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Africa, sustainable development and climate change
Prospects of Paris and beyond

ClimDev-Africa



Simulating agricultural land-use adaptation decisions under changing climate using multi-agent system model in the Upper East Region of Ghana

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Outline

- Introduction
- Objectives
- Study area
- Methodological approach
- Results
- Conclusions and recommendations

Introduction

- ✚ Gaps between current knowledge and policymakers: Need to improve tools for integrated assessment, to investigate interactions between components of Human and Environment System (HES), and the consequences of different policy decisions (IPCC, 2001)
- ✚ Complexity of Agricultural land-use systems in the context of climate change calls for **multidisciplinary analyses** (Veldkamp and Lambin 2001)
- ✚ **Coupled HES**: one of the new multidisciplinary approaches implemented in the research area (Scholz, 2003)
- ✚ **Multi-Agent System model** (MAS): New integrated research for studying complex systems (Le, 2005; Latynskiy, 2014)

Objectives

- ❖ To develop a multidisciplinary approach for exploring relationship between local communities and natural savannah ecosystem under changing climate using multi-agent system model
- To operationalise Land Use Dynamic Simulator (LUDAS) as multi-agent system in examining the implications of climate change in the adaptation of agricultural land-use

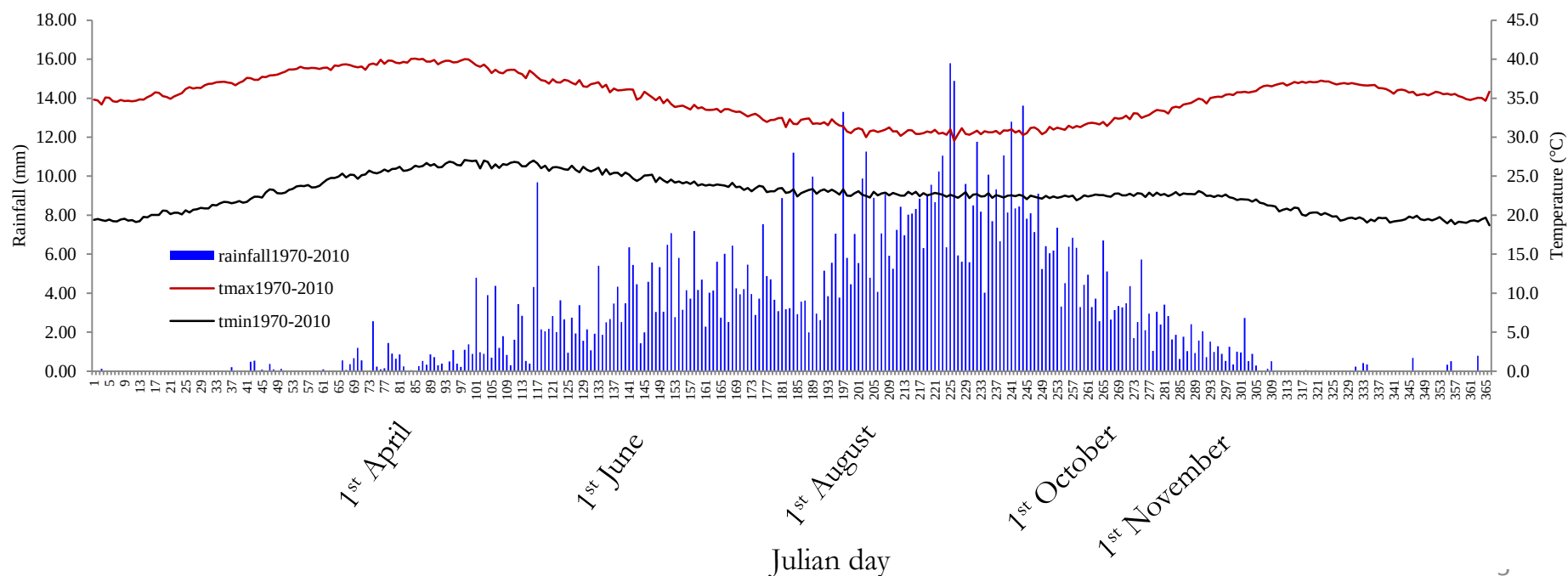
Climatological characteristics of the study area during 1970-2010

