The Wildfire Danger in the Irradiated Forests around Chernobyl: The Science and Politics

Chad Oliver

Pinchot Professor of Forestry and Environmental Studies, and

Director of the Global Institute of Sustainable Forestry

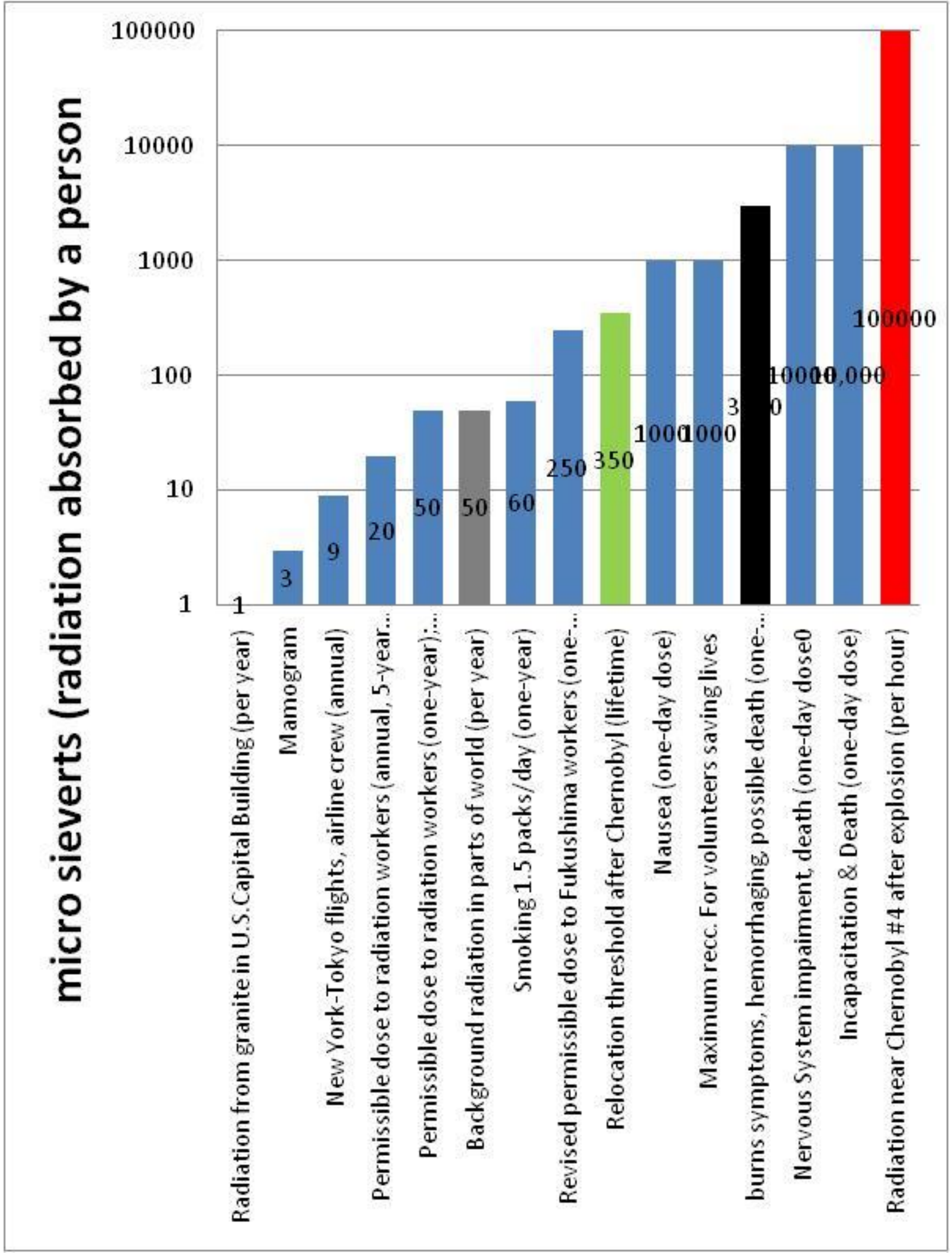
School of Forestry and Environmental Studies

Yale University

Kroon Hall, Burke Auditorium

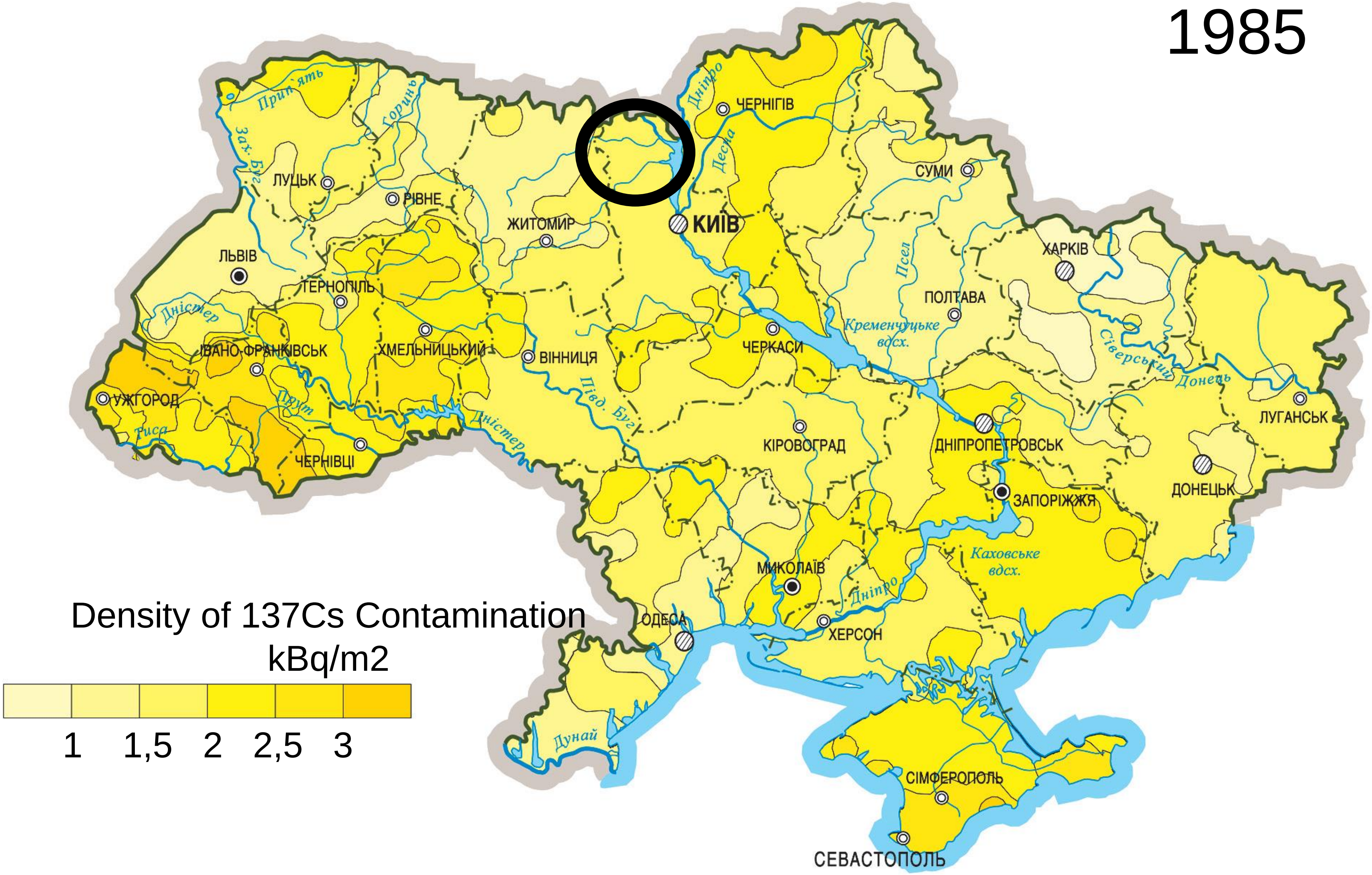
March 30, 2011
Noon -1 PM


ENGINEER
THE PROJECT MANAGEMENT UNIT (PMU)
ИНЖЕНЕР
ГРУППА УПРАВЛЕНИЯ ПРОЕКТОМ (ГУП)
ЧАЕС
eDF
Battelle
CONTRACTOR
NOVARKA, a Joint Venture made of:
VINCI Construction Grands Projets
(VCGP, leader) and
Bouygues Travaux Publics (BуTP, member)
NOVARKA
ПОДРЯДЧИК
Совместное предприятие NOVARKA в составе:
VINCI Construction Grands Projets
(VCGP-ведущая фирма) и
Bouygues Travaux Publics (BуTP - участник)


micro sieverts (radiation absorbed by a person
100000
10000
1000
100
10
1
Radiation from granite in U.S.Capital Building (per year)
Mamogram
New York-Tokyo flights, airline crew (annual)
Permissible dose to radiation workers (annual, 5-year...
Permissible dose to radiation workers (one-year):...
Background radiation in parts of world (per year)
Smoking 1.5 packs/day (one-year)
Revised permissible dose to Fukushima workers (one-...
Relocation threshold after Chernobyl (lifetime)
Nausea (one-day dose)
Maximum recc. For volunteers saving lives
burns symptoms, hemorhaging possible death (one-...
Nervous System impaiment, death (one-day dose0
Incapacitation & Death (one-day dose)
Radiation near Chernobyl #4 after explosion (per hour)
1
3
9
20
50
50
60
250
350
1000
1000
10000
10,000
100000

