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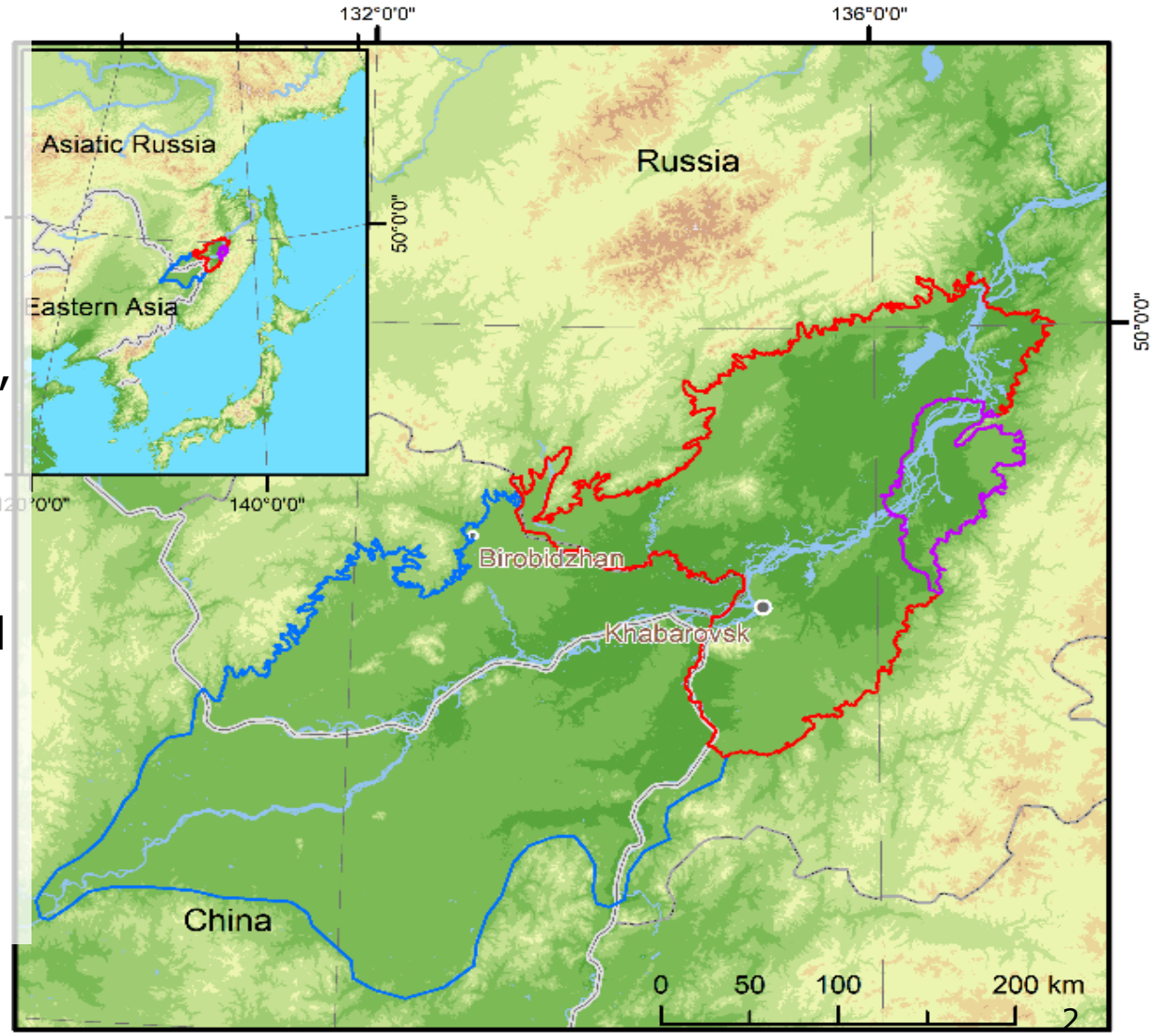
Estimation of fire areas on non-forest lands of the Middle Amur Lowland in 1984-2020 based on remote sensing data of average spatial resolution

