Carbon, Climate and Managed Land in Ukraine
Integrating Land Use Data and Models for NEESPI

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Introduction:

Research Activity: Land use for agriculture, climate variability and change in Ukraine.

Research Timelines: current, 1990-present; future, to 2030, 2050, 2080.

Technical Goal: Model agricultural systems focusing on crop and management factors relevant to carbon cycling.

Tools: 1) Dynamic Crop models; 2) agro-ecological zoning; 3) experimental, statistical and

remote sensing data sets.

Introduction:

Contributor to NEESPI: Non boreal, managed ecosystems. Interactions of human activity and socio-economic change on land processes.

Funding Period: Mar. 2005-Feb. 2008.

This presentation reports on the first year of activities, focusing on developing modeling tools for agriculture in Ukraine.

Motivation:
(general)

Agriculture is a fundamental human activity that plays *a dual role* in global change:

- It has been, is and will continue to be <u>a key driver of</u> global change → climate change;

- In coming decades, it is likely to be <u>greatly affected by</u> climate change.

Motivation:
(specific)

- **Agriculture is important in** Ukraine:
  - ~30 Mha /60 Mha cultivated;
  - > 20% GDP is from agriculture;
- **Important socio-economic changes ~** last 15 yrs:
  - Collapse of N inputs and productivity;
  - Break-down of large cooperative structure;
- **Participant in Kyoto Protocol**:
  - Joint Implementation Projects (LULUCF);
  - National Communications
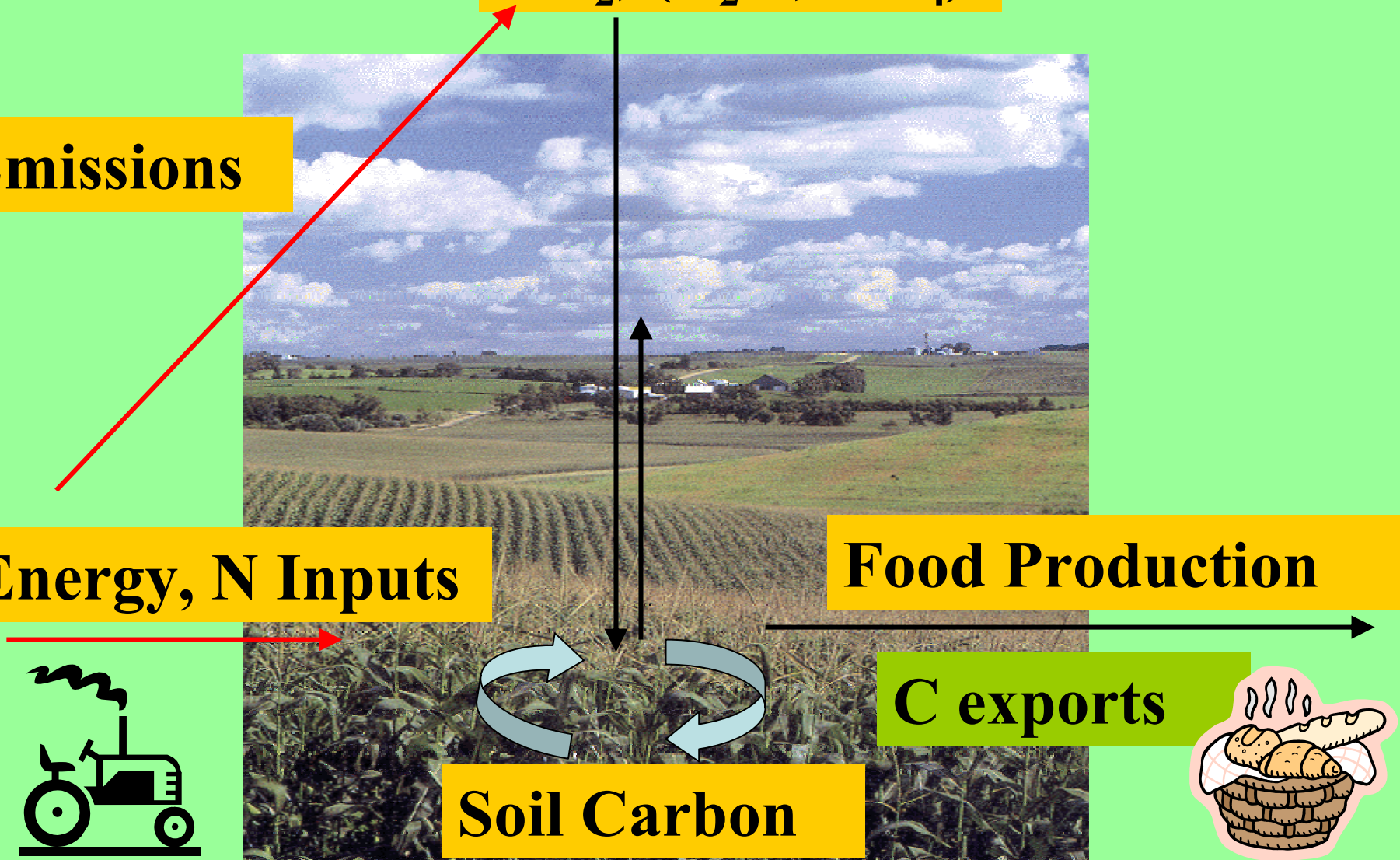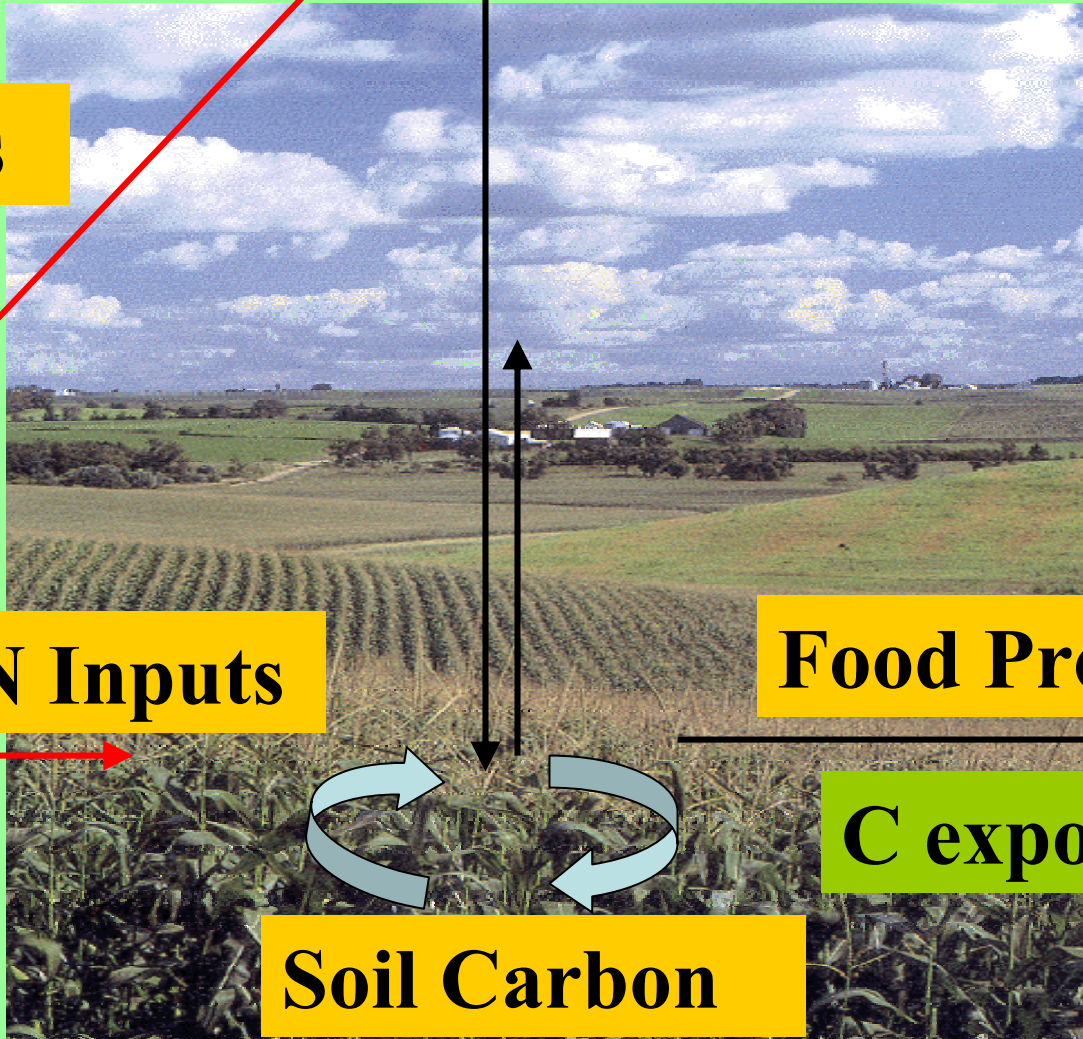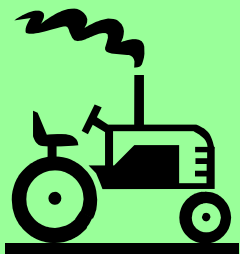
Agriculture and Carbon Cycling