Rainfall, annual average

	Rainfall (mm)	Year
Maximum record	1365	1999
Mean	990	
Minimum record	671	1977

Temperature, daily average

	Max temp (°C)	Min temp (°C)
Maximum value	40	27
Mean	35	23
Minimum value	30	19





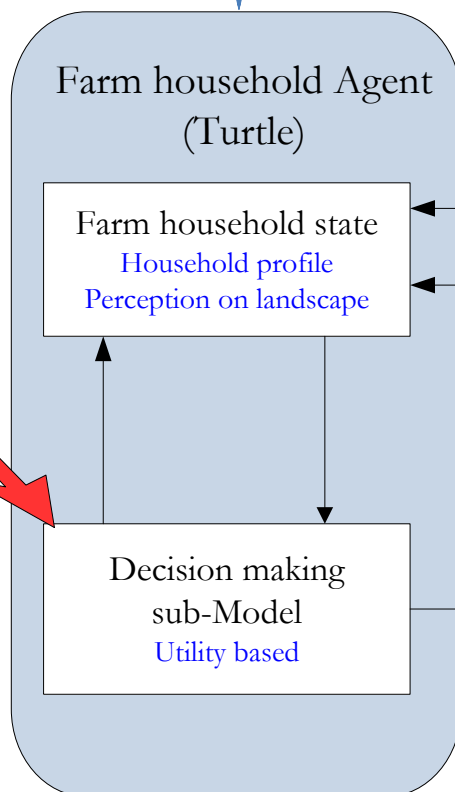
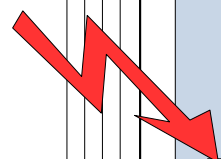
Framework of SKY-LUDAS

Global Policy Sub-Model
Policy intervention
Climate change and Variability



SKY-LUDAS:
Sumbrungu-Sirigu
-Kandiga-Yuwa

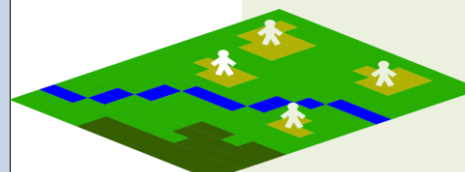
*Perception and
Adaptation sub-
models as two-step
decision making*



Perceptions

Benefits

Agricultural production



Tenure relations

Actions

Land uses
Adaptation adjustments
on land uses

Landscape unit Agent
(Patch)