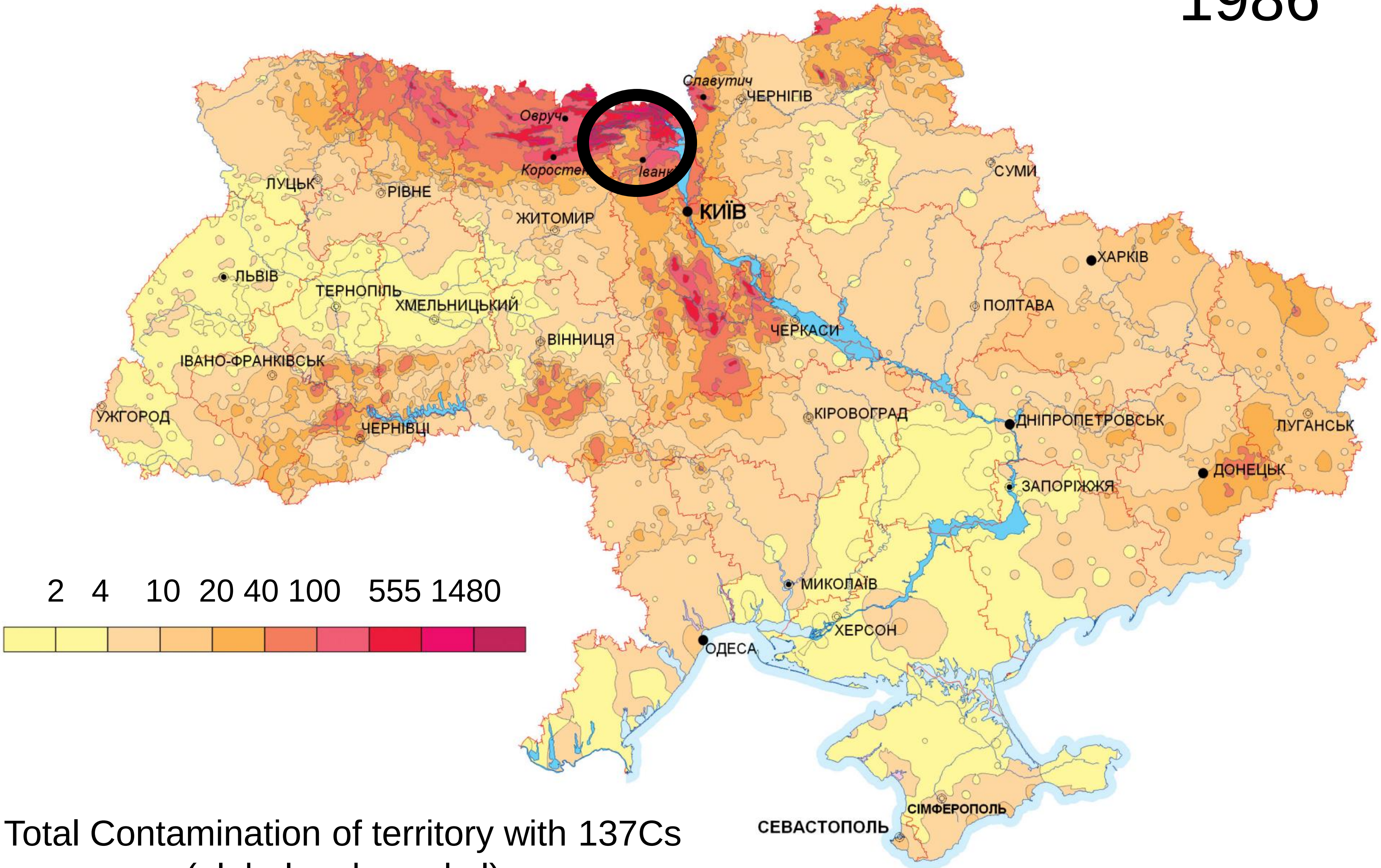

ТИМ ХТО
ВРЯТУВАВ
СВІТ

1985



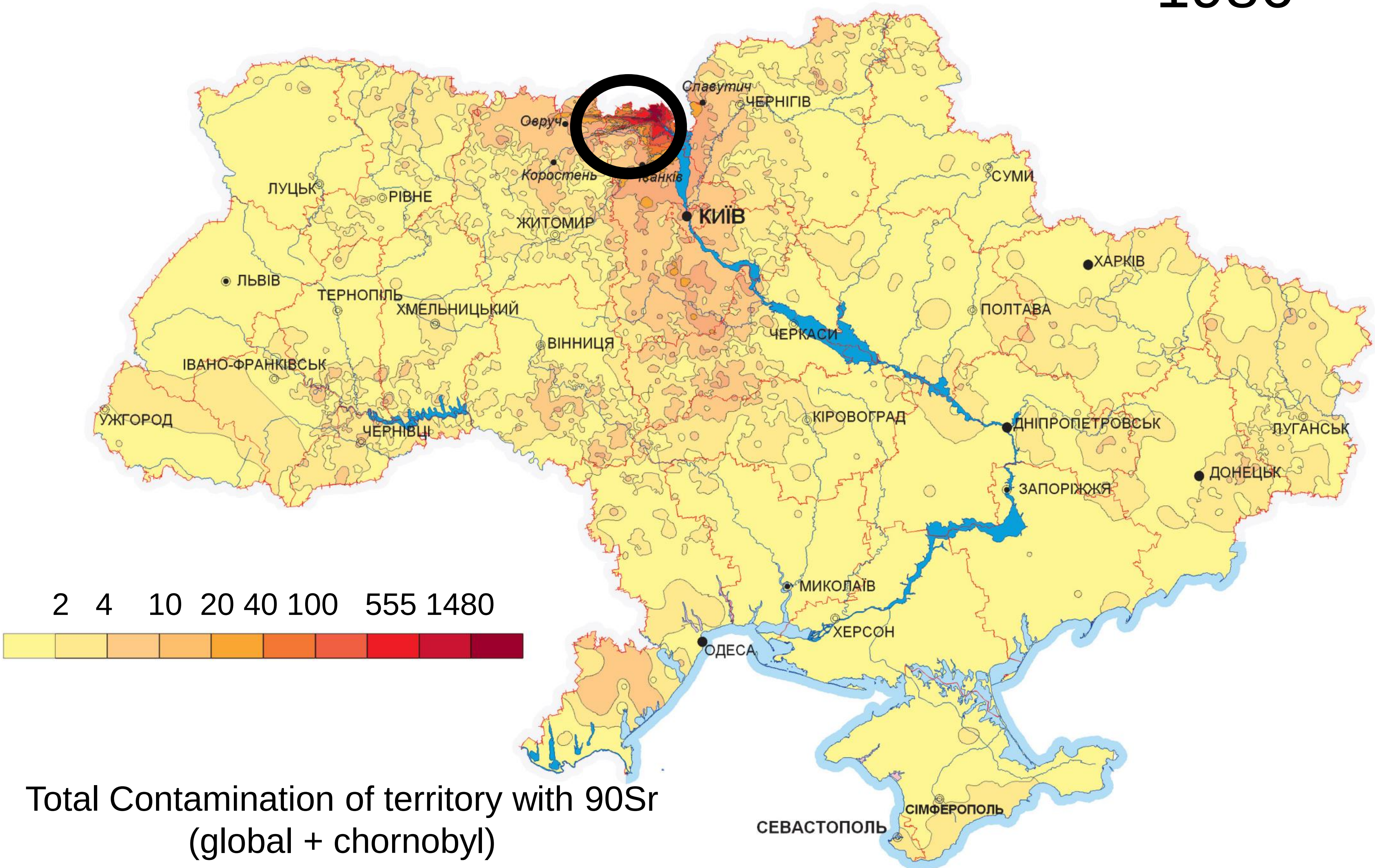
Density of 137Cs Contamination
kBq/m2
1
1,5
2
2,5
3
ЧЕРНІГІВ
СУМИ
КИЇВ
ЖИТОМИР
ЛУЦЬК
РІВНЕ
ЛЬВІВ
ТЕРНОПІЛЬ
ХМЕЛЬНИЦЬКИЙ
ВІННИЦЯ
ІВАНО-ФРАНКІВСЬК
УЖГОРОД
ЧЕРНІВЦІ
ЧЕРКАСИ
ПОЛТАВА
ХАРКІВ
КІРОВОГРАД
ДНІПРОПЕТРОВСЬК
ЗАПОРІЖЖЯ
ДОНЕЦЬК
ЛУГАНСЬК
МИКОЛАЇВ
ОДЕСА
ХЕРСОН
СІМФЕРОПОЛЬ
СЕВАСТОПОЛЬ
Прип'ять
Горинь
Зах. Буг
Дніпро
Десна
Псел
Кременчуцьке вдсх.
Сіверський Донець
Дністер
Прут
Тиса
Півд. Буг
Каховське вдсх.
Дунай

