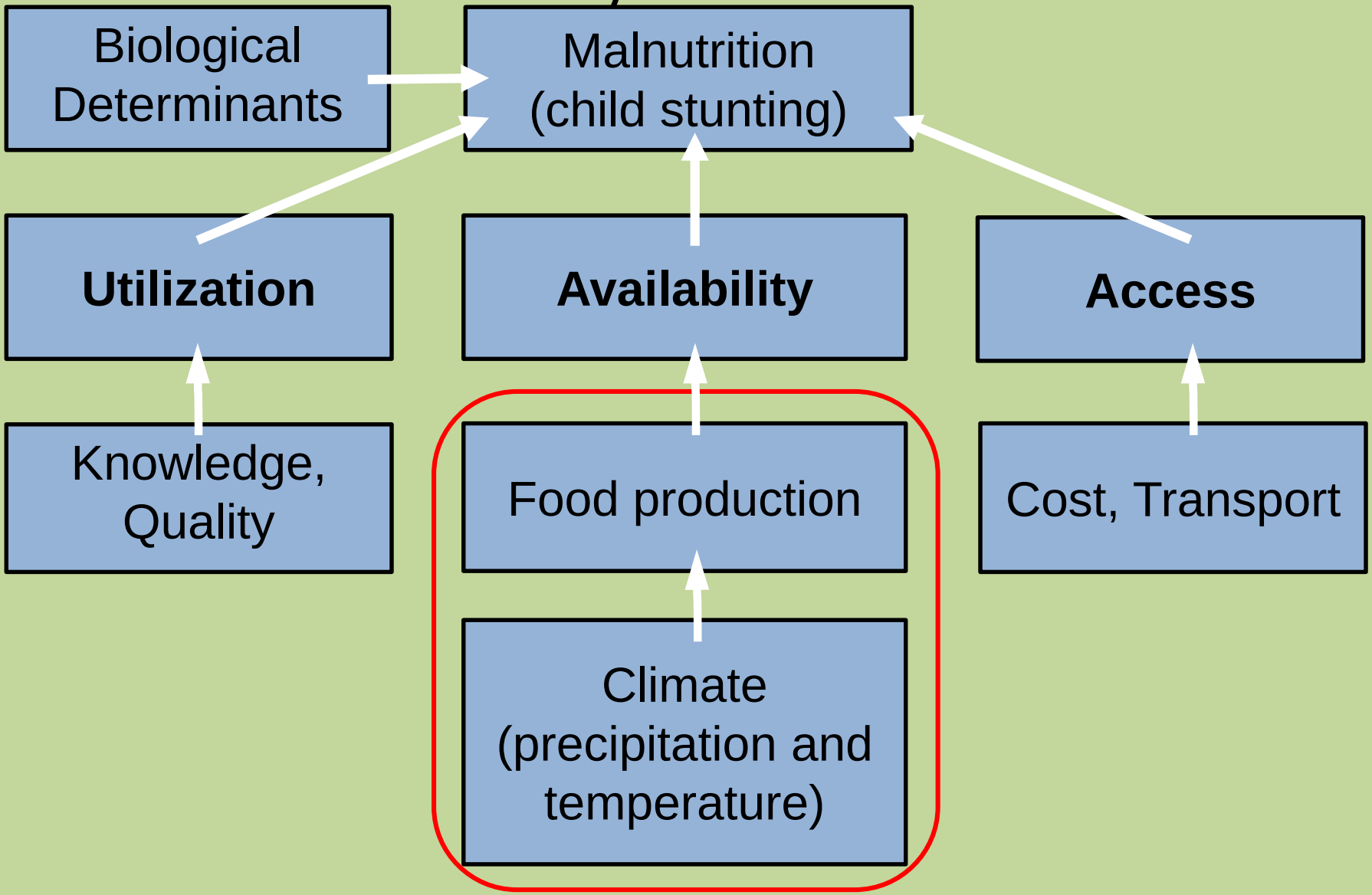
Agriculture and health in a context of climate change: Food availability under different climate scenarios in West Africa

Kathryn Grace

Gregory Husak

Food Availability: Linking household food security and climate



Why Cropped Area?

