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food security analysis

Shock Impact Simulation Model (SISMod)

July 2013 (Revision)



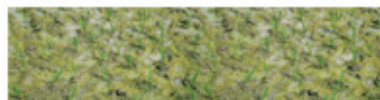
Outline

1. What is SISMod?
2. How does SISMod work?
3. Outputs of SISMod
4. Case Study - Niger
5. Way forward : potential use of SISMod



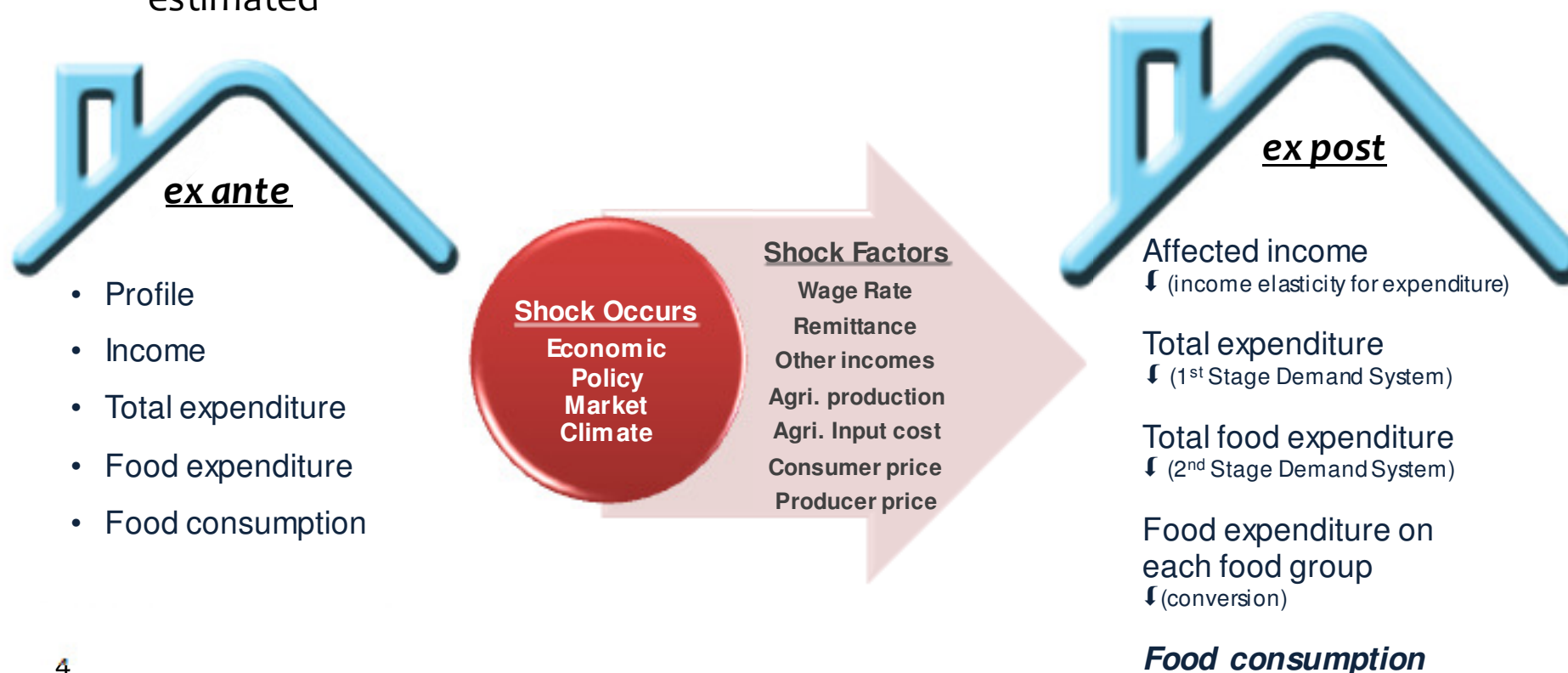
What is SISMod?

- A macroeconomic modelling system jointly developed by EST/FAO and VAM/WFP with the support of the Irish Government
- To provide quantitative estimation on the *ex-ante* and *ex-post* impact of various types of shocks (e.g. market, economic, political, climatic) on livelihood and food security
- To identify who and where is the most affected by shock and to what extent, by geographic locations, by different livelihood groups, by income groups and by gender, etc.
- To simulate for future scenarios of potential shocks, as well as interventions
- Country coverage: Pakistan, Bangladesh, Nepal and Tajikistan, and expanding to Tanzania, Niger, Nigeria, South Sudan, Malawi, Cambodia...



How does SISMod work?

- Households' adaptive capacity (in terms of allocation of income to expenditure) is simulated by taking elasticities and demand systems into the model
- Food security of each household (in terms of food consumption) is one of the ultimate outputs
- Depth of Hunger, Number of People Undernourished, Food Gap can then be estimated





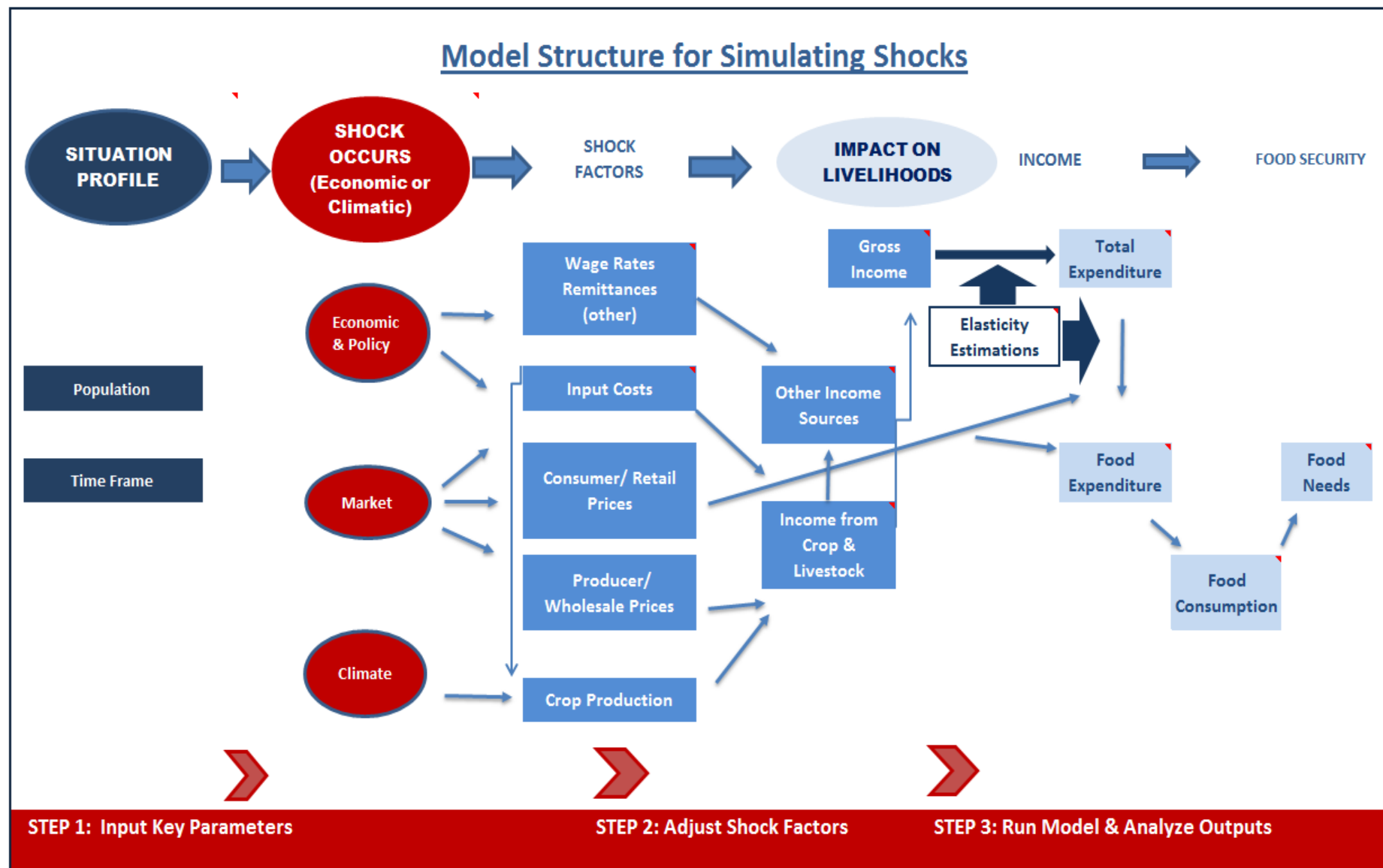
Theoretical Background

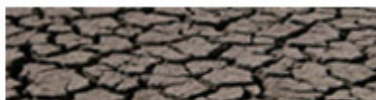
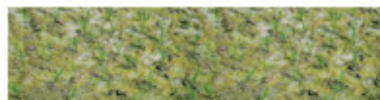
- SISMod adopts the Agricultural Household Models (AHM) approach from Singh, Squire and Strauss (1986)
- AHM incorporate production and consumption decisions of a rural household as the household is both producer and consumer
- Different from the pure consumer model, the household budget in AHM is endogenous and depends not only on the traditional price effect, but also the farm profits (and other incomes), which can offset the impact of price changes on food consumption





Model Structure





Two-Stage Food Demand System

1st Stage – Linear Expenditure System (LES)

- To allocate **total HH expenditure** over broad **groups of commodities**: food, housing, transportation, health, clothing, durable goods, education...

LINEAR EXPENDITURE SYSTEM (LES) DEMAND EQUATIONS

In the LES, demand equations are assumed to be linear in all prices and incomes and the set of demand functions is expressed in expenditure form:

(1)

$$P_I X_I = P_I R_I + \beta_I \left[Y - \sum_j [P_j R_j] \right]$$

with $0 < \beta_I < 1$, $\sum_I \beta_I = 1$ and $Y > X_I$. Where $P_I X_I$ (P_I and X_I are aggregated price and quantity indices for commodities within group I) is expenditure, and R_I and β_I are parameters. Y is household total expenditure. The uncompensated own-price and cross-price elasticities associated with equation (1) are:

$$(2) \quad \eta_{II} = (1 - \beta_I) P_I R_I / (P_I X_I) - 1 \text{ AND}$$

$$(3) \quad \eta_{IJ} = -\beta_I (P_J R_J) / (P_I X_I).$$

The expenditure elasticities are: (4) $\mu_I = \beta_I Y / (P_I X_I)$.



Two-Stage Food Demand System

2nd Stage – Linear Almost Ideal Demand System (LAIDS)

- To estimate **price (own-price & cross-price) elastic consumption** for each **group of food**: wheat, rice, maize, millet, other grain, other cereal, root, bean & pulse, vegetable, fruit, meat & fish, dairy product & egg, oil, sugar...