1986

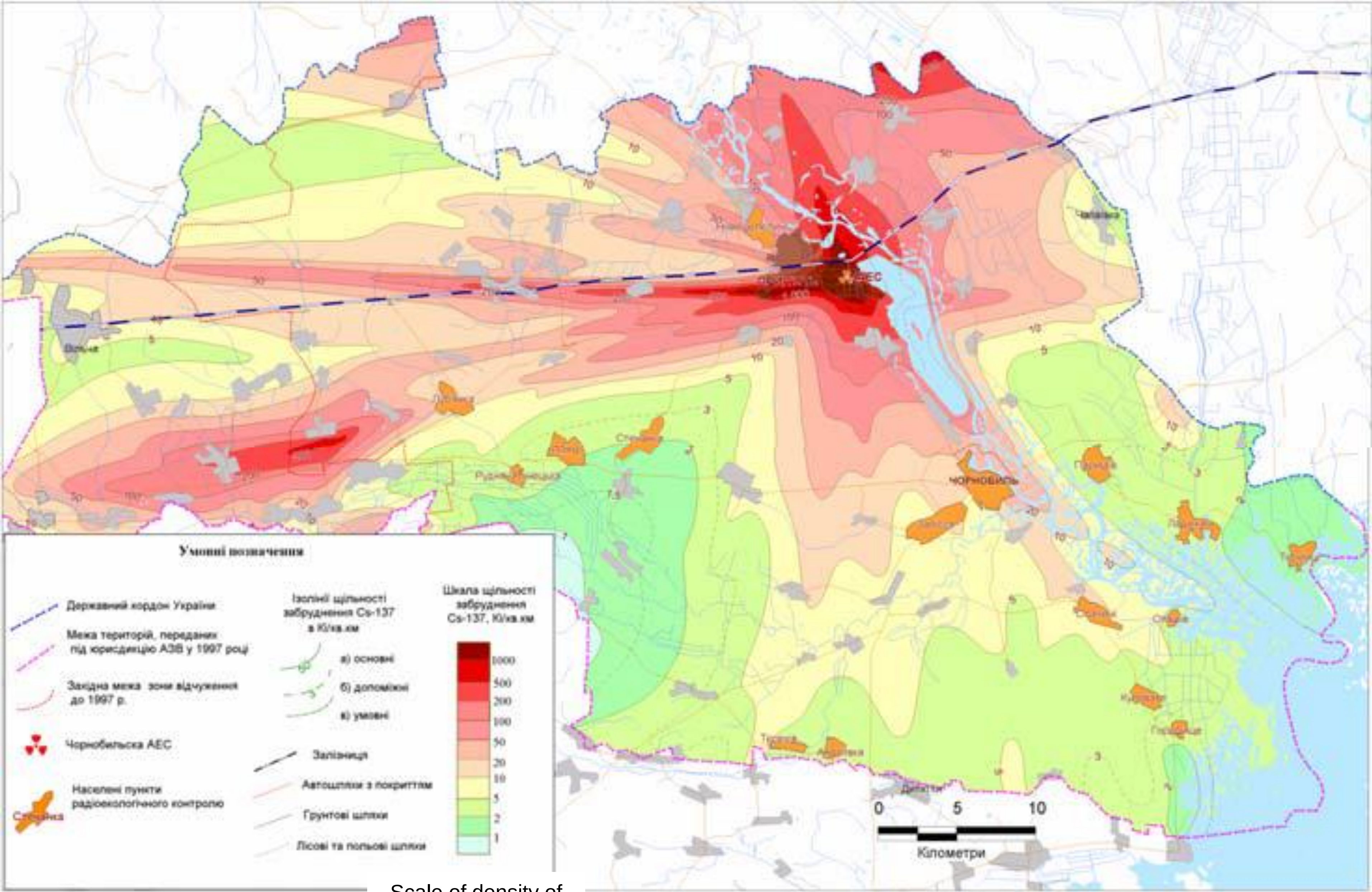


Total Contamination of territory with 137Cs
(global + chornobyl)
kBq/m2

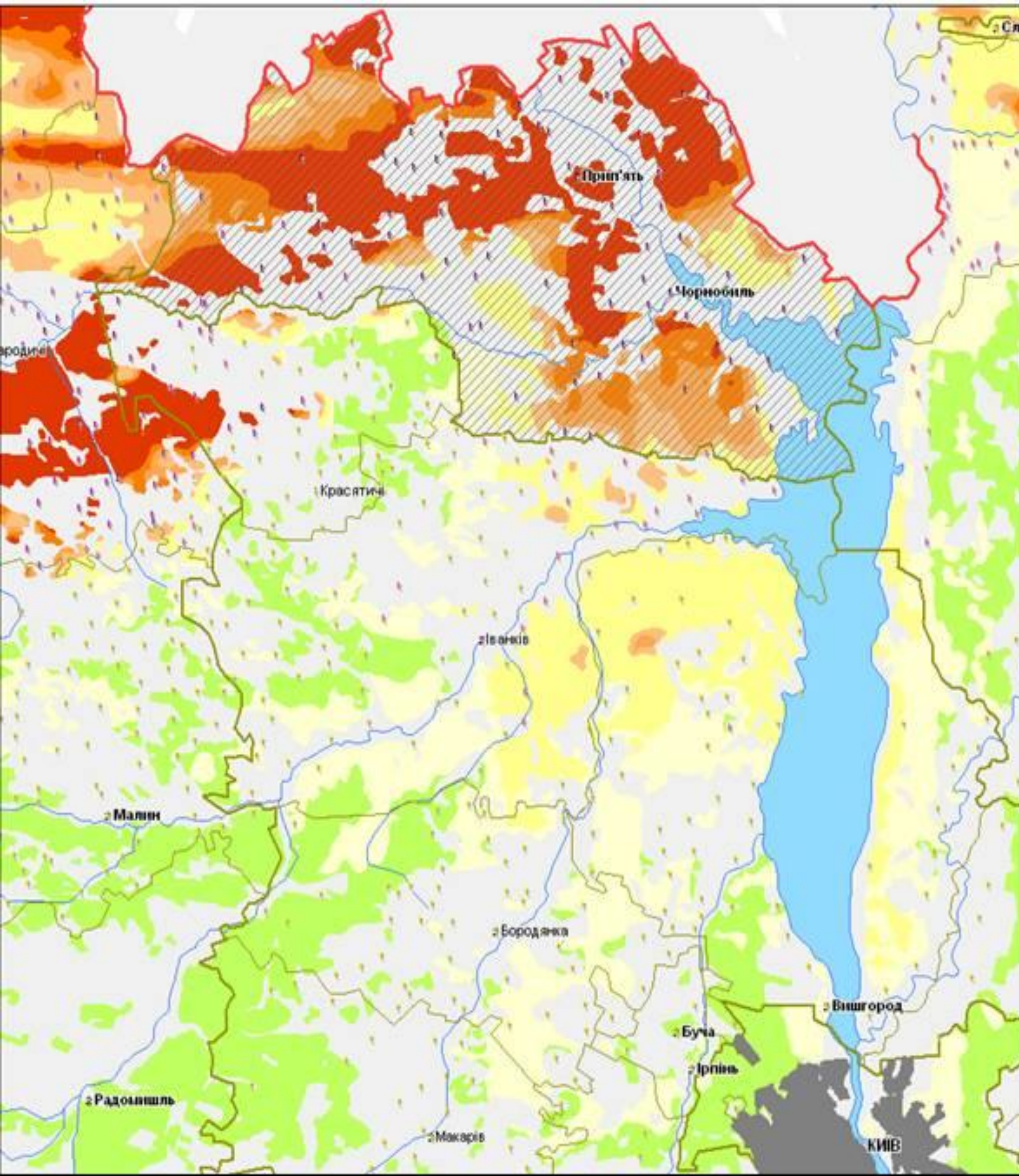
1986



Total Contamination of territory with 90Sr
(global + chornobyl)
kBq/m2



Scale of density of contamination by 137Cs



Zone	Density	Restrictions
1st	> 555 kBq/m^2	Development of the special regime for forestry. Limitation of the working time
2nd-c	370- 555 kBq/m^2	Limitation of utilization of wood for the people's needs
2nd-b	370- 259 kBq/m^2	Not allowed to use wood as the fuel and to manufacture the domestic goods and facilities for the foodstuff storing
2nd-a	185- 259 kBq/m^2	Limitation of utilization of the fuel and hungry wood and meat of the wild animals. Prohibition to hunting roe
3th-b	74- 185 kBq/m^2	Prohibition of consumption of the wild berries and mushrooms. Limitation of utilization of the medical plants and wild animals
3th-a	37-74 kBq/m^2	Limitation of utilization of the mushrooms, wild berries and some medical plants
	<37 kBq/m^2	Utilization of the forest products without limitation


РЕСТОРАН

Scientific team leaders, with Chernobyl Fire Department:

Johann Goldammer (front, right)

Sergiy Zibtsev (back, left of Dr. Goldammer)