- Can measure food production/availability
- Reduce uncertainty in existing cropped area estimates
- Food Security in the context of climate change
- Understand crop activity potential

How we measure outcomes

- Stunting
  - Height-for-age compared to a WHO standard
  - Short stature reflects deficiencies in calories and micronutrients
- Reproduction
  - Number of births (deaths, miscarriages, stillbirths)
  - Family size goals (more resources -> bigger families)

Research Objectives

- Estimate cultivated area using remotely sensed data
- Estimate baseline regression models that link health outcomes to cultivated area
- Evaluate health outcomes with attention to climate scenarios (climate -> cultivated area -> health)

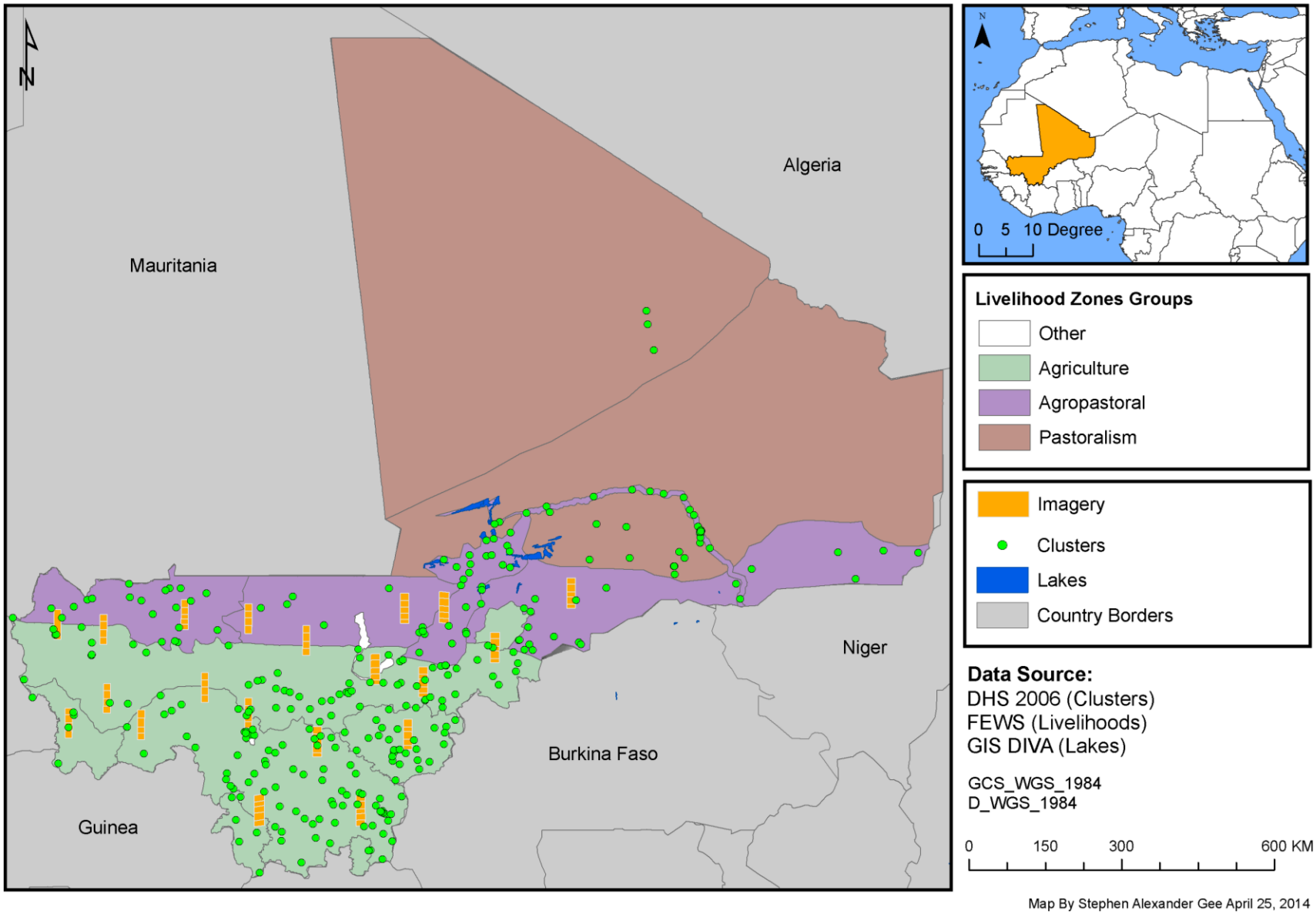
Context

- Mali and Burkina Faso are among the poorest and least developed countries in the world
- Mostly rural (65%, 73%)
- High dependence on rainfed subsistence agriculture
- Characterized by high levels of food insecurity and child malnutrition (seasonal “Hunger Periods”)
- Rapid population growth (+fert. and –mort.)