LINEAR ALMOST IDEAL DEMAND SYSTEM (LAIDS)

Consider the LAIDS with L equations for latent share of each food group in total consumption s_{hi}^* for household h (Deaton and Muellbauer 1980):

$$(1) \quad s_{hi}^* = \sum_{k=1}^K \alpha_{ik} x_k^h + \sum_{j=1}^L \gamma_{ij} \ln p_j^h + \beta_i \ln \left(\frac{M_h}{P_h} \right) + \varepsilon_{hi}, i = 1, \dots, L$$

where $x_k^h = 1, x_2^h, \dots, x_K^h$ are demographic variables, M_h is total expenditure, and P_h is the price index. The adding-up, homogeneity, and symmetry restrictions are in Equations (2), (3) and (4), respectively:

$$(2) \quad \sum_{i=1}^L \alpha_{i1} = 1, \sum_{i=1}^L \alpha_{ik} = 0 \text{ for } k \geq 2$$

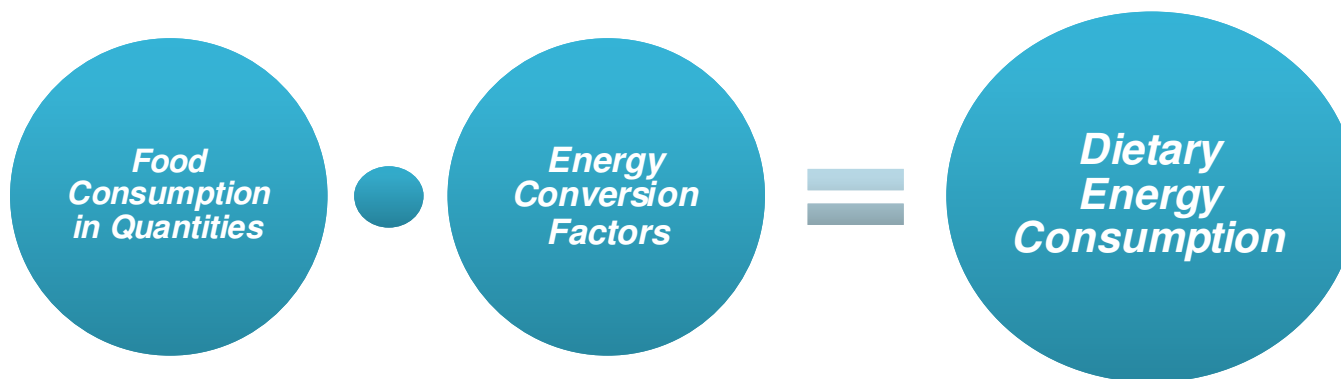
$$(3) \quad \sum_{i=1}^L \gamma_{ij} = 0 \text{ for all } j = 1, \dots, L, \sum_{i=1}^L \beta_i = 0, \sum_{i=1}^L \varepsilon_{ih} = 0 \text{ for all } h$$

$$(4) \quad \sum_{j=1}^L \gamma_{ij} = 0 \text{ for all } i$$



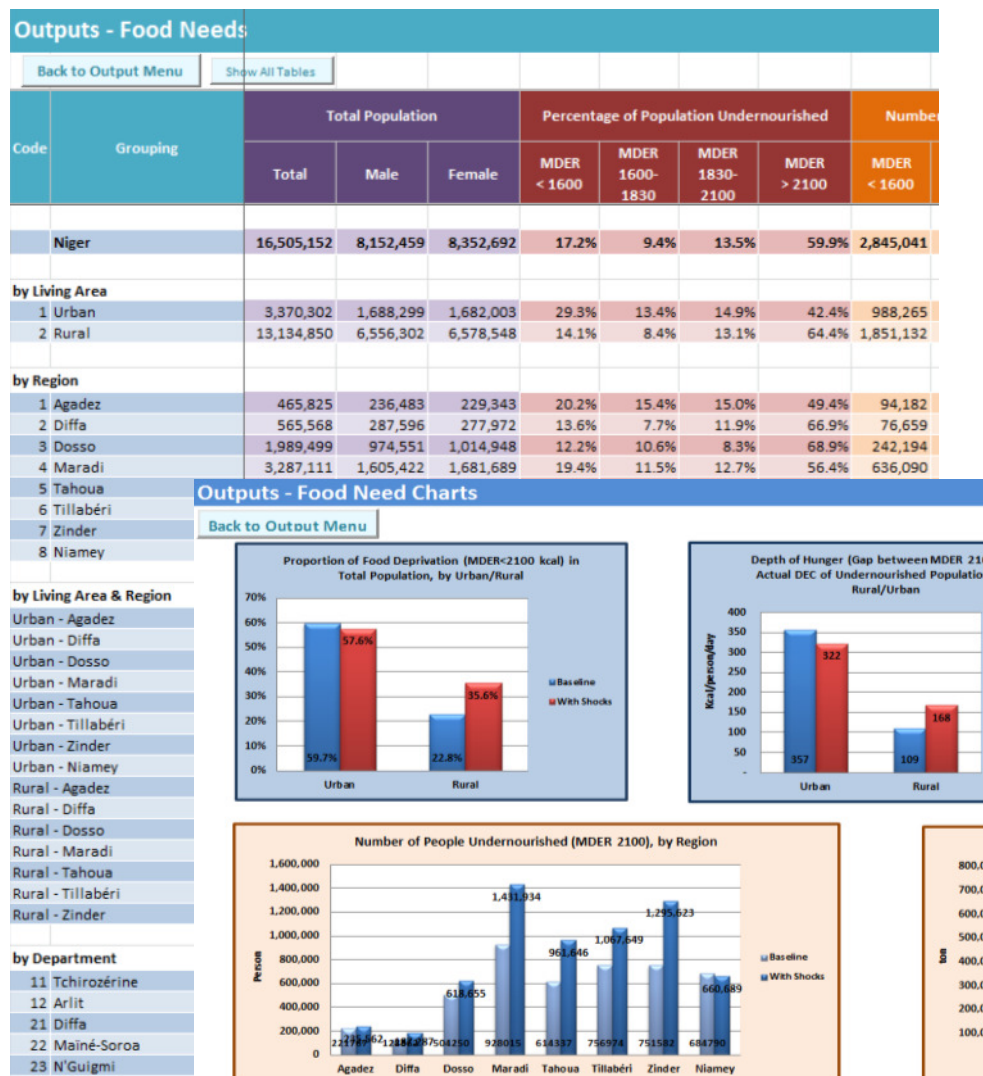
Per Capita Dietary Energy Consumption (DEC)

- Per Capita Dietary Energy Consumption (DEC) is the amount of food, in kilocalorie (kcal) per day, for each individual in the total population (FAO, 2008)
- DEC is converted from food consumption in quantities, which derived from the 2nd stage demand system, by using energy conversion factors
- To estimate food security indicators

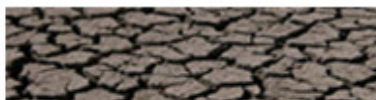




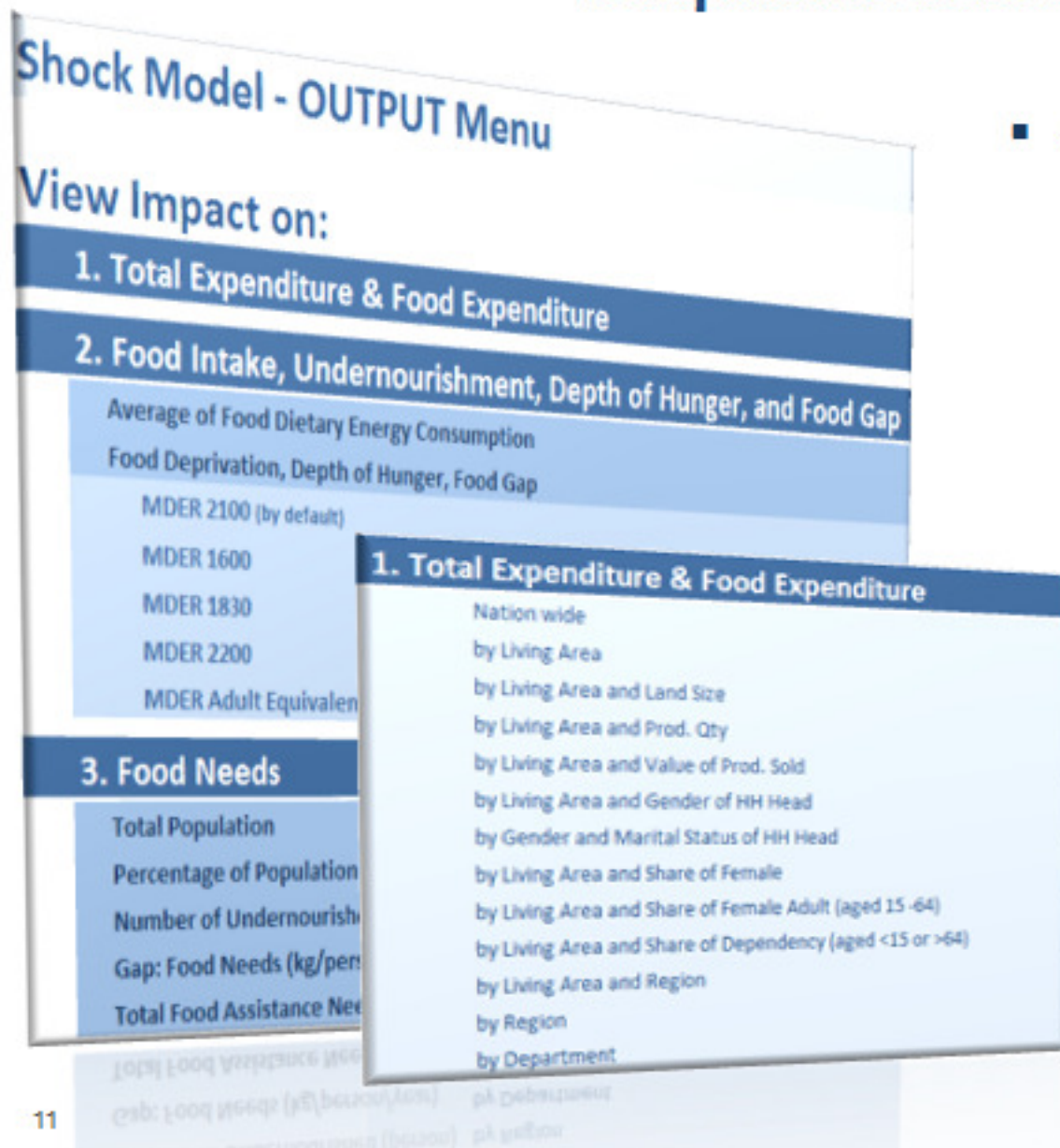
Key Indicators for Interventions



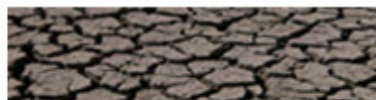
- Proportion of food deprivation in population (*below the minimum dietary energy consumption (MDEC) thresholds*)
- Number of undernourished people
- Depth of hunger (kcal/person/day)
(*Deficit in absolute terms between the average DEC of the deprived population and the MDEC*)
- Gap of Food Needs (kg of cereal /person/year)
(*Cereal needed to meet the undernourished*)
- Total Food Assistance Needed to Meet the Needs (ton/year)



Outputs of SISMod



- All outputs can be viewed with :
 - Different population groupings (*Gender, Smallholders, Income, Livelihoods Zone, Geographical location*)
 - Minimum dietary energy consumption threshold breakdowns
 - Table and chart formats



Groupings for Gender Analysis

Grouping	Sampling		Proportion of Food Deprivation in Total Population (%) MDER 2100		Depth of
Urban - Male headed	33%	1,287	60.6%	58.3%	
Urban - Female headed	6%	248	54.9%	53.9%	
Rural - Male headed	53%	2,072	22.4%	35.5%	
Rural - Female headed	7%	285	27.0%	36.6%	
by Gender and Marital Status of HH Head	% HH	No. HH	Baseline	With Shocks	Base
Male headed - Never married	2%	72	72.9%	66.5%	
Male headed - Monogamous marriage	66%	2,566	29.2%	38.9%	
Male headed - Polygamous marriage	17%	660	28.3%	40.9%	
Male headed - Widower	1%	25	54.5%	65.3%	
Male headed - Divorced	1%	31	49.4%	49.4%	
Male headed - Separated	0%	5	95.3%	95.3%	
Female headed - Never married	0%	9	15.6%	12.1%	
Female headed - Monogamous marriage	2%	68	35.3%	45.0%	
Female headed - Polygamous marriage	1%	25	42.4%	45.6%	
Female headed - Widower	9%	341	32.7%	40.2%	
Female headed - Divorced	2%	81	45.8%	46.2%	
Female headed - Separated	0%	9	70.7%	70.7%	
by Living Area and Share of Female	% HH	No. HH	Baseline	With Shocks	Base
Urban - Female None	2%	64	86.5%	77.3%	
Urban - Female <20%	1%	25	60.3%	54.2%	
Urban - Female 20%-40%	8%	327	59.3%	55.7%	
Urban - Female 40%-60%	15%	567	58.2%	55.2%	
Urban - Female 60%-80%	11%	428	59.0%	59.9%	
Urban - Female 80%-100%	3%	124	57.0%	57.0%	
Rural - Female None	1%	23	70.5%	70.5%	
Rural - Female <20%	1%	41	24.4%	56.3%	
Rural - Female 20%-40%	14%	540	21.9%	35.2%	
Rural - Female 40%-60%	25%	966	22.9%	34.9%	
Rural - Female 60%-80%	16%	618	20.5%	34.6%	
Rural - Female 80%-100%	4%	169	29.2%	35.6%	

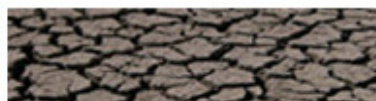
- Gender of HH head
- Share of female in HH
- Share of female adult in HH
- Gender and marital status of HH Head



