

Analysis of Wildfire Likelihood and Opportunities for Mitigation in the Chernobyl Irradiated Forests

By

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LMS Portfolios

The Landscape Management System (LMS, McCarter et al. 1998) provides a variety of tools for examining management consequences on forested landscapes. LMS and associated tools were used to investigate the potential impacts on fire in the Chornobyl forested landscape. In addition a first attempt at finding management alternatives to minimize fire risk was investigated.

Because of the large number of stands in the inventory information for the Chornobyl project the inventory data was broken into 11 LMS 2.x portfolios to facilitate handling the data and running simulations. Subsequent analysis can be done using LMS 3.x, which can handle the larger data sets. For this initial analysis the use of LMS was limited to LMS 2.x.

Eleven portfolios were created (4 for the Co area, 7 for the Di area). Each portfolio has a Rebuild Portfolio done to fill in missing information in the inventory.

Two additional portfolios were created. The first was of a contiguous area that was to contain a variety of stands (ChornobylDemo). This area consisted of 208 stands. It was initially used for investigating FFE fire risk variables and way to minimize risk. Because of the portfolio size and lack of elevation data for the area the preliminary analysis was switched to a portfolio that included the representative stands (ChornobylGroups). This portfolio was then used for fire risk simulations that could be displayed on the landscape.

All portfolios, this writup, and source images are posted on the internet at:

<http://lms.cfr.washington.edu/Chornobyl/>

FVS Growth Model

The Forest Vegetation Simulator (FVS, Dixon 2002, Wykoff et al 1982) - Lake States (LS) Variant was used for the forest simulations in this analysis.

FVS Calibration

Aaron and Mykhaylo provided analysis showing differences in expected growth and the growth model used. For this example analysis the performance of red pine and scotch pine in the Lake States variant of FVS were compared historical growth data from the Ukraine.

The results presented to date are inconclusive, but suggested that red pine was a better match for expected growth dynamics of the Ukraine pine forests. Further analysis should be done using additional growth information from the Ukraine and a more exhaustive examination of multiple elements of growth. The FVS growth model provides a variety of keywords for adjusting the behavior of the growth model. Adjustments to the diameter growth (BAIMULT and FIXDG), height growth (HTGMULT, FIXHTG and HTGSTOP), crown change (CRNMULT), crown width (FIXCW), and mortality (MORTMULT and FIXMORT) are available. Any adjustments should be done carefully and in small steps because of the interrelated nature of the growth equations in the FVS model. Adjusting diameter growth will influence the mortality behavior of the stand.

An examination of the current inventory information suggest that the calibration exercise will only need to be done for the pine (RN) and birch species (PB) because they dominate the current inventory (Table 1.). The proportion of dominance should be re-examined using the new inventory collection that is proposed to make sure the stands are still dominated by the same species.

Table 1. Proportion of inventory by species code.

Species	Percent Basal Area
RN	80.0
PB	10.0
OS	5.0
WO	3.0
QA	1.0
AH, AP, BL, BP, EC, JP, NS WA	0.0