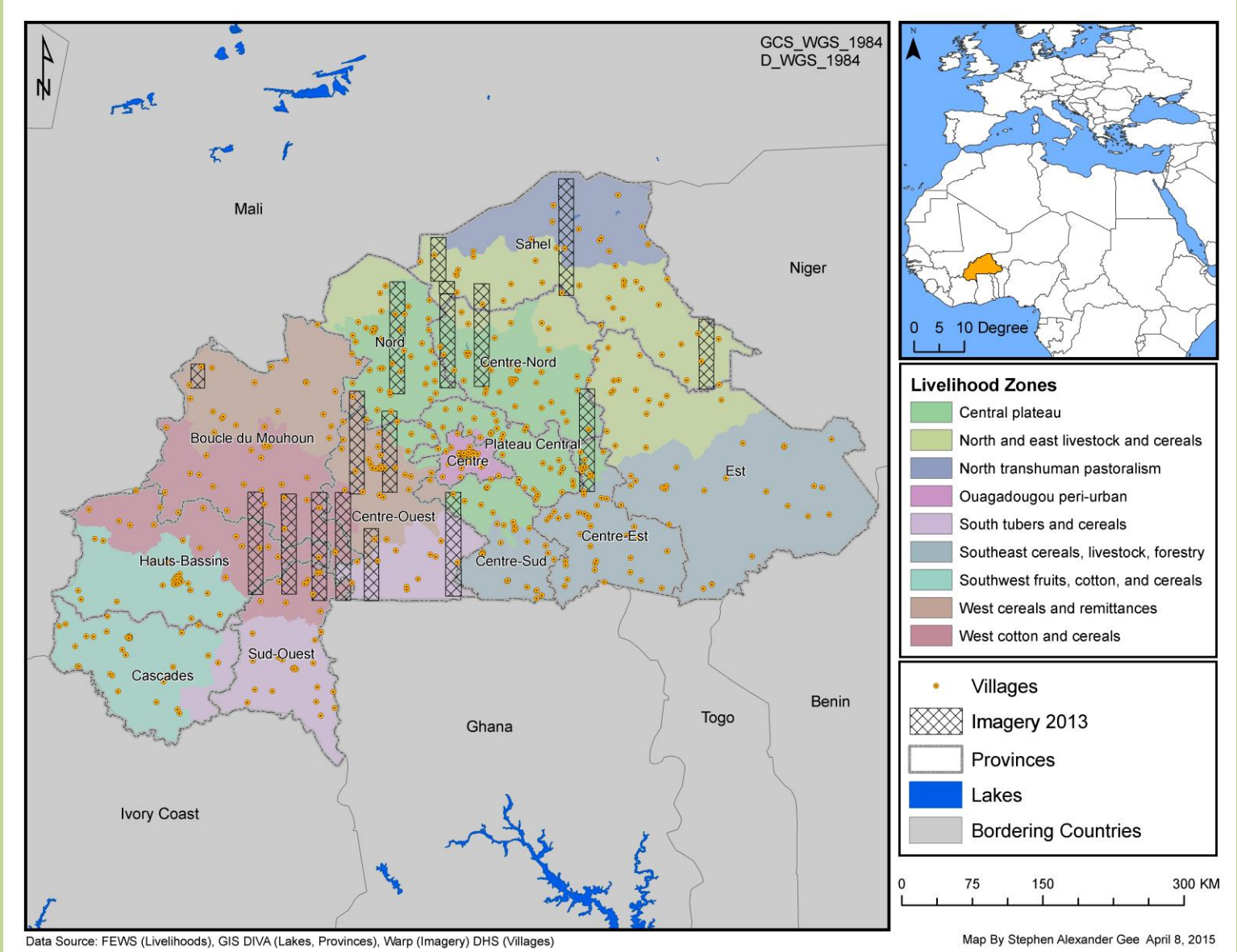
Data

- Livelihood zones
  - FEWS NET/USAID effort to characterize the dominant livelihood strategies of high priority countries
  - Based on geophysical/landscape characteristics, local experts, climate patterns, market behavior
- Demographic and Health Survey Data (2010, 2013)
  - Geocoded at the community cluster level (approximately 10-20 households)
  - Children's health information
  - Household/individual data

Livelihood zones, DHS clusters and Imagery



Livelihood zones, DHS clusters and imagery



Data cont.