Groupings for Smallholder Analysis

Grouping	Sampling		Proportion of Food Deprivation in Total Population (%) MDER 2100		Depth of
by Living Area and Land Size	% HH	No. HH	Baseline	With Shocks	Baseline
Urban	39%	1,535	59.7%	57.6%	
Rural - None	11%	432	36.3%	42.7%	
Rural - Smallest (20%)	10%	390	34.4%	46.6%	
Rural - 2nd smallest (20%)	10%	391	21.1%	34.9%	
Rural - Middle (20%)	10%	388	21.6%	36.9%	
Rural - 2nd largest (20%)	10%	381	18.1%	31.9%	
Rural - Largest (20%)	10%	375	14.4%	24.4%	
by Living Area and Prod. Qty	% HH	No. HH	Baseline	With Shocks	Baseline
Urban	39%	1,535	59.7%	57.6%	
Rural - None	16%	629	30.9%	37.4%	
Rural - Smallest (20%)	9%	353	33.3%	47.6%	
Rural - 2nd smallest (20%)	9%	350	24.5%	43.6%	
Rural - Middle (20%)	9%	360	19.0%	30.4%	
Rural - 2nd largest (20%)	9%	335	18.8%	32.0%	
Rural - Largest (20%)	8%	330	14.2%	23.3%	
by Living Area and Value of Prod. Sold	% HH	No. HH	Baseline	With Shocks	Baseline
Urban	39%	1,535	59.7%	57.6%	
Rural - None	42%	1,617	25.1%	37.7%	
Rural - Smallest (20%)	4%	151	25.2%	44.6%	
Rural - 2nd smallest (20%)	4%	155	23.6%	35.1%	
Rural - Middle (20%)	4%	146	15.2%	30.6%	
Rural - 2nd largest (20%)	4%	147	11.6%	21.7%	
Rural - Largest (20%)	4%	141	22.2%	27.2%	

- Land size
- Production quantity
- Value of Production Sold
- (all per capita)



Groupings for Income Group & Livelihood Zone Analysis

Grouping	Sampling		Proportion of Food Deprivation in Total Population (%) MDER 2100		Depth of H
by Agro-Ecologic Zone (from the HH Survey)	% HH	No. HH	Baseline	With Shocks	Baseline
Urban	39%	1,530	56.5%	59.4%	
Agricultural Zone	23%	900	28.2%	36.1%	
Agro-pastoral Zone	23%	891	34.6%	41.4%	
Pastoral	16%	629	26.9%	36.2%	
by Livelihoods Zone (from FEWSNET)	% HH	No. HH	Baseline	With Shocks	Baseline
Desert	4%	142	44.7%	47.6%	
A'R Mountains Cultivation Zone	4%	154	39.9%	40.5%	
Pastoral Zone	6%	226	37.4%	44.6%	
Agro-Pastoral Zone	15%	586	35.7%	42.9%	
Rainfed Agriculture Zone	44%	1,746	36.6%	42.6%	
Sub-Zones Of High Work Out-Migration	6%	239	27.3%	36.2%	
Southern Irrigated Cash Crop Zone	11%	421	30.4%	39.7%	
Komadougou River&Lake Chad Cash Crop	5%	186	31.1%	36.7%	
Niger River Irrigated Rice Zone	6%	250	41.8%	46.7%	
by Income Group	% HH	No. HH	Baseline	With Shocks	Baseline
Low	25%	988	38.6%	43.9%	
Mid-Low	25%	987	36.8%	47.4%	
Mid-High	25%	988	30.2%	37.3%	
High	25%	987	32.4%	35.5%	
by Living Area and Income Group	% HH	No. HH	Baseline	With Shocks	Baseline
Urban - Low	10%	383	57.6%	60.6%	
Urban - Mid-Low	10%	382	61.3%	63.9%	
Urban - Mid-High	10%	383	57.9%	60.1%	
Urban - High	10%	382	48.8%	52.9%	
Rural - Low	15%	605	37.4%	43.1%	
Rural - Mid-Low	15%	605	34.3%	44.4%	

- Agro-Ecologic zone
- Livelihoods zone
- Income group
- Living area and income group



Groupings for Geographical Location Analysis

Grouping	Sampling		Proportion of Food Deprivation in Total Population (%) MDER 2100		Depth of
by Living Area and Region	% HH	No. HH	Baseline	With Shocks	Base
Urban - Agadez	2%	83	53.2%	46.8%	
Urban - Diffa	1%	36	41.2%	39.1%	
Urban - Dosso	2%	71	53.5%	50.5%	
Urban - Maradi	3%	129	44.3%	41.7%	
Urban - Tahoua	3%	114	40.1%	44.6%	
Urban - Tillabéri	1%	44	44.4%	46.8%	
Urban - Zinder	4%	142	66.4%	71.8%	
Urban - Niamey	24%	916	71.6%	67.2%	
Rural - Agadez	9%	340	43.7%	55.8%	
Rural - Diffa	9%	337	20.1%	31.8%	
Rural - Dosso	9%	350	22.4%	28.6%	
Rural - Maradi	9%	333	26.9%	43.8%	
Rural - Tahoua	8%	314	17.8%	28.5%	
Rural - Tillabéri	9%	347	28.9%	40.2%	
Rural - Zinder	9%	336	17.3%	33.6%	
by Region	% HH	No. HH	Baseline	With Shocks	Base
Agadez	11%	423	49.3%	50.6%	
Diffa	10%	373	23.8%	33.1%	
Dosso	11%	421	26.0%	31.1%	
Maradi	12%	462	29.2%	43.6%	
Tahoua	11%	428	20.2%	30.2%	
Tillabéri	10%	391	29.7%	40.6%	
Zinder	12%	478	23.1%	38.1%	
Niamey	24%	916	71.6%	67.2%	
by Department	% HH	No. HH	Baseline	With Shocks	Base
Agadez - Tchirozérine	10%	388	47.4%	53.1%	
Agadez - Arlit	1%	35	57.7%	39.3%	
Diffa - Diffa	3%	131	25.0%	30.3%	
Diffa - Mainé-Soroa	4%	139	22.0%	38.2%	
Diffa - N'Guigmi	3%	103	24.5%	28.1%	

- National total
- Urban/Rural
- Region
- Department



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Case Study - Niger

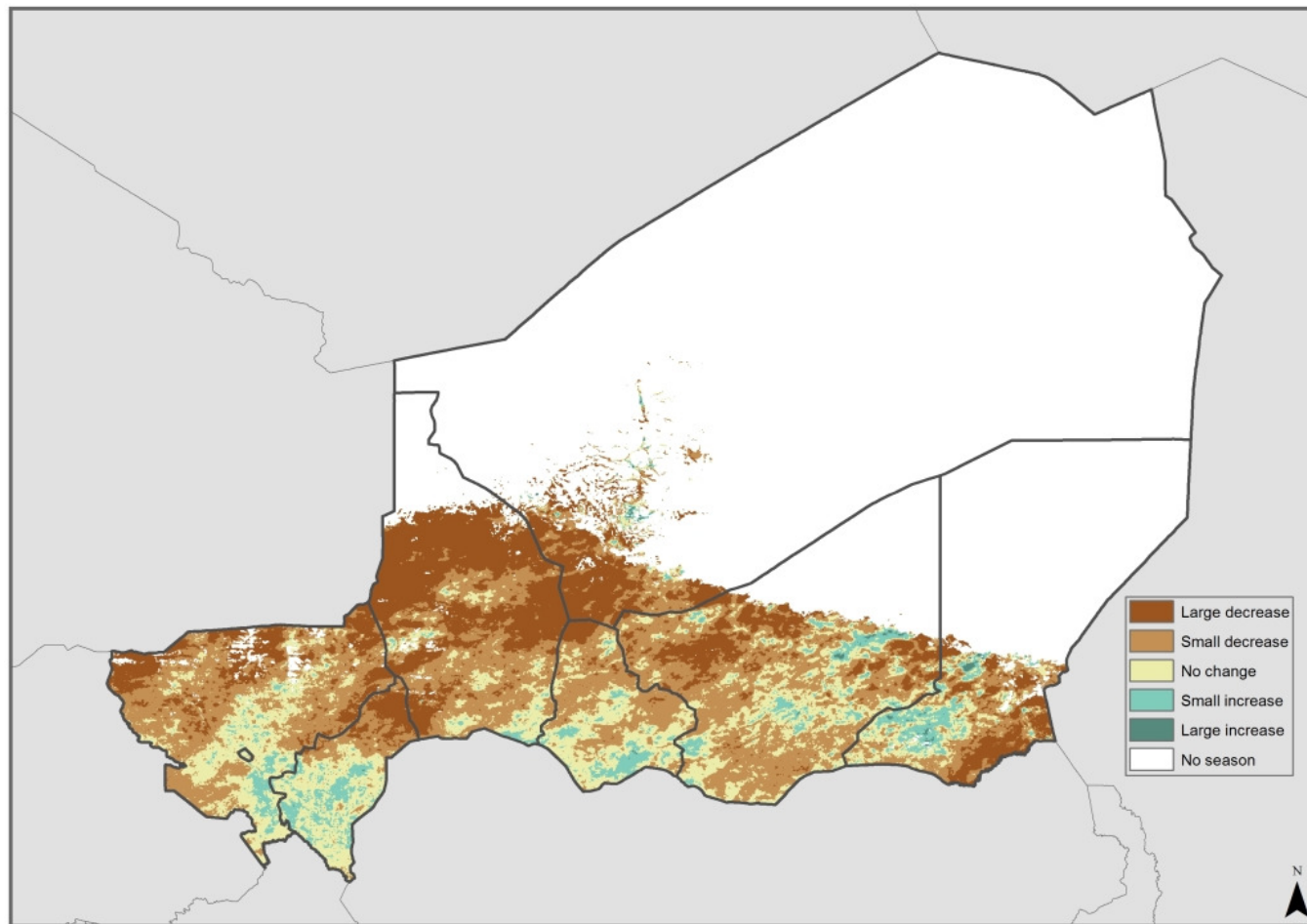


Food Security Context

- Niger, a landlocked country in the Sahara-Sahel belt, with a population of over 16 million
- Ranks last on the 2013 Human Development Index (186 of 186)
- The fertility rate is among the highest in the world, at 7.6 births per woman, and the infant mortality rate is 87.98 deaths per 1,000 live births, ranks the 7th in the world
- Millet and sorghum are the staple food in Niger
- Agriculture contributes about 40% of GDP and provides livelihood for about 90% of the population

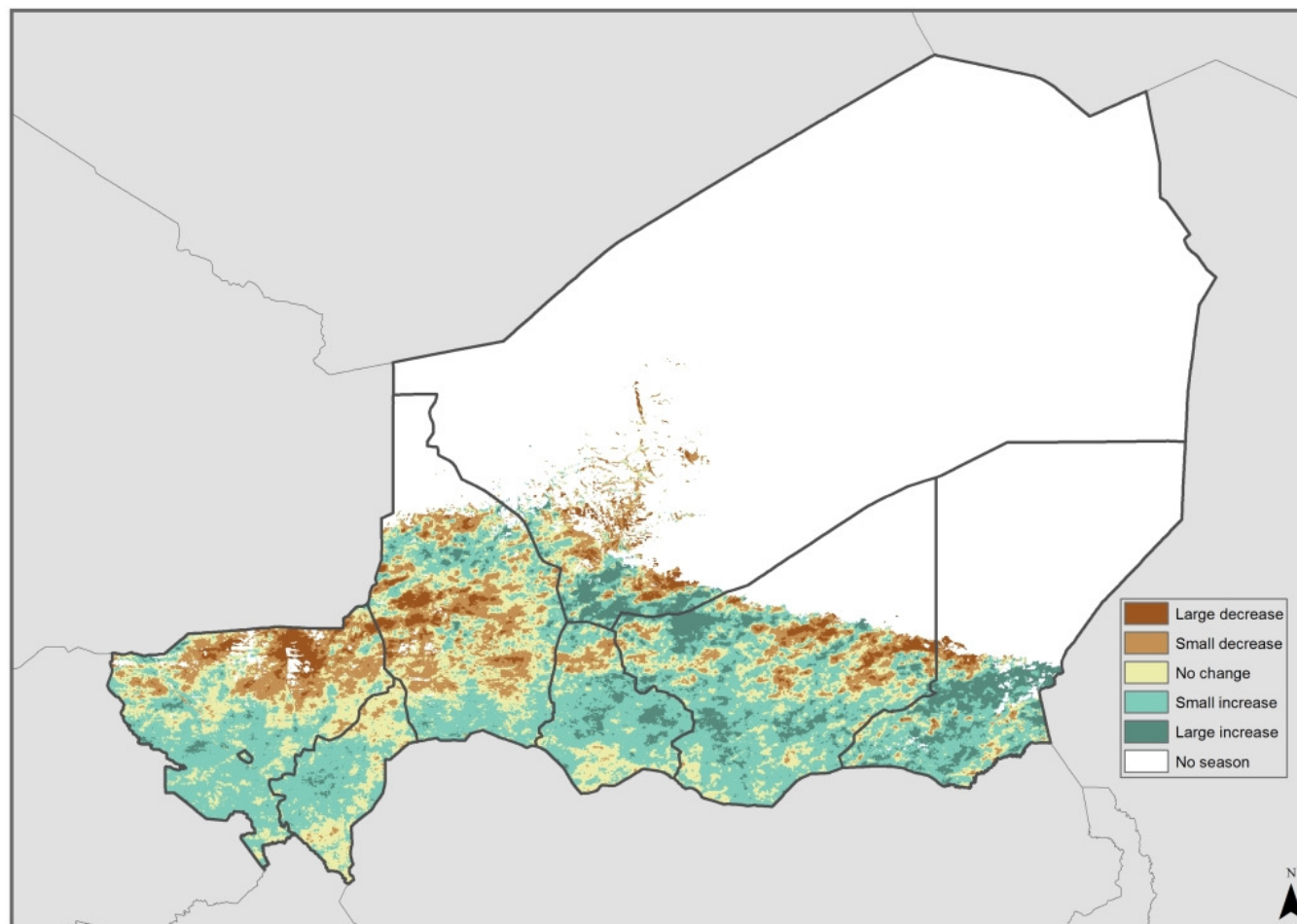


NDVI 2004/05 vs. long-term-average (2002-2012)