The Middle Amur Lowland is a part of the transboundary Amur-Sungari Plain

In the last decade, much attention in Russia and in the world has been paid to fires in non-forest territories – steppe and forest-steppe spaces of the European part of Russia, the south of Western Siberia and others. One of such regions where meadow-swamp landscapes of the boreal zone are widespread is the Russian part of the trans-boundary Amur-Sungari Plain – the Middle Amur Lowland.



map
of terrain types of the Middle Amur Lowland

I. Plains

low (up to 200 m) accumulative and accumulative –denudation

1. Alluvial
2. Alluvial - proluvial
3. Deluvial- proluvial
4. Volcanogenic

uplifted (200-500 m) denudation and denudation – erosion

5. Deluvial- proluvial

II. Piedmont ***high (elevation of 500 – 1000 m) denudation –tectonic***

6. Fold-block

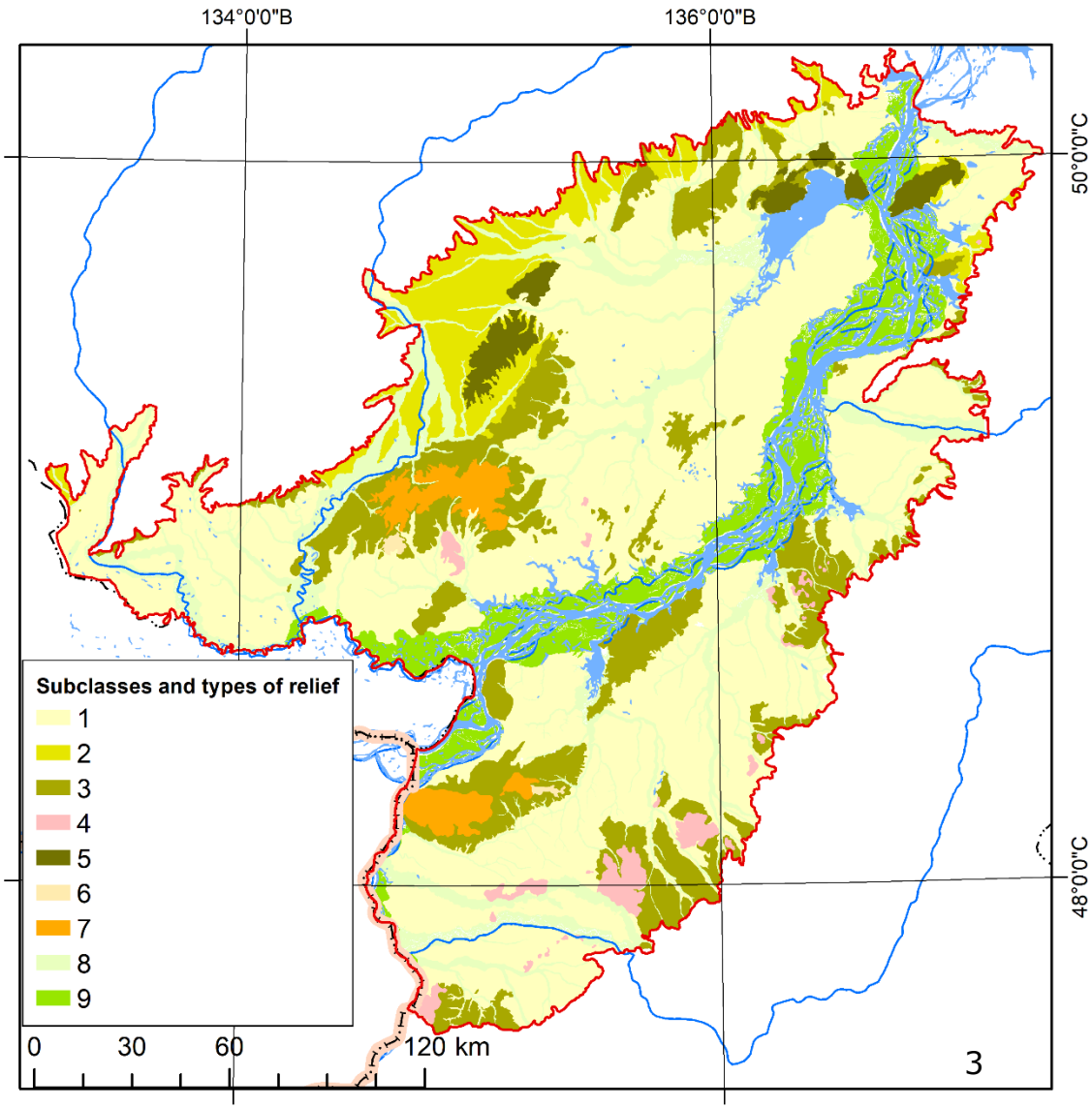
III. Low mountains (*elevation of 500 - 1000 m) denudation and denudation - erosion*