- 1 meter remotely sensed data used to produce estimates of annual food production (cultivated area)
  - Very high resolution remotely sensed imagery from growing seasons is processed (crop or not crop) and used to “train” a GAM
  - GAM is used to predict in places without imagery and used to hindecast (Husak et al. 2008; Grace, Husak et al. 2012; Grace, Husak, Bogle, 2014)

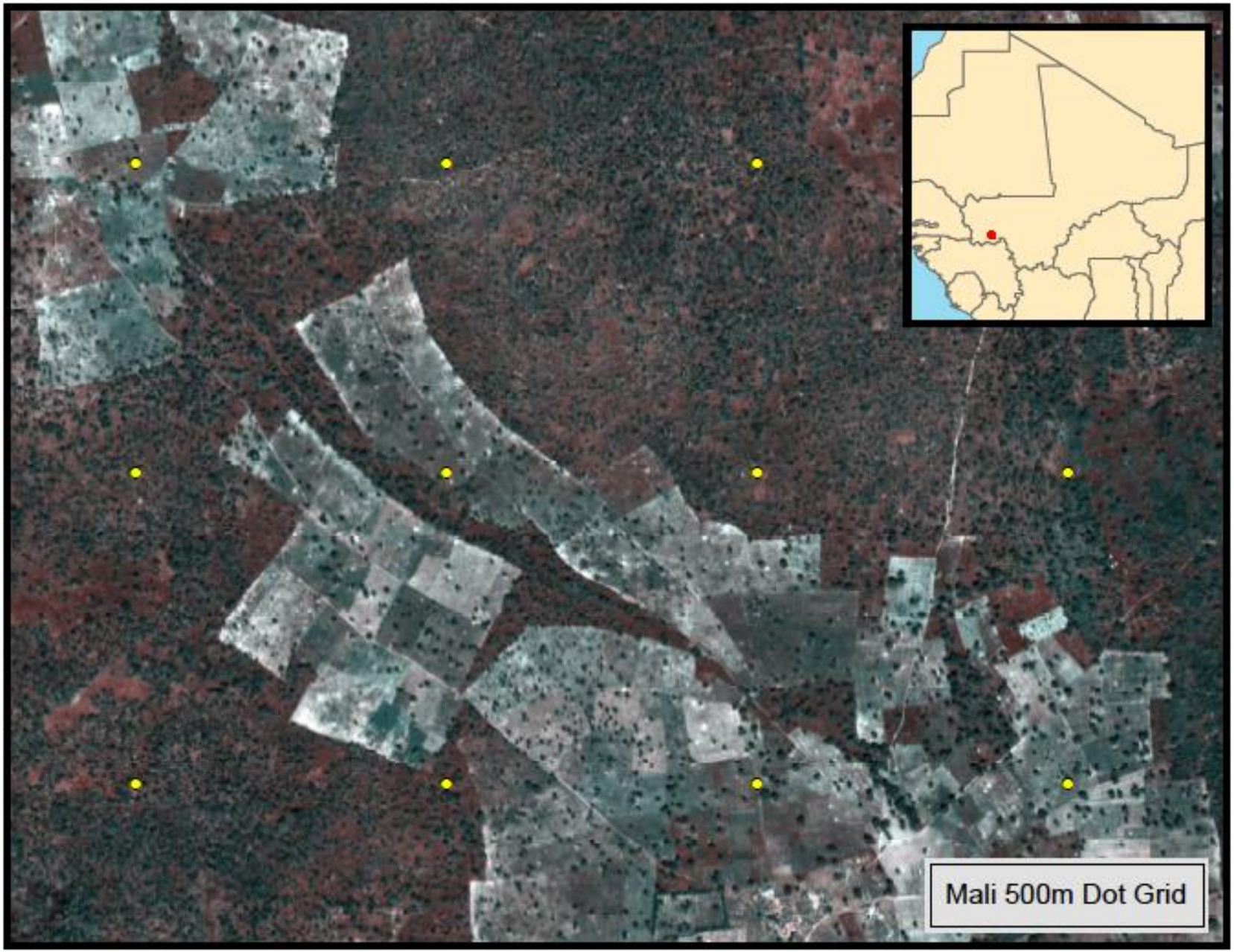
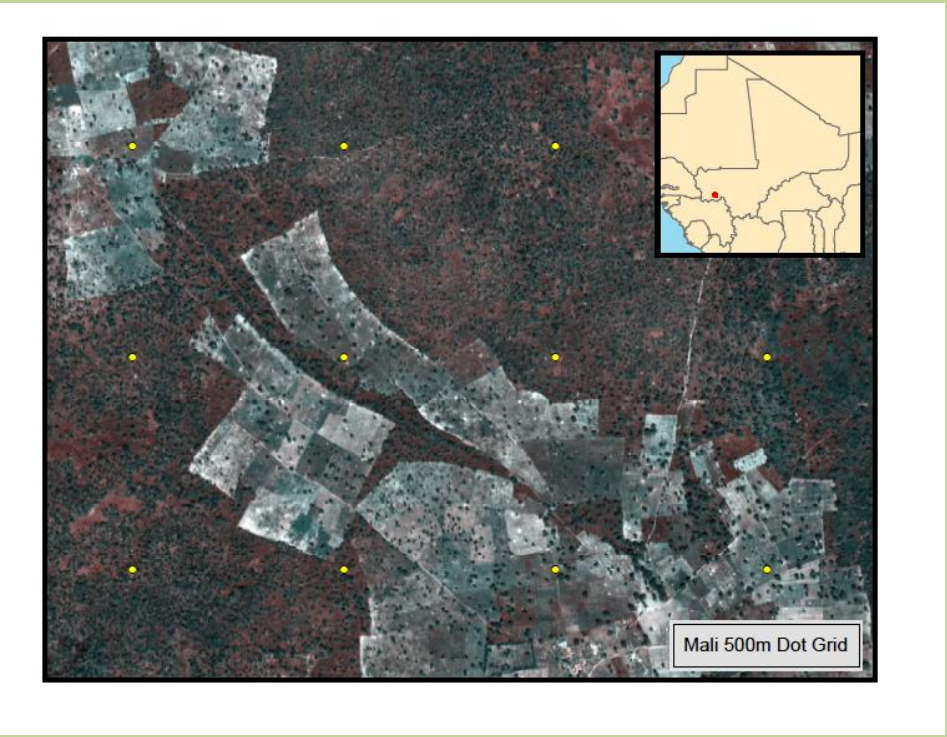
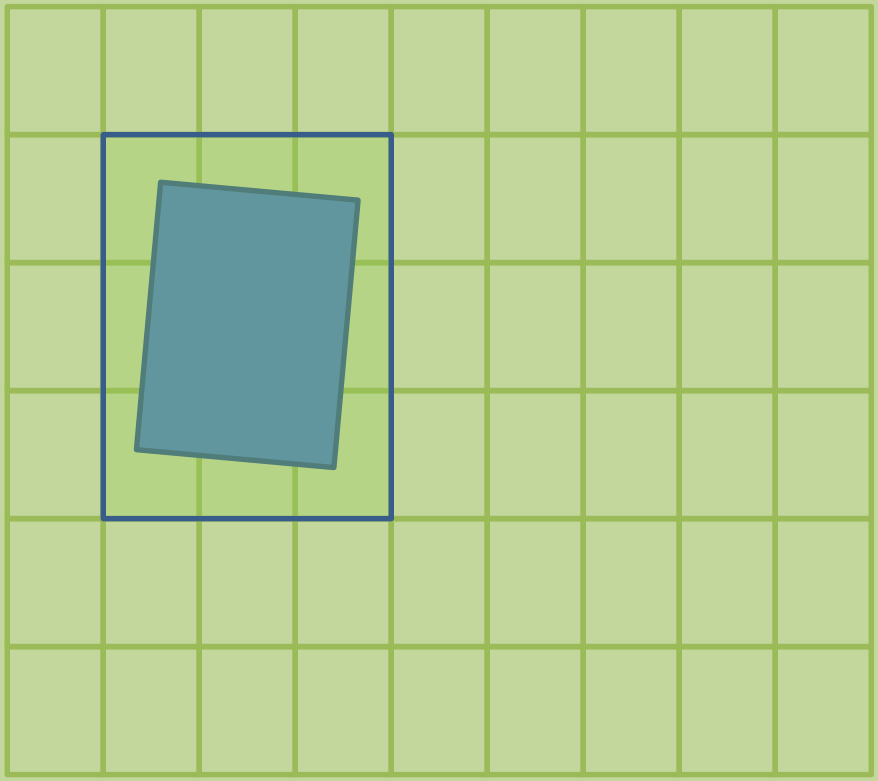