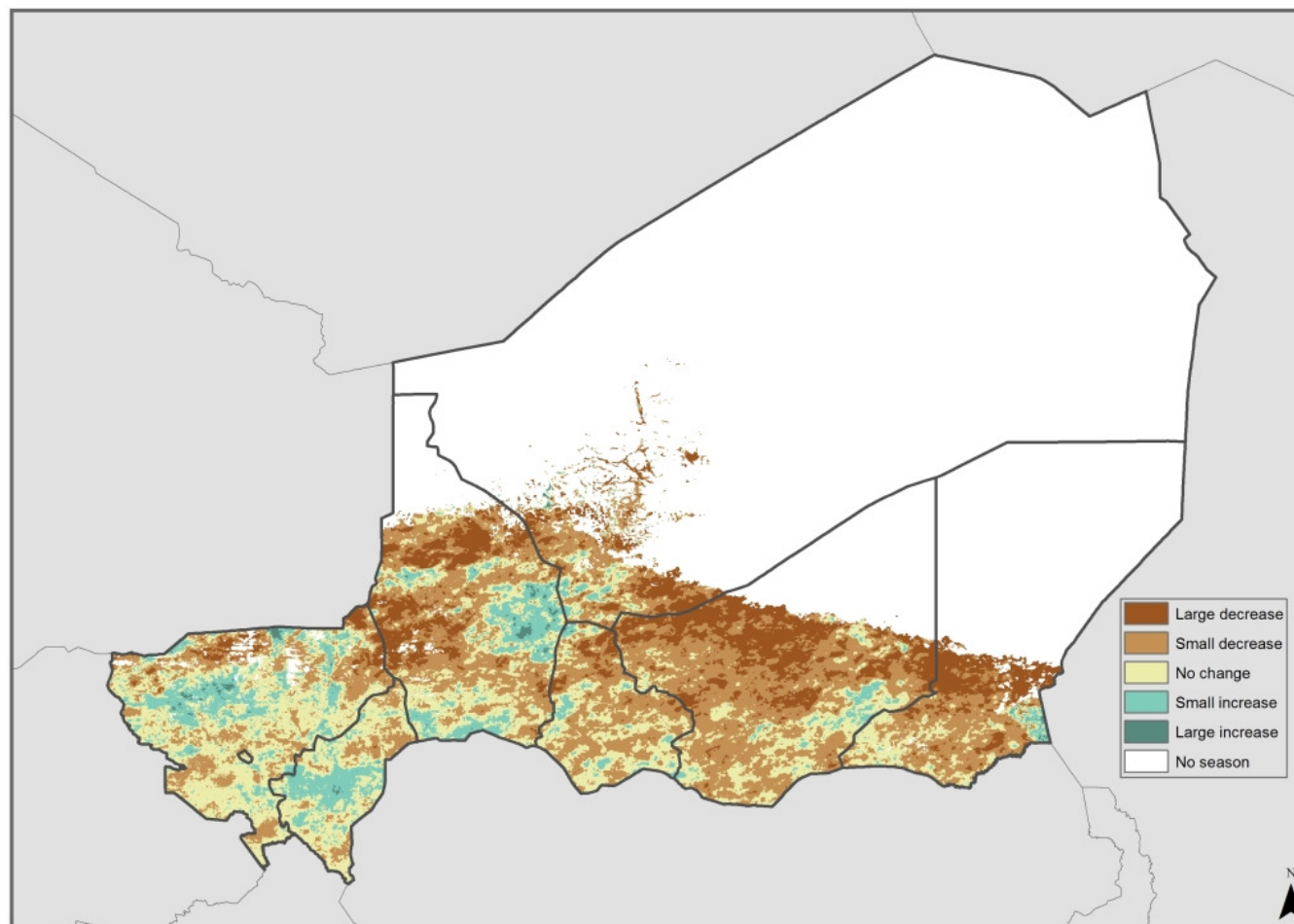


NDVI 2005/06 vs. long-term-average (2002-2012)



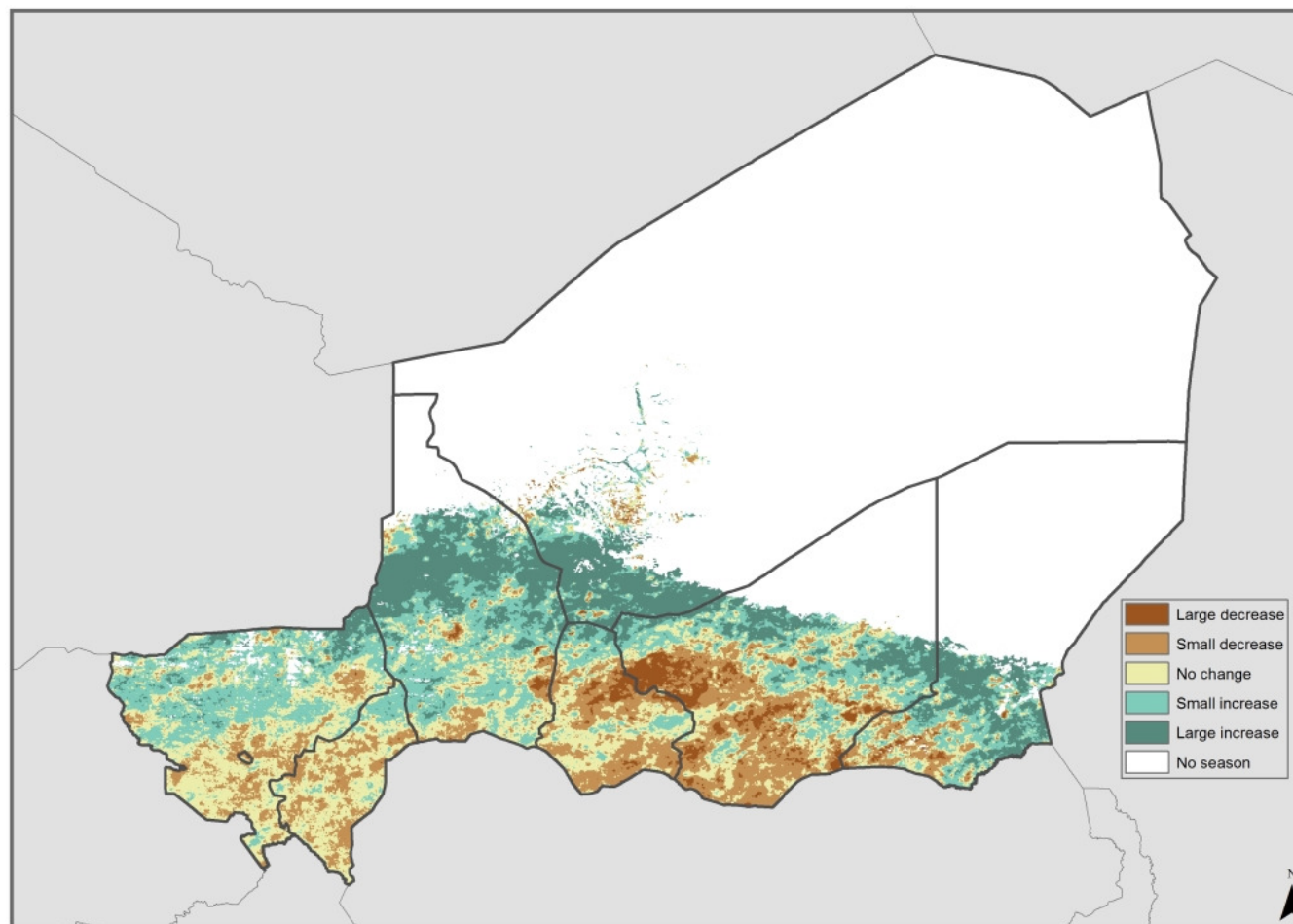


NDVI 2006/07 vs. long-term-average (2002-2012)



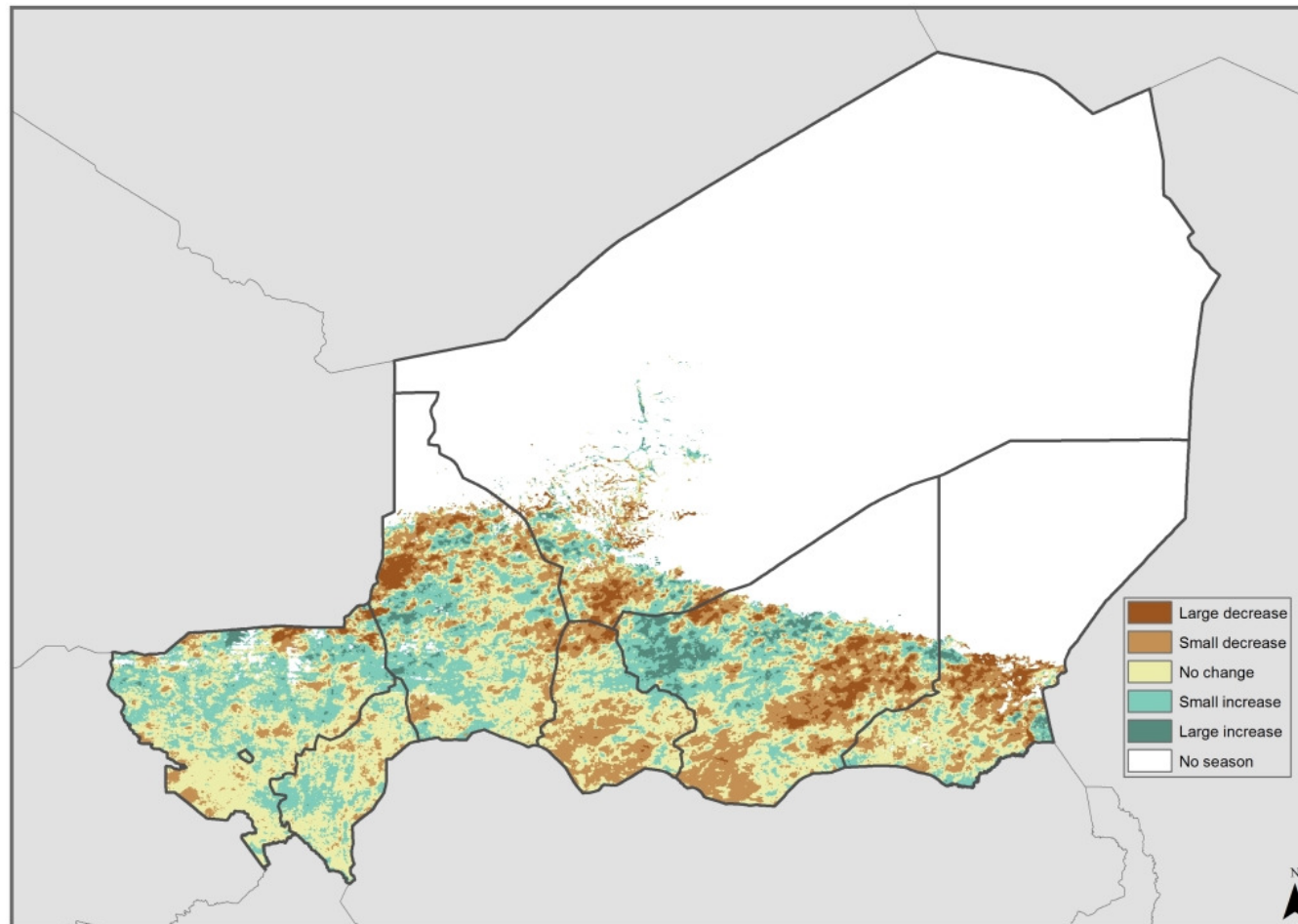


NDVI 2007/08 vs. long-term-average (2002-2012)



