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

PI's: Francesco N. Tubiello, Cynthia Rosenzweig, Columbia University and NASA-GISS, New York, NY USA

Co-PI's: Gunther Fischer, Anatoly Schvidenko, International Institute for Applied Systems Analysis, Austria

Mykola Zalogin, consultant for Ukrainian Ministry of the Environment

BACKGROUND

This NEESPI project focuses on assessing, currently and over the next 30 years, potential impacts of climate and land use change on agriculture and forestry.

In Ukraine, a bread basket of the former Soviet Union, a large portion of land is managed for agriculture and forestry. Key patterns of the last 15 years have been land abandonment, together with recent developments of new cultivations for exports, including bio-energy crops.

Within this scenario, interactions between carbon cycle, competing land use for agriculture and forestry need to be considered in order to predict potentials for bio-energy and carbon sequestration. The modeling tools developed to date include dynamic crop models (DSSAT), agro-ecological zone (AEZ-IIASA), and forestry statistical

PURPOSE AND HYPOTHESIS

What are the consequences to carbon storage from changes in agricultural land management due to both socio-economic trends and climate change impacts?

What are the effects from likely adaptation and mitigation strategies? (i.e,. Joint Implementation under the Kyoto Protocol; Green Investment Schemes, European Trading Scheme; Bio-energy projects)

The hypothesis is that both climate change and socio-economic trends, including creation of large private holdings with new land intensification for export and bio-energy, will affect land use change in Ukraine significantly, with consequences for the overall land carbon budget.

PROJECT TOOLS

Modeling tools are created to assess and quantify specific aspects of potential change, including adaptation and mitigation responses.

The emphasis is on biophysical descriptions of agricultural systems within existing agro-ecosystem models, at various scales, from farm site to regional and national level.

An agro-ecological zone model, the IASA AEZ, allows for regional scaling of the farm-level results. Project scientists integrate existing data on Ukrainian crop and forestry production including major management types and regimes from 1990 to present. Collaborating Ukrainian scientists provide support for gathering and understanding local observed data, RS and statistics. In particular, RS allows for model validation as well as understanding current dynamics of land, including divisions into small, medium and large agricultural enterprises.

MATERIALS AND METHODS

APPROACH/METHODOLOGY

This project uses a combination of results of local to regional level (crop models, agro-ecological zone approach) to characterize current and future agricultural land use in Ukraine. Statistical and RS data are employed to support and evaluate model performance. Adjustment to methodology needed so far only refers to current number of sites for which data where available, i.e., 5 rather than 25. This is not seen as a problem given that the regional AEZ simulations cover the entire territory of Ukraine, and will thus enable us to overcome the site limitation.

PROGRESS REPORT

We have made progress on all three main goals stated in the project proposal and summarized above: crop model site simulations for climate change; agro-ecological zone modeling for climate change; and statistical/RS data.

We have experienced problems with RS collection in the sense that only two Oblasts were made available due to late start of that project component; we believe that data from these two oblasts are sufficient to carry out project analyses and model testing.

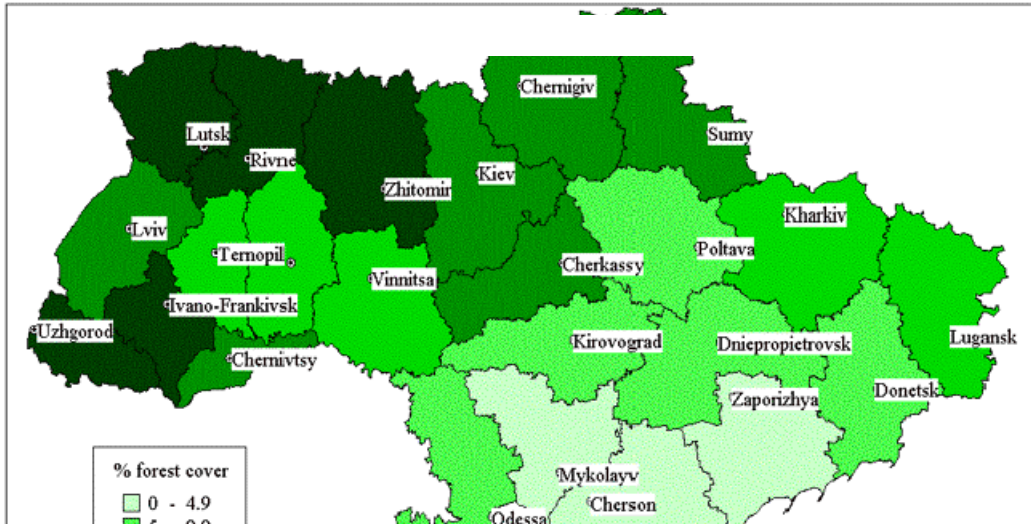
PROGRESS REPORT (cont'd)

