To what extend can satellite rainfall estimates be used for crop yield prediction in West Africa?

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Institut de recherche pour le développement



Introduction Context and challenges



Agriculture

-

Cereal production /hab. ↘

Population growth





Introduction Context and challenges

70% of the population

-

Cereal production /hab. ↘

Agriculture

Population growth

95% Rainfed

Crop yield increase = a challenge for tomorrow

Context and challenges





Introduction Context and challenges

-



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Context and challenges





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Context and challenges





Translate climate variations in terms of agricultural relevant variables

How to make crop yield predictions?



Where can we find rainfall data?

How to make crop yield predictions?



Crop yield

Where can we find rainfall data?



Long historical time series Insufficient network density Missing data Delay in reporting time

How to make crop yield predictions?



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Past, present and future climate **Big biases**

How to make crop yield predictions?



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... and ?

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Past, present and future climate Quite bad spatial resolution



Quasi global coverage Better and better resolution Increasingly available Accessible in near real time

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Crop yield

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Introduction How to make crop yield predictions?



To what extend can satellite rainfall estimates be used for crop prediction ?

Material and Method Satellite rainfall products assessment.



To what extend can satellite rainfall estimates be used for crop prediction ?

Material and Method Satellite products to assess

Near real time

	Satellite Product	Туре		
al time $\left\{ igspace{1.5cm} ight\}$	PERSIANN	Uncalibrated		
	CMORPH		Satellite data only Satellite and in situ	
	TRMM 3B42-RT			
	GSMAP-MKV+			
-	GPCP-1dd	Calibrated		
	TRMM 3B42v6			
	RFEv2		udid	



Daily, 1°, 2003-2009

Material and Methods Area of study and groundbased data



2003-2009 mean annual rainfall

Material and Methods

Crop modelling

2 Mechanistic crop models Field scale Daily time step

Niamey



Based on water balance No account for nutrient



- 3 pearl millet:
- Hainy Kire (early)
- Somno (late)
- Souna 3 (early)

Djougou



First aim: quantify soil erosion impacts on soil productivity Nutrient uptake taken into account



Maize, low fertilization (5kg of N /year).













What are these biases due to ?



What drives maize yields in Benin?





What drives maize yields in Benin?





What drives maize yields in Benin?



What drives maize yields in Benin?



The number of rainy days is crucial for crop yields in Benin





Maize yield bias



 \rightarrow Systematic bias

Results The rainfall biases in Benin



Maize yield bias and cumulative rainfall bias



 \rightarrow No systematic bias





Maize yield bias and rainy days number bias



An underestimation of the number of rainy days in Benin

What drives millet (souna) yields?





What drives millet (souna) yields?



The total rainfall amount is crucial for crop yields in Niger

What drives millet (souna) yields?



An underestimation of the total rainfall amount leads to an underestimation of millet yields

12/15

What drives millet (souna) yields?



An underestimation of the total rainfall amount leads to an underestimation of millet yields

12/15





13/15

The biases in Niger are reduced by correcting the total rainfall



The biases in Benin are reduced by correcting the rainfall distribution



Conclusion

- Satellite rainfall estimates may introduce **large biases** in crop yield prediction.
- Rainfall estimates bias propagation to yield **depends on the crop and region considered**.
- Crop yield biases are **not simple extrapolation** of rainfall cumulative amount biases, **rainfall distribution** is crucial as well.
- Uncalibrated products give the highest biases.

Prospects

- Compare simulated yield variations with yield observation
- What happens if radiation is taken from satellites as well ?
- Would a statistical bias correction improve near real time products performance for an Early Warning System application?

Thank you for your attention !

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Material and Method: Bias attribution What are crop yield biases due to ?



Material and Method: Bias attribution What are crop yield biases due to ?



Material and Method: Bias attribution What are crop yield biases due to ?



Material and Method: Crop models



Based on water balance

3 pearl millet:

- Hainy Kire (local, early)
- Somno (MTDO) (local, late)
- Souna 3 (improved, early)

EPIC

First aim: quantify erosion effect on soil productivity



800

400 600 Observed yield (kg/ha)

200

0

Satellite	Тура	Temporal	Spot Por	Temp. Res.
Product	туре	coverage	spat. Res.	
PERSIANN	Near real time	03/2000 →	0.25°	3h
CMORPH	Near real time	12/2002 →	0.072° (0.25°)	30min
TRMM 3B42-RT	Near real time	2002 →	0.25°	3h
GSMAP-MKV+	Global uncalibrated	01/2003-12/2008	0.1°	1h
GPCP-1dd	Global calibrated	1997 →	1°	daily
TRMM 3B42v6	Global calibrated	01/1998 →	0.25°	3h
RFEv2	Régional calibrated	01/2001 →	0.1°	daily