Map of Chornobyl Stands by type

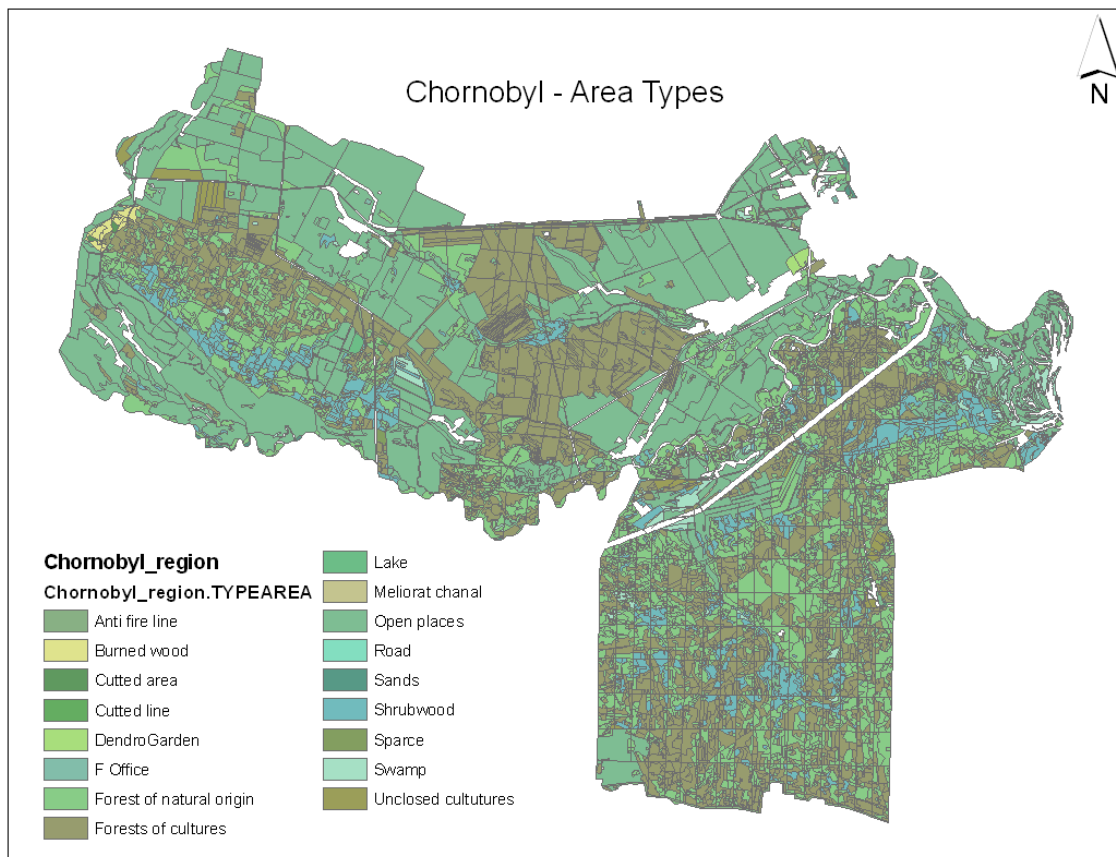


Figure 1. Chornobyl area showing various forest types in the area.

Map of location of stand groups on the Chernobyl landscape

Because of the large number of individual stands in the landscape a classification was done by Aaron to provide a grouping of stands based on species, site, and age. This classification, described by Aaron, resulted in the following groups of stands on the Chernobyl landscape. The groups were then used to further analyzed fire risk using the Ukraine Fire Risk classes and FFE fire risk variables.