The next steps from here will be to complete climate change simulations with AEZ Ukraine, and to initiate inter-comparison among site and regional-level results. Having completed the addition of a carbon-cycle component to the site models, next steps in the third year of performance will be the addition of carbon cycle components to the AEZ model, a task that is running late with respect to earlier schedules. Additional RS data will focus on four remaining Oblasts of importance to agriculture and forestry for assessment of model performance. Finally, scenarios of land use change to 2030 will be developed and agricultural production and its underlying land use will be computed to 2030.

PRODUCTS --FORESTRY

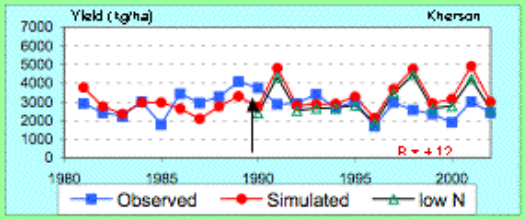
Map of Ukrainian forests (IIASA, 2007)

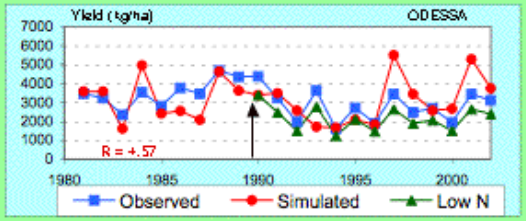
Forest cover in regions (IIASA)

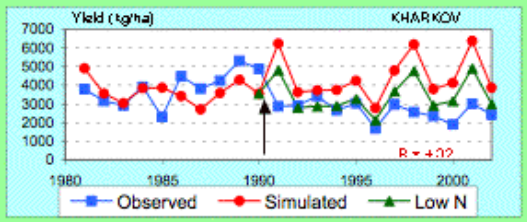


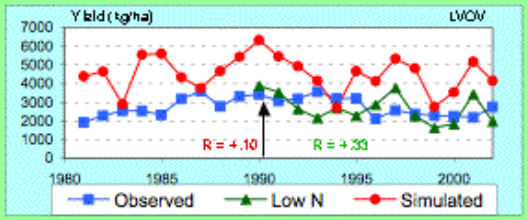
PRODUCTS -AGRICULTURE

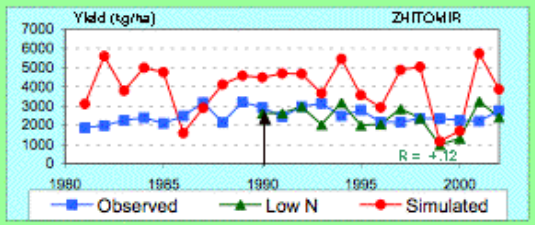
Dynamic Crop Models: Evaluation, Winter Wheat
Effects of 70% Reduction in N Fertilizer after 1990
From 100 to 30 kg N/ha