7. Folded and fold-block

IV. River floodplains

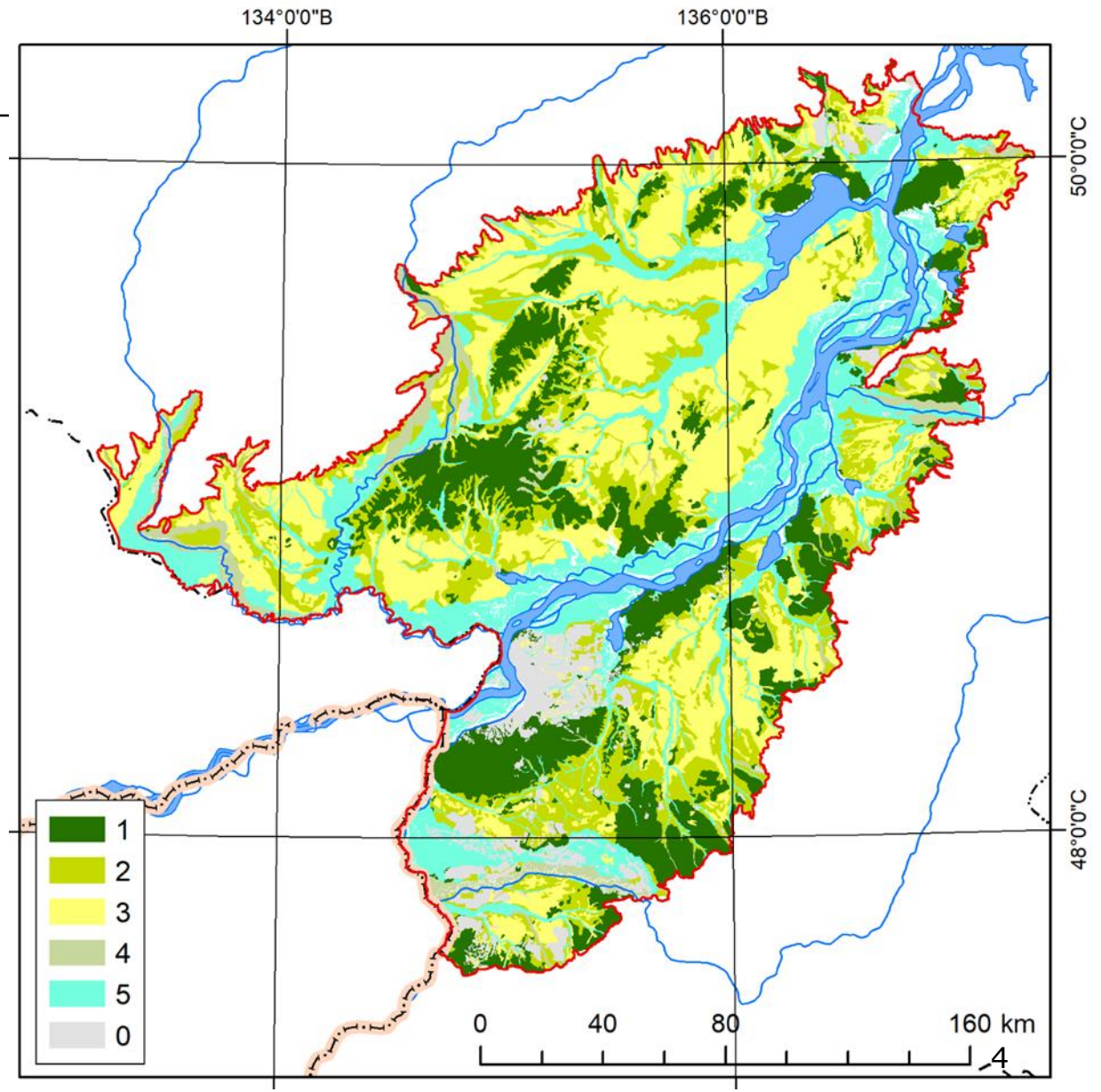
8. Accumulative floodplains of small and medium-size rivers