Mali 500m Dot Grid

Image Interpretation



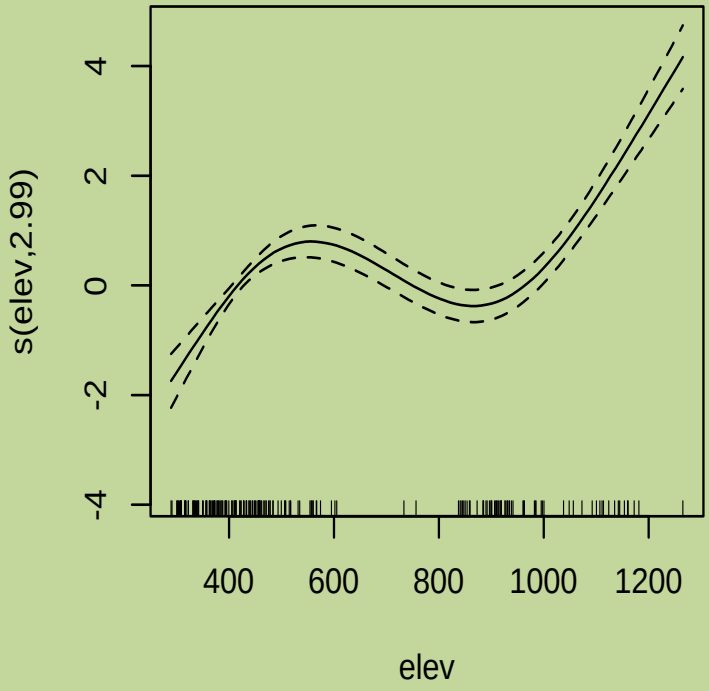
- Interpret 10s of thousands of points using VHR imagery
- Rule of thumb is to have 10% of the wide area covered by VHR imagery
- More important is a representative collection of points which capture the range and diversity of landscape characteristics

Build Statistical Relationship



- Attribute interpreted points with predictor data
- Build relationships between predictors and proportion of crop
- Identify significant variables and use them in a stepwise generalized additive model