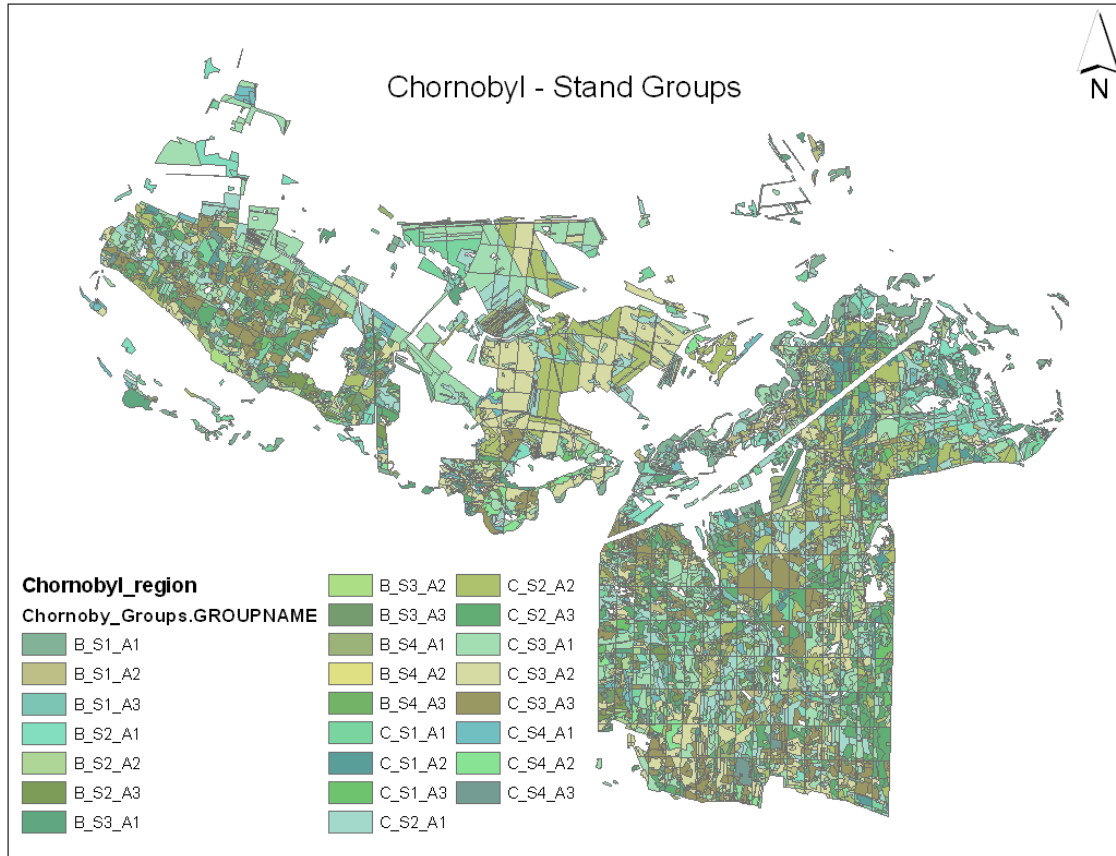


Figure 2. Location of stand groups in the Chernobyl area. Stand groups are named for a three part classification: B = broadleaf, C = conifer; Site class 1-4; Age class 1-3.

Ukraine Fire Risk Maps:

The Ukraine Fire Risk classification program uses information on stand age, stand moisture class, and stand type (conifer or broadleaf) to determine a risk

Table 2. Ukraine Fire Risk classification rules.

Ukraine Fire Risk Class	Description
1 (I)	Forests < 40 years old; conifer forest in very dry and dry sites; young plantations < 7
2 (II)	Forests > 40 years in moderate soil humidity types; broadleaf forests in dry condition
3 (III)	Conifer stands > 40 years on moist and damp sites
4 (IV)	Conifer stands > 40 years on swamps; broadleaf stands on moist and damp sites
5 (V)	Broadleaf forests in swamps

Using the above classification rules (Table 2) the following risk classification was developed using a Python program that merged information on stand age, stand moisture class (from GIS) and stand type (conifer/broadleaf) based on the basal area of the existing inventory. This allows for a more dynamic classification of the landscape because of changing stand age and stand composition.

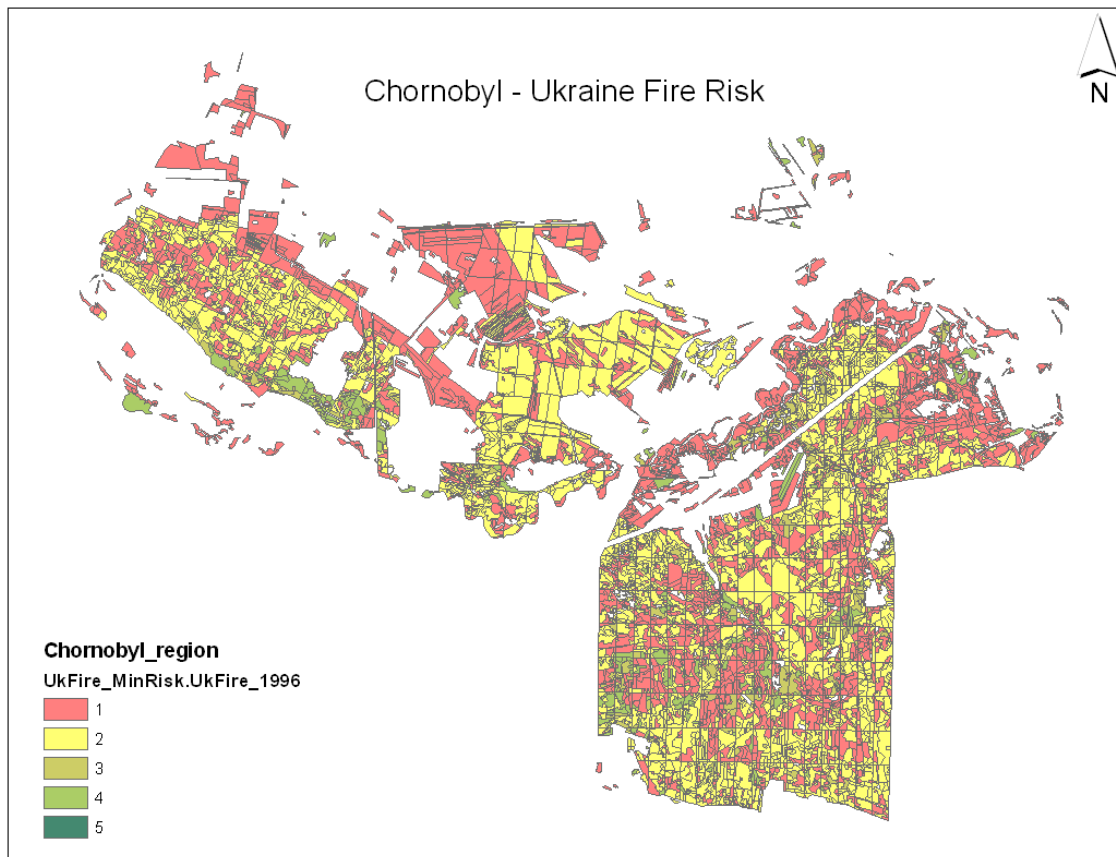


Figure 3. Ukraine Fire Risk class for 1996.