9. Accumulative floodplains of big rivers (Amur, Ussuri)



map
of types of landscapes of the Middle Amur Lowland

Types of landscapes:
1 – forest,
2 – forest-meadow-swamp,
3 – meadow-swamp,
4 – floodplain, mainly forest,
5 –floodplain, mainly meadow-shrubby.
0 – anthropogenic lands (residential, agricultural)



Source materials and methods

To estimate the areas of fires, remote sensing data is used based on :

1. Active combustion detection (low spatial resolution data (250–1000 m) MODIS and VIIRS.
2. Analysis of the consequences of burning and mapping of burns using data of medium and high spatial resolution (10 - 30 m).

The second approach was used to highlight the areas covered by the fire. The high recurrence rate of grass fires and the alternation of years with low and high burning rates determined the need to use a long observation period to determine the average long-term characteristics of wildfires and their trends.

Due to the relatively low frequency of observations and the high rate of vegetation renewal in the spring and possible snowfall in the autumn, all cloudless data of free access from Landsat satellites 5 (475 pieces), 7 (328 pieces), 8 (189 pieces) were used for the period from 1984 to 2020.

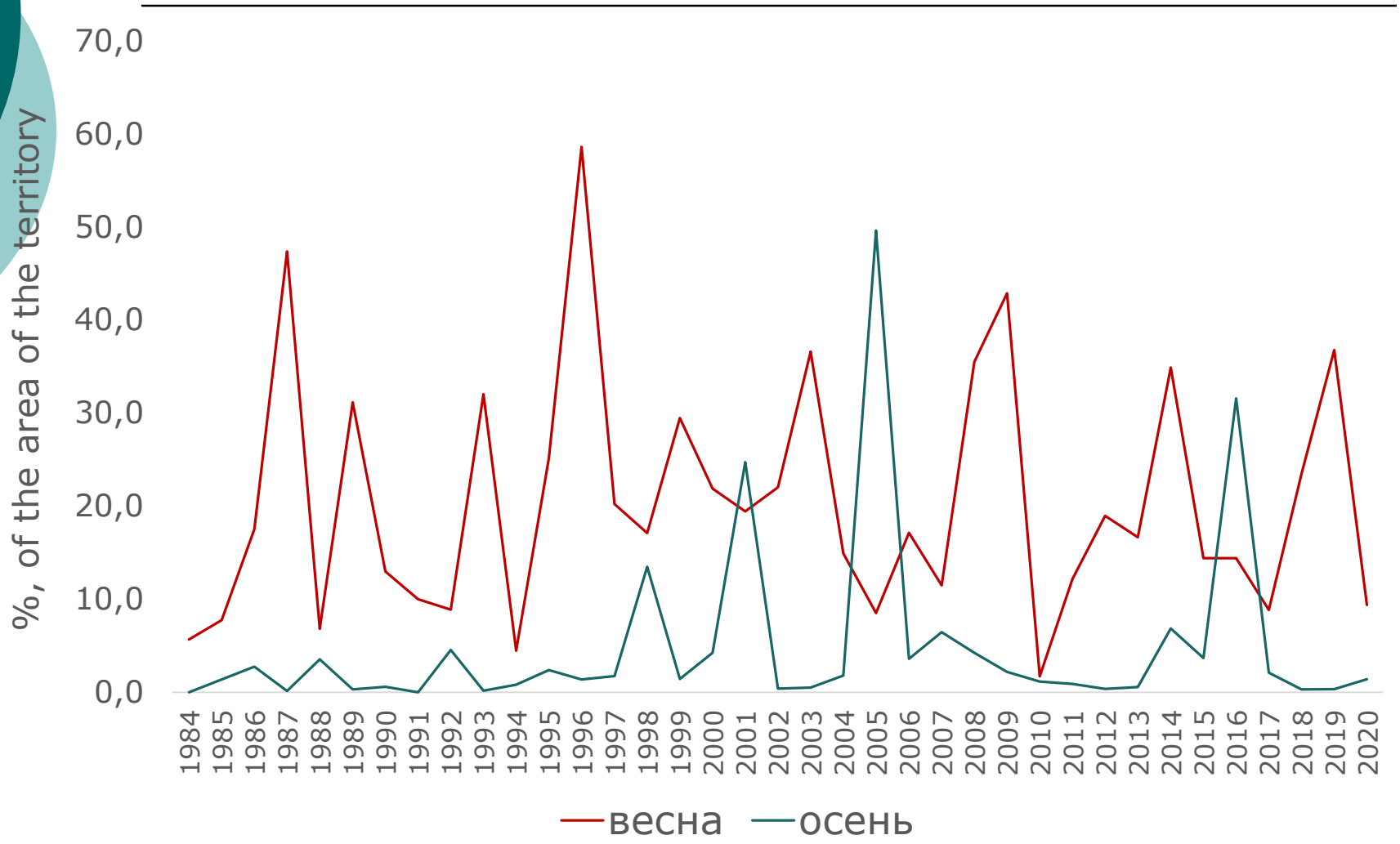
Remote sensing data processing was carried out by the expert interpretation method in the ArcGIS 10.5 program. To compensate for possible decryption errors, territories covered by fires in the previous autumn were removed from the areas of the spring fires of the current year.

Table 1

Areas of fires in various types of landscapes of the territory

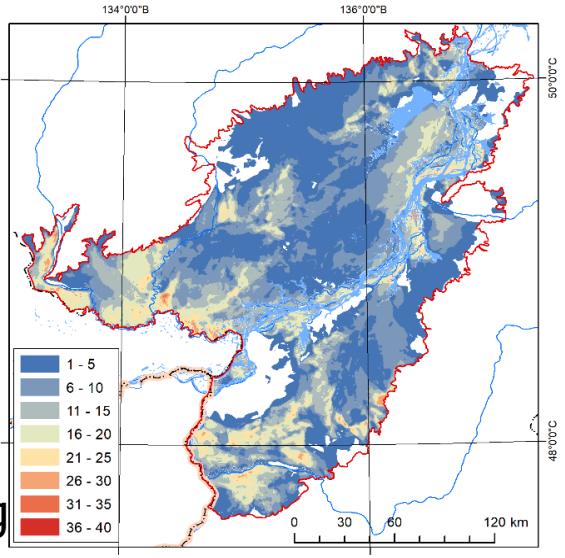
Types of landscapes	Area, ha	Percentage of landscape type not affected by fires	Burned area for 1984 - 2020, % of the area of the landscape type	Share of spring fires,%
1 – forest,	717497	22,8	445,2	76,9
2 – forest-meadow-swamp,	754063	5,5	1056,6	78,5
3 – meadow-swamp,	1165982	4,1	1000,0	77,3
4 – floodplain, mainly forest,	165003	36,8	443,7	85,3
5 – floodplain, mainly meadow-shrub	881856	2,7	1317,4	85,7
∑	3894246	10,2	938,4	80,7

