The role of environmental, socioeconomic, institutional, and land-cover/ land-use change factors to explain the pattern and drivers of anthropogenic fires in post-Soviet Eastern Europe: a case study comparison of Belarus, European Russia, and Lithuania

Jessica L. McCarty[1], Peter Potapov[2], Alexander Prishchepov[3], Svetlana Turubanova[2], Matthew C. Hansen[2], Vladimir Romanenkov[4], Dmitry Rukhovitch[5], Polina Koroleva[5], Maxim Dubinin[6]

1 Michigan Tech Research Institute (MTRI)
Michigan Technological University
3600 Green Court, Suite 100 ♦ Ann Arbor, MI 48105
(734) 913-6874 – Phone ♦ (734) 913-6880 – Fax
jmccarty@mtu.edu

2 Department of Geographical Sciences
University of Maryland
2181 LeFrak Hall♦ College Park, MD 20742
(301) 405-2129 – Phone ♦ potapov@umd.edu

3 IAMO, Leibniz Institute of Agricultural Development in Central and Eastern Europe
Theodor-Lieser-Str. 2, D-06120 Halle, Germany
prishchepov@iamo.de

4 All-Russian Institute for Agrochemistry
Pryanishnikova St., 31a
127550 Moscow, Russia
viuageoset@gmail.com

5 V.V. Dokuchaev Soil Institute
Pyjevky Lane 7 Office 67
119017 Moscow, Russia
landmap@yandex.ru
soilmap@yandex.ru

6 NEXTGIS
Vavilova, 41, office 2
Moscow, Russia 117312
maxim.dubinin@nextgis.org
nextgis.org

Background

This project focuses on quantifying the relationship of land-cover/land-use (LCLU) change in the former Soviet Union, specifically Belarus, European Russia, and Lithuania (Figure 1), from agricultural abandonment and afforestation and the relationship of this LCLU change to anthropogenic fires. This region of Eastern Europe is a well-documented area of LCLU change and also of consistent prescribed burning and recent extreme fire events. These three countries have taken three different paths towards economic development since the fall of the Soviet Union. This project will quantify changes in agricultural land use in a large area of Eastern Europe as well as analyze the drivers of anthropogenic fire in an area where climatic changes and human-environmental impacts are important contributors to extreme fire events that have caused significant loss of life, property, and ecosystem functioning.

In this NASA Land-Cover/Land-Use Change Early Career Scientist Project, we are completing the following: 1) map land-cover/land-use (LCLU) change from agricultural land abandonment, cropland reestablishment, and afforestation in Belarus, European Russia, and Lithuania from 1990 to 2010 using moderate to high resolution satellite data; 2) analyze the relationship of observed LCLU change with socioeconomic conditions, land management practices, policy, proximity to infrastructure, and agricultural management across time and space; 3) using the results of the LCLU change analysis, analyze potential origins and spread of fire while also comparing extreme fire year of 2010 to fires for years 2011 to 2013.

Project Outcomes

This project will produce a Landsat-based LCLU change map for two decades, 1990 - 2000 and 2000 - 2010, of the study area where LCLU change will be mapped across vegetation and/or land use type, including dominant tree group and peatland classes. A statistical model of LULC changes will also be developed, providing further insight into the drivers of LULC change across these three former Soviet countries. Finally, the results of these first two analyses will allow for further investigation into the drivers of anthropogenic fire observed in Eastern Europe, an important consideration for the impacts of extreme fires on the local human populations and ecosystems as well as a documented source of short-lived climate forcers in the Arctic system.

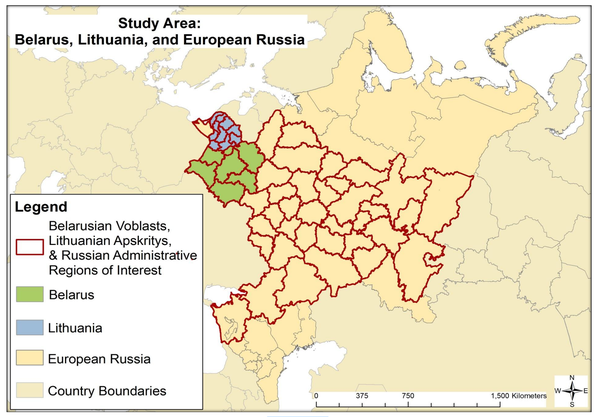

Figure 1

Preliminary Results

Co-I Potapov and researchers at the University of Maryland Department have created preliminary Landsat-based estimates of forest loss and gain in European Russia. This data set, which has a nominal resolution of 120 m sampled from 30 m Landsat pixels, is created as a loss or gain likelihood product for years 2000 to 2012. We can complete a preliminary analysis of afforestation in our study region as well as the relationship between fire and LCLU change (this section). Figure 2 shows a forested region in northern European Russia where there is some spatial agreement between 91-95% forest loss and burned area mapped by the 500 m Moderate Resolution Imaging Spectroradiometer (MODIS) MCD45A1 Burned Area Product. The minimal forest loss in southern Russia (Rostovskaya Oblast) at the 91-95% likelihood shows little agreement with the MCD45A1 burned area product (Figure 3).

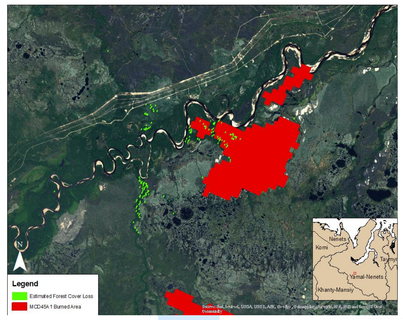

Figure 2

Figure 3

Figure 4 shows the highly variable relationship between 91-95% likelihood forest loss at annual time steps with amount of burned area in hectares. There appears to be short cycles of burn periods, perhaps associated with timber harvesting. Note the peak of burned area corresponding to high likelihood forest loss in 2010, an extreme fire year in European Russia.

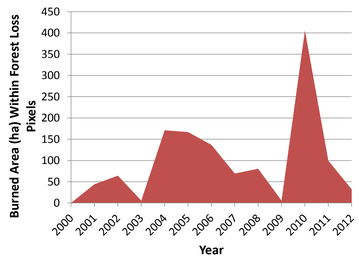

Figure 4

Coordination with U.S. State Department Black Carbon Initiative

Recent and ongoing research in Black Carbon emissions supported by the U.S. State Department is complementary to the objectives of this project. In particular, Dr. Tatiana Loboda (also a NASA LCLUC Early Career Awardee) has been tasked to produced a cropland-specific burned area dataset for the Russian Federation. Field data collected during this work will be shared with Dr. Loboda and the cropland burned area produced for Russia will be shared with PI McCarty, improving our modeling efforts of linking anthropogenic fire to LCLU change in our study region.

Coordination with International Research

This project also incorporates climatic and biophysical variables to analyze the drivers of anthropogenic fire and its relation to LCLU change. To that end, our project will coordinate with Bill de Groot of the Canadian Forest Service to produce estimates of Fire Behavior for our study area (rate of spread, fuel consumption, and fire intensity) from the Canadian Fire Effects Model (CanFIRE: http://www.glfc.forestry.ca/canfire/). CanFIRE is currently used in a NASA-funded project to study fire effects in Siberia (PI Conard). Additionally, we are coordinating with Dr. Johann Goldhammer and his team at the Global Fire Monitoring Center (GFMC) to have access to the data and maps produced by EurAsian Fire Danger System (http://www.fire.uni-freiburg.de/fwf/eurasia1.htm) starting in spring 2013. Figure 5 shows the 29 March 2013 Fire Weather Index for Eurasia. As with the NGO cooperation, we are willing to share our data, results, and expertise with these groups as well.

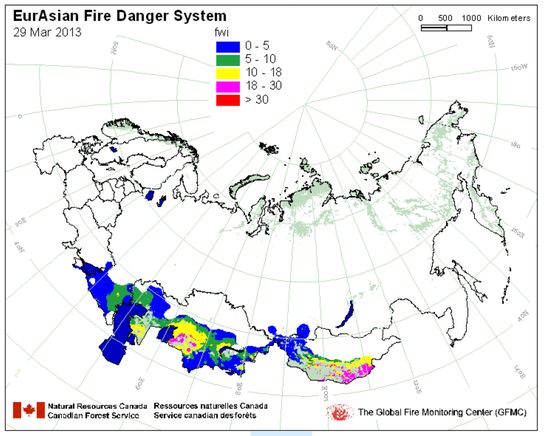

Figure 5

Coordination with NGOs

This project is supported by three U.S.-based non-governmental organizations (NGOs) - Clean Air Task Force (catf.us), International Cryosphere Climate Initiative (iccinet.org/), and Pacific Environment (http://pacificenvironment.org/) – and two Russia-based NGOs – Greenpeace Russia (http://www.greenpeace.org/russia/en/) and Bellona Russia (http://www.bellona.org). These NGOs have pledged to assist our project with access to their data, knowledge, in-country networks and services when needed as well as funding for our Russian collaborators as needed through our project. For example, ICCI currently funds Collaborators Rukhovitch and Koroleva to continue their cropland mapping efforts in Rostovskaya Oblast in southern Russia. Representatives from the NGOs will be invited to all project meetings. Results and data from this project will be shared with the NGOs upon request.

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Current and Future Work

Currently, PI McCarty and Co-I's Potapov and Prishchepov have been invited to submit a scientific manuscript to a special Northern Eurasian Earth Science Partnership Initiative (NEESPI) issue of Environmental Research Letters. Final versions of the preliminary project results detailed on this poster will be included in this manuscript in addition to inclusion of socio-economic drivers for forest change in our study region.

Utilizing automated Python and gdal scripts, all 500 m MODIS MCD45A1 Burned Area Data and the 1 km MODIS MOD/MYD14A1 Active Fire Data have been processed for the project study area for years 2001 – 2012. Land cover type has been assigned using both MODIS and Medium Resolution Imaging Spectroradiometer (MERIS) products. As project-specific LULC products become available, the fire analyses will include these datasets as well.

We will hold our first project meeting in Moscow 18-19 June 2013 to be hosted by the All-Russian Institute for Agrochemistry (Collaborator Romanenkov). Following this meeting, McCarty, Potapov, and Turubanova will complete two weeks of fieldwork in selected sites of European Russia with a focus on collecting data to validate the 30 m LCLU product and investigating satellite observed fires in croplands, grasslands, forests, peatland, and potential abandoned croplands.

Acknowledgements

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