CO_2, (N_2O, CH_4)

Emissions

Energy, N Inputs

Food Production

C exports

Soil Carbon

Modeling Tools, From Site to Region:

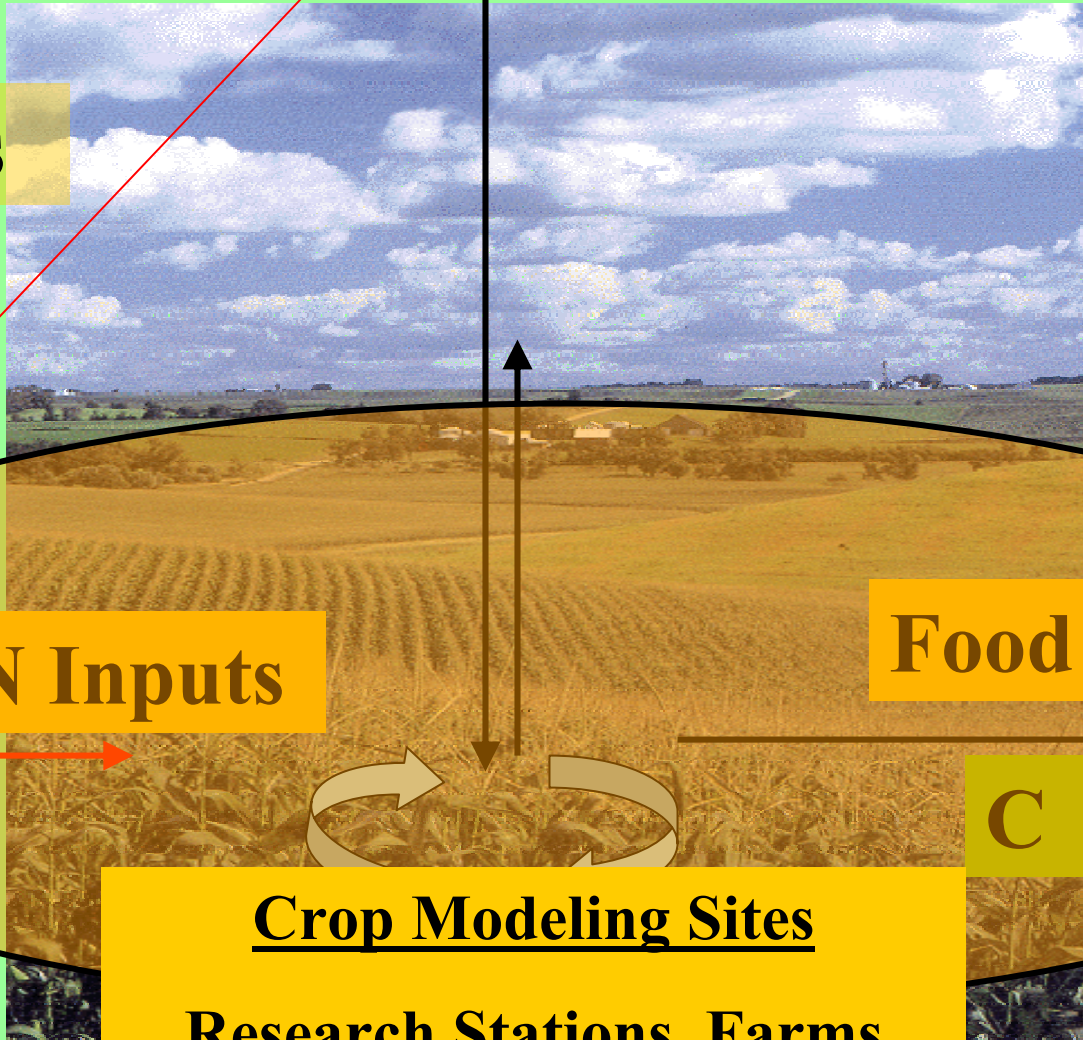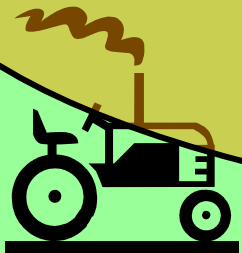## Dynamic Crop Models

$CO_2, (N_2O, CH_4)$
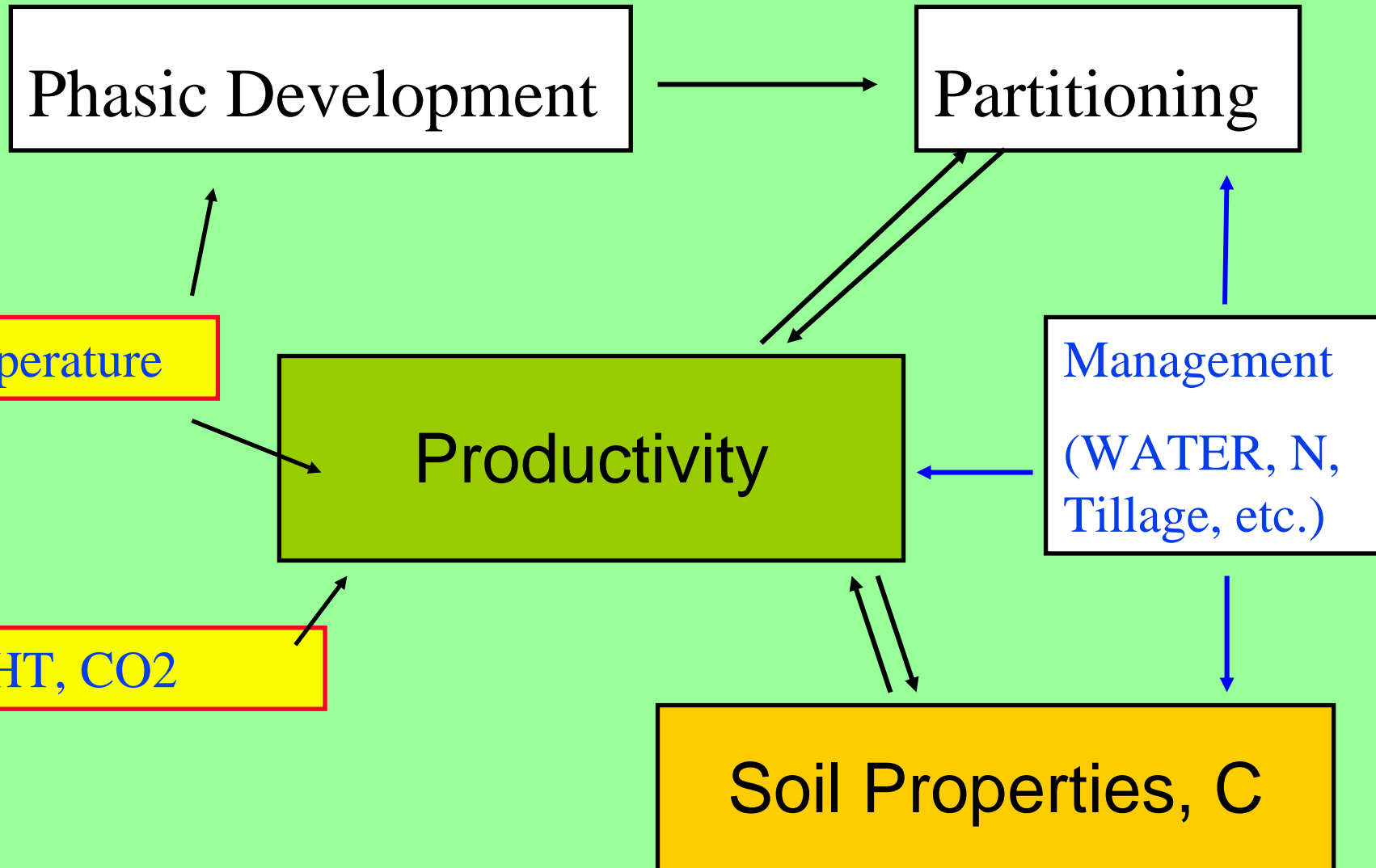
Emissions

Energy, N Inputs

Food Exports

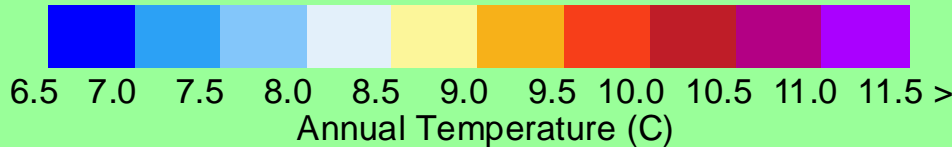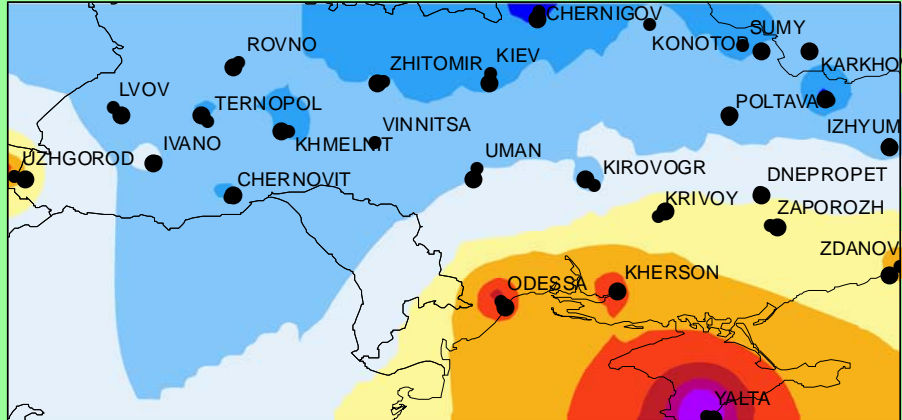C

