



RECONSTRUCTING DISTURBANCE HISTORY FROM DISTRIBUTION OF LAND COVERS IN THE RUSSIAN FAR EAST: FIRST RESULTS

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INTRODUCTION



The Russian Far East (RFE) is an area of the highest biological diversity within temperate forests globally. It is home to several endemic and endangered species including charismatic large cats – the Amur tiger and the Far Eastern leopard.

Designated as a Global Priority Tiger Conservation Landscape, the RFE is considered to have the highest probability of persistence of tiger populations over the long term. It is the largest contiguous Tiger Conservations Landscape of ~270,000 km², which supports ~ 500 Amur tigers in the wild.



Amur Tiger (photo courtesy of WCS)



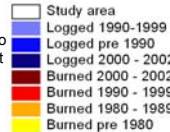
Far Eastern Leopard (photo courtesy of WCS)

Tiger and leopard habitat is shaped and transformed by natural (e.g. wildland fire) and anthropogenic (e.g. logging) disturbances. A number of recent studies have shown an increase in tiger habitat modification from climate-induced changes in fire regime as well as economically-forced deforestation through large-scale timber harvesting operations.

Forests of the RFE present a mosaic of stands at various stages of post-disturbance recovery. In this study, we attempt to use satellite data to reconstruct disturbance record in the RFE over the last 40 years using the forest mosaic as a proxy for time since the last disturbance.

DATA AND METHODS

1. We developed a moderate resolution (i.e. 30m) disturbance dataset for the RFE from the publicly available (prior to the USGS full archive release) Landsat MSS, TM, and ETM+ imagery.



• Disturbances were identified and mapped using a combination of automated and analyst driven methods

• Mapped disturbances were time-stamped using "Quick look" images and grouped into decadal samples.

2. Moderate resolution data were overlaid by the MODIS ~500m grid to identify MODIS cells with $\geq 50\%$ "disturbance". The training dataset was composed of 70% of randomly selected "disturbance" cells. The remaining 30% of the cells with $\geq 50\%$ "disturbance" were used as the validation set.

3. Additional training data for "mature forest" category were mapped using the MOD12Q1 forest classes within undisturbed forested areas visible throughout the Landsat record.

4. Decision tree mapping was developed from 46 MODIS-based variables obtained for 2008:

	MCD43A4						MOD11A2/MYD11A2				
	B1	B2	B3	B4	B5	B6	B7	NDVI	NBR	Day LST	Night LST
Mean 3min											
Mean 3max											
MeanJJA											
MeanJF											

where mean3min = mean of 3 minimum values during 2008, mean 3max = mean of 3 maximum values, meanJJA = mean June – August, meanJF = mean January-February

INITIAL RESULTS

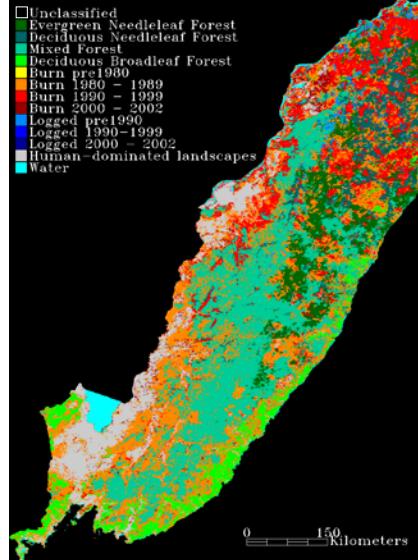
• Human dominated landscapes including

- croplands,
- cropland/natural vegetation mosaic,
- urban areas

were masked using MOD12Q1 c4 product

• Water was mapped using MOD44W product

Class	% area
ENF	7.92
DNF	6.60
MF	26.41
DBF	5.84
burn70	0.00
burn80	26.70
burn90	10.92
brun00	1.38
log80	1.41
log90	0.00
log00	0.00
human	10.55
water	2.27



ACCURACY ASSESSMENTS

• Accuracy assessment of classification results was conducted using a validation sample obtained from the moderate resolution disturbance database.