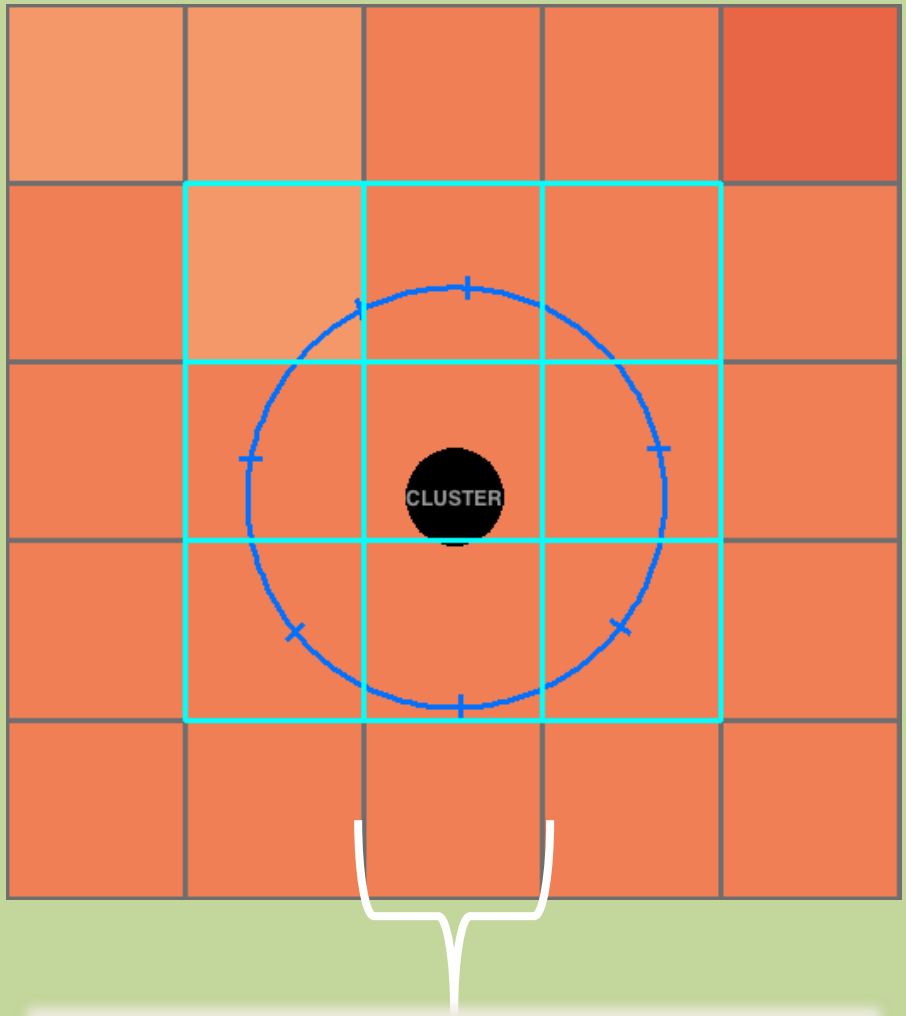
Expand Statistical Model



- Apply the model to areas without support of VHR data
- Captures the proportion of crop at each modeling unit
- Modeling units are then aggregated to capture the crop proportion/area over the reporting unit

Matching people to environmental data

- One cluster (sampling unit) will contain several children/households
- Grid cell containing the cluster and cells touching that cell are averaged
- Compared to health outcomes



Linking Cropped Area to Malnutrition

- Regression models
  - Independent variables
    - cultivation for each community
  - Dependent variables – relate to malnutrition (stunting, reproduction, mortality…)
- Modify cultivated area inputs (NDVI and rainfall, specifically) to evaluate impact on cultivated area and refit regression models

Variable		Estimate	Sig.
No School		0.0877	
Primary		**0.4671**	***
Secondary		0.7657	
Age group 20-24		-0.0148	
25-29		-0.1468	
30-34		**-0.3271**	*
35-39		-0.2503	
40-44		**-0.4771**	**
45-49		-0.3792	
Mother's height		**0.0025**	***
Married		0.0561	
CEB		**0.0408**	*
Low birth weight (no)		**0.3718**	***
Finished Floor		0.0074	
Livelihood			
North	Cereals/livestock	-0.053	
	Pastoralism	**-0.3487**	.
South	Cereals	-0.1498	
	Cereals/livestock	-0.053	
	Fruits/cotton/livestock	-0.0239	
West	Cereals	-0.0533	
	Cotton/cereals	**-0.1757**	*

Burkina Faso Results: stunting

Food Availability?

More agriculture indicates healthier kids.

Variable		Estimate	Sig.
Primary		0.0582	
Secondary		**0.2529**	*
Higher		0.825	
Age group			
20-24		-0.2048	
25-29		-0.082	
30-34		-0.0938	
35-39		-0.2157	
40-44		**-0.3664**	*
45-49		**-0.7323**	*
Mother's height		**0.002**	***
Married		0.109	
CEB		0.0262	
Low birth weight (no)		0.0056	
Finished Floor		**0.3054**	**
Livelihood			
Dogon	Millet/wild foods	0.0489	
	Millet/livestock	-0.2471	
Niger delta	Rice/livestock	-0.1795	
North-west	Sorghum/livestock	0.0734	
	Sorghum/millet/cotton	-0.5723	*
South	Maize/cotton/fruits	-0.2122	
	Maize/sorghum/fruits	-0.3621	
West	Rainfed millet/sorghum	-0.0165	

Mali Results: Stunting

Food Availability?