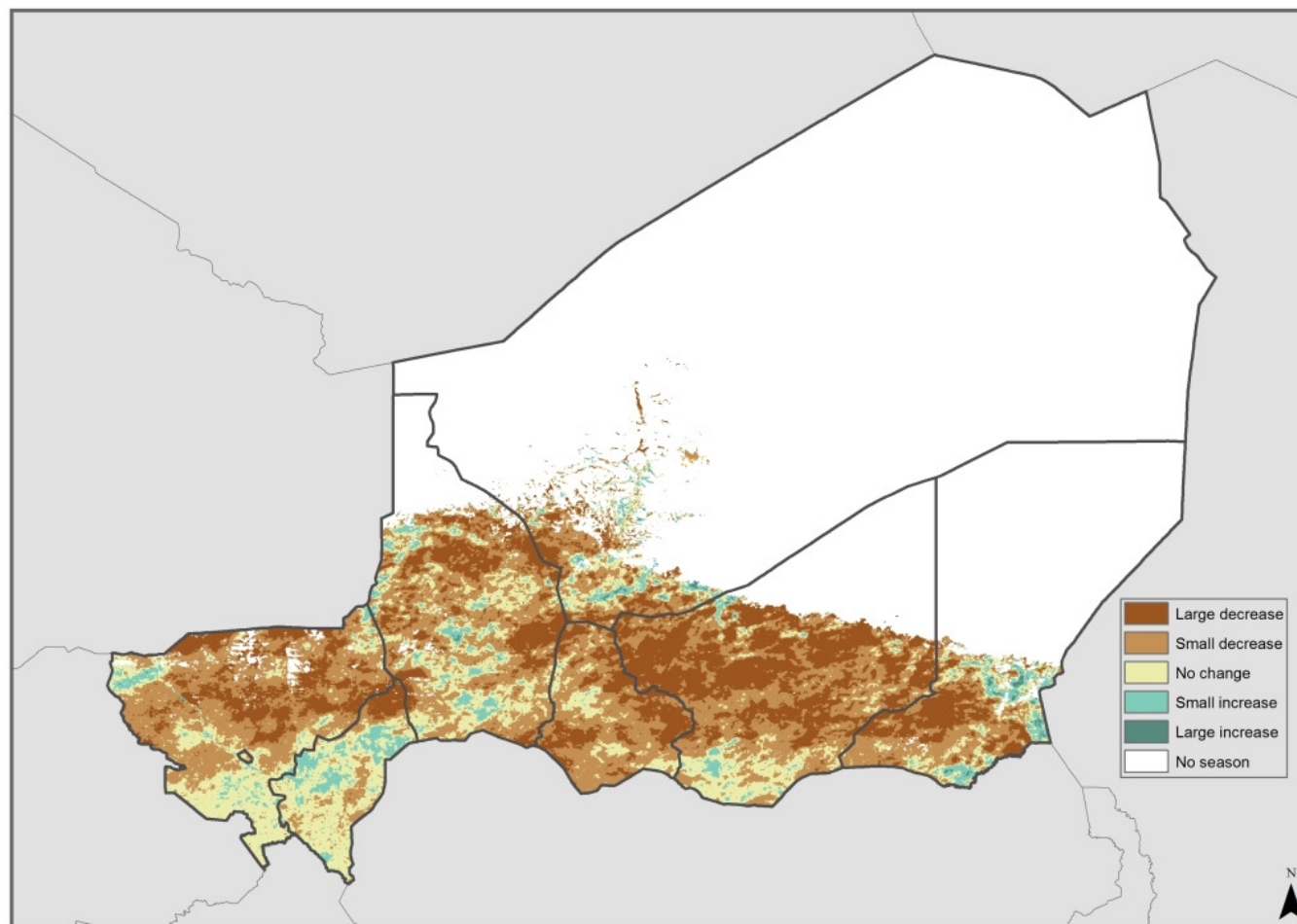


NDVI 2008/09 vs. long-term-average (2002-2012)



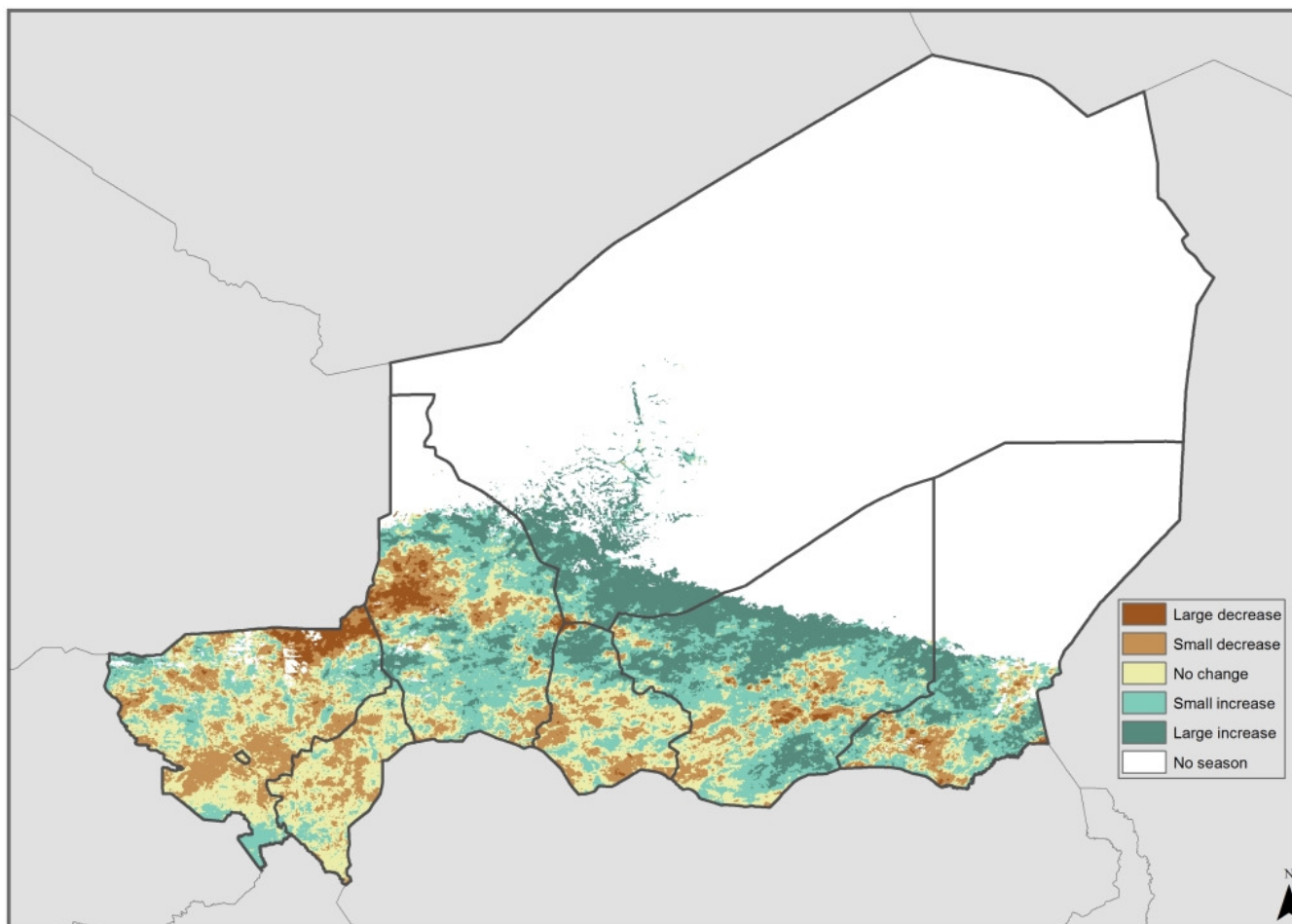


NDVI 2009/10 vs. long-term-average (2002-2012)



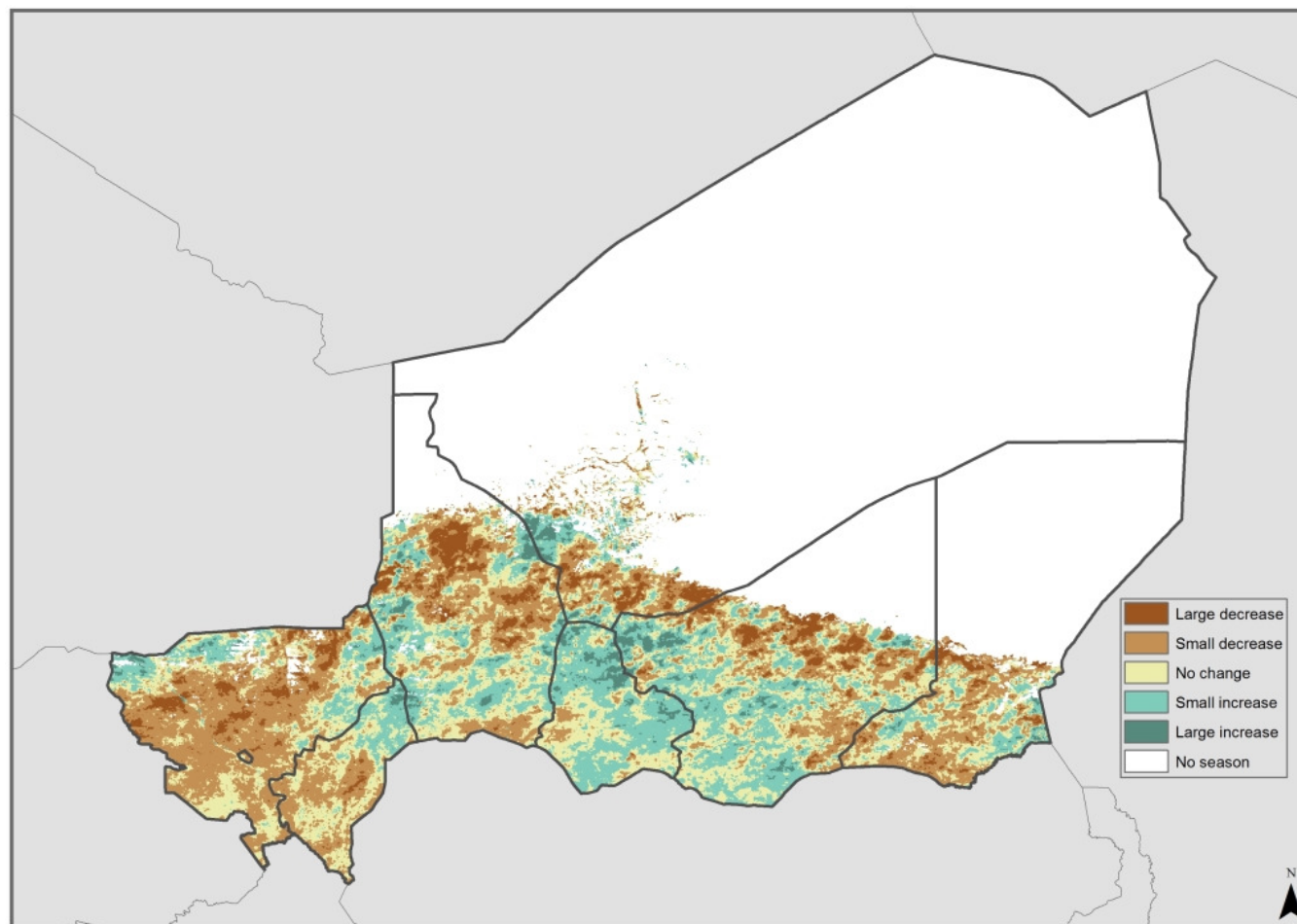


NDVI 2010/11 vs. long-term-average (2002-2012)