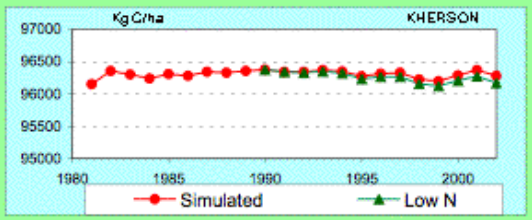




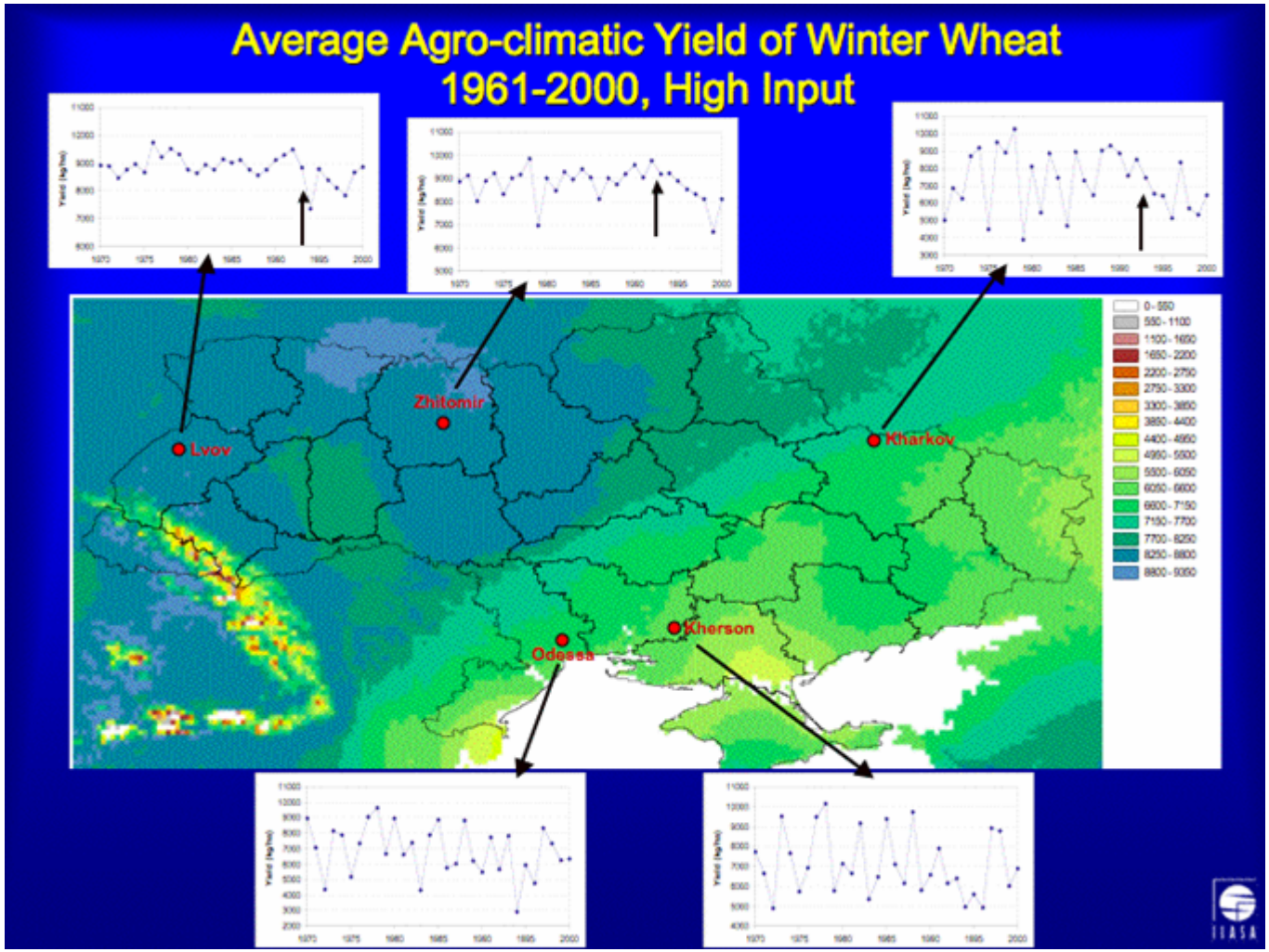




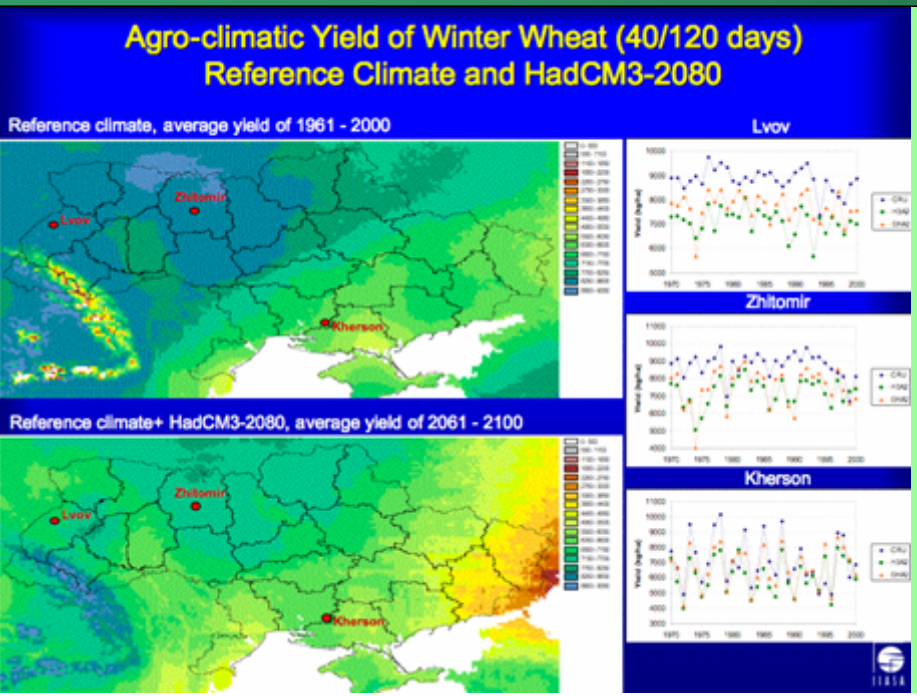
Potential Effect on Soil C



PRODUCTS --AGRICULTURE

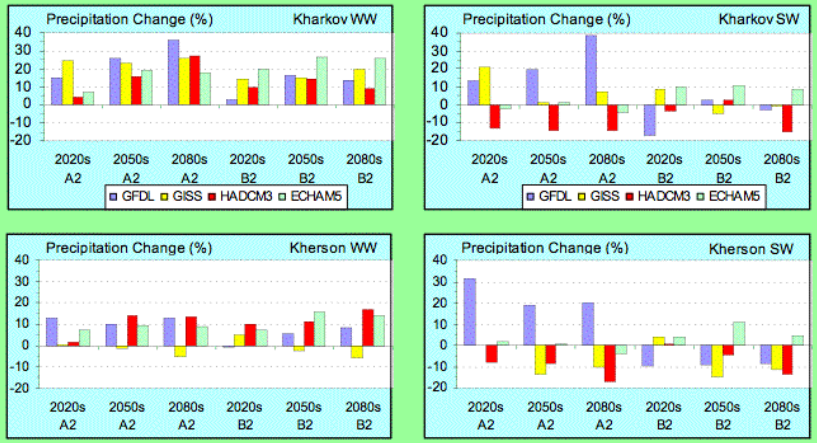


PRODUCTS -IMPACTS