Biophysical sub-Model
Production based

Biophysical state
Land performance based

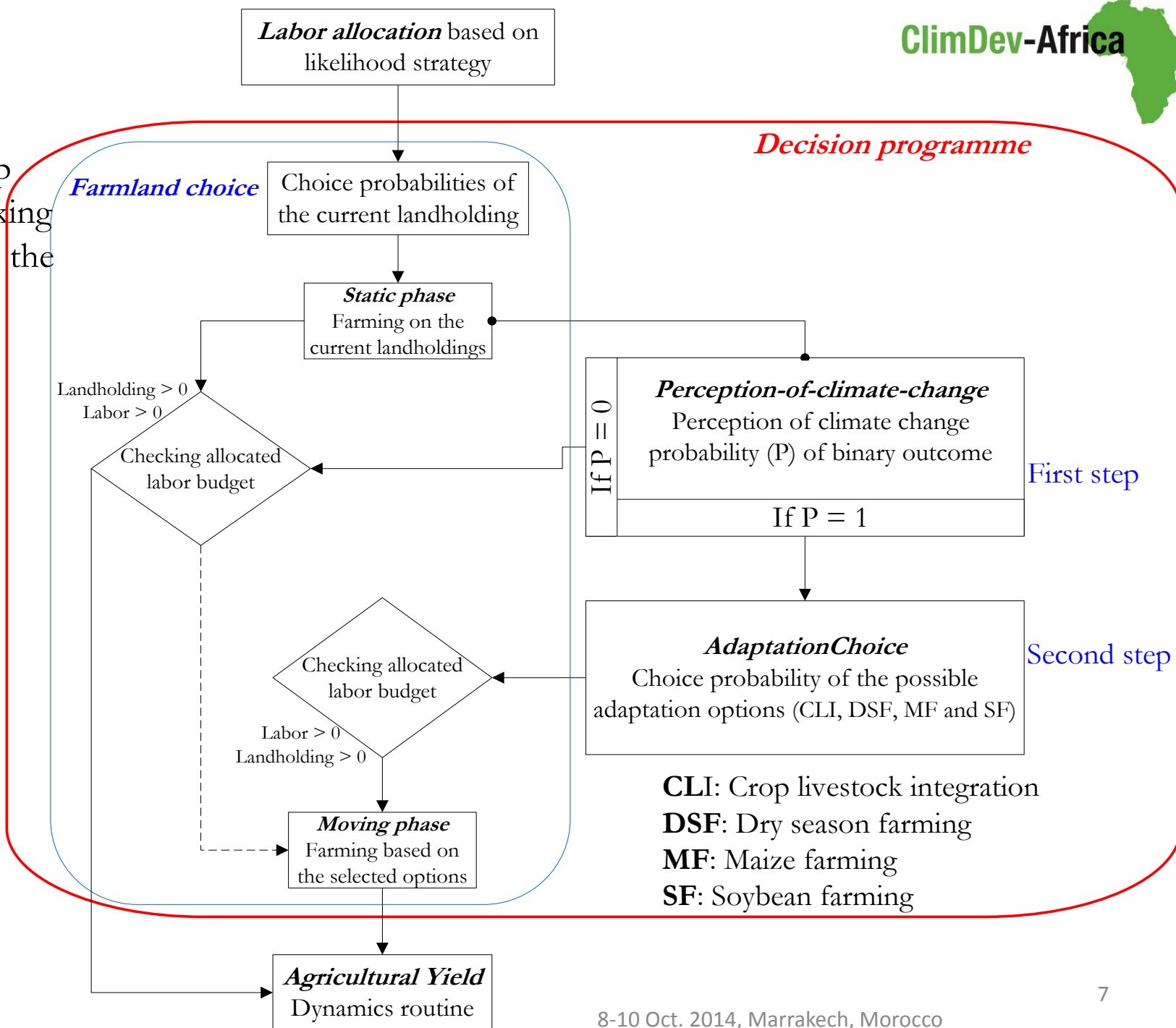
Emergent properties