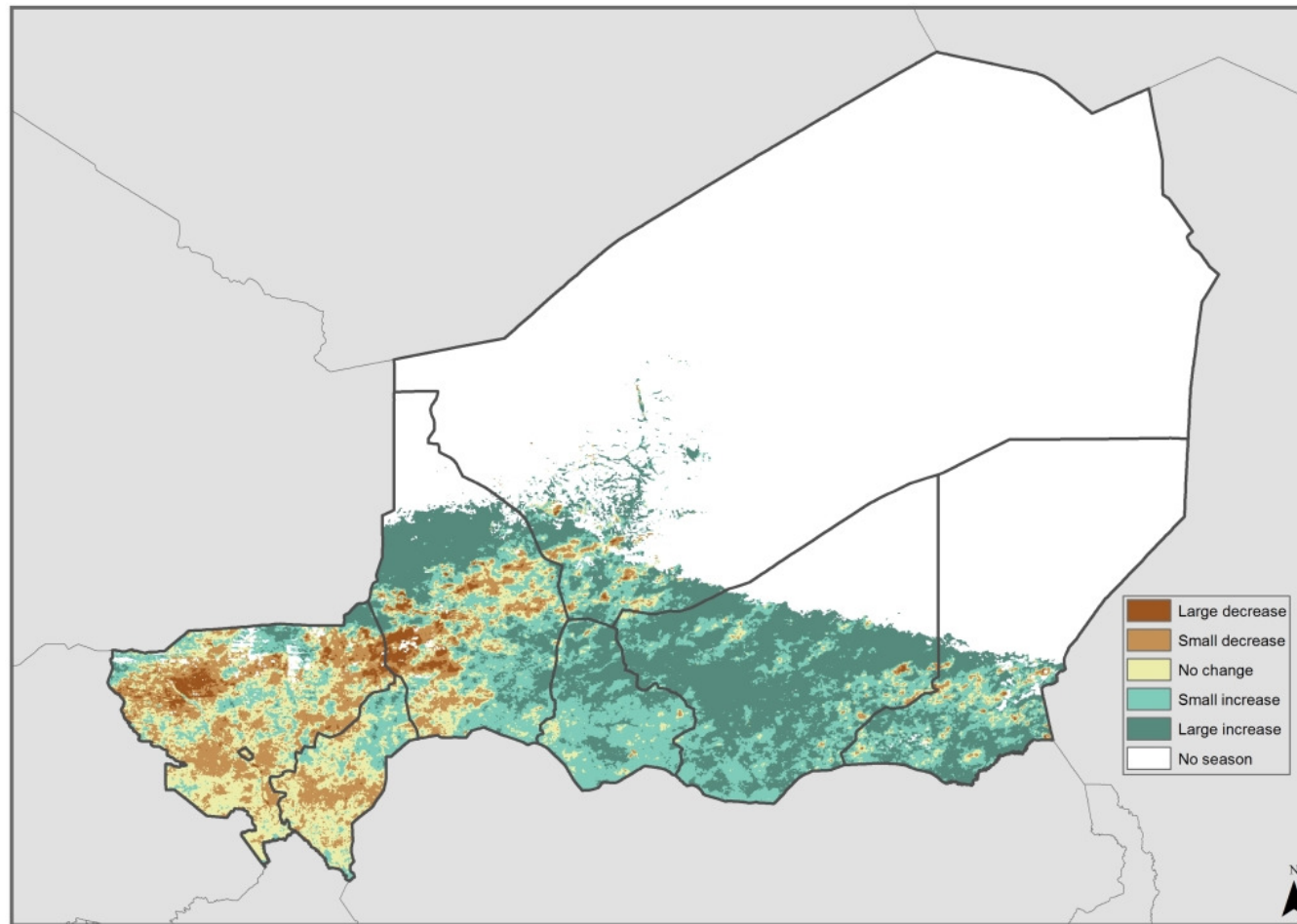


NDVI 2011/12 vs. long-term-average (2002-2012)



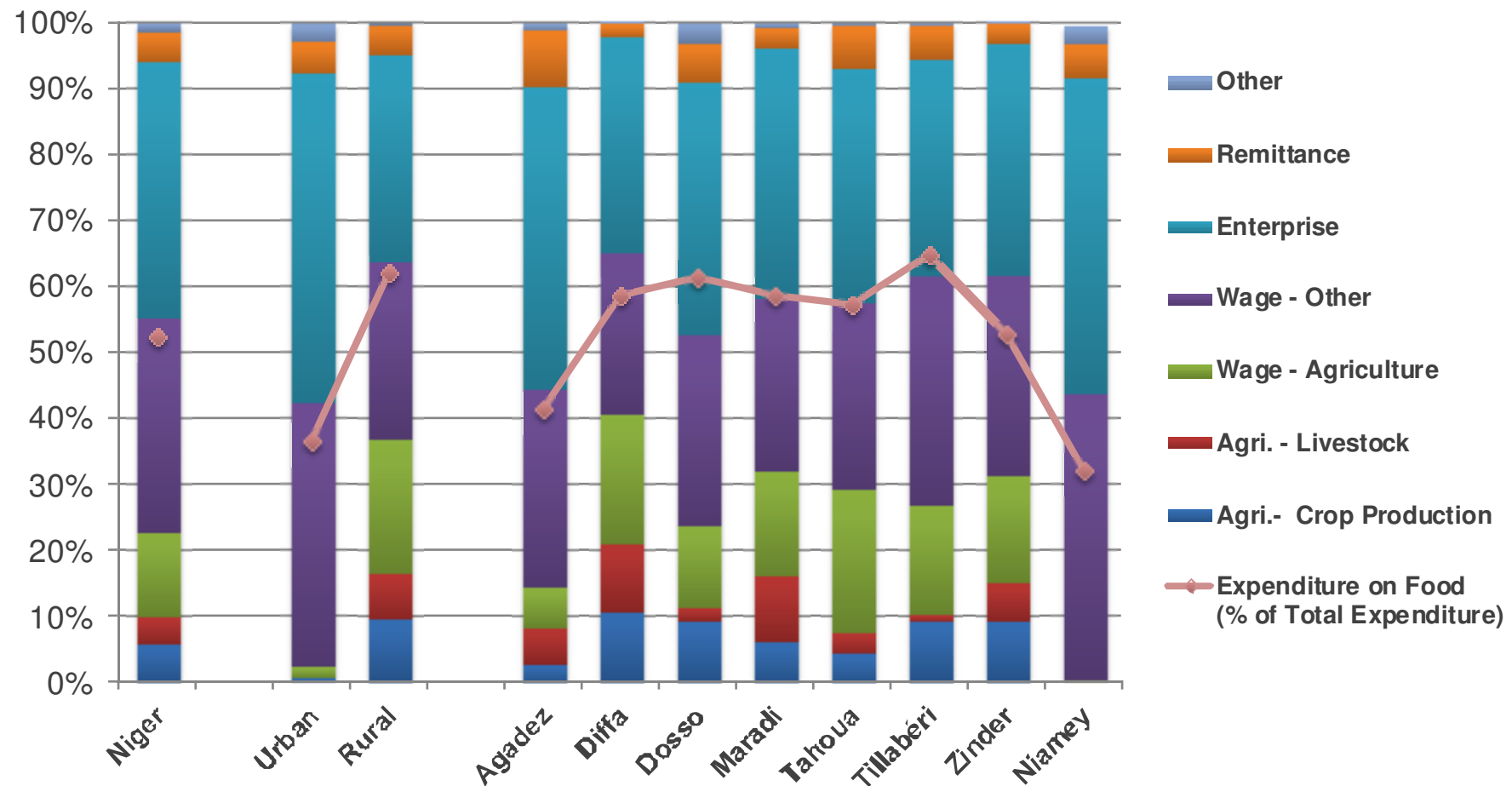


NDVI 2012/13 vs. long-term-average (2002-2012)



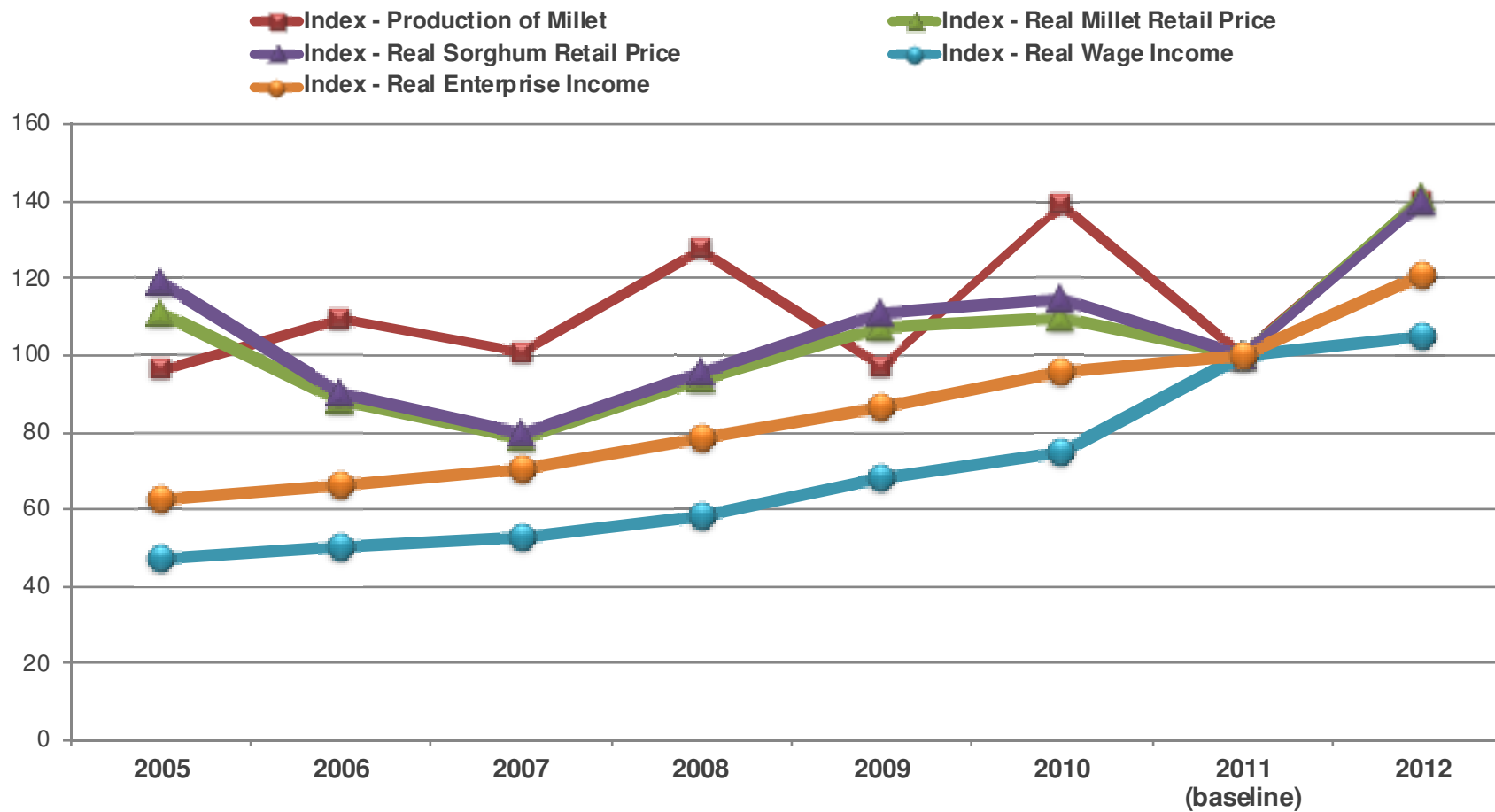


Share of Household Income Sources and Expenditure on Food by region, HH profile of the baseline year