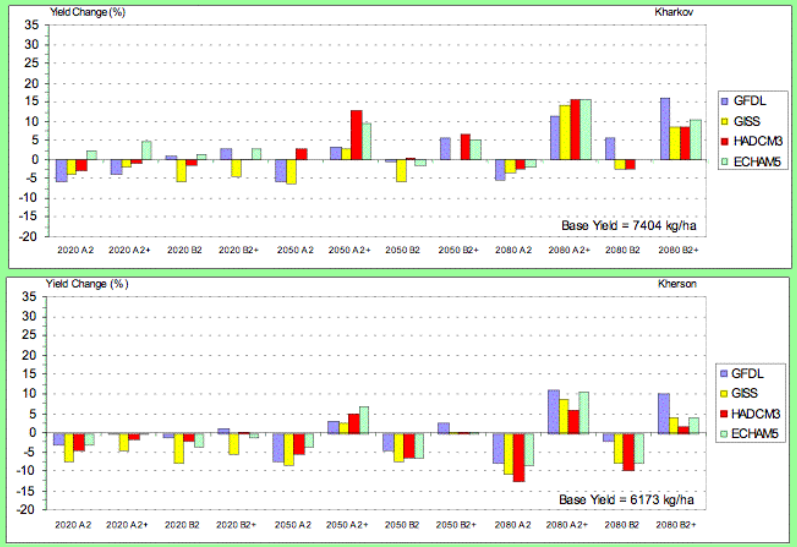


NNESPI-U: Dynamic Crop Models: Climate Change

Projected GCM Growing Season Precipitation Change



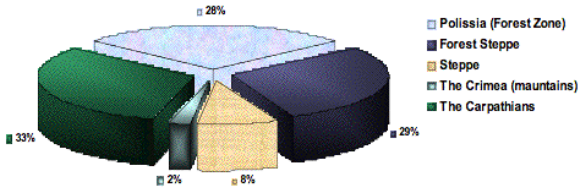
NNESPI-U: Dynamic Crop Models: Climate Change