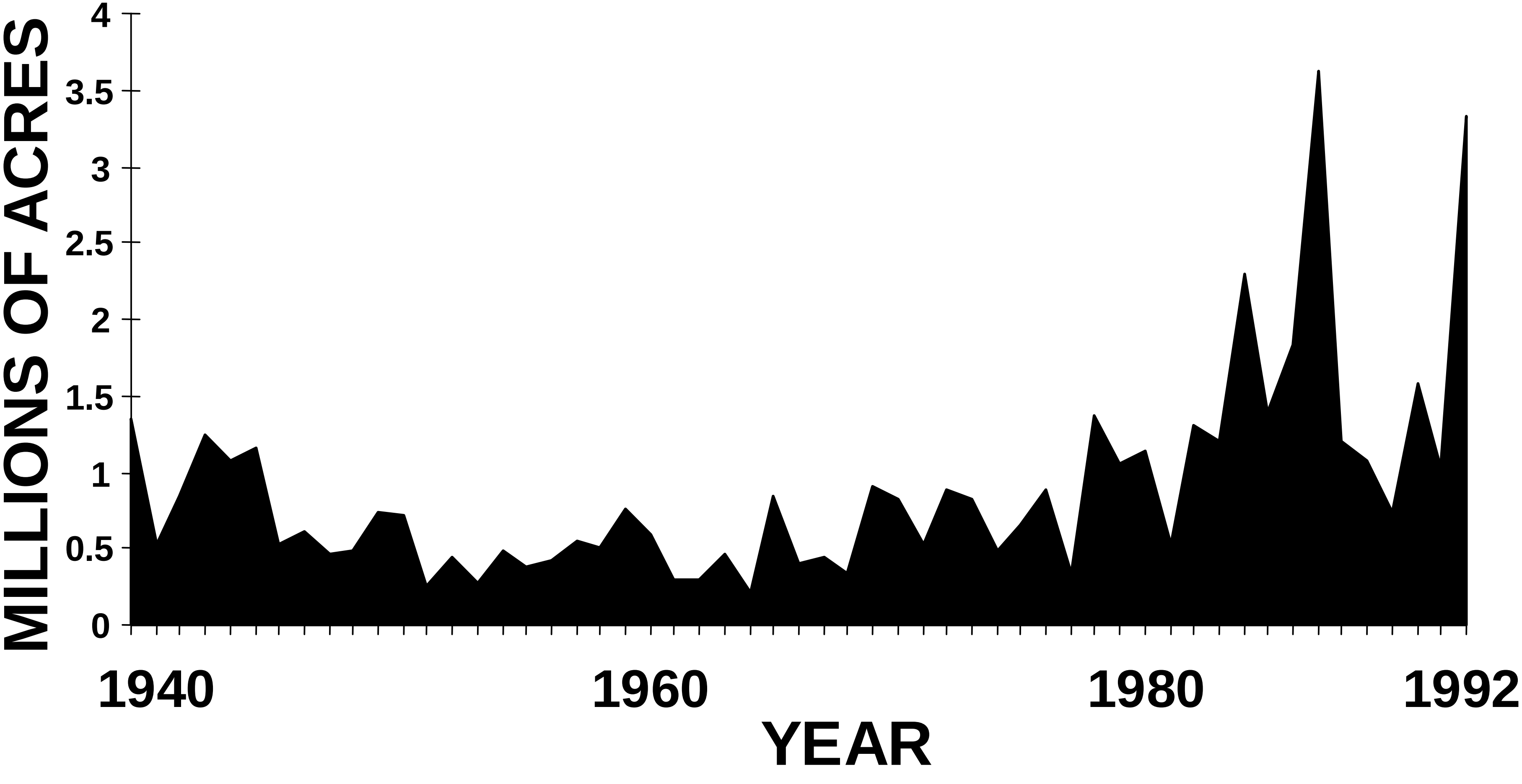
Chad Oliver (front, left of Dr. Zibtsev)

Dmytro Melnychuk, not shown

(Dr. Aaron Hohl is in background, to left of Dr. Oliver)

Crowded Forest, American West
(Yakama Reservation)

AREA BURNED ANNUALLY BY WILDFIRES IN THE WESTERN UNITED STATES, 1940-1994



GISF Research Paper 001

Assessing the Environmental, Social, and Economic Impacts of Wildfire

Douglas C. Morton, Megan E. Roessing, Ann E. Camp, and Mary L. Tyrrell

Forest Health Initiative

Yale University
School of Forestry & Environmental Studies
Global Institute of Sustainable Forestry

Scotts pine forest in Chernobyl radioactive zone, Ukraine. These forests are overly crowded and need thinning to reduce fire danger

Photo, C. Oliver

Radioisotopes found in Chernobyl Exclusion Zone Forests

90 Sr —common in CEZ, high dose coeff. for external exposure pthwys;
Half life: 20-28 years

137 Cs --common in CEZ, high dose coeff. for external exposure pthwys;
Half life: 30 years

154Eu --high dose coeff. for external exposure pthwys;
Half life: 9 years

238Pu, 239Pu, 240Pu —high dose coefficients for internal exposure pthwys;
Half life: 6,500 – 24,000 years

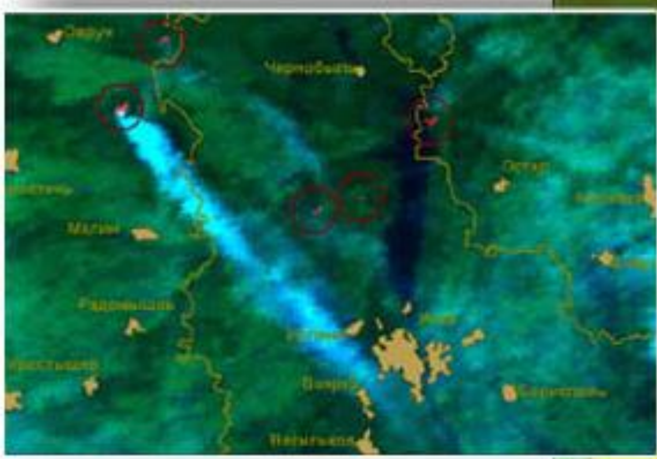
241Am —high dose coefficients for internal exposure pthwys.
Half life—432 years

Table 1. Estimated fuel component radionuclides in soil and vegetation of the 30-km Chernobyl exclusion zone in Ukraine in 2000 and 2010. Fuel component radionuclides in 2000 in upper 30-cm soil layer outside the ChNPP industrial site, excluding the activity located in the radioactive waste storages and in the cooling pond are from Kashparov et al. (2003). Estimates of concentration factors (ratio of radionuclides in vegetation and litter to soil) in forest and grasslands were derived from Lux et al. (1995), Sokolik et al. (2004), Yoschenko et al. (2006).

Radionuclide	Radionuclide Inventory (Bq)			Ratio Combustible/Soil	
	Soil in 2000	Soil in 2010	Combustible in 2010	Forest	Grassland
^{90}Sr	7.7E+14	6.1E+14	1.5E+14	0.351	0.023
^{137}Cs	2.8E+15	2.2E+15	5.8E+13	0.101	0.037
^{154}Eu	1.4E+13	6.4E+12	8.5E+10	0.031	0.005
^{238}Pu	7.2E+12	6.7E+12	8.4E+10	0.03	0.004
$^{239,240}Pu$	1.5E+13	1.5E+13	2.0E+11	0.031	0.005
^{241}Am	1.8E+13	1.8E+13	4.7E+11	0.062	0.01

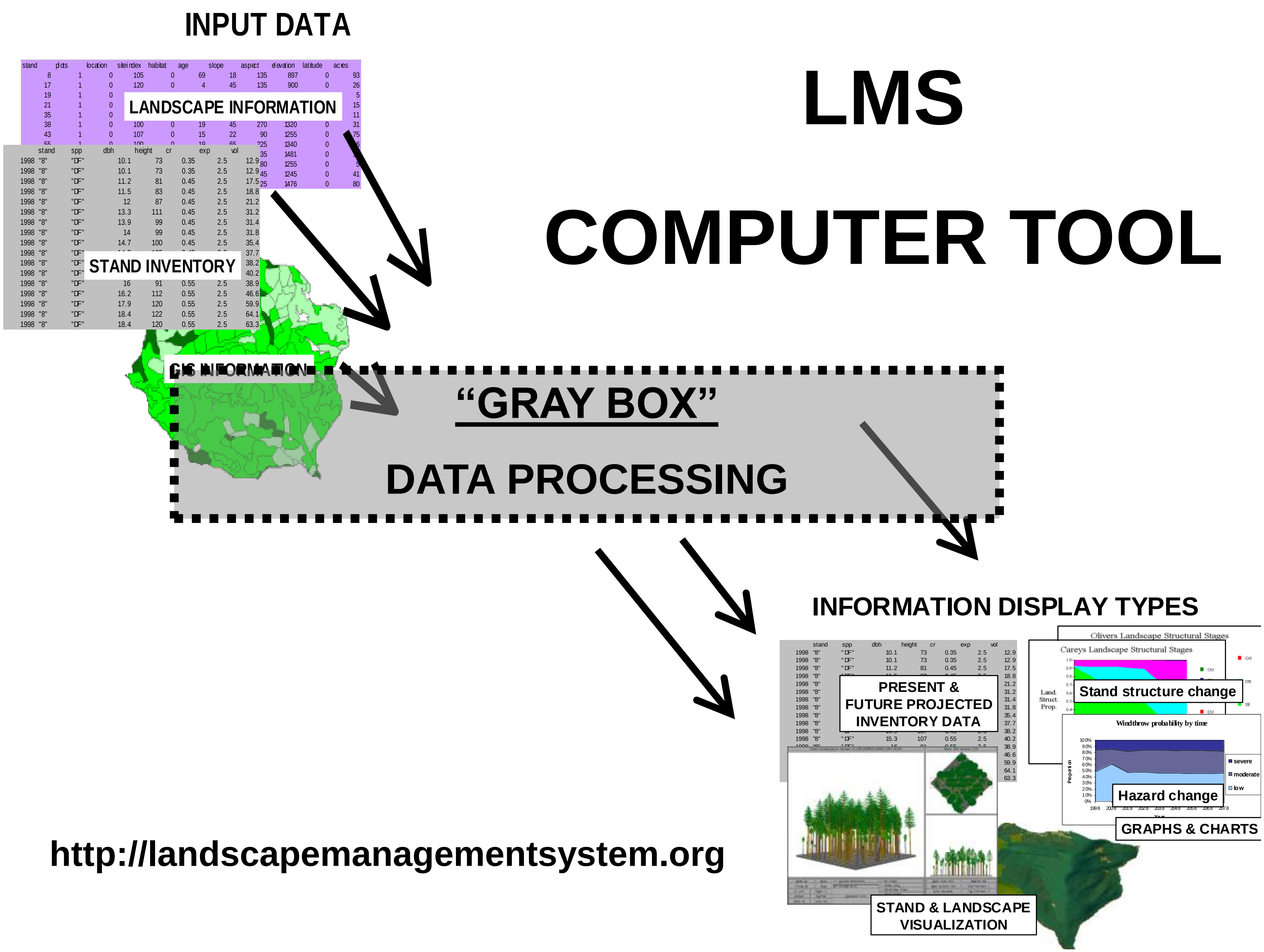
Схема локалізації осередків пожеж в Київській та Житомирській областях 8 травня 2003 року

Фрагмент космічного знімку із супутника NOAA 08.05.2003, 18-30, наданого Українським центром менеджменту землі та ресурсів