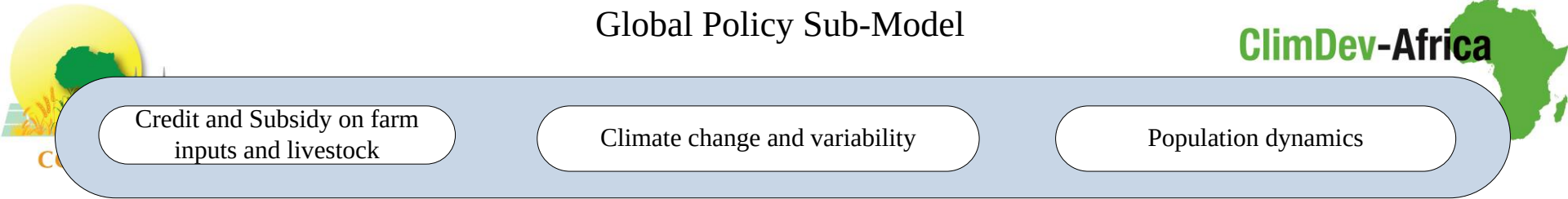


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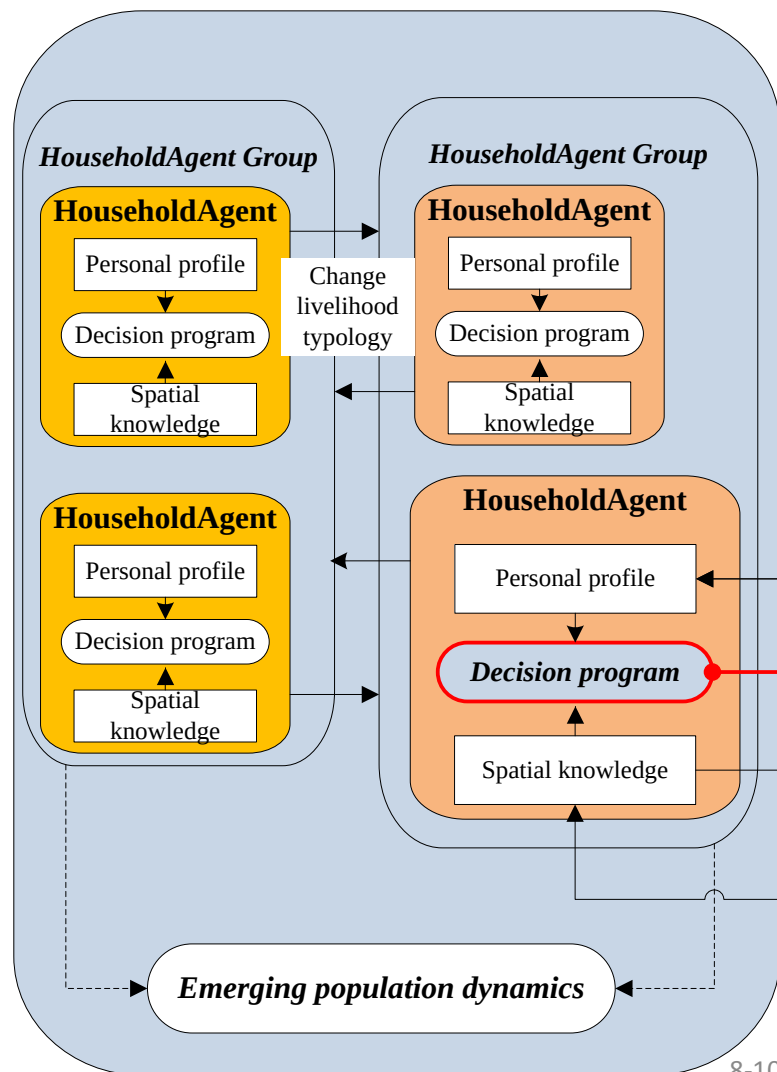