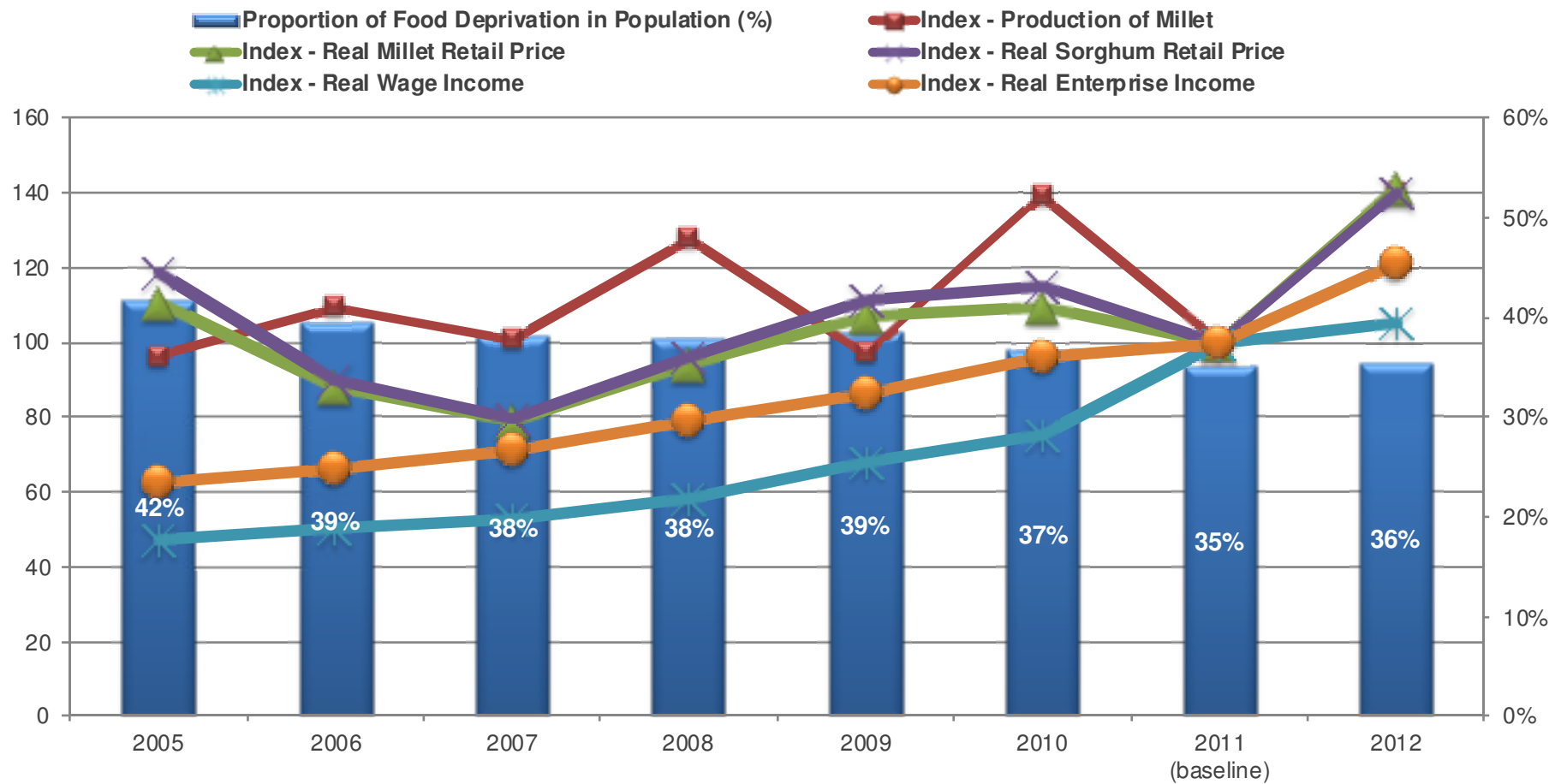


Trend of Major Shock Factors by year





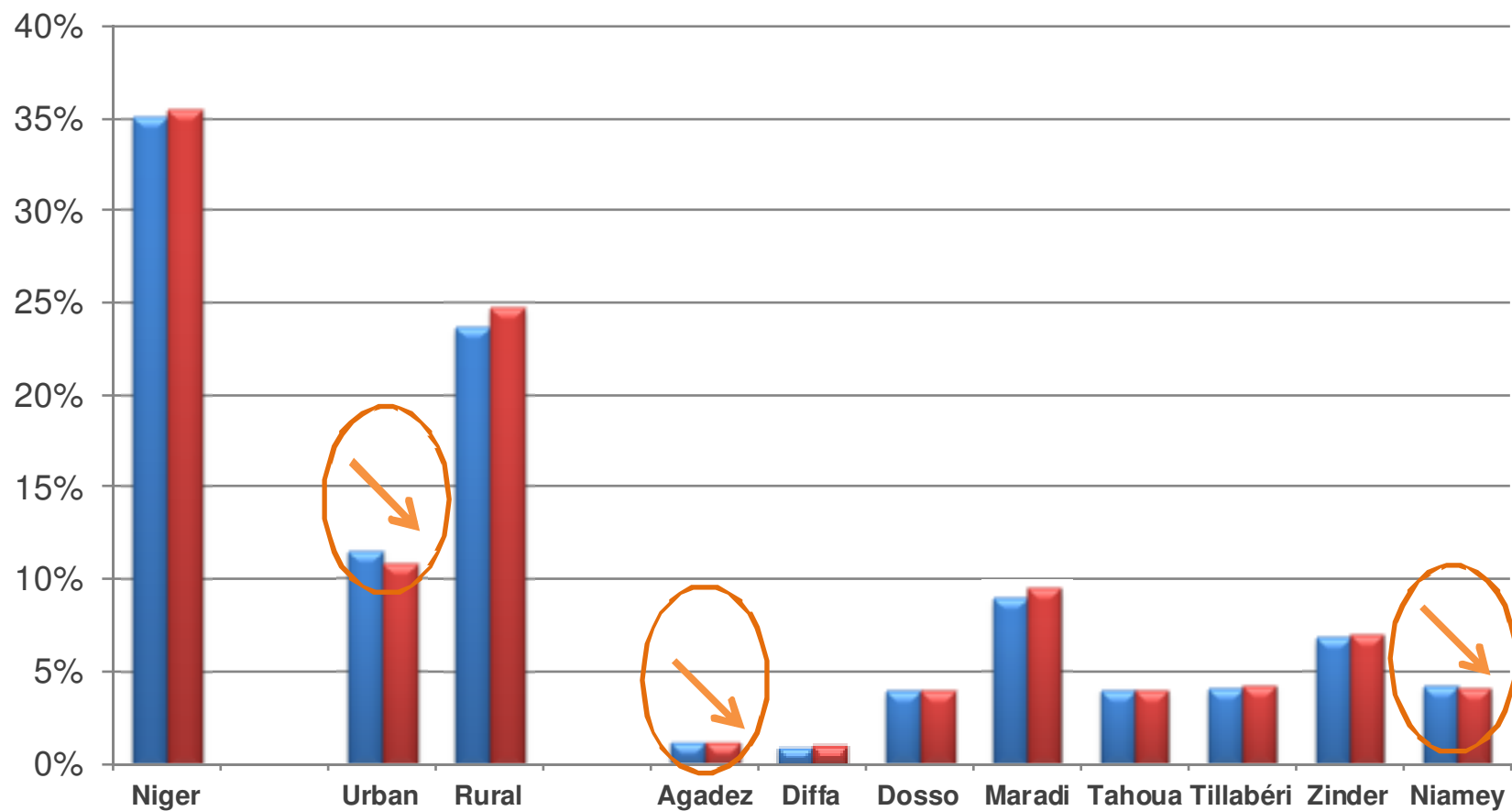
Proportion of Food Deprivation in Population (MDEC < 2100 kcal) by year

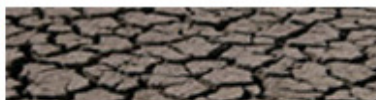




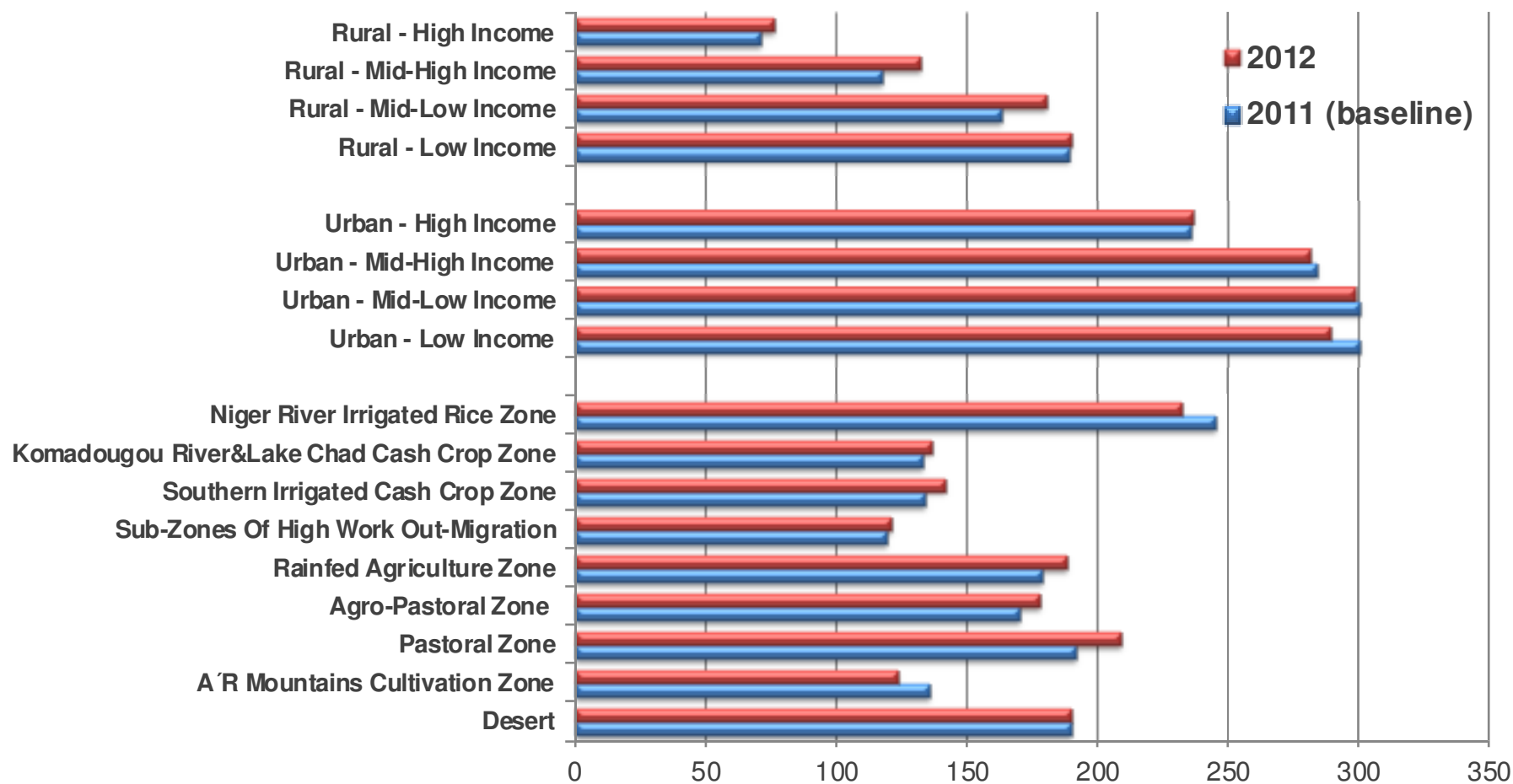
Proportion of Food Deprivation in Total Population (MDEC < 2100 kcal) by urban/rural, by region

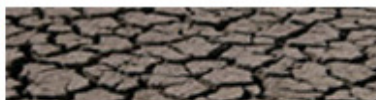
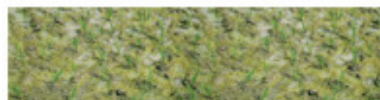
■ 2011 (baseline) ■ 2012