Crop Modeling Sites

Research Stations, Farms

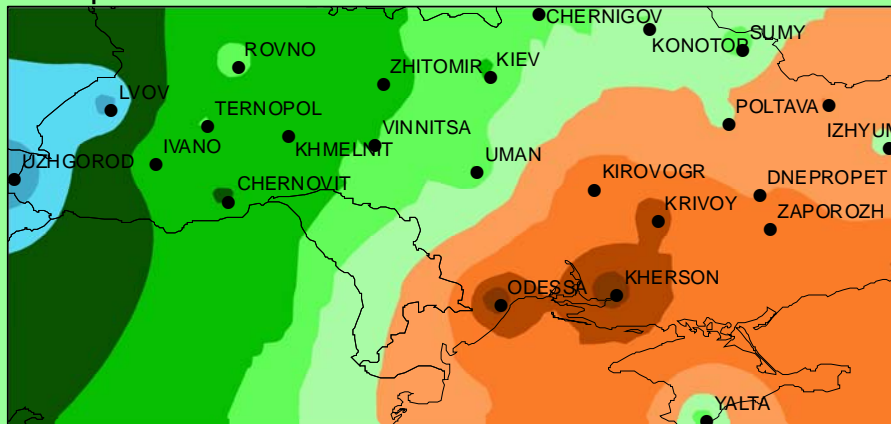# Modeling Tools, From Site to Region:
Dynamic Crop Models

Dynamic Crop Models: 25 Sites

Temperature

Annual Temperature (C)

6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0 10.5 11.0 11.5 >

Precipitation

Annual Precipitation (mm)

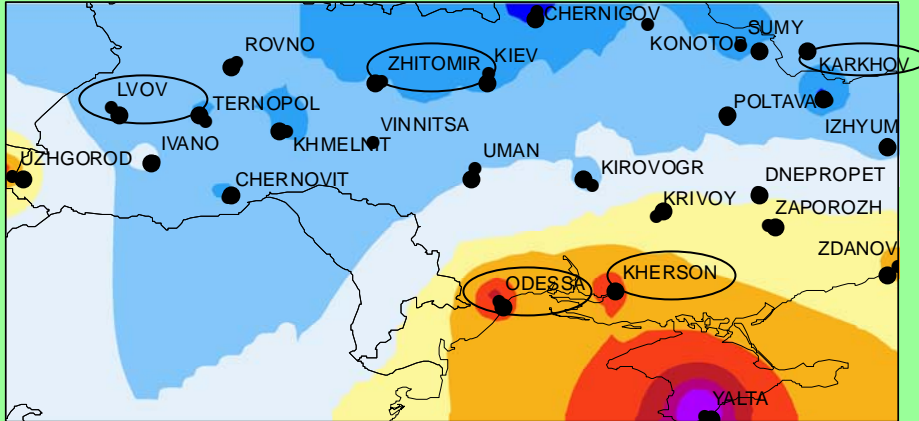450 475 500 525 550 575 600 625 650 675 700 >
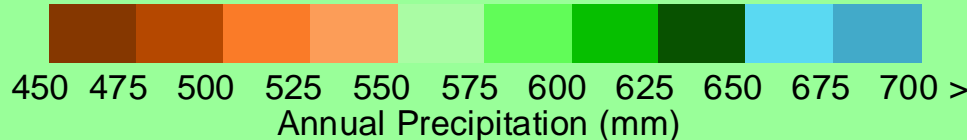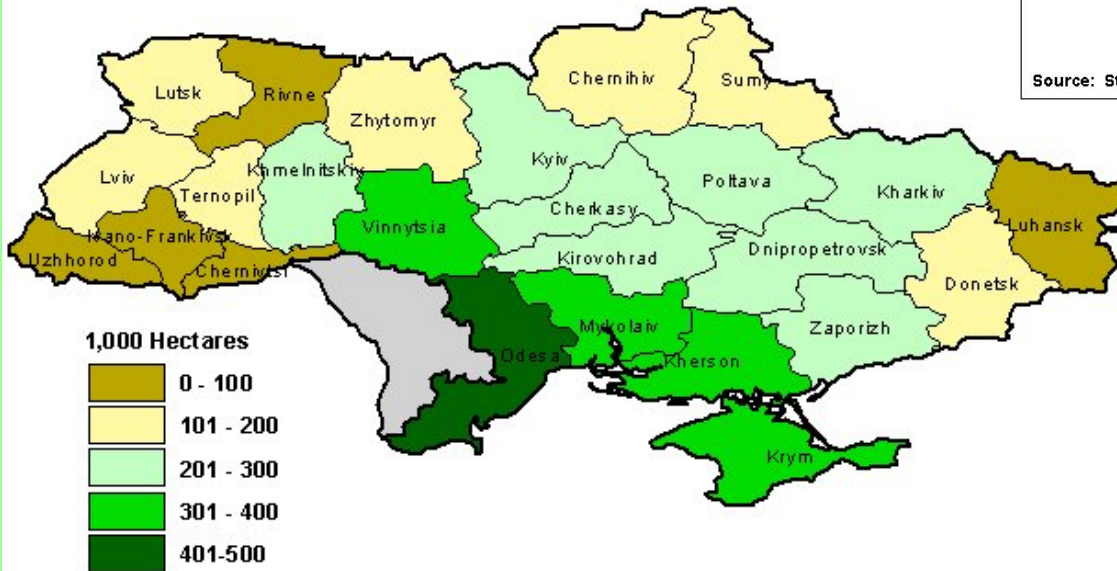
At each site:

-- Soil and climate data;

-- Crop management data;

   Winter Wheat, Maize, Potato, Sunflower

   (planting dates, N and water, cultivar
     types, etc.)

-- Site or rayon-level statistics

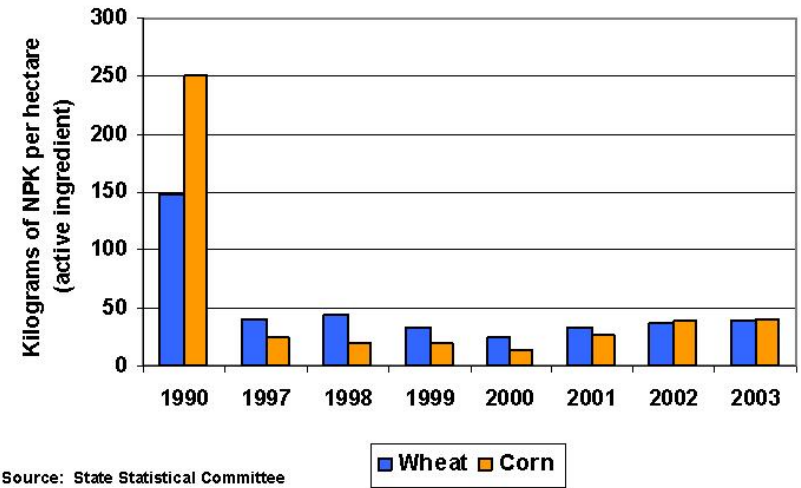# Dynamic Crop Models: Evaluation, Winter Wheat