The two-step decision making integrated in the decision programme

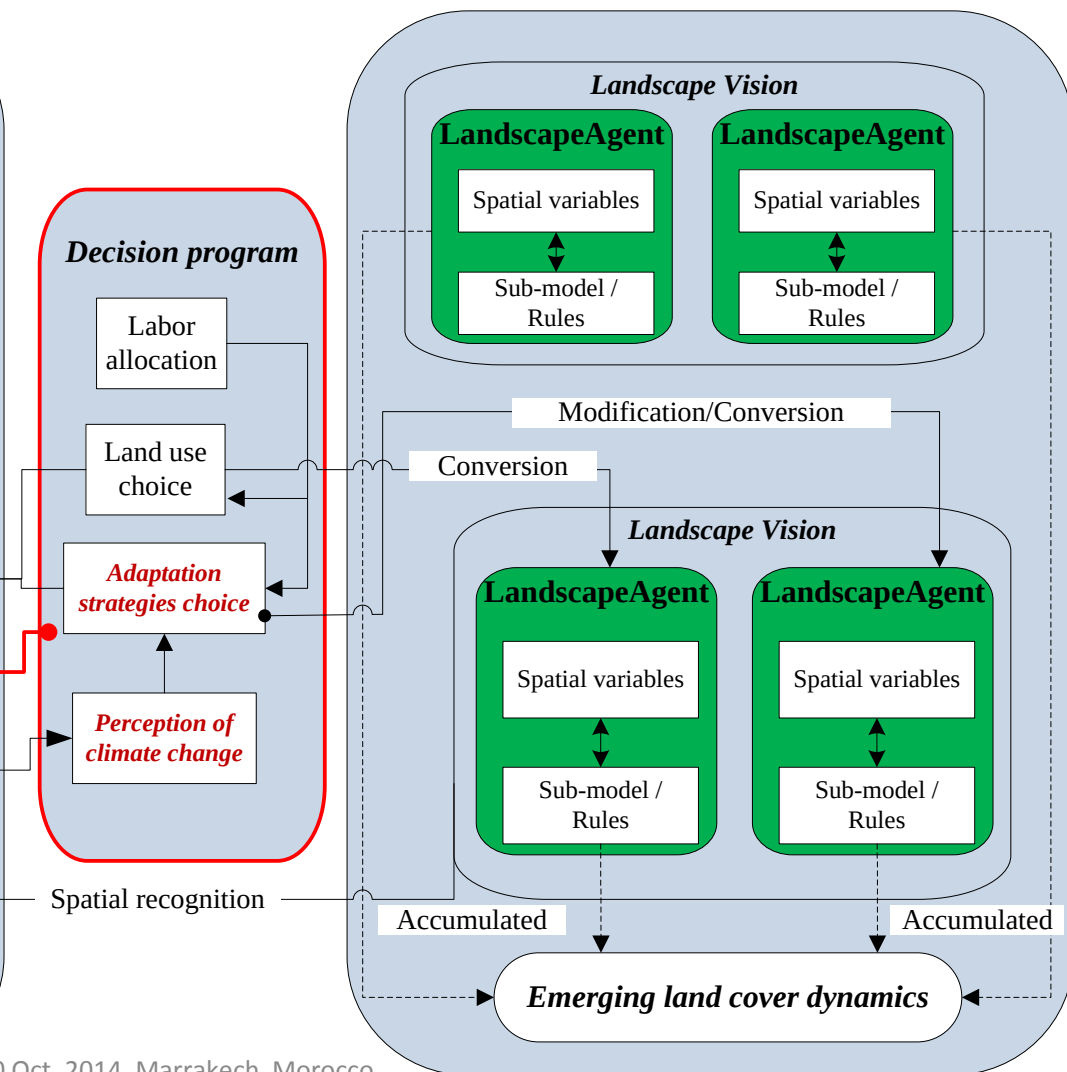




Household module



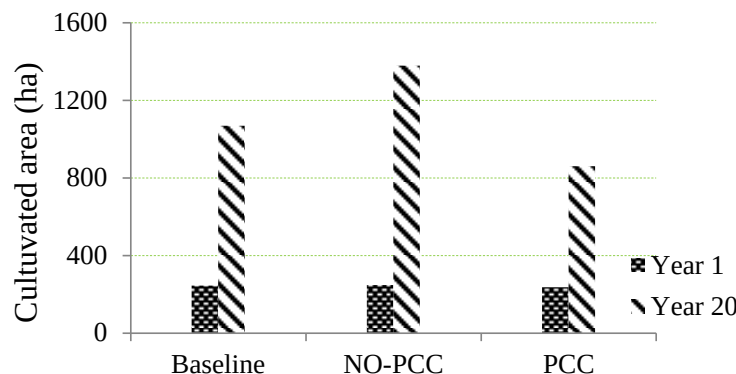
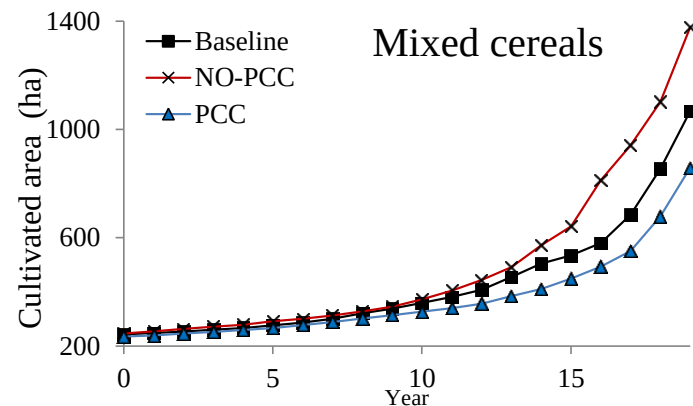
Landscape module



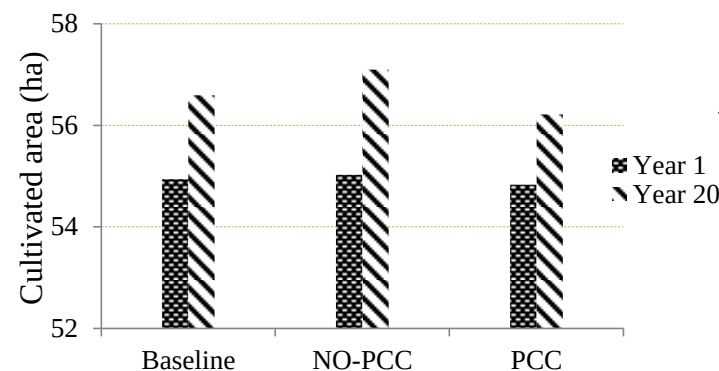
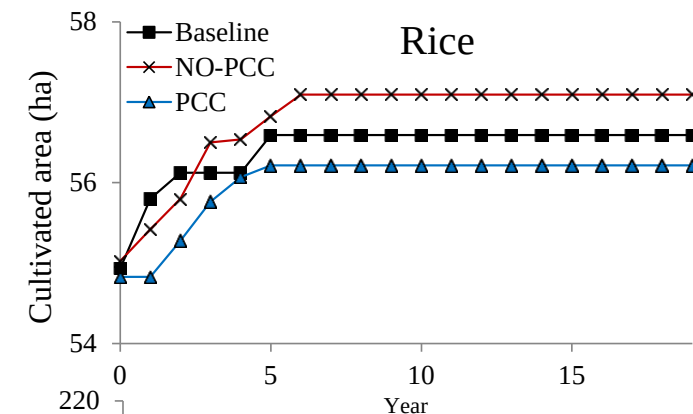