• Two subsets of accuracy assessment include:

- a generalized (disturbed / mature forest) assessment (right)
- a full classification assessment (below)

Accuracy Assessment for Aggregated Classes

Predicted classes	Observed classes				Omission %
	mature tree disturbance	mature tree	total %	total (pix)	
mature tree disturbance	90.96	4.49	12.73	1837	9.04
total	9.04	95.71	87.27	12592	4.29
total (pix)	100	100	100	14429	
Commission %	30.43	1.01			

Overall Accuracy = 95.2457%
Kappa Coefficient = 0.7622

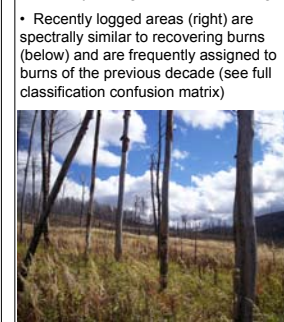
Accuracy Assessment for Full Classification

P	Class	Observed classes										Total %	Total (pix)	Omission %	
		ENF	DNF	MF	DBF	burn70	burn80	burn90	log80	log90	log00				
r	ENF	93.53	0	0	0	0	0.81	1.86	0.33	1.19	1.85	13.33	4.07	587	6.47
o	DNF	0.23	72.87	1.44	0.82	15.22	0.89	0.23	0	7.14	2.58	0	1.82	263	27.13
d	MF	0	0	93.1	0	4.35	0.69	0	0	3.97	0.37	3.33	3.03	437	6.95
i	DBF	0	1.6	0	88.56	21.01	1.47	0.1	0	0	0	0	3.09	446	11.44
t	burn70	0	0	0	0	0	0	0	0	0	0	0	0	0	100
c	burn80	1.62	23.4	4.8	10.35	36.96	55.61	6.14	7.4	28.17	38.01	13.33	20.34	2934	44.39
o	burn90	3.7	1.6	0	0.27	20.29	36.47	89.75	23.33	34.52	51.66	7.0	59.14	8532	10.25
d	brun00	0.92	0	0	0	1.45	3.11	1.71	68.94	3.57	2.95	0	7.7	1111	31.06
c	log80	0	0.53	0.72	0	0.72	0.94	0.22	0	21.43	2.58	0	0.81	117	78.57
i	log90	0	0	0	0	0	0	0	0	0	0	0	0	0	100
o	log00	0	0	0	0	0	0	0	0	0	0	0	0	0	100
s	Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	
o	Total (pix)	433	188	417	367	276	3600	7363	1230	252	271	30	14429		
s	Commission %	31.01	47.91	11.2	27.13	0	9.177	22.56	23.67	59.85	0	0			

Overall Accuracy = 74.6309%
Kappa Coefficient = 0.6021

EARLY FINDINGS

- Initial results show that ~47% of the area is covered with mature forest stands whereas over 40% is in some stage of recovery after a full or partial disturbance.
- Wildland fire is a major disturbance agent in the RFE, particularly in the northern conifer-dominated landscapes
- Identified logging areas mostly found in coniferous forest stands (however, it is not clear at this point whether they can be reliably mapped in mixed stands where selective logging prevails)
- Areas disturbed before 1980 are spectrally very similar to mature forests and are not readily distinguishable in the imagery.
- Recently logged areas (right) are spectrally similar to recovering burns (below) and are frequently assigned to burns of the previous decade (see full classification confusion matrix)



Recovering burn from 2003 fire season shown in 2006.



Recent (2006) logging site in larch stand

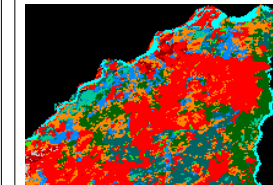
- Both natural and anthropogenic disturbances of forest cover intensified from the beginning of 1980s.
- Few mature coniferous stands remain within the potential tiger habitat

FUTURE DEVELOPMENT

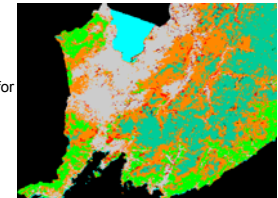
Future development will focus on:

1. Improving differentiation between mature forests and recovering disturbances:

- increase the number of training pixels for mature forest classes
- add MODIS-based metrics to enhance separation of Deciduous Broadleaf and Mixed mature forests in the winter



Potential artifact of misidentifying "logged areas" (shown in blue) in larch and spruce/fir dominated landscapes.



Potential artifact of mapping "logged areas" (shown in blue) in conifer-dominated communities in the northern section of the RFE using available Landsat and high resolution imagery in Google Earth.

c) evaluate the accuracy of mapped logged areas (left) in conifer-dominated communities in the northern section of the RFE using available Landsat and high resolution imagery in Google Earth.

2. Further explore sub-sectioning the single decision tree to provide better distinction for: a) the time of disturbance; b) the type of disturbance.

3. Use the FAREAST model to: 1) evaluate the potential for tree cover presence in areas identified as "disturbed" to separate them from naturally-occurring non-tree-dominated landscapes; 2) validate the model's accuracy of early (30 years post-disturbance) succession in the RFE.

ACKNOWLEDGEMENTS

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