Temperature

Ukraine: Estimated Winter Wheat Area by Oblast

1,000 Hectares
- 0 - 100
- 101 - 200
- 201 - 300
- 301 - 400
- 401 - 500
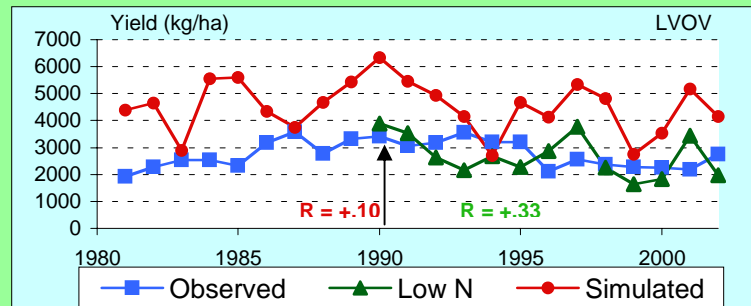
Production Estimates and Crop Assessment Division, FAS, USDA
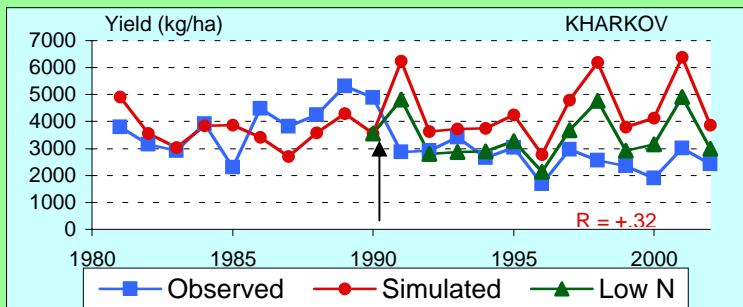
Ukraine: Application Rates of Mineral Fertilizers

Kilograms of NPK per hectare (active ingredient)

Source: State Statistical Committee

Wheat Corn

Dynamic Crop Models: Evaluation, Winter Wheat Effects of 70% Reduction in N Fertilizer after 1990 From 100 to 30 kg N/ha
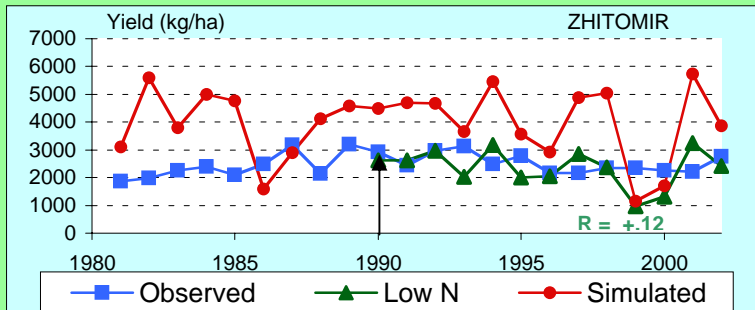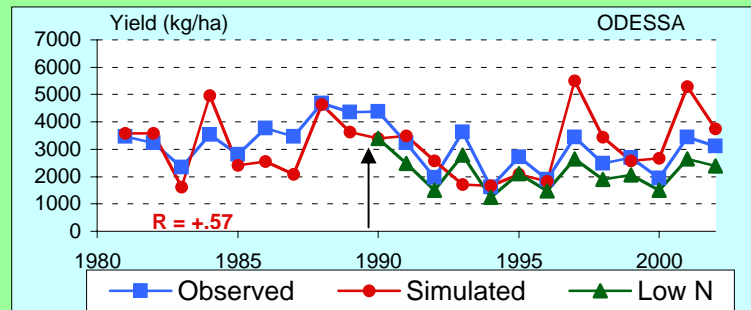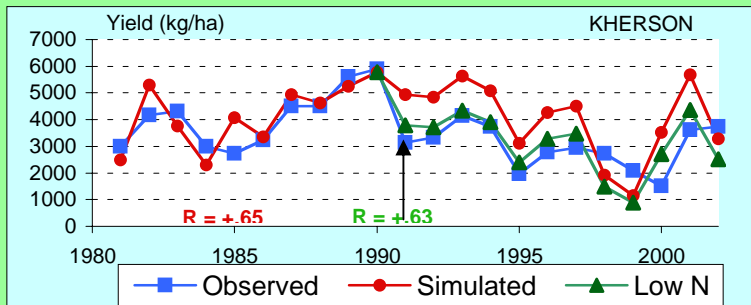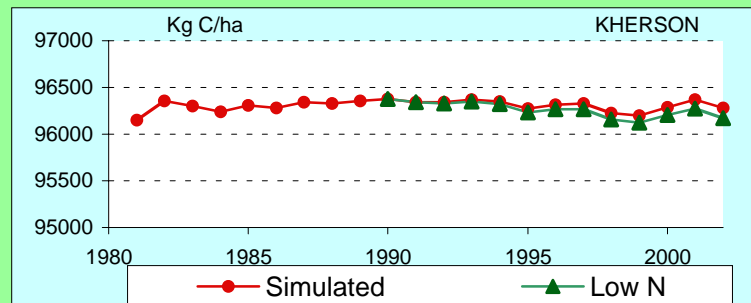
Agro-Ecological Assessment of the Impacts of Climate Change on Ukrainian Agriculture: Preliminary Results

Modeling Tools, From Site to Region:

Agro-ecological Modeling

CO_2, (N_2O, CH_4)