Simulation results (1) ClimDev-Africa

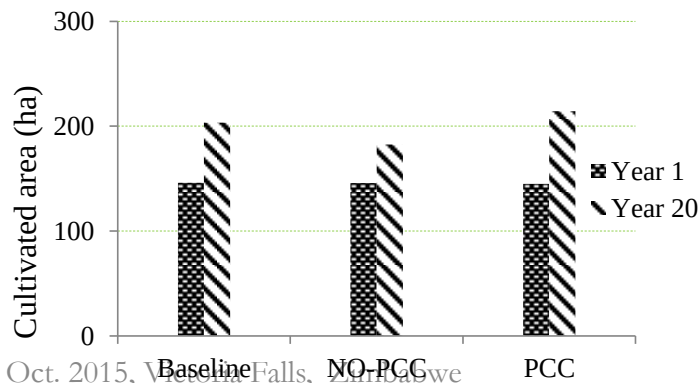
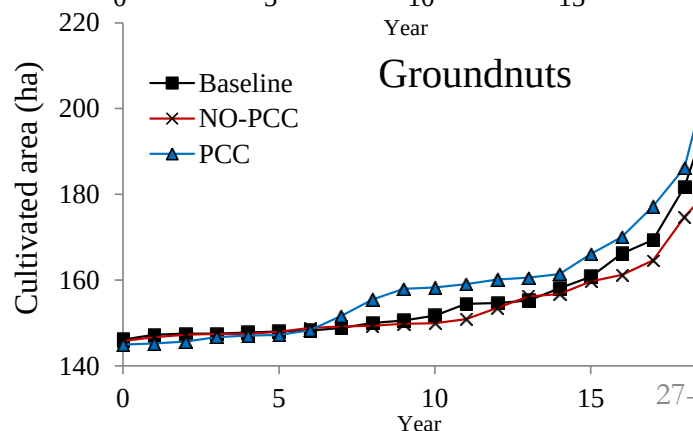
Implications of climate change in land-use adaptation decision