Areas of spring and autumn fires in the territory in 1984 - 2020

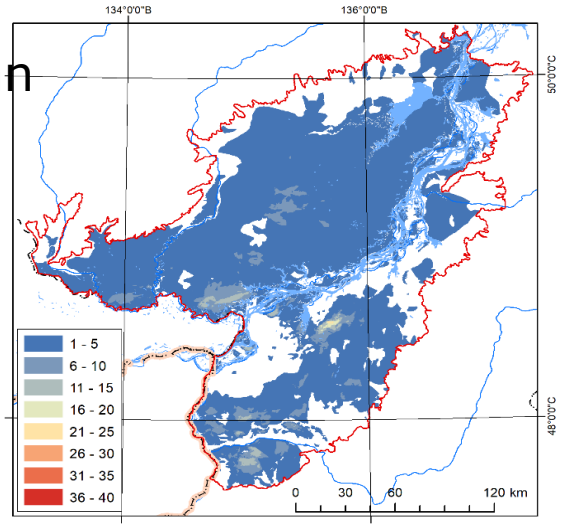


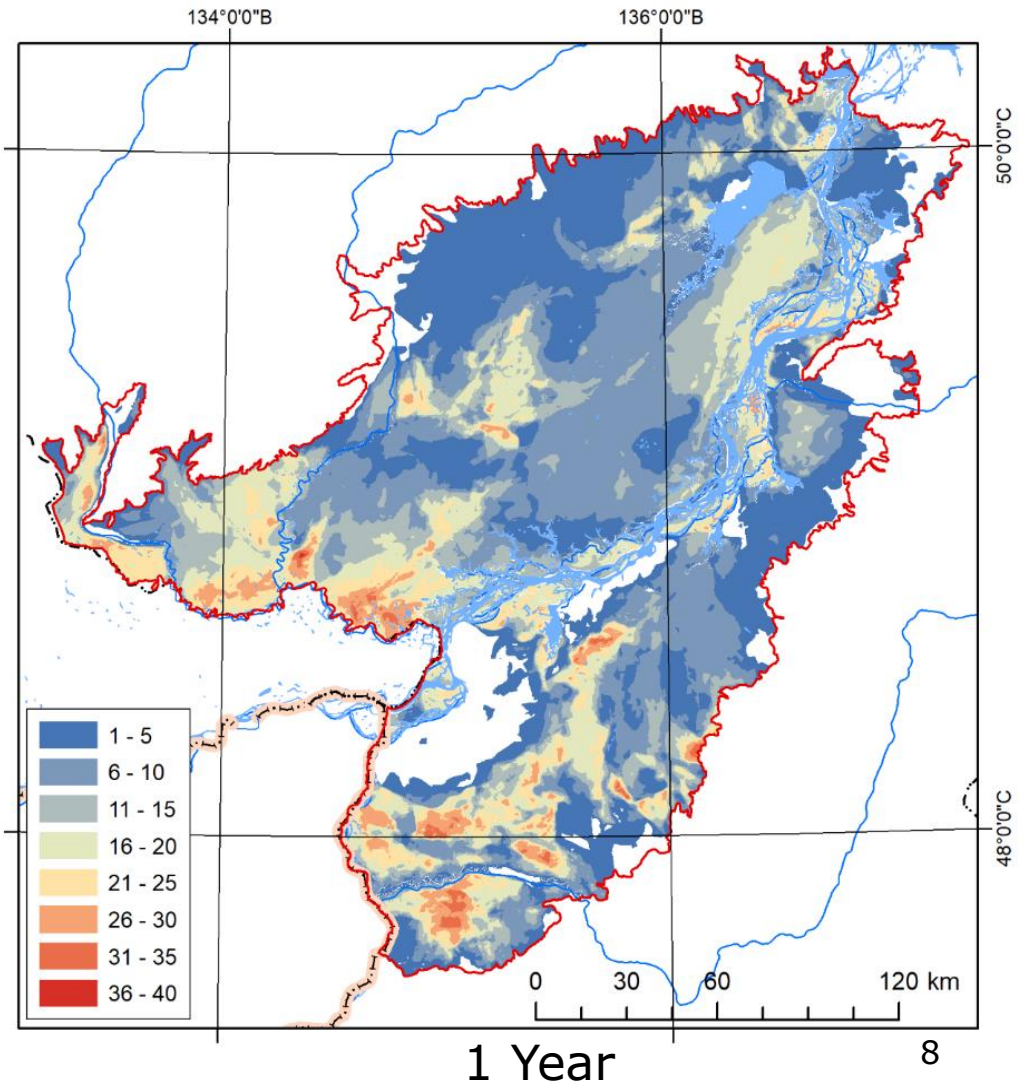
Frequency of fires passage from 1984 to 2020