Emissions

Energy, N Inputs

Food Exports

C

Crop Modeling Sites

Research Stations, Farms

From site to Region: Steps in AEZ Methodology

Soil Map

Terrain
Slopes

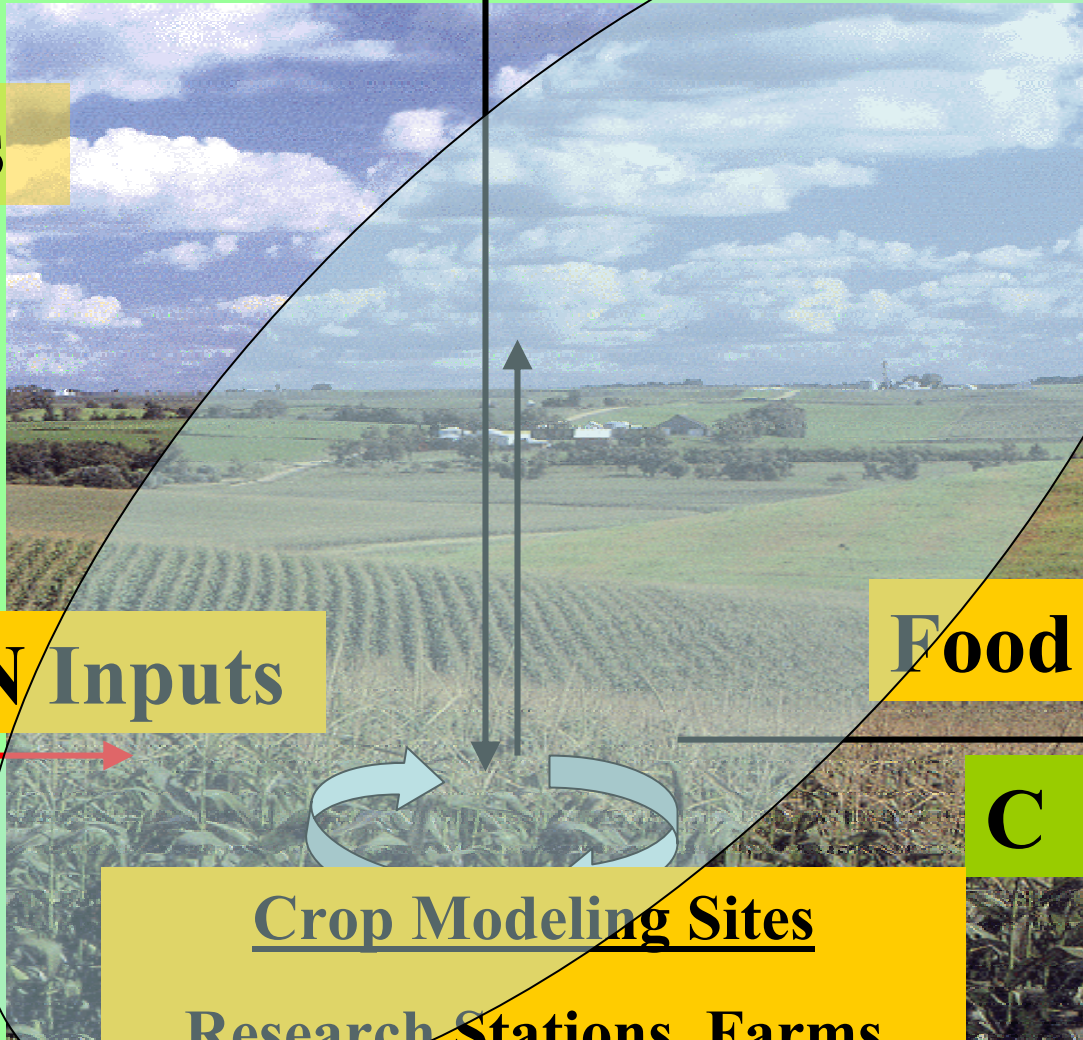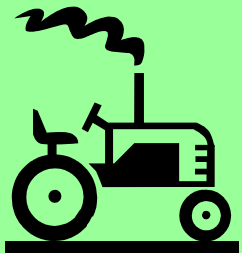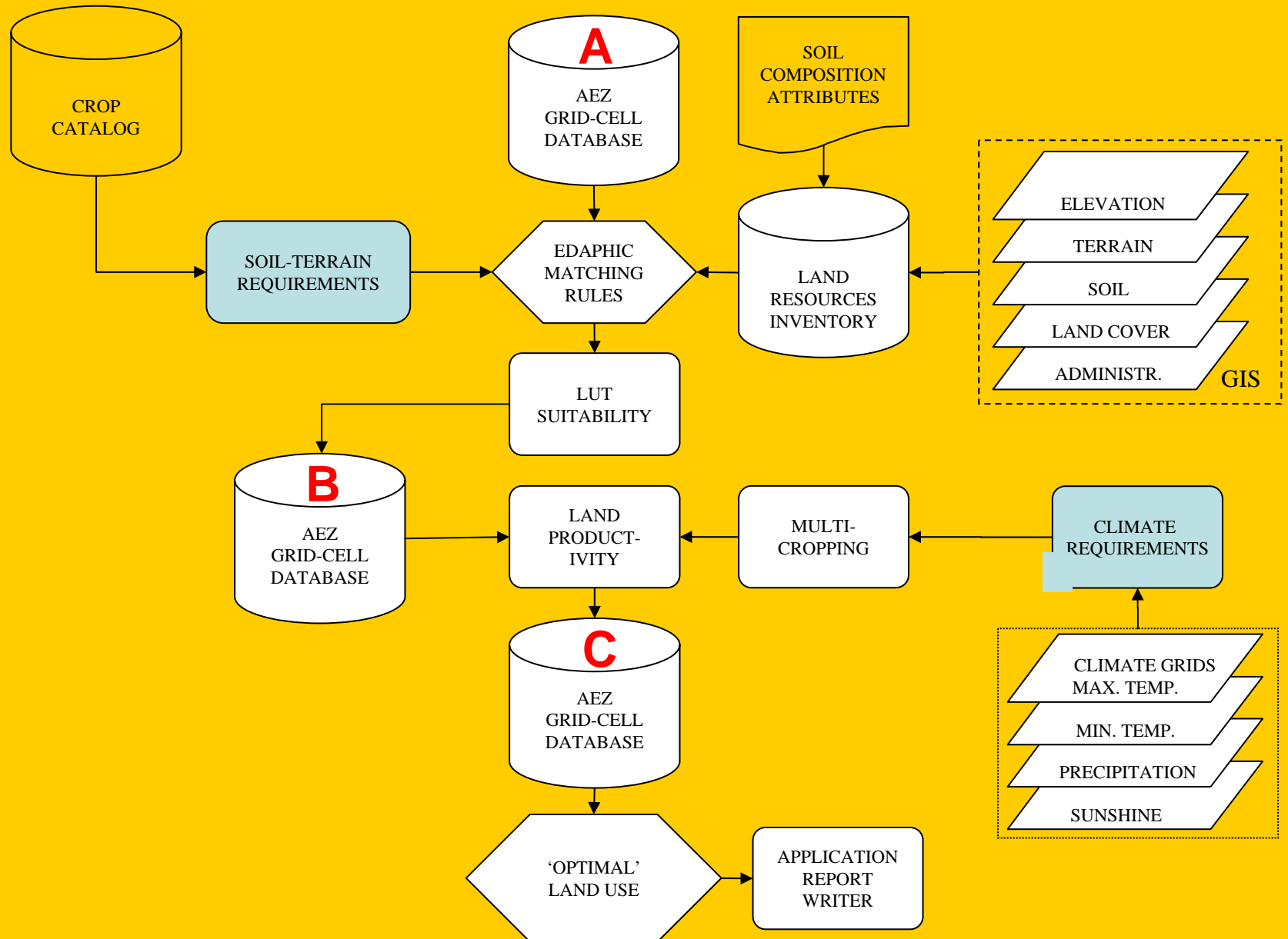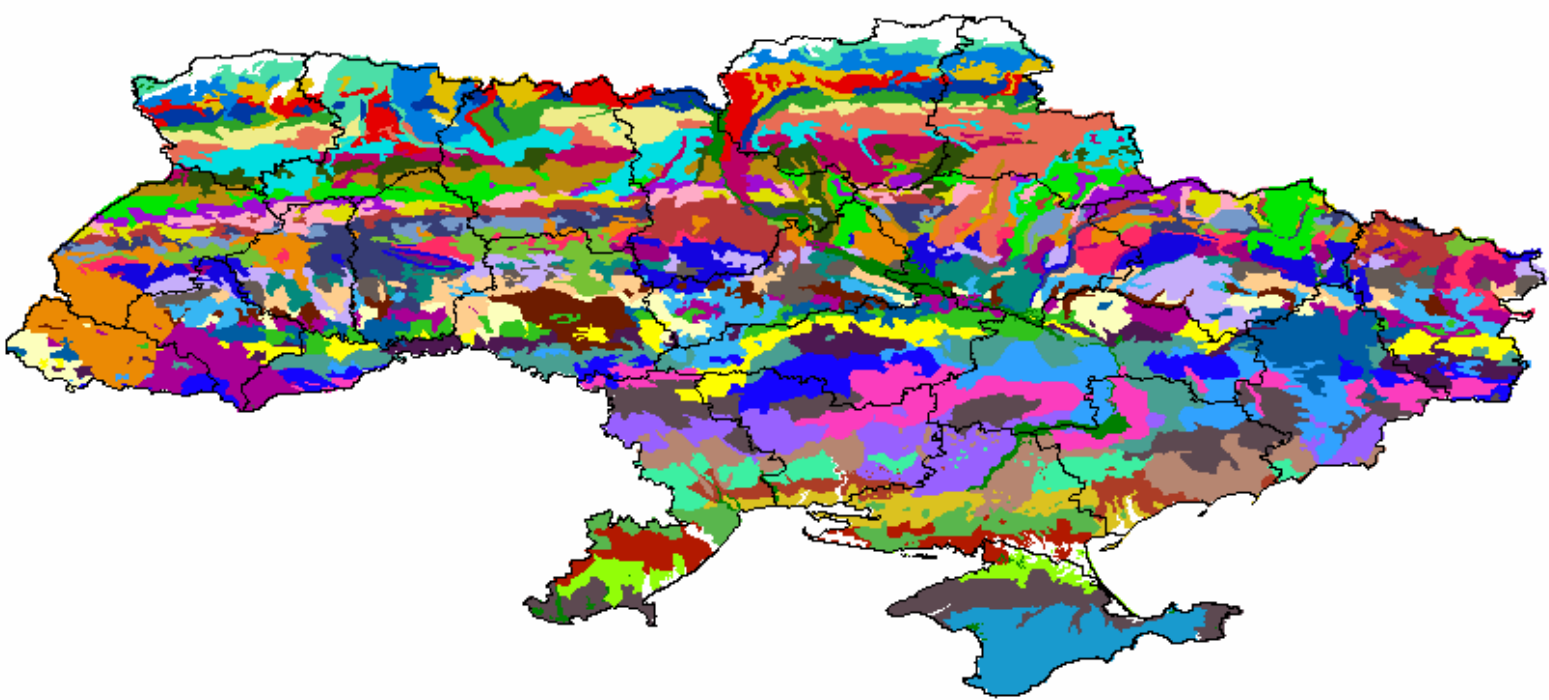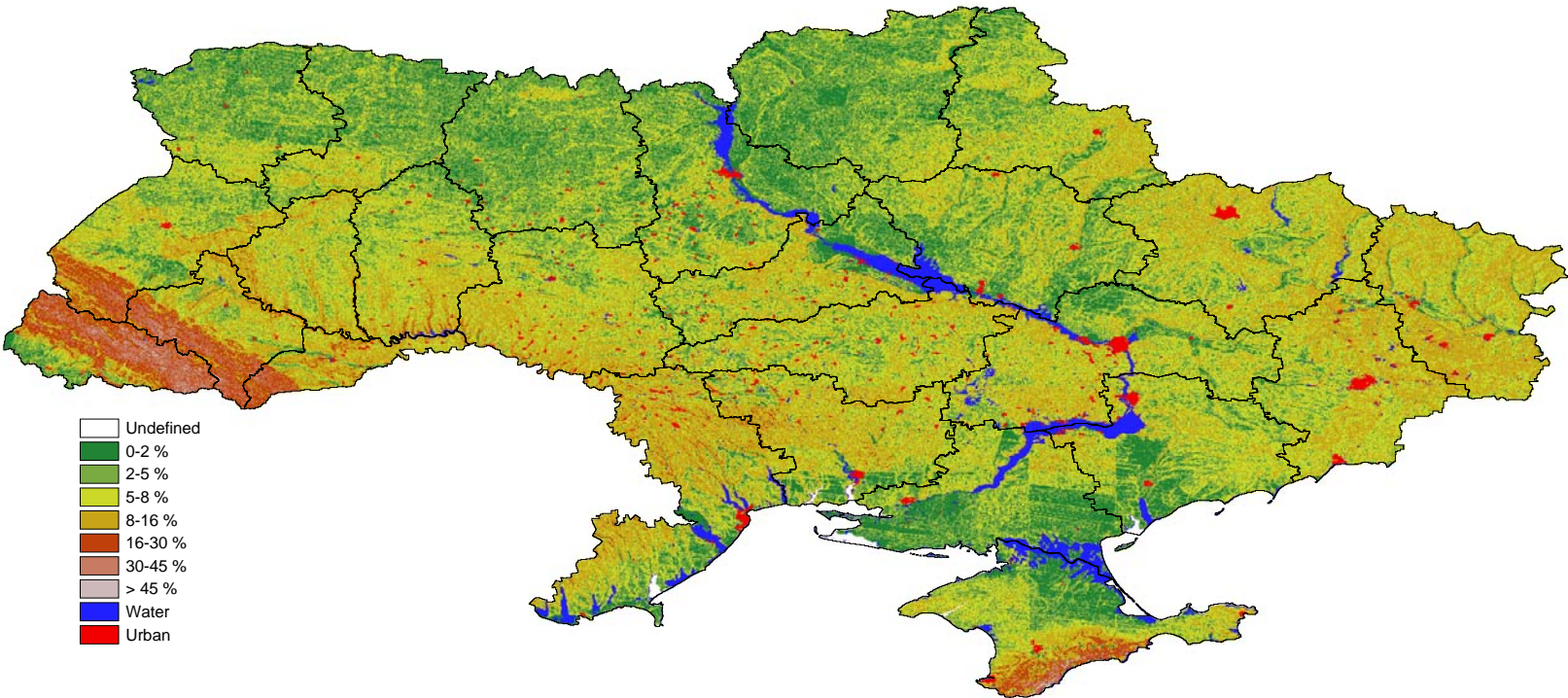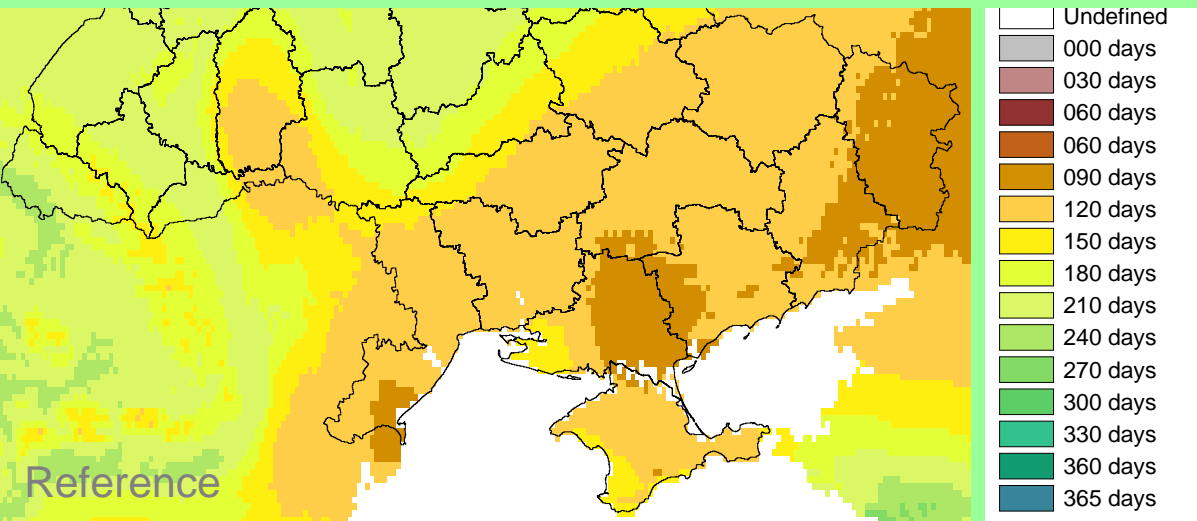|	
☐	Undefined
■	0-2 %
■	2-5 %
■	5-8 %
■	8-16 %
■	16-30 %
■	30-45 %
■	> 45 %
■	Water
■	Urban

