The actual date of the onset of the rainy season of the last year is published at the beginning of each year. This information is given to the directories of agriculture for each region, which pass it to the local farmers.

Question: *You mentioned aspects of prediction. What's the most important factor for you: short-,mid- or long-term?*
Answer: We are more interested in short-term predictions.

Question: *Do you have any information concerning the traditional planting rules of the farmers? Did you evaluate the reliability?*
Answer: A common planting rule is sowing after the migration of the birds. We can't evaluate this assumption, because we're no farmers. Furthermore some farmers incorporate these factors, some farmers not. I think you can't say that these traditional planting rules are reliable.

Question*: Does the definition after STERN et al. calculate the date onset of the rainy season or the date of planting?*

Answer: It depends how you define the onset of the rainy season. In this work I defined the onset of the rainy season in an agronomical way: that means the date when the rainy season starts, is the optimal date for planting.

6. Stakeholder Discussions RSSC project

A stakeholder discussion also followed, lead by Patrick. Its goal was to identify priority research needs in the context of a new project RCCS. The major questions to be answered were:

- Where to focus (research questions)?
- What to add/change?

The results of the discussions were:

1. Climate

Research questions/needs:

- Carbon Sesquestion, organic toxic components
- Improving adaptation indigenous strategies CC
- Evaluation Adaptation strategies (CC)
- Optimization and automation weather observation network
- Analysis variability and prediction extreme events (dry spells, temperature, rainfall, wind)
- Analysis and modeling of weather conditions on urban pollution
- Cloud seeding
- Impact squall lines on infrastructure (velocity,intensity)
- Impact CC and variability on weather sensitive diseases
- Adapting regional models for Sahelian regions (model development)
- Impact weather on energy production (solar...)

2. Natural Resources Management & Food Security (Agriculture)

Research questions/needs:

- Onset of the Rainy Season
- Impact CC on Agric.

- Cropping techniques (CC)
- Reduction aET
- Tillage conservation techniques (agroecolog. zones)
- Identification of suitable regions for agri. (CC)
- Evaluation adaptation strategies (CC)
- Impact CC and variability on weather sensitive pests

3. Water

Research questions/needs:

- Reduction Evaporation of surface water and siltation (Development Techniques)
- Flood control – construction dams, dykes
- Early warning systems (models)
- Evaluation adaptation strategies (CC)
- Economic study water reservoirs in the framework of market gardening

4. Soil

Research questions/needs:

- Sequester carbon
- Evaluation adaptation strategies (CC)
- Technical improvement geothermy
- Characterization & monitoring soil (regional)
- Spatial characterisation albedo

5. Social aspects

Research questions/needs:

- Decentralization and land issues

6. Specific needs for agriculture service

- Adapting models (GCMs, regional models)
- Soil moisture information
- Type crop
- Actual ET
- Extremes (dry spells, extreme humidity) accounting for stage of crop development

7. Collaboration - data sharing

INERA (agronomic data)

- MetServices (weather data)
- (Geographic Institute BF)

8. Collaboration – field studies

- Evaluation ORS definitions

Focus: Research ORS

Q: Are you interested that the ORS topic will be continued? How can your institution contribute to this research? What can be modified (improved)? Participants gave their opinion, comments and suggestions.

a) Are you interested to be involved in the research concerning the subject "Onset of the rainy season"?

- All participants of the workshops are definitively interested to collaborate in this field.
- Adaption of the topic to our subject (agricultural meteorology)
- Documentation of MATLAB in French
- Procurement and Management data
- Explanation of the basics

b) In which way can your institution contribute for the research on the topic "onset of the rainy season"?

- Supervision and provision of master and PhD theses in this topic
- Sharing input data (different spatial and temporal distribution) and results of simulations (support and suggestions)
- Calibration of the new models
- Keeping contact with resident farmers
- Characterization of soil properties and composition

c) Other suggestions and comments

- *Cropsyst* could be applied for our purposes
- Sponsoring scholarships for e.g. PhD candidates
- Find more possibilities for the calibration of this model
- Absorption of costs (accommodation, journey) for the people of the rural areas

- Adaption of training to the respective educational level
- Continuing the work with the model CropSyst, in order to calibrate the model and run simulations
- Training of related topics (e.g. workshops)
- Possibility to get more MATLAB licenses
- Consideration of political matters in the models

7. Closing

M. Ali GARANE, Director of Meteorology thanked all the participants and the lecturers. He officially closed the workshop around 2:00 p.m.

8. Annex

ORS –WS list of participants			
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Time schedule

GLOWA Volta workshop „Modelling the onset of the rainy season and potential implications for agriculture in West Africa"

Contact: Dr. Patrick Laux (patrick.laux@kit.edu); Greta Jäckel (greta.jaeckel@googlemail.com); Prof. Dr. Harald Kunstmann (harald.kunstmann@kit.edu)
Karlsruhe Institute of Technology (KIT), Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU)

	Day 1	Day 2	Day 3	Day 4	Day 5
9:30 – 12:00	Introduction and overall objective of the training workshop Software Installation (Matlab, *CropSyst*)	Introduction to the definition of the onset of the rainy season (ORS) and methods for its prediction	Introduction to model-based crop yield simulation using *CropSyst*	Impact of planting date on simulated crop yields – A case study for Cameroon	Interpretation of the results for Ghana/BF Short presentation of each participant: Applicability of workshop material in practice (institutional needs, own activities) Final discussions of the workshop
Lunch break					
14:00 – 16:00	Introduction to Matlab and practical exercises	Practical exercises using Matlab	Setup of *CropSyst* and first exercises simulations for Ghana/Burkina Faso	Practical exercises using output of regional climate simulations for Ghana/Burkina Faso	Stakeholder discussions: "Regional Science Service Center for West Africa", identification of prior research needs
Coffee break					
16:30 – 18:00	-		Setup for simulation exercises (Day 4)	Preparation and conduction of ORS optimization runs for the Volta basin	Stakeholder discussions: "Regional Science Service Center for West Africa", identification of prior research needs