Spring



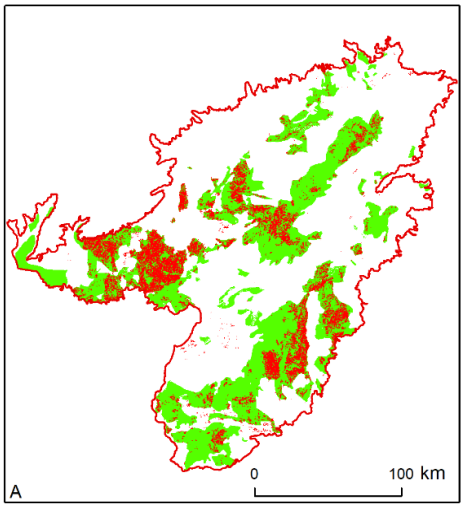
Autumn

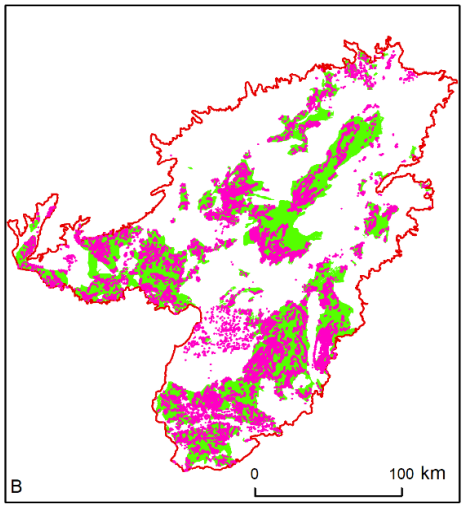




1 Year

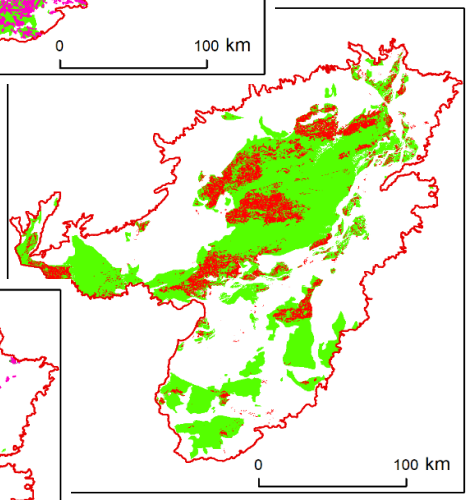
Comparison of results with GABAM, HS VIIRS and NOAA and Greenpeace data for 2014, 2016, 2020