Crop types in the study: Ukraine

The selection of crops for the present Ukrainian AEZ study is based on the considerations listed below:

a) the most significant crops in terms of sown (harvested) areas;

b) importance of the crops for food security;

c) economic effect (profitability) of the production of the crops;

d) the world's and domestic trends of the economic development;

e) National Programme of the Development of the Ukrainian Agricultural Sector

Crops types for AEZ study			
Cereals		*Industrial crops*	
Winter wheat	2	Sugar beet	4
Spring wheat	3	Sunflower	4
Rice	2	Soya	3
Winter rye	2	Flax	4
Millet	4	*Vegetables*	
Winter barley	2	Cabbage	4
Spring barley	2	Tomato	4
Oats	3	Onion	4
Maize for grain	4	*Potato*	4
Buckwheat	2	*Fodder crops*	
Pea	3	Maize for silage	4
Bean	3	Alfalfa	1
Total	79	Grass	3

Application: Climate Change Impacts

Length of Growing Period for current and projected climate of the 2080s

Legend (Length of Growing Period):
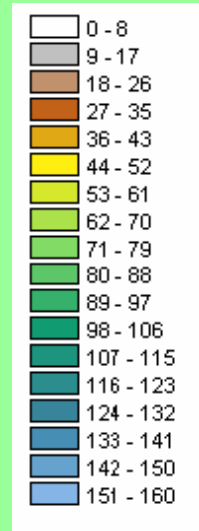- Undefined
- 000 days
- 030 days
- 060 days
- 060 days
- 090 days
- 120 days
- 150 days
- 180 days
- 210 days
- 240 days
- 270 days
- 300 days
- 330 days
- 360 days
- 365 days