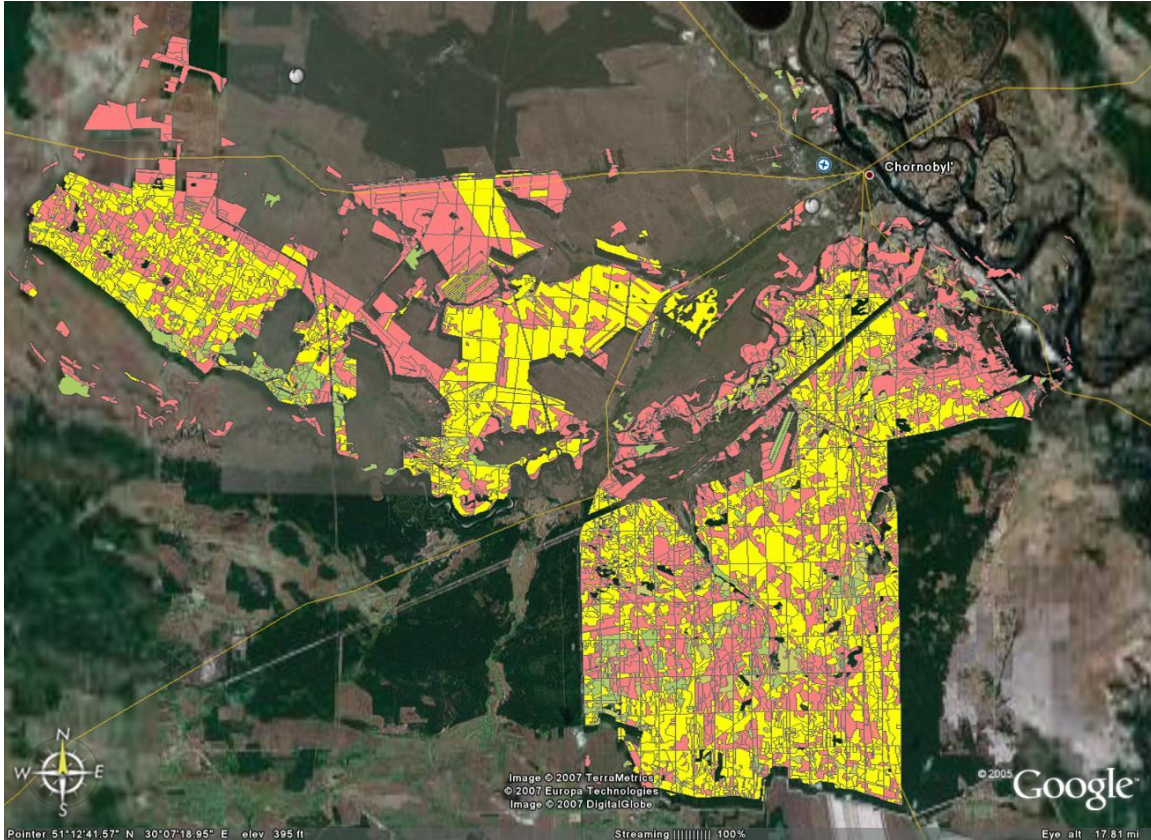


Figure 4. Google Earth image showing Ukraine Fire Risk Classification on Chornobyl landscape.
Note area to right of classified area which appears to be a large open area possibly from burns.

The resulting risk classification map shows 36% area in risk class 1 (2487 stands) and 38% in risk class 2 (2649 stands) in 1996.