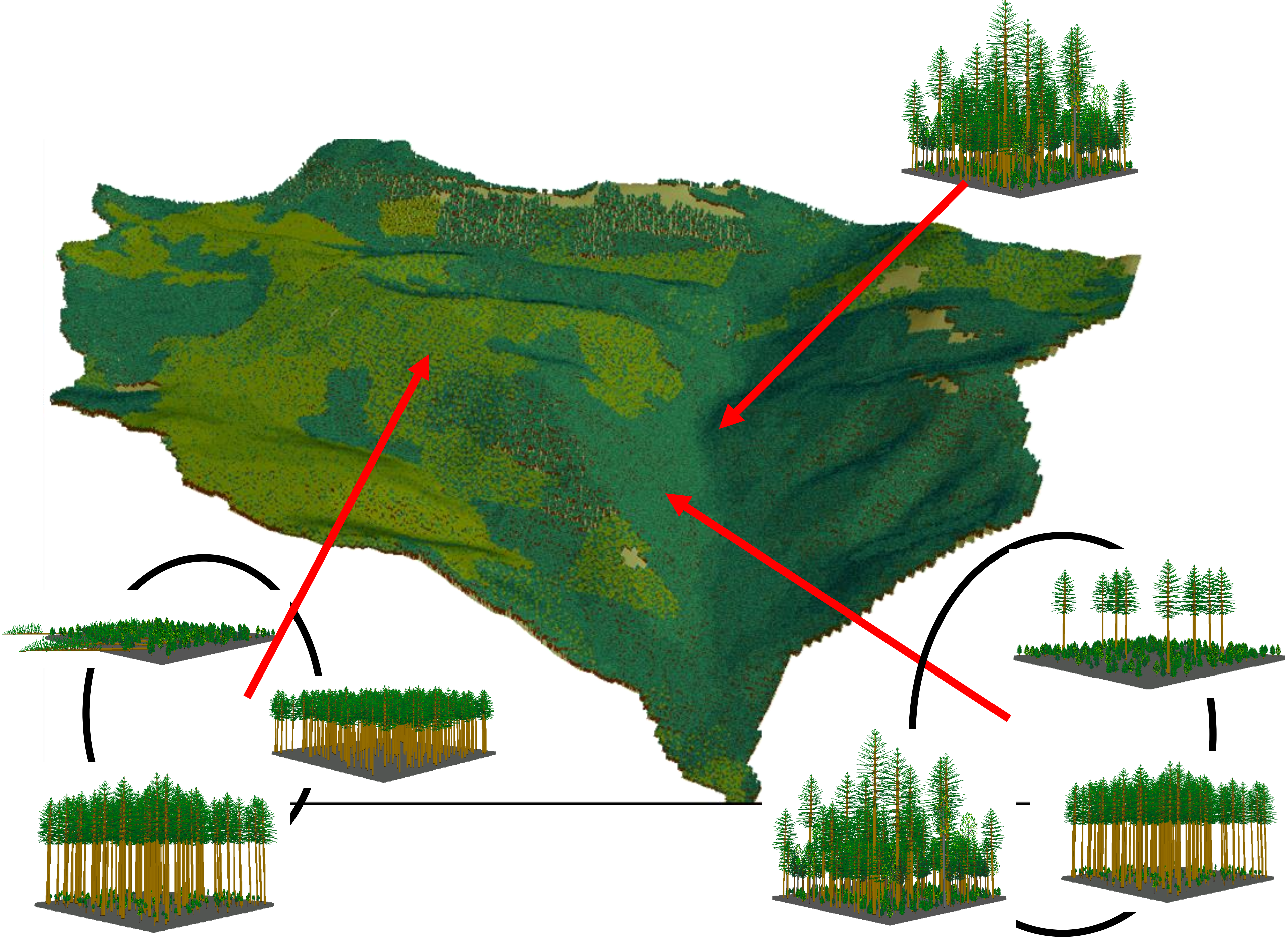



26

LMS COMPUTER TOOL



http://landscapemanagementsystem.org



Ukrainian Forest Service Inventory

LMS Platform

The Landscape Management System (LMS, McCarter et al. 1998; Oliver et al. 2009) provides a variety of tools for examining management consequences on forested landscapes by analyzing each stand and linking results at the landscape level. (See http://Landscapemanagementsystem.org)

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

Ukraine Fire Risk Classification Rules

(See later slide)

United States Forest Service, FVS, FFE, Crowning Index

(See later slide)

GIS

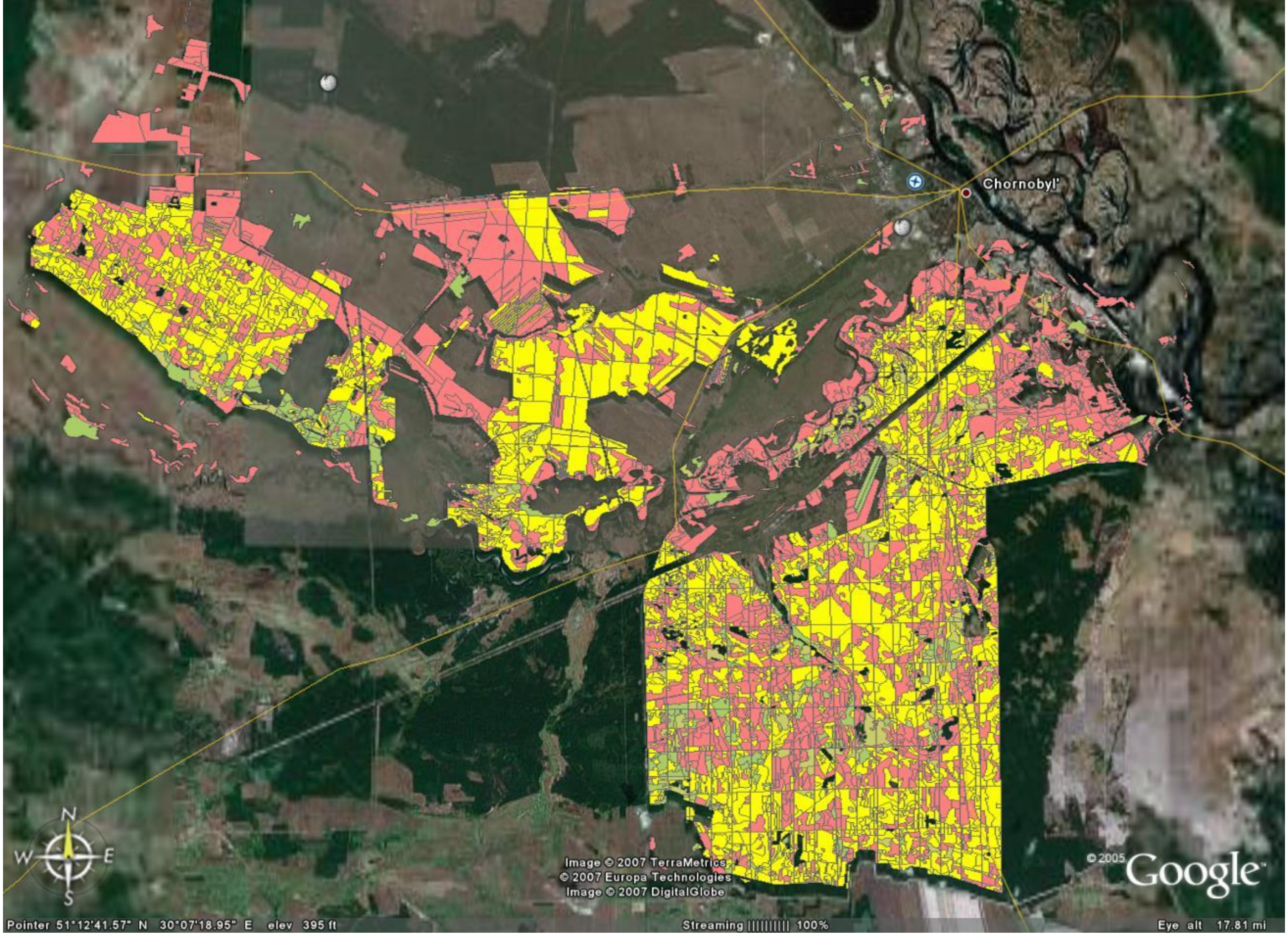


Figure 4. Google Earth image showing Ukraine Fire Risk Classification on Chornobyl landscape. Note area to right of classified area which appears to be a large open area possibly from burns.