Reference

HADCM3 A2, 2080s

ECHAM A2, 2080s

Application: Climate Change Impacts

Reference

HADCM3 A2, 2080s

ECHAM A2, 2080s

Legend (P/PET Ratio):
- 0 - 8
- 9 - 17
- 18 - 26
- 27 - 35
- 36 - 43
- 44 - 52
- 53 - 61
- 62 - 70
- 71 - 79
- 80 - 88
- 89 - 97
- 98 - 106
- 107 - 115
- 116 - 123
- 124 - 132
- 133 - 141
- 142 - 150
- 151 - 160
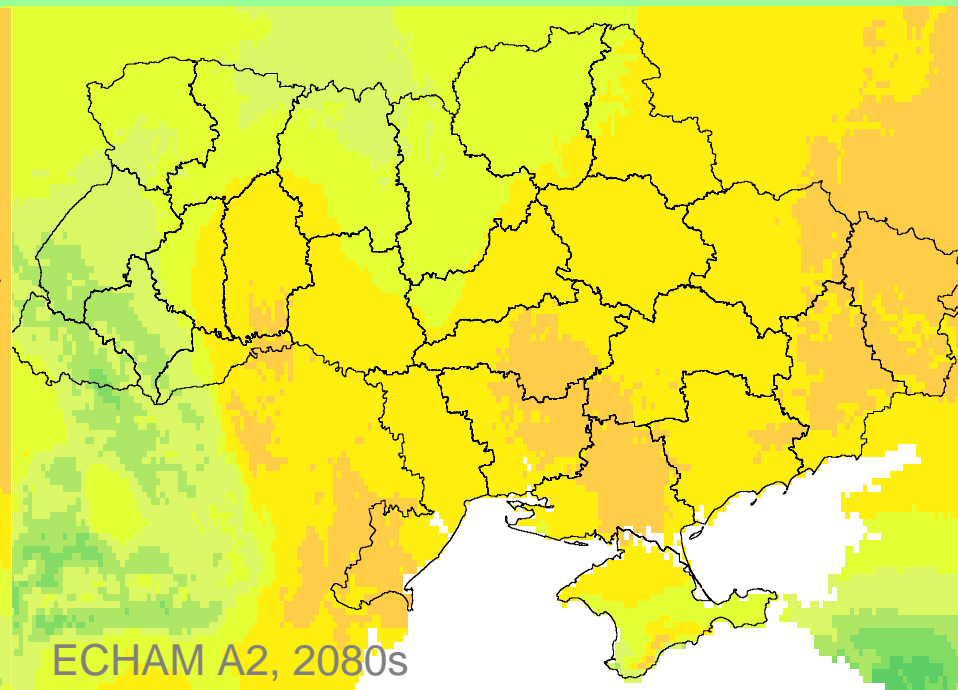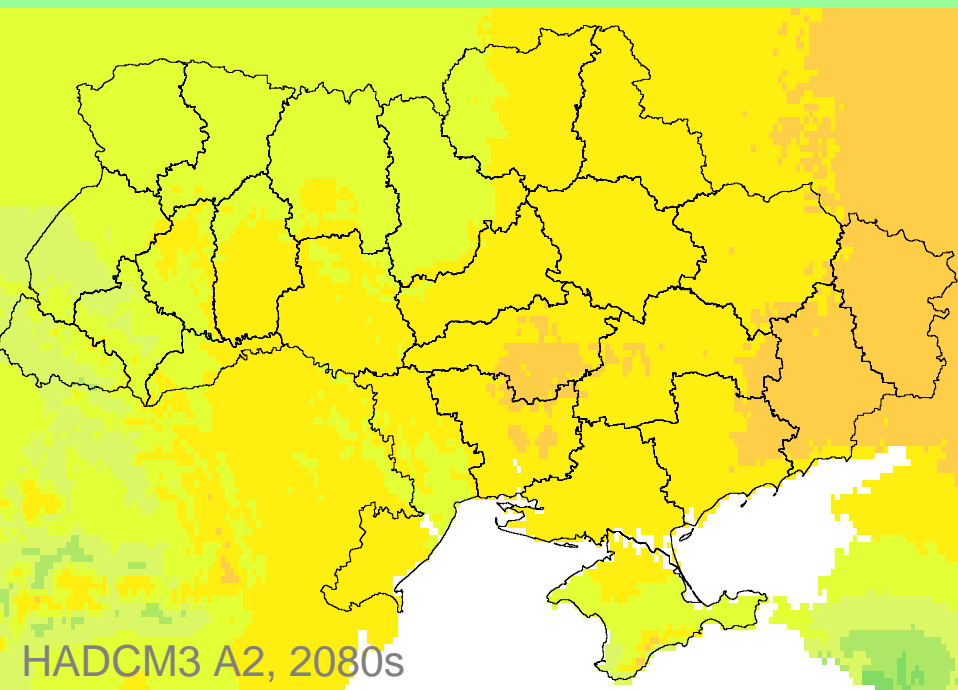
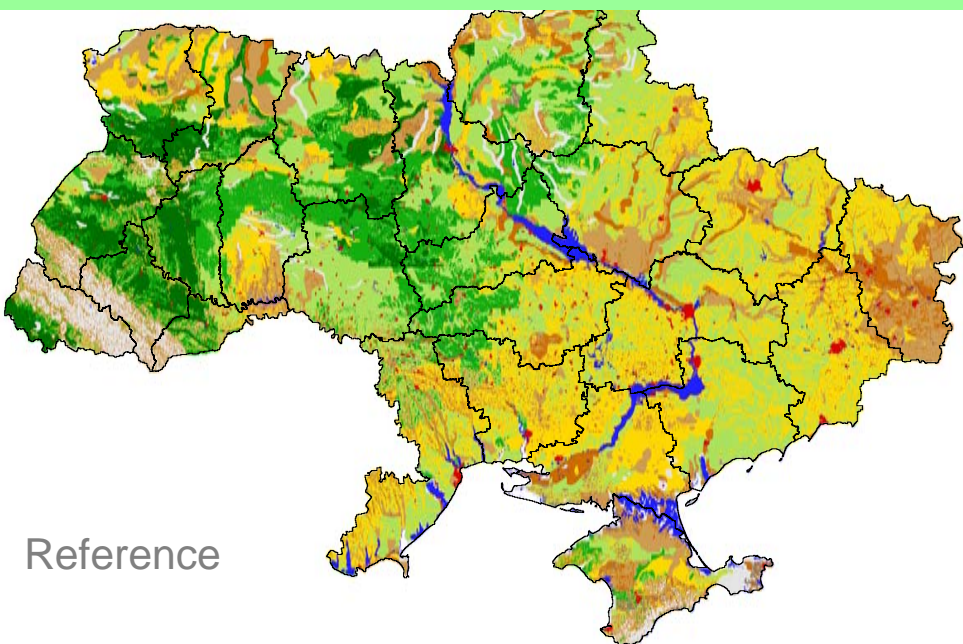Annual P/PET Ratio for current and projected climate of the 2080s
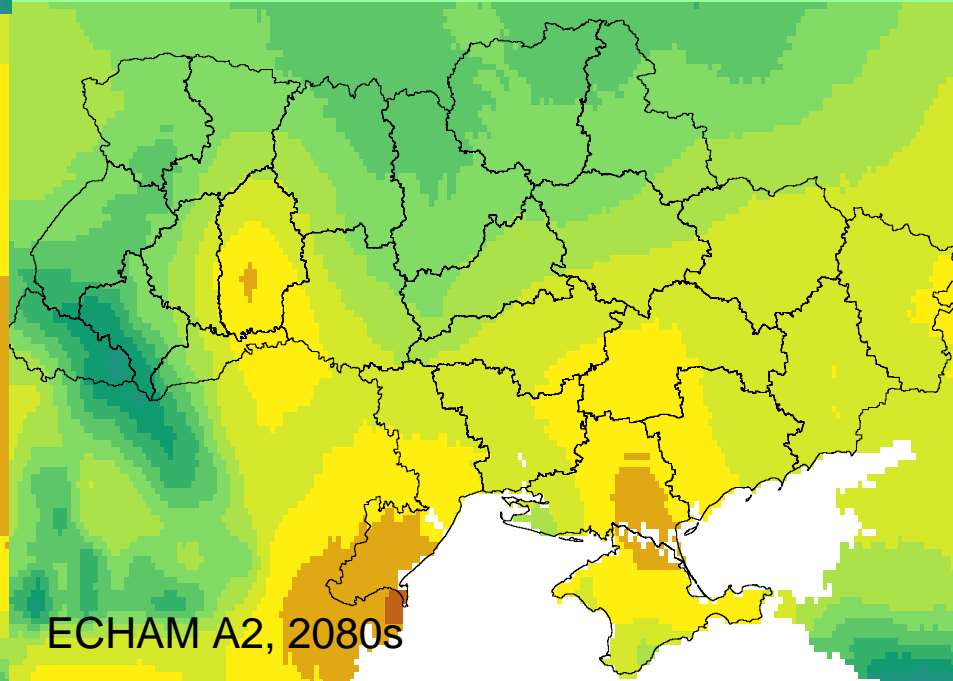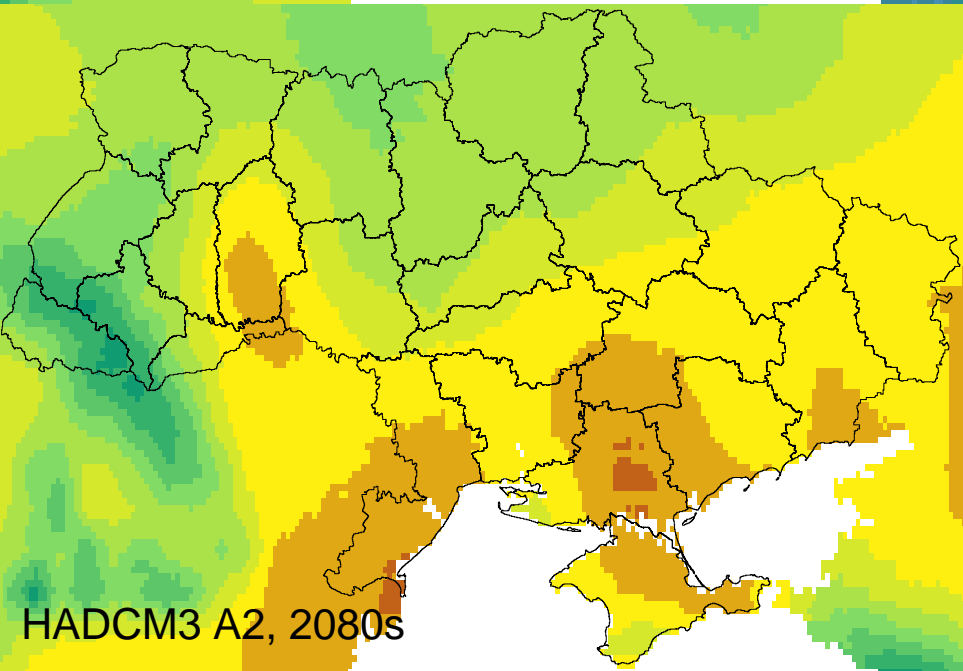
Application: Climate Change Impacts

Suitability of Wheat under current and projected climate of the 2080s

Legend:
- Undefined
- SI > 75 : Very high
- SI > 63 : High
- SI > 50 : Good
- SI > 35 : Medium
- SI > 20 : Moderate
- SI > 10 : Marginal
- SI > 0 : Very marginal
- Not suitable
- Water
- Built-up