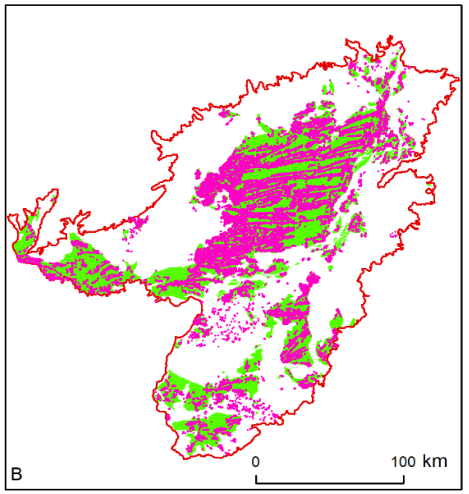




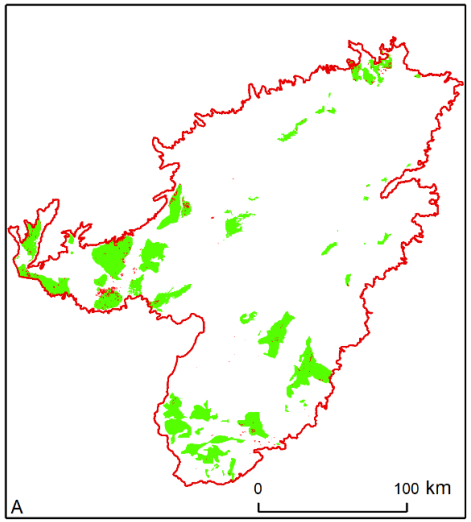
2014

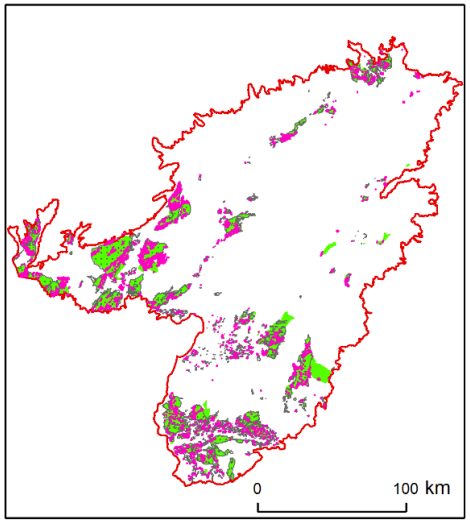
2016





2020





green - our materials,
red – GABAM,
crimson – VIIRS,
gray – Greenpeace (for 2020)

Possible reasons for underestimating fire areas in automated mapping:

1) Smoked territory

2) A small supply of vegetable combustible materials, resulting in a low combustion rate

3) The impossibility of detecting fires with low spatial resolution satellite devices due to their small area or high speed of movement of the edge of the fire in the form of a narrow and long strip

4) Rapid regrowth and growth of herbaceous vegetation in the spring, combined with a long shooting interval, reduces the radiation in the IR channel

5) The heterogeneity of the land cover makes it difficult to select an appropriate background temperature.

Conclusions:

The results of our work show a significant underestimation of the areas of meadow fires according to official statistics.

Thus, according to the average long-term data, fires affected from 27 to 35% of non-forest ecosystems within the Central Amur Lowland; in some years, the areas of fires exceed 50% of the area of the territory, which is comparable to the areas of forest fires in the Khabarovsk Territory as a whole. At the same time, according to official data, non-forest fires in the Khabarovsk Territory account for only 8.9%.

The underestimation of the influence of meadow fires is associated, in our opinion, primarily with the imperfection of methods for automatic mapping of burned areas, leading to an underestimation of their areas.

Thank you for your attention

Acknowledgments

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