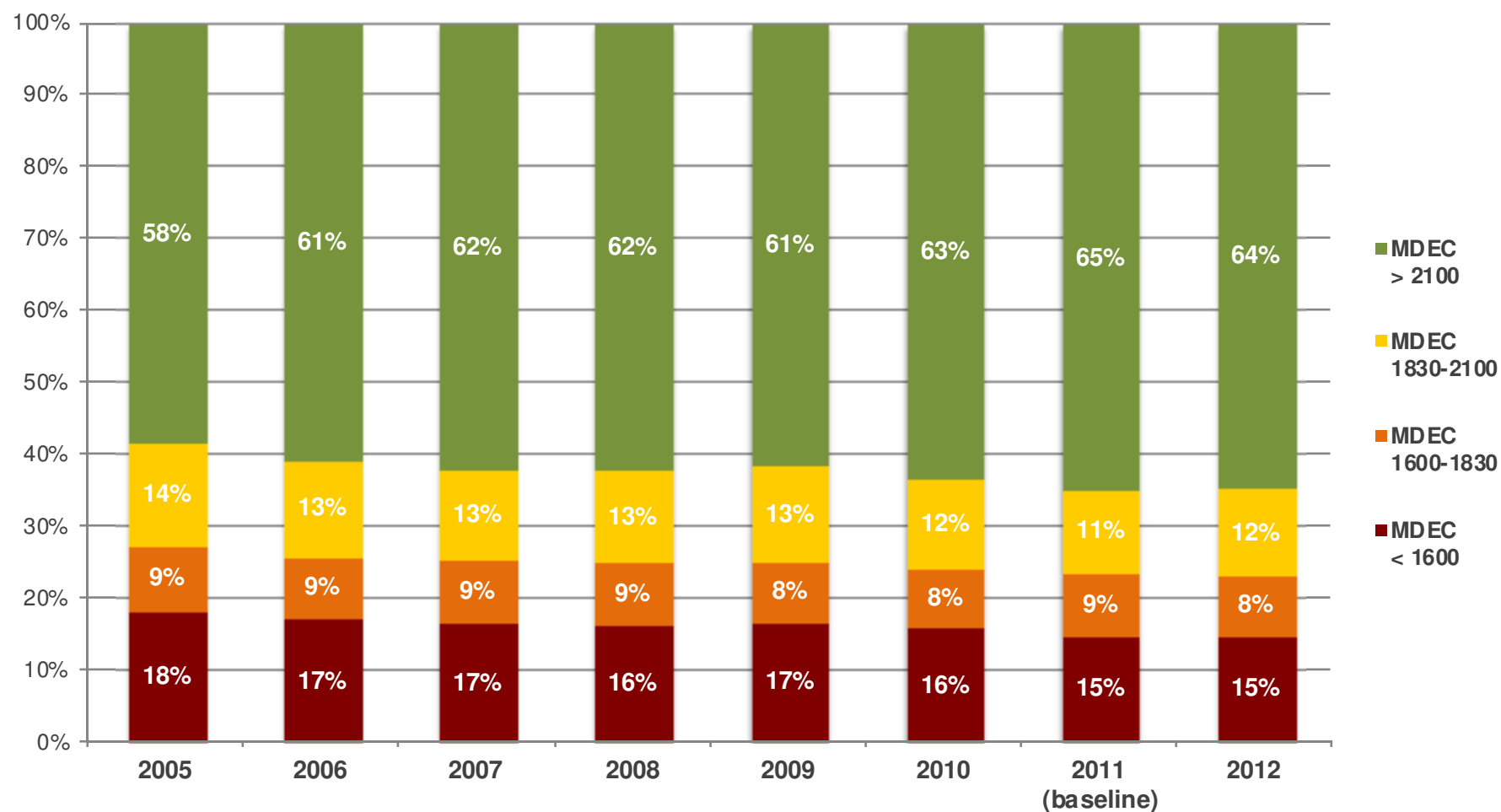


Depth of Hunger in kcal/person/day (MDEC < 2100 kcal) by rural income group, by urban income group, by livelihood zone



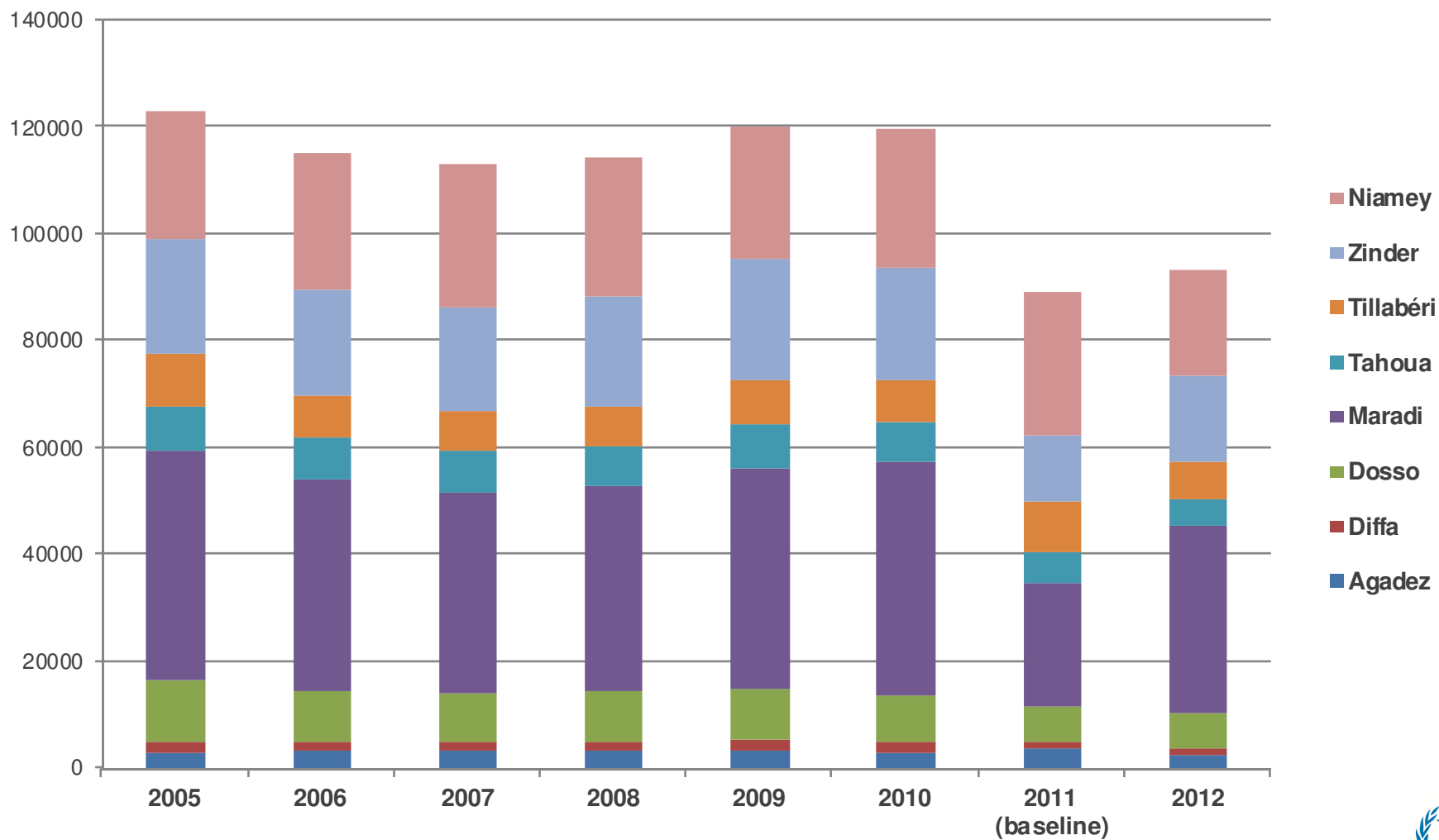


Breakdown of Undernourished Population by year



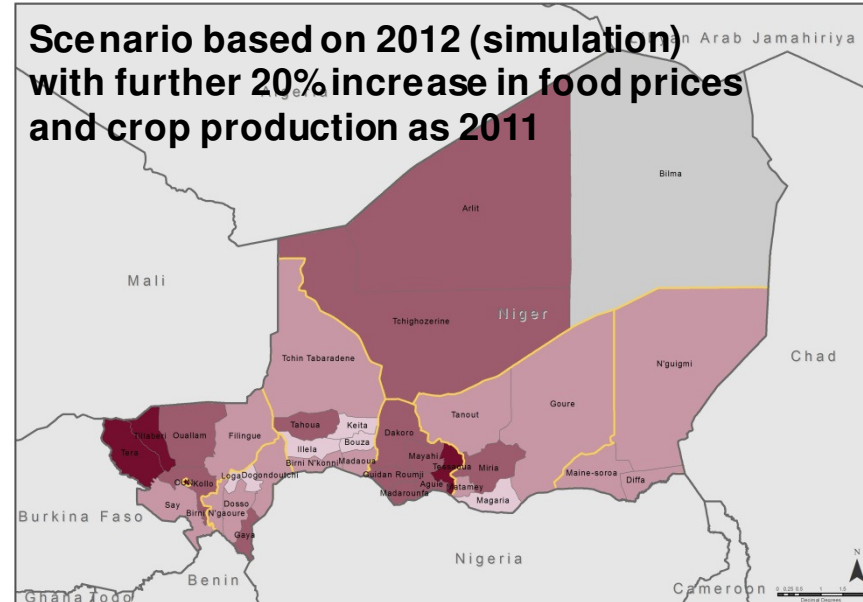
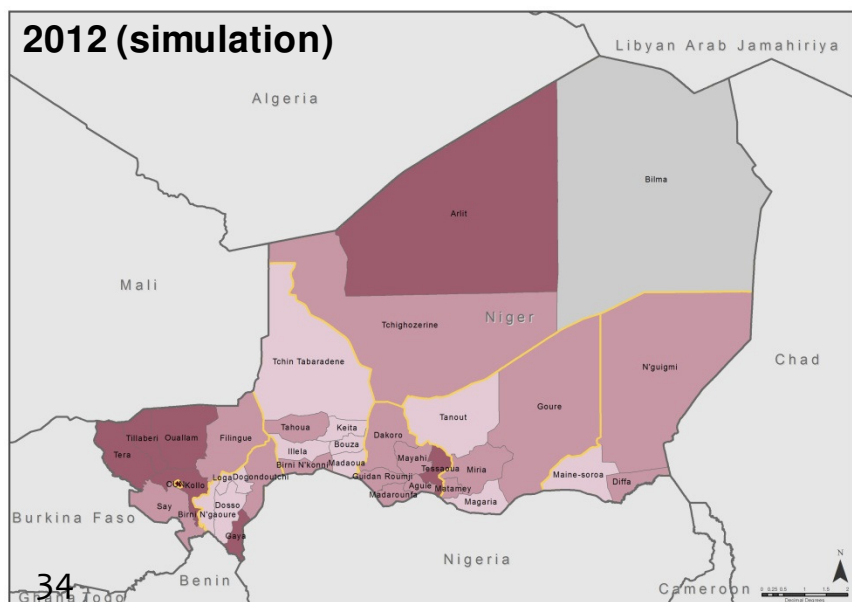
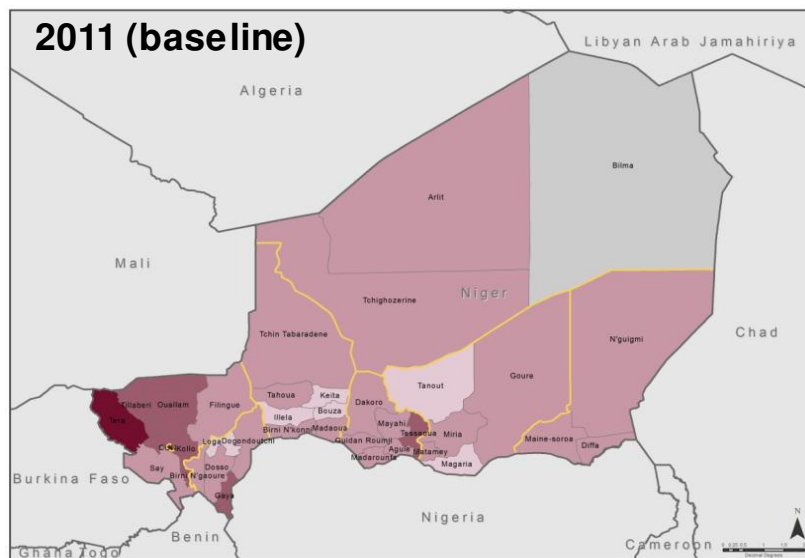


Total Food Assistance Needed to Meet the Needs in tonne (MDEC < 2100 kcal) by region, by year





Depth of Hunger (<MDEC 2100)





Conclusion

Shock Impact Simulation Model could have several implications:

- **Monitoring**

- track and measure impact of shocks (e.g. price, drought, flood...) on household food security

- **Assessment**

- provide timely and meaningful quantitative estimations at macroeconomic level and baseline information for further in-depth food security assessment

- **Program & Policy**

- identify the vulnerable groups (geographical location, community, livelihood and gender-based) for programing
- simulate the result/impact of past, current or future programs/policies on the population for planning and evaluating



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Thank You