Reference
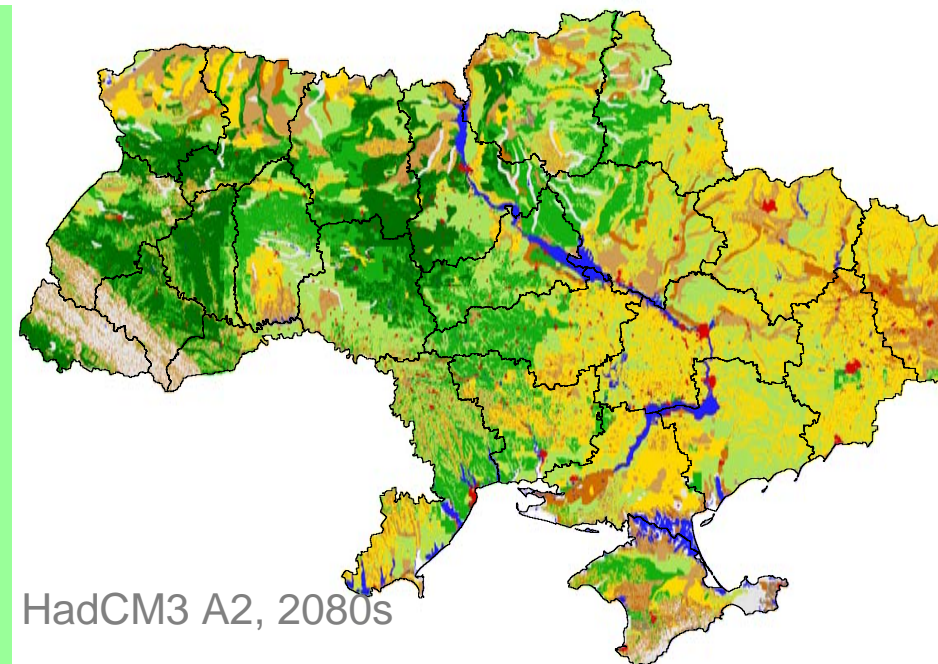
HadCM3 A2, 2080s
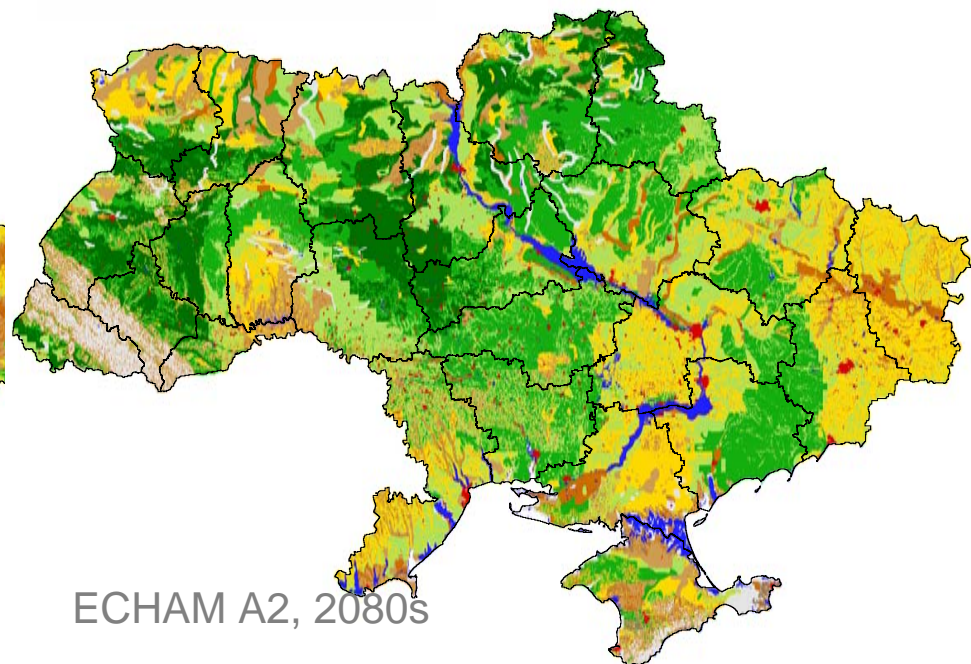
ECHAM A2, 2080s

Summary:

-- Crop Models: interannual dynamics

-- AEZ: Spatial Scaling;

-- Next: Transfer dynamic functionality from
  site to regions, including carbon;

-- Use Remote sensing for validation
  (landsat, NDVI, derived vegetation products)

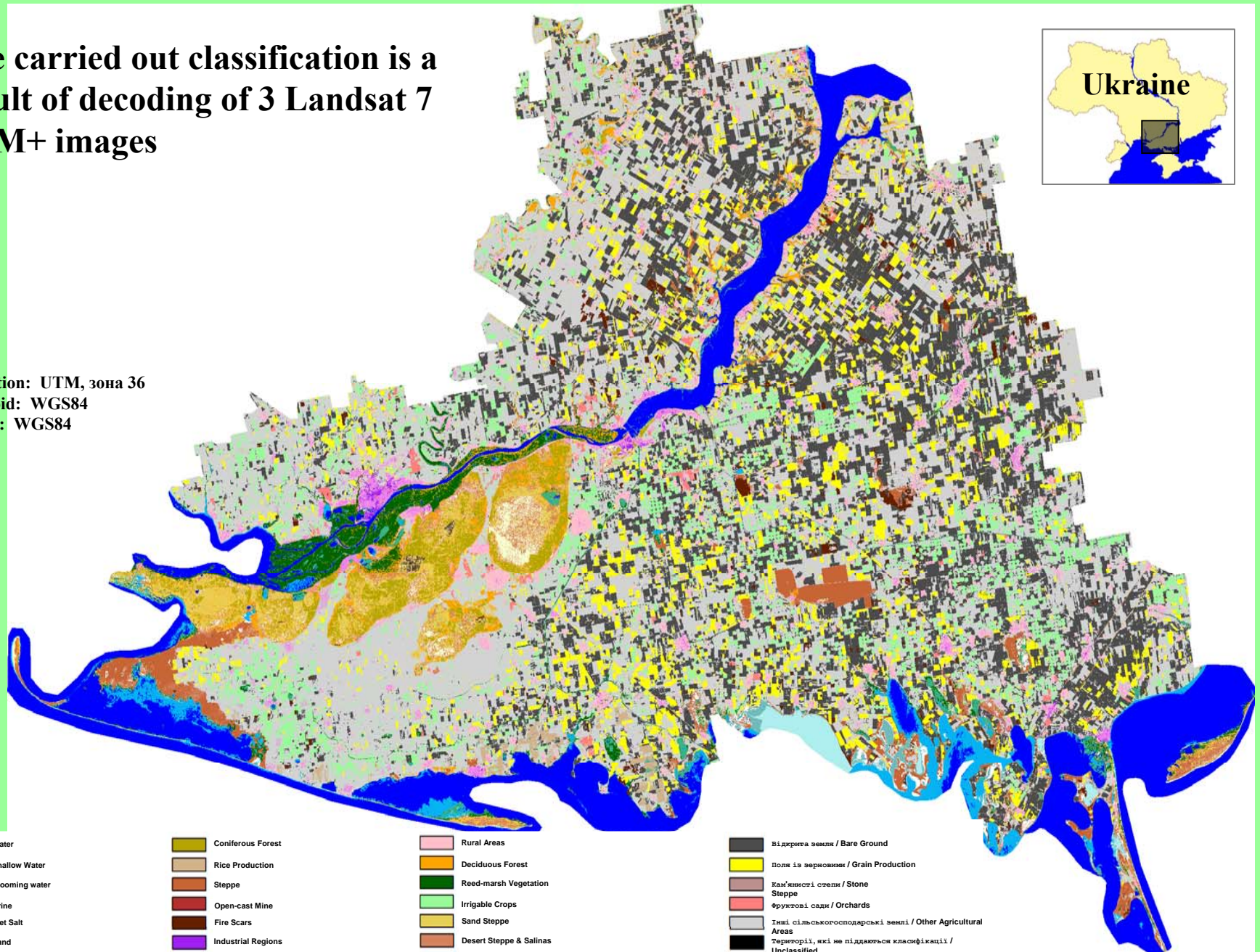**The carried out classification is a result of decoding of 3 Landsat 7 ETM+ images**

Ukraine

Projection: UTM, зона 36
Spheroid: WGS84
Datum: WGS84

Water	Coniferous Forest
Shallow Water	Rice Production
Blooming water	Steppe
Brine	Open-cast Mine
Wet Salt	Fire Scars
Sand	Industrial Regions
Dry Salt	Urban Areas

Rural Areas	Відкрита земля / Bare Ground
Deciduous Forest	Поля із зерновими / Grain Production
Reed-marsh Vegetation	Кам'янисті степи / Stone Steppe
Irrigable Crops	Фруктові сади / Orchards
Sand Steppe	Інші сільськогосподарські землі / Other Agricultural Areas
Desert Steppe & Salinas	Території, які не піддаються класифікації / Unclassified
Bushes & Sparse Tree Growth	

Distribution of agricultural land by farm type in 2002
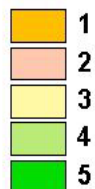
| Class | % of oblast's total agricultural land | | | % of agricultural land of total oblast's land |
	Households	Private farms	Agricultural enterprises	
1	< 20	4 - 15	65 - 80	> 70
2	20 - 30	3 - 15	60 - 75	> 50
3	30 - 40	2 - 6	55 - 65	> 45
4	40 - 60	1 - 3	40 - 55	> 45
5	71	2	27	36

Conclusions:

Good Applicability of site crop models to Ukraine case studies

☐ Simulations can capture interannual variability and fertilizer-N shock signal after 1990 for productivity, maybe for soil C;

Agro-ecological zone model implemented for Ukraine: current, and future climates (2030, 2050, 2080).

Poor additional data for sites, although collection ongoing;

Remote sensing utilization main focus of next two years

THANK YOU !