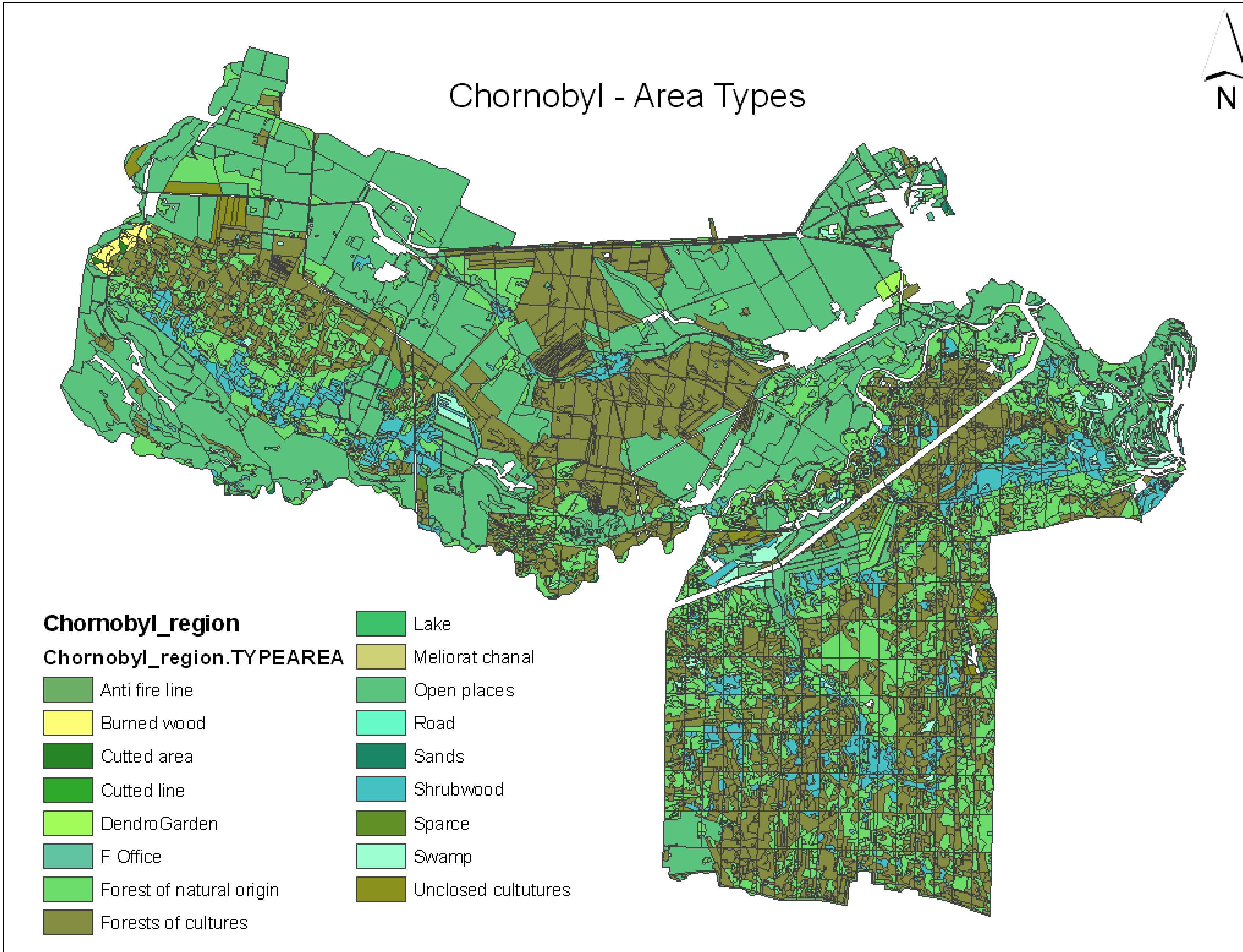


Figure 1. Chornobyl area showing various vegetation types in the area.

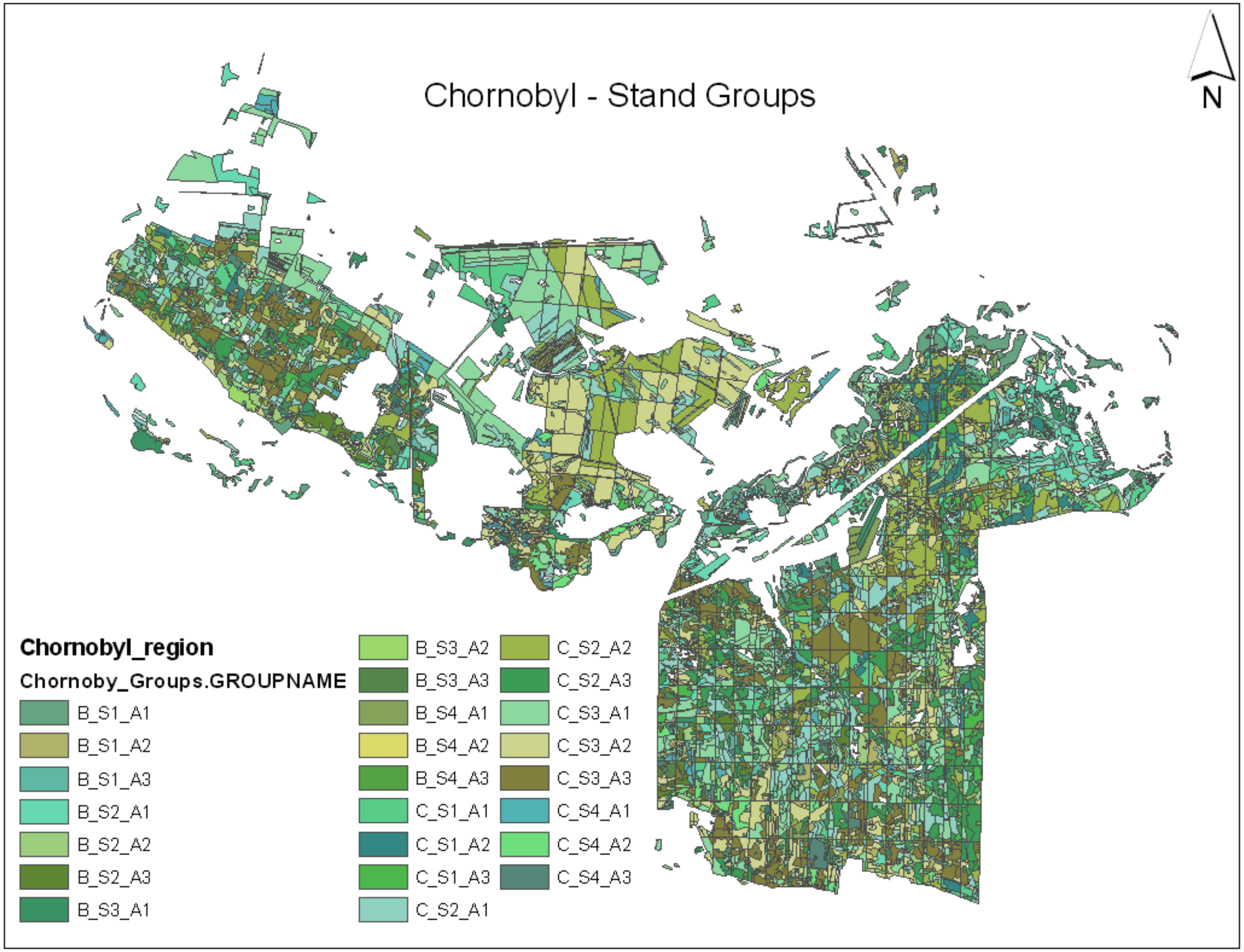
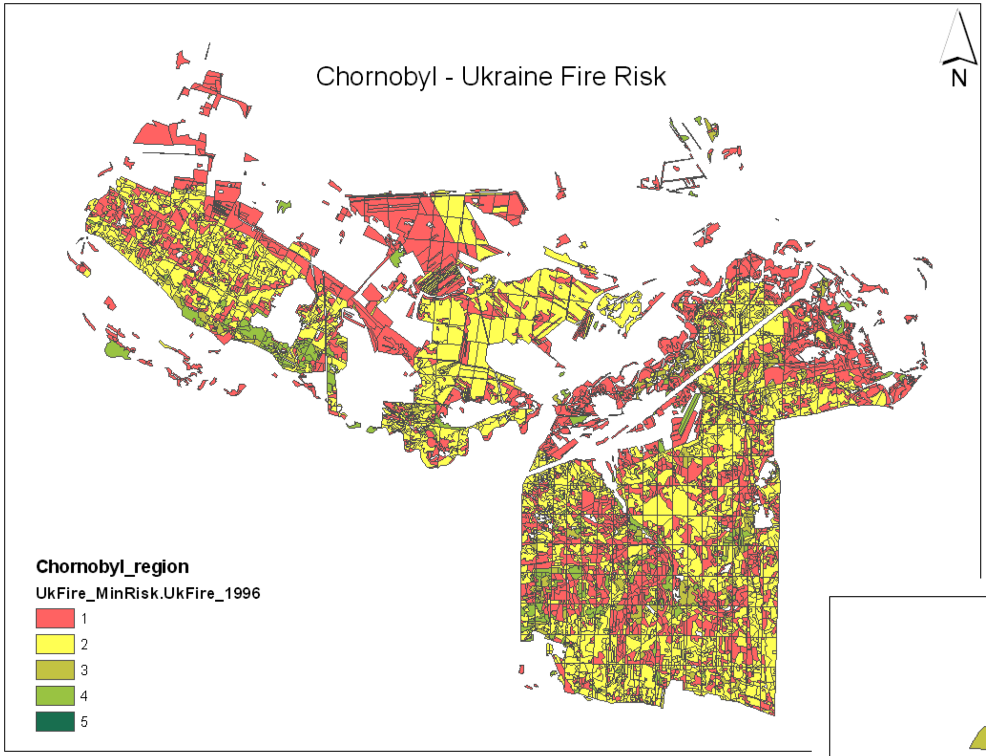


Figure 2. Location of stand groups in the Chornobyl area. Stand groups are named for a three part classification:

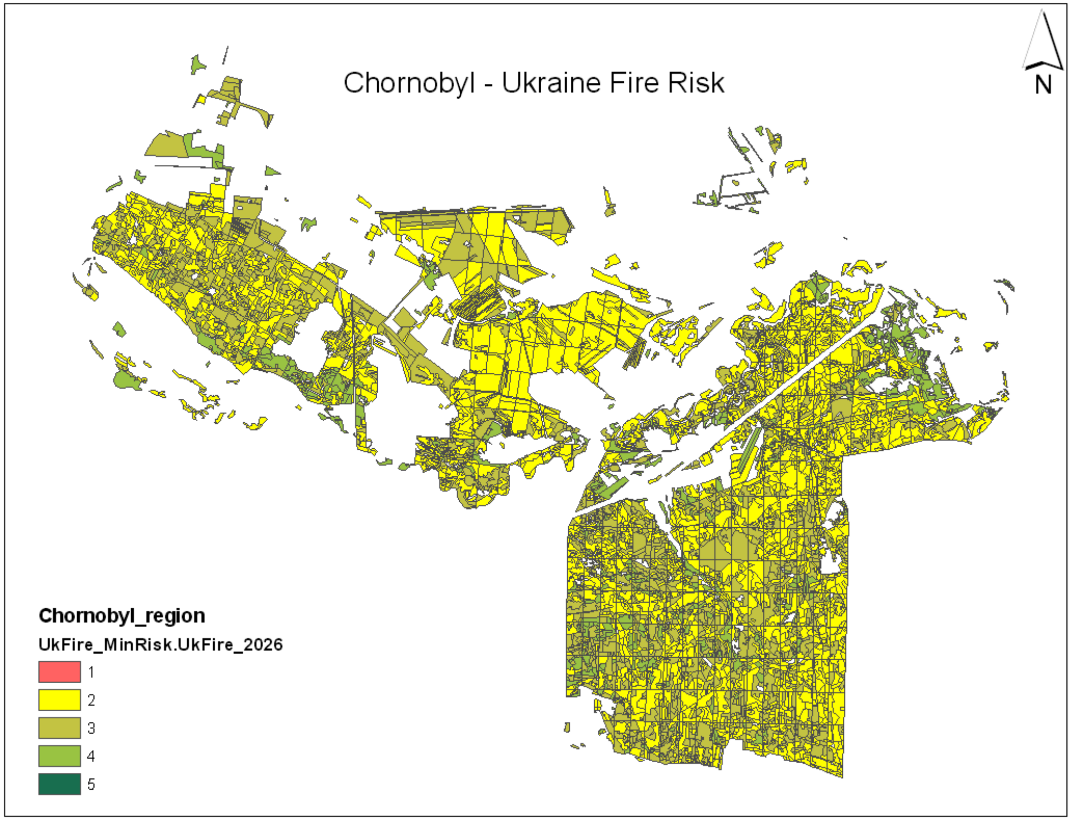
1--Species group--B = broadleaf, C = conifer;

2--Site class 1-4;

3--Age class 1-3.

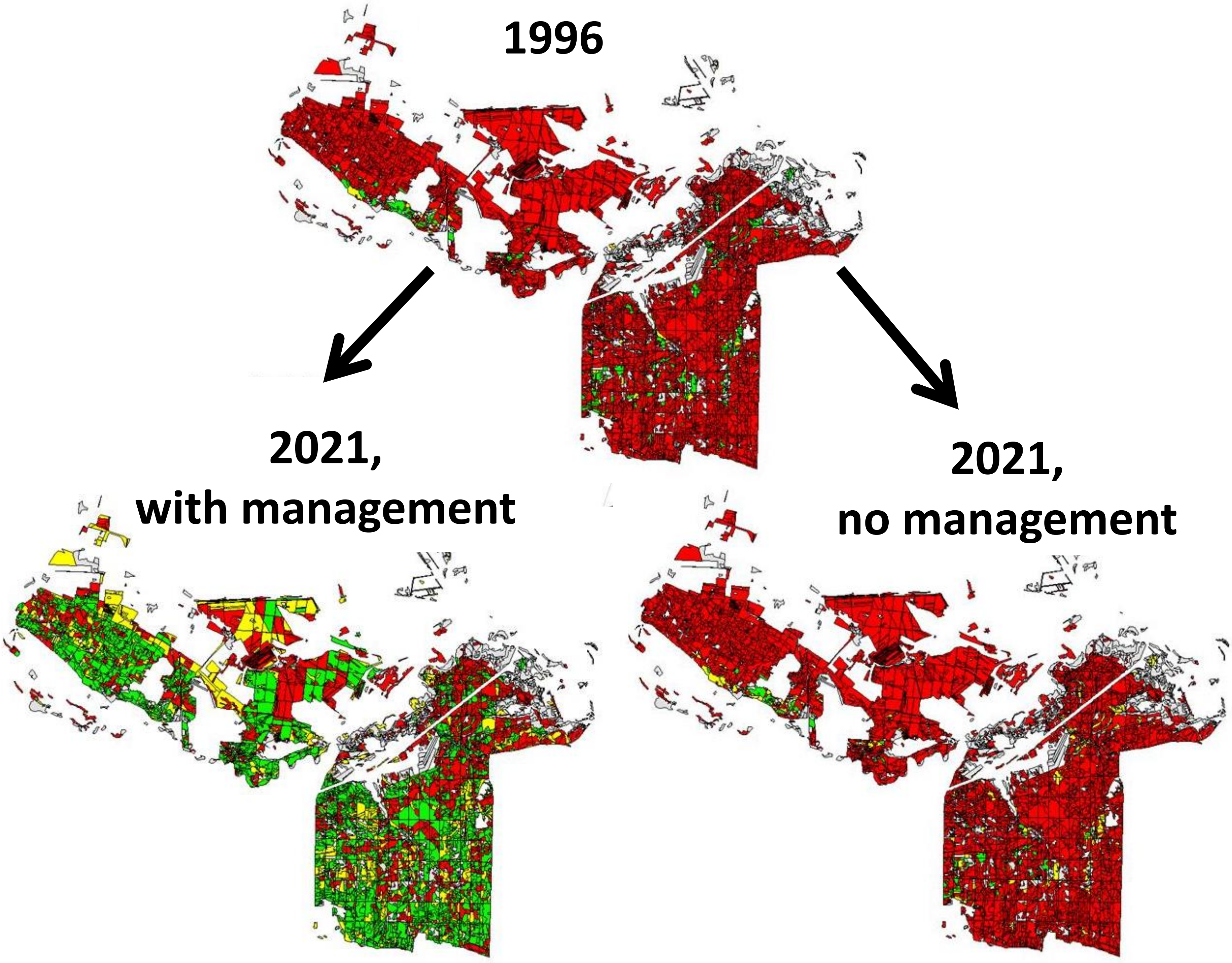


<<1996



Ukraine Fire Risk classes.

2021>>


1996
2021,
with management
2021,
no management

Before thinning.

Immediately after thinning.

Equipment that can do the thinning with minimal exposure of people to radioactive dust

A concern was to ensure the important issue did not become delayed with pseudo-scientific contrarians, such as:

"…there's a new global warming scandal unfolding which involves the U.N. Intergovernmental Panel on Climate Change, its Chairman, Raj Pachauri... The scandal is rapidly unfolding…So far, U.K. reporters have uncovered two now bogus claims in the U.N. climate change report:"

--*Daily Mail, Telegraph, 2011. http://deathby1000papercuts.com/2010/01/scandal-over-u-n-climate-report-ipcc-chairman-grows-yet-another-claim-debunked/*

"It's all a lie…The earth is not warming and climate always changes—and they know it. Global warming is the Grandest of all tyranical schemes."

--*Brian Sussman. 2010. Climategate. WND Books, Washington, D.C.*

"This report, we believe, amounts to little more than a prologging advocacy statement. It was prepared by a group of academic and timber industry foresters…"

--*Bill Meadows, President of the Wilderness Society, statement to U.S. Congress, 1997, commenting on a report to U.S. Congress by a panel of seven university professors and former Executive Vice President of American Forests.*

"[Chad] Oliver, however, has no biological credentials, being a forester by training…"

--*Mark Lawler, "Sierra Club National Forests Committee, May 1992 update," in newsletter commenting on testimony to U.S.Congress by Prof. Chad Oliver (at that time University of Washington, and formerly Biology Dept. faculty member, Harvard University).*

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OSCE
Advanced Seminar
Wildfires and Human Security
Fire Management on Terrain Contaminated by Radioactivity, Unexploded Ordnance (UXO) and Land Mines
ABSTRACT VOLUME

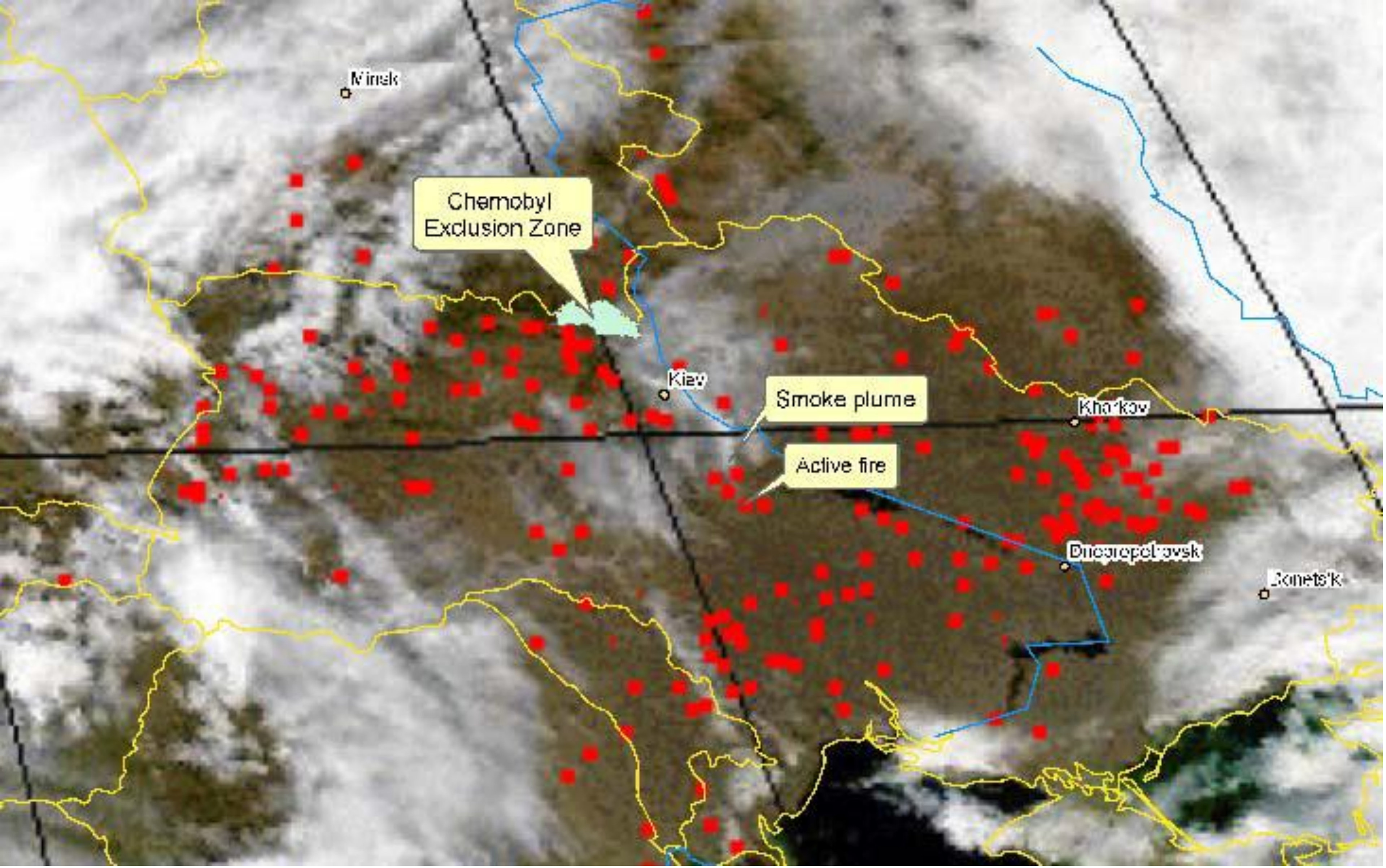
27-Jul-07

International Meeting on "Reducing Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forests"

sponsors	National Agriculture University of Ukraine (NAUU; now National University of Life and Environmental Sciences of Ukriane)
sponsors	Yale University School of Forestry and Environmental Studies, Global Institute of Sustainable Forestry
sponsors	United Nations Global Fire Monitoring Center
sponsors	United Nations International Strategy for Disaster Reduction (UNISDR)
sponsors	Ministry of Ukraine of Emergencies and Chernobyl Affairs
	Government of Ukraine
	Council of Europe
	Organization for Security and Cooperation in Europe
	IUCN
	State Forestry Committee of Ukraine
	More than 80 participants from the following countries:

Belgium	Switzerland
Belarus	Russia
France	Ukraine
Germany	U.S.A.
Spain	

2007	July 26-27	International Meeting on "Reducing Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forests"
	November 20	UN Resolution: "Resolution adopted by the General Assembly" 62/9: Strengthening of international cooperation and coordination of efforts to study, mitigate, and minimize the consequences of the Chernobyl disaster
2008	February 25	Ad hoc meeting in Washington, D.C.--Yale University Global Institute, Chopivsky Family Foundation, European Insurance, World Bank
	September 22-23	presentation at "Public authorities and civil society together for a safe European nuclear future" sponsored by the Council of Europe
	October 6	"National Round Table: Reduce Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forest" (25 participants)
	November 21	"UN Action Plan on Chernobyl to 2016: Final Version"
2009	April 1	"Viktor Yushchenko--Accomplishments on Chernobyl" (President of Ukraine)
	October 6-8	"Wildfires and Human Security: Fire Management on Terrain Contaminated by Radioactivity, Unexploded Ordnance (UXO) and Land Mines'
2010	August	"Presentation on findings" by Dr. Aaron Hohl, Yale University; Pentennial, World Meeting of IUFRO, Seoul
	Sept 30 - Oct 2	"Education, research, and innovations in forestry and park management in Ukraine at the context of regional and global challenges"
2011	April	"Presentation at "25 Year Anniversary of the Chernobyl Catastrophe"
	May	"Presentation at "Wildfire 2011: The 5th International Wildland Fire Conference." South Africa



MODIS satellite image of fire locations (red dots) and smoke in Ukraine and its neighboring countries, April 16, 2006.

Others Contacted

Chopivsky Family Foundation*

Yale Professors (Ellen Brennen-Galvin, John Wargo)*

Former United States Ambassadors

Global Insurance Companies

European Bank of Reconstruction and Development

World Bank

European Union, Commissioner for the Environment

President of Ukraine (V. Yushenko)

President of United States (G.W.Bush)*

Institute of Radiation Protection, German Research Center for Environmental Health (GmbH)

NATO (North Atlantic Treaty Alliance

Professor Yeter Goksu, Ankara & Aniyaman Univ.'s, Turkey*

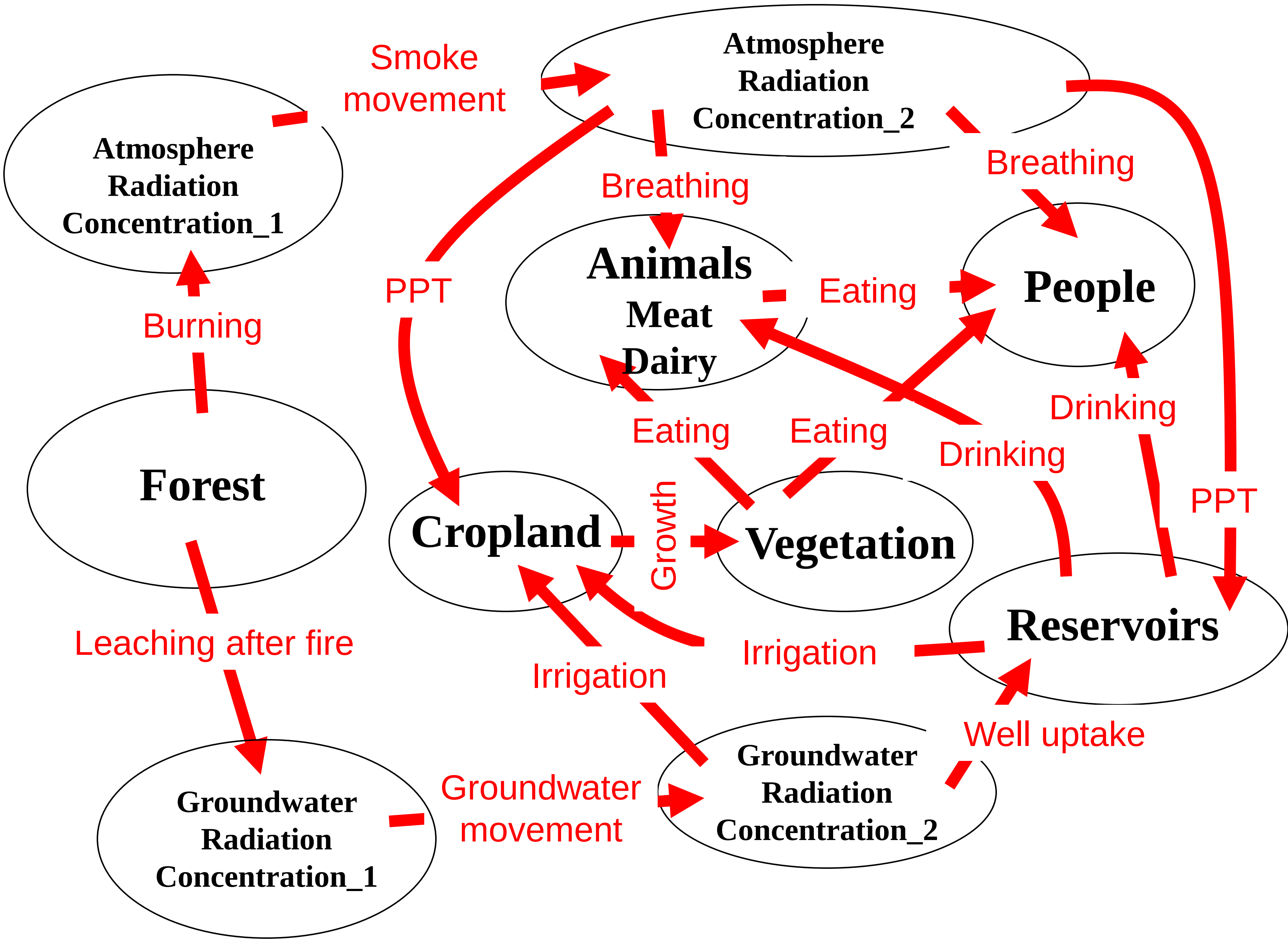
* Indicates they followed up with action.

October 6, 2008

"National Round Table: Reduce Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forest" (25 participants)

Presidium	V. Shandra, Minister of Emergencies, Ukraine
Presidium	V. Kolosha, Deputy Minister
Presidium	D. Melnychuk, Rector, National Agriculture University of Ukraine
Presidium	C. Oliver, Professor and Director, Global Institute of Sustainable Forestry, Yale University, School of Forestry and Environmental Studies
Presidium	J.Goldammer, United Nations Global Fire Monitoring Center, Germany
Presidium	G. Chopivsky, Jr., Chopivsky Family Foundation
	Ministry of Emergencies, Ukraine
	Special State Enterprise, Ukraine
	Ministry of Environmental Protection, Ukraine
	Ministry of Agriculture Policy, Ukraine
	Ministry of Education and Science, Ukraine
	State Sanitary-Epidemic Service
	State Forestry Committee
	National Academy of Science
	Ukrainian Agricultural Academy
	Ukrainian Academy of Medical Science
	Yale University, School of Forestry and Environmental Studies, Global Institute of Sustainable Forestry, