Understanding global farmland abandonment with the aid of satellite remote sensing

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Few words about me

- Born and raised in St. Petersburg, Russia
- Graduated from Russian State Hydrometeorological University, Russia
- 2004-2005, IREX USDS GIS certificate program, Oklahoma State University
- 2005-2010, PhD, University of Wisconsin-Madison
- 2010-2014, post-doc, Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Germany
- 2014-until present, University of Copenhagen, associate professor
- Coordination of Global Land Program’s “Agricultural Land Abandonment as a Global Land-Use Change Phenomenon” working group

Focus on measuring land transitions, human dimension of land system change

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Structure of presentation

- Motivation
- What is farmland abandonment?
- Challenges to study farmland abandonment
- Major milestones in application of satellite remote sensing
- Existing research gaps and ways to go
- Population growth goes hand-in-hand with agricultural expansion
- Vanishing remaining intact areas
Widespread farmland abandonment

Cropland abandonment from 1992 to 2020

Zheng...Prishchepov, Yin.. In Review
Widespread and diverse farmland abandonment

Abandonment in the Mediterranean

Abandonment in steppe biome

Abandonment in sub-tropical regions

Abandonment in temperate regions

Photos: Prishchepov A Source: Prishchepov. Oxford Bibliography
Strong implications to the environmental and socioeconomic processes

- Globally important carbon sink
- Various impacts on biodiversity
- De-fragmentation of landscapes
- «Rewilding»
- Invasive species
- Impacts on hydrology
- Spread of wildfires
- Impacts on livelihoods
- Population of outmigration
- Rural hollowing
- Loosing the esthetic of rural landscapes

Invasive Heracleum sosnowskyi, Russia

Abandoned settlements, Spain

Photos: Prishchepov A.
Studying farmland abandonment is difficult

- There is no existing uniform definition (varies across agencies, timing of abandonment, appearance in the ground)
- Terminology is diverse “abandonment”, “set-aside”, “postagrogenic”, “deactivated”
- Abandonment can be complete, semi-abandoned, hidden abandonment
- Abandonment is a transition process-new land uses may evolve
- Dual perception of farmland abandonment-site specific
- Change of electromagnetic signal due to abandonment can be subtle (e.g., abandonment of managed grasslands in steppe biome)
Defining farmland abandonment

..... the cessation of farming (could be grassland, cropland) leading to the natural restoration of vegetation or degradation of farmland facilities up to four or five years (FAO 2006)

..... idle plot without signs of cultivation up to three years (European Environmental Agency)

....”cropland in time I, abandoned (e.g., shrubs) in time II”
Abandonment in the ground

Source: Kolecka 2018
Progress on monitoring farmland abandonment

- Point-based field surveys, e.g., Land Use and Coverage Area frame Survey in Europe-EUROSTAT (LUCAS)
  - Land cover
  - Land use

- National and subnational agricultural surveys, FAOSTAT
  - Dynamic of croplands and livestock
  - Aggregated data
  - No tracing abandonment, rather proxies

Cropland abandonment from various sources in Russia

Schierhorn..Prishchepov et al. 2013
Fundamental role of satellite remote sensing

Probably the very first study on farmland abandonment with the aid of single image Landsat MSS image dates (30% of claimed abandonment from 1990 to 1993, no accuracy assessment)

1-Actively managed grasslands, 2-delay of greenup on abandoned grasslands due to plant litter

Peterson and Aunap, 1998
Decisive role of NASA LCLUC program

- Witnessing implications of institutional changes on land use after collapse of the Soviet Union

Evaluating the effects of institutional change on regional hydrometeorology: Assessing the vulnerability of the Eurasian semi-arid grain belt (2005-2008)
PI: Dr. Geoff M. Henebry

Post-USSR land cover change in Eastern Europe: socioeconomic forcings, effects on biodiversity, and future scenarios (2005-2008)
PI: Dr. Volker C. Radeloff
Decisive role of NASA LCLUC program

Changes in NOAA AVHRR land surface phenology due to farmland abandonment and livestock decline in Kazakhstan
de Beurs and Henebry, 2004, RSE

Accumulated growing degree-days (AGDD)

Landsat single image dates (as for forest-cover change) are insufficient to map abandonment. Specific image dates matter. Superiority of machine-learning methods.
Prishchepov...Radeloff, 2012, RSE
Decisive role of NASA LCLUC program

MODIS NDVI phenology metrics and time-series boost classification accuracies and help to map abandonment at sub-continental level
Alcantara.. Prishchepov.. Radeloff, 2012, RSE.
Alcantara.. Prishchepov.. Radeloff, 2013, ERL

Mapping yearly cropland extent with MODIS NDVI, may relax definitions of abandonment (e.g., calculating land-use intensity)

Estel.. Prishchepov.. et al., 2015, RSE
Changing paradigm on data accessibility

Source: Zhu et al., 2019, RSE
Time-series analysis to capture farmland abandonment at earlier stages

Application of spectro-temporal segmentation algorithms to benefit on image times series. Example of LandTrendr

Source: Yin, Prishchepov ...Radeloff, 2018, RSE
Time-series analysis to capture farmland abandonment at earlier stages

Application of spectro-temporal segmentation algorithms to benefit on image times series. Example of LandTrendr

Application in temperate regions-cropland abandonment

Application in steppe biome-grazing abandonment

Application in tropics-sugarcane abandonment

Source: Yin, Prishchepov .. Radeloff., 2018, RSE

Source: Dara... Prishchepov et al., 2020, RSE

Source: de Castro et al., 2022, RSE
Benefiting from multisource remote sensing

Multisource imaging helps to ascribe the unique features of abandoned fields

SAR (Sentinel-1) may perform better or in combination with optical data (Sentinel-2, Landsat 8) rather optical alone

Applications of LiDAR alone or in combination with other RS products

Source: Huang, et al., 2019, Land

Moving from case studies to continental level analysis

Sub-continenal mapping of different stages of natural succession on abandoned fields

Source: Glushkov... Prishchepov, 2021, ERL

Abandonment across Caucasus

Source: Buchner... Yin, Radeloff 2021, RSE
Moving from case studies to continental level analysis

Secondary forest regrowth in Brazil, 1986-2018

Source: Silva Junior et al., 2020, Scientific Data

Global cropland decline, 1990-2020

Source: Potapov et al., 2021, Nature Food
Interesting studies linking to various processes

Farmland abandonment among smallholder farmers linked to armed conflicts and food insecurity in South Sudan

Source: Olsen ..Olofsson,... Prishchepov, 2021, Nature Food

Multisite mapping of farmland abandonment

Source: Yin ..Radeloff, 2019, RSE
Interesting studies linking to various processes

Linking ongoing greening and farmland abandonment in Poland with non-parametric trend (NPT) and LandTrendr (LTR)

Source: Kolecka, 2021, RSE
Degree of afforestation is a proxy for timing and duration of farmland abandonment.
Interesting studies linking to various processes

First review on land abandonment


Complexity of definitions of farmland abandonment

What we learned so far

- Multiseasonal, multisource imagery matter, plus phenology characteristics may improve classification accuracies
- Progress in time-series analysis allowed to capture earlier timing of farmland abandonment
- Farmland abandonment is widespread
- Abandonment may or may not lead to greening and carbon intake
- Abandonment may result in novel ecosystems
- NASA LCLUC Program plays a decisive role in studying farmland abandonment
Existing Research Gaps

- Global land cover products do not fully capture abandonment
  - we need to move toward global abandonment maps
- One abandonment definition “does not fit all”
  - we need to account for regional land-use practices
- Abandonment is not static but a transition class
  - we need to understand new land uses, other than agriculture
- Abandonment is not about cropland, but other land uses too
  - testing the methods in other agricultural land-use systems
- Abandonment represents a plethora of land transition in the ground
  - quantifying such diversity
- Overuse GoogleEarth-like VHR satellite imagery
  - priority to capture land abandonment in the ground

Other topics: resolution, drivers, syndromes, implications, context, etc.
Stay Tuned!

Thank you!
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