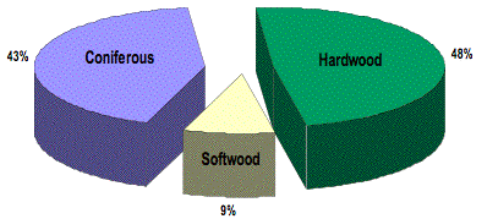


GCM Projected Change in Irrigated Winter Wheat Yield

PRODUCTS -CARBON

Distribution of phytomass by natural zones and groups of species





Carbon of live biomass in Ukrainian forests

Dominant species	Carbon, th. t						
	Foliage	Crown wood	Stem wood	Roots	Understory	Green forest floor	Total
1	2	3	4	5	6	7	8
Pine	3124.28	11804.20	112536.11	24881.87	1053.86	3108.91	156509.23
Spruce	2680.76	4712.02	31598.89	11332.98	143.49	156.50	50624.64
Total coniferous	***6246.25***	***17369.72***	***150186.53***	***38210.17***	***1230.02***	***3322.96***	***216565.65***
Oak	2321.02	19562.43	93567.58	17926.35	1662.67	2552.23	137592.28
Beech	907.51	13421.77	49250.45	20217.68	678.00	849.22	85324.62
Total hard deciduous	***3659.60***	***36605.48***	***158936.59***	***41543.82***	***2651.38***	***3904.67***	***247301.56***
Birch	636.46	2497.58	13900.90	3758.13	397.02	522.60	21712.70
Aspen	47.37	181.99	1376.39	586.11	49.51	54.95	2296.32
Alder	208.17	1057.59	10277.34	2593.71	304.83	405.58	14847.21
Total soft deciduous	***1029.14***	***4250.81***	***28585.31***	***7844.69***	***851.31***	***1128.10***	***43689.37***
Total	13664.60	73110.21	424458.66	109046.22	7388.38	13138.68	640806.75
Average, t/ha	***1.4***	***7.7***	***44.7***	***11.5***	***0.8***	***1.4***	***67.5***

RESULTS

NEW FINDINGS. We are analyzing crop simulation data relative to the interactions of nitrogen fertilizer management and crop production in the Ukraine across the "divide" of pre- and post-1990. It is common to assume that collapse of production was a direct consequence of the collapse of fertilizer use. However we find no strong dependence on fertilizer in key producing areas of the Ukraine, due to the fact that soils there are carbon rich and thus less dependent on fertilizer application.

NEW POTENTIAL: Comparisons of site model simulations and agro-ecological results will provide for developing new insights into the relative importance of local vs. regional factors that determine production and are thus key drivers of land use.

NEW PRODUCTS. Climate change simulations for Ukraine under the suite of scenarios and management options investigated so far constitute a new and original contribution to the literature and will be submitted for publication in the coming months.

PRODUCTS -LAND USE and SOCIO-ECONOMIC FACTORS

CONCLUSIONS

The project “Carbon, Climate and Managed Land in Ukraine: Integrating Data and Models of Land Use for NEESPI” has developed an initial set of modeling sites and regions, as well as provided a focus for gathering statistical datasets.

New climate change runs provide information to land users and policy makers in terms of potential risks to production and options for adaptation. Validation of the site models has been successfully completed and has provided new insights into specific historical trends in crop production. Addition of carbon modules was completed only for the site models and will be the main tasks for year 3 with respect to AEZ. Progress has been made in developing strong relationships with local Ukrainian partners.

We are planning to use ongoing results form this project to inform and gather local stakeholders interested in issues related to land use and carbon sequestration in Ukraine, of importance to the imminent launch of the UNFCCC Joint Implementation Program, which under the Kyoto Protocol and the recent EU trading scheme allows for funding of land-based projects in countries such as Ukraine with economies in transition.

BIBLIOGRAPHY

Fischer. G., Van Veltuizen. H., Gumenyuk, K., and Tubiello, F.N., 2007. The Agro-ecological zone model for Ukraine. Initial Results. IIASA IR 005.

Tubiello, F.N., Rosenzweig, C., Goldberg, R., 2007. Impacts of climate change on wheat and maize production in Ukraine. In preparation.

Shvidenko, A., 2007. Statistical dataset of forestry in Ukraine. IIASA Interim Report. In press.