Risk Class	# Stands - 1996	Prop - 1996	# Stands - 2026	Prop - 2026
None	1219		1219	
1	2487	36%	0	
2	2649	38%	3284	48%
3	246	4%	1797	26%
4	307	4%	608	9%
Total	6908		6908	

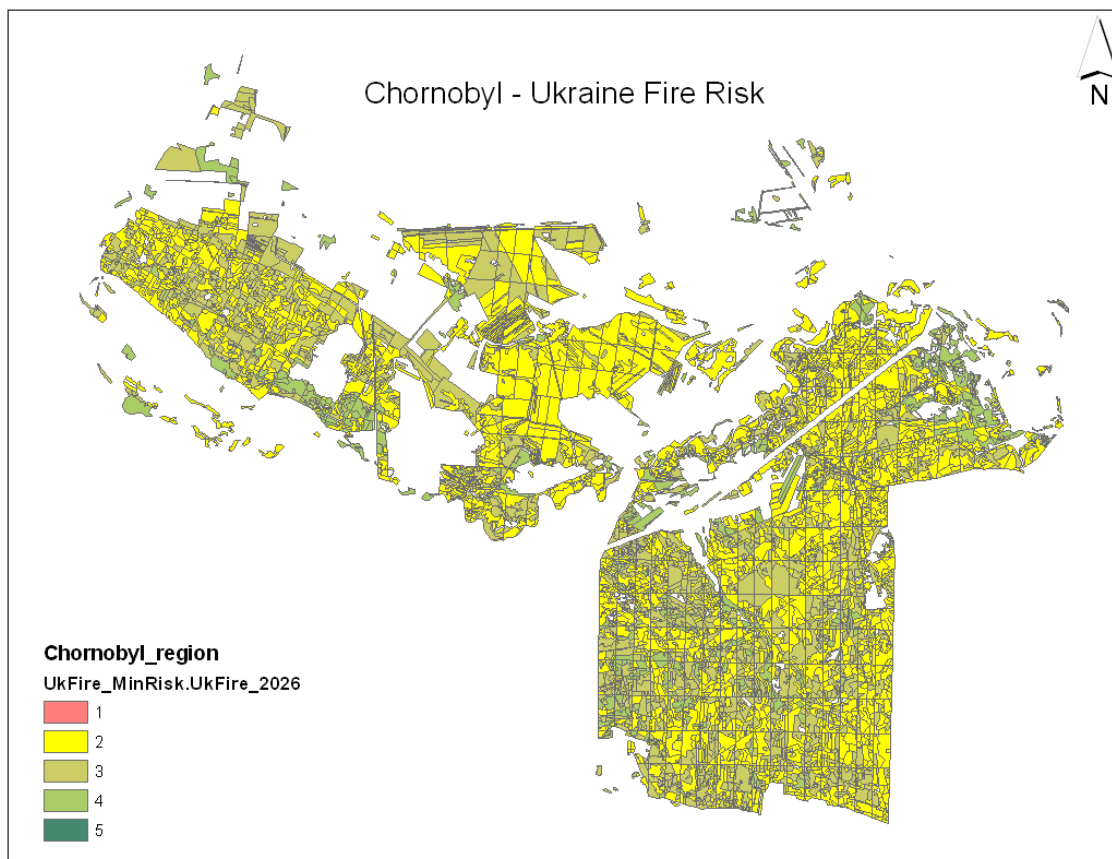


Figure 5. Ukraine Fire Risk class for 2021. Note that stands decrease in risk because the stands are aging.

After 30 years the landscape is dominated by risk class 2 (3284 stands) and risk class 3 (1797 stands). This change in fire risk is due to a simple aging of the stands and does not reflect improved stand conditions through time.

FFE Fire Risk Maps:

The Fire and Fuels Extension (FFE, Reinhardt and Crookston 2003) to the Forest Vegetation Simulator (FVS) was used to make preliminary estimates of fire risk in Chornobyl forests. FFE provides a number of fire risk variables that can be used to evaluate the risk for individual stands. For this analysis we concentrated on the Crowning Index, which is the 20-foot wind speed necessary to sustain an active crown fire. Crowning index was classified into 4 classes: No Risk (-1), High (0-25), Moderate (25-50) and High (50+).

The following FFE Crowning Index Maps were produced using ArcMap and outputs from FFE.

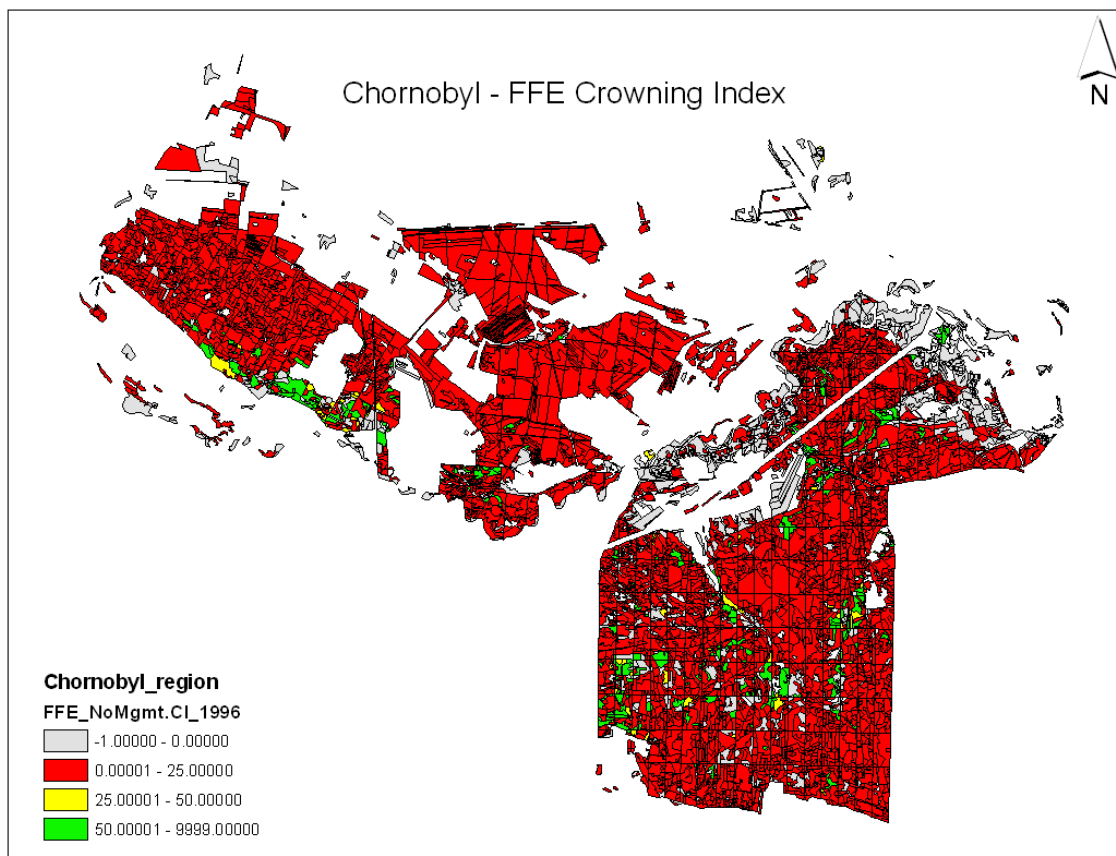


Figure 6. FFE Fire Risk Map using Crowning Index for 1996 with No Management. Classes are High (0-25), Moderate (25-50) and Low (50+).

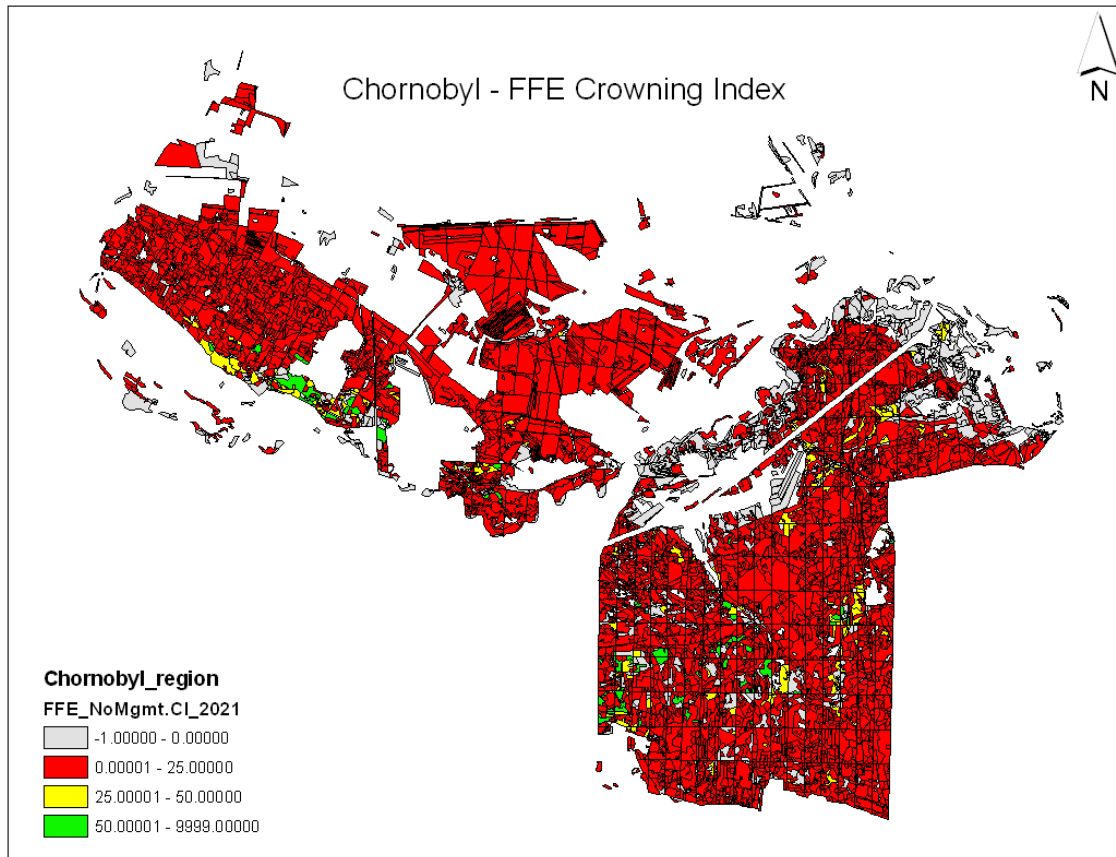


Figure 7. FFE Fire Risk Map using Crowning Index for 2021 with No Management.

Treatment Scenario to Minimize Fire Risk

All stands with a high fire risk were thinned to 250 TPA from below in 1996. For stands where this treatment did not result in a reduced fire risk the stands were converted to broadleaf stands in 1996. The stands in the second group which was converted to broadleaf were older conifer stands (C_S1_A3, C_S2_A3, C_S3_A2, C_S3_A3, C_S4_A2, C_S4_A3). The results of reduction in Crowning Index are shown in Figure 7.

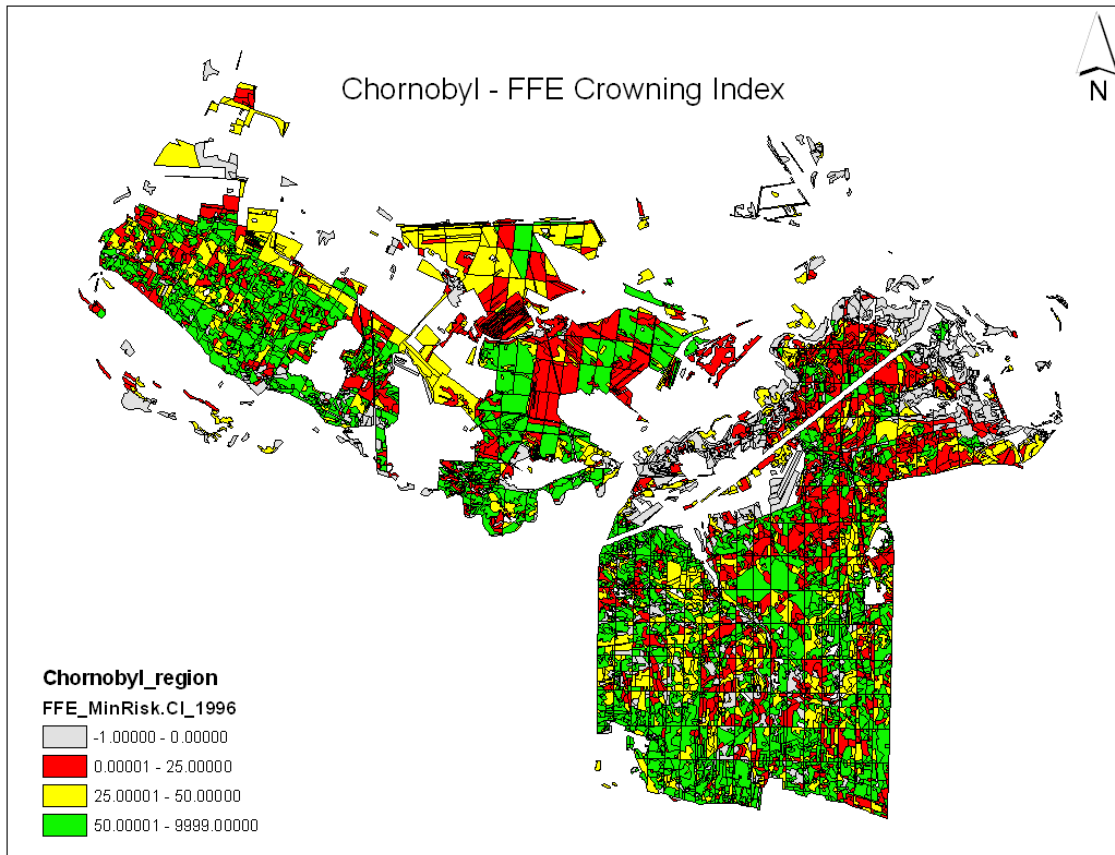


Figure 8. FFE Fire Risk Map using Crowning Index in 1996 with Management to minimize fire risk.

Figure 8 shows Crowning Index for the treated landscape after growth to year 2021. Notice that fire risk is increasing because no additional treatments have been applied to the landscape. A more complete analysis needs to be performed that includes treatments overtime to keep the fire risk low, but also to balance the operations on the landscape so that they don't overwhelm the management and operational infrastructure.

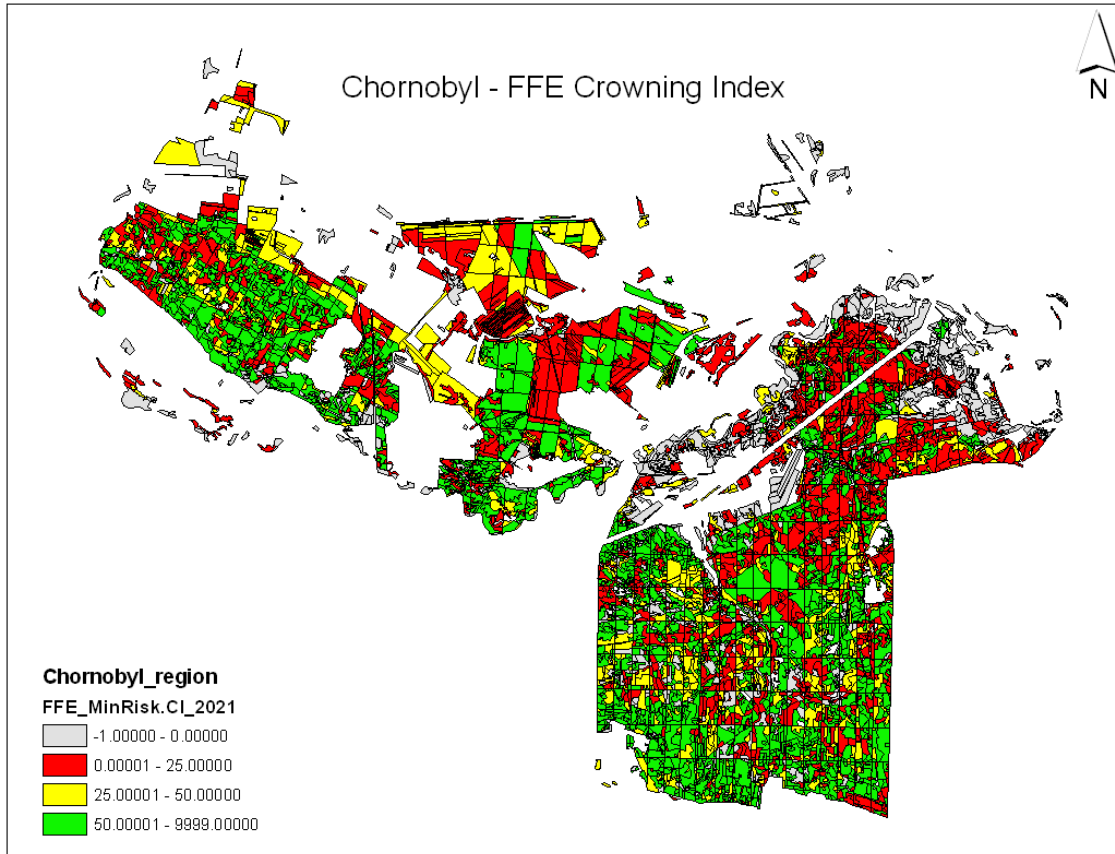


Figure 9. FFE Fire Risk Map using Crowning Index for 2021 with Management to minimize fire risk. Note fire risk is increasing because management was only done in 1996 in this example.

Literature Cited

- Dixon, G. E. 2002. Essential FVS: A User's Guide to the Forest Vegetation Simulator. U.S. Department of Agriculture, Forest Service, Forest Management Service Center. Internal Report. 209 p.
- McCarter, J. B., J. S. Wilson, P. J. Baker, J. L. Moffett, and C. D. Oliver. 1998. Landscape management through integration of existing tools and emerging technologies. *Journal of Forestry* 96:17-23.
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- Wykoff, W. R., N. L. Crookston, and A. R. Stage. 1982. User's Guide to the Stand Prognosis Model. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. General Technical Report INT-133. 241 p.