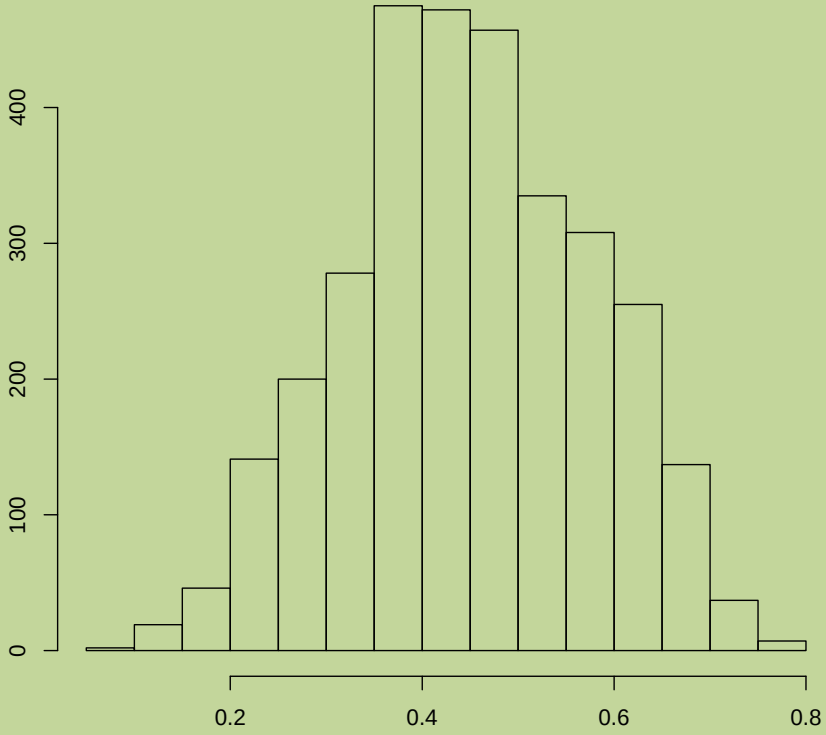
In specific vulnerable contexts food production matters – almost all livelihood zones with increased ag show less stunting, regardless of biological or behavioral characteristics

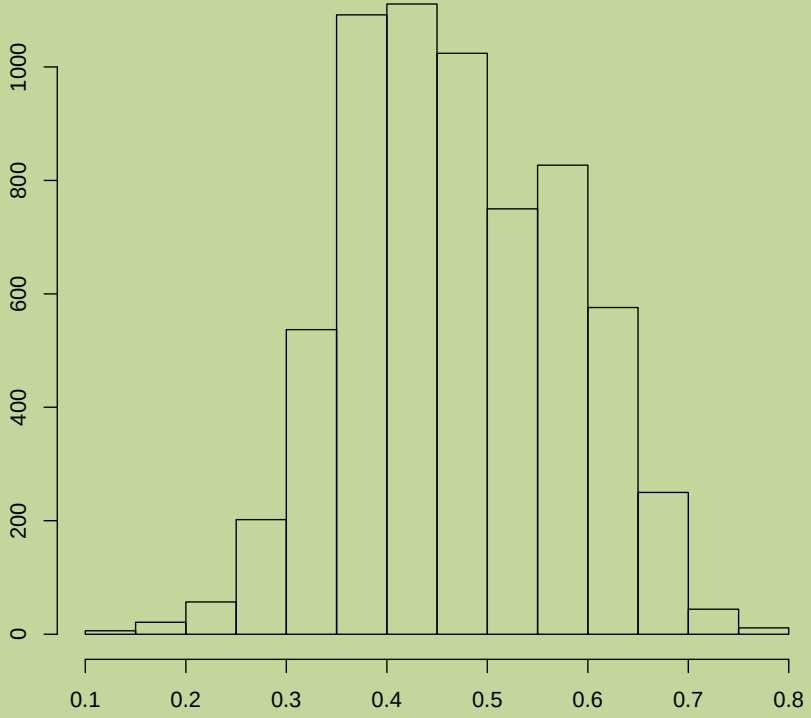
Scenarios: How food availability impacts household health

- Using IPCC scenarios we consider socio-economic versus climate and food production. All play an important and non-negligible role.
- What happens if crop production is reduced by an average of 25% Mali? - this corresponds to a reduction in rainfall that varies across Mali but that could be anticipated in worst case scenario. We see an increase in stunting from 34% to 38% - more sick children.
- If crop production increases we see an increase in births – a population growth.

Scenarios: How food availability impacts household health

What happens if crop production is reduced by an average of 25% Mali? - this corresponds to a reduction in rainfall that varies across Mali but that could be anticipated in worst case scenario.





Thank you!!

grace@geog.utah.edu
husak@geog.ucsb.edu

The work presented here is based on collaborative research conducted by Kathryn Grace, Greg Husak, Nicholas Nagle, Seth Bogle, Chris Funk, Frank Davenport, Amy Lerner, Jude Mikal