❖ Increasing cultivated area of mixed cereals

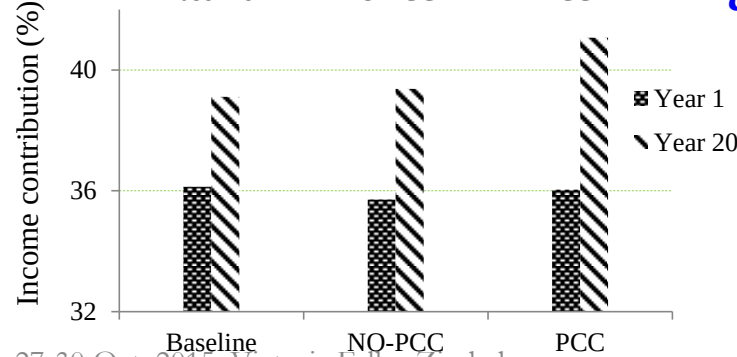
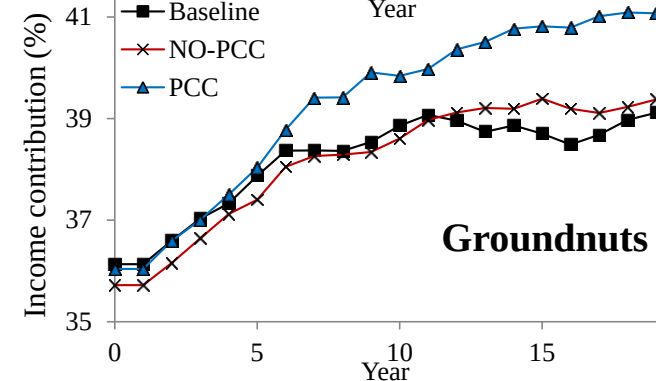
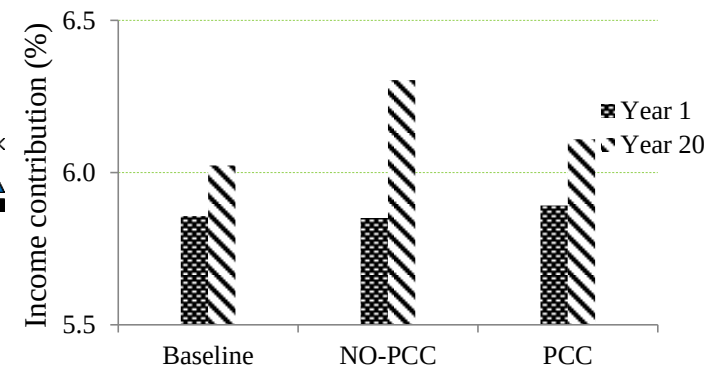
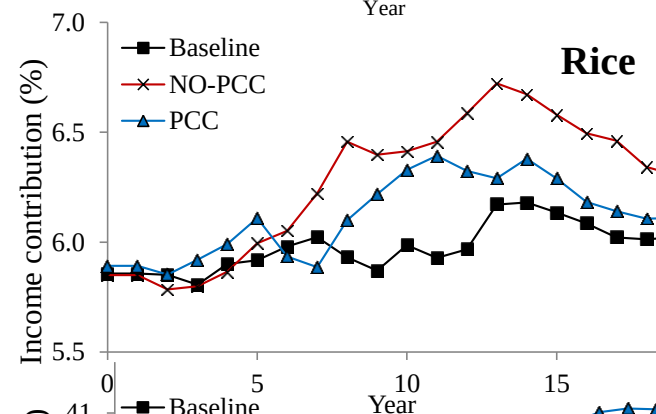
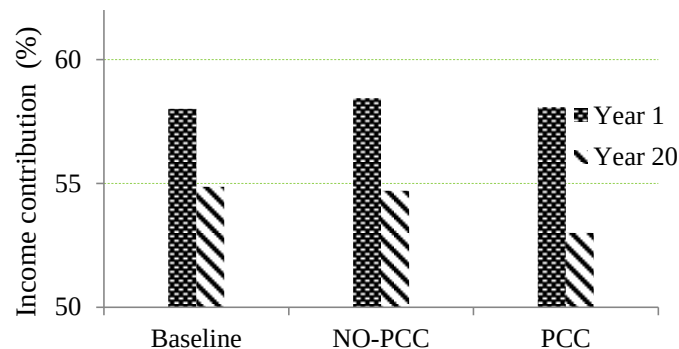
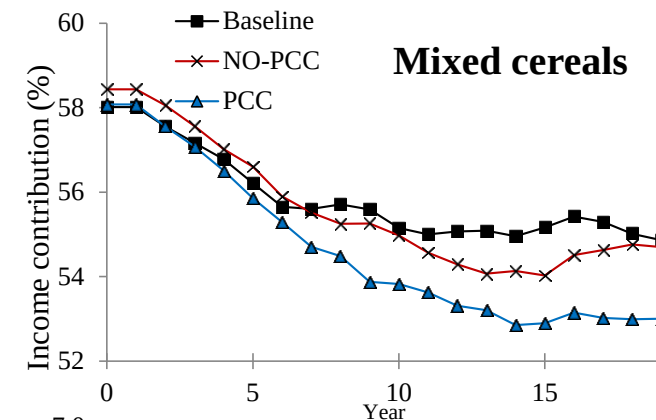


❖ cultivated area of rice : abrupt increase, then constant over time



❖ Increasing cultivated area of groundnuts

Implications of climate change in land-use adaptation decision



Income structure: SKY-LUDAS revealed a decreasing income contribution of mixed cereals unlike the contribution of rice and groundnuts;

Strategy to climate change: *Groundnut: not only cash crop, but coping measure*

- ❖ Even though the cultivated area of mixed cereals dominated, but its contribution to income structure in the households is decreasing. which is supported by Schindler (2009) : *“A gradual shift among land-use types from traditional cereals farming to cultivation of rice and groundnuts was observed during the last decades”*: Good indicator of resilience
- ❖ **Contribution:** Answer to the critical question of whether some adaptation practices are stimulated by climate or other factors (Deressa, 2008; Gbetibouo, 2009): Case of groundnuts
- **Integrated research for studying land-use adaptation:**
 - ✓ **SKY-LUDAS as an integrated land-use model:** Farmers have adapted their land-use to climate change based on their income source and gradual change in the cultivated land-use in the purpose of being less dependent on vulnerable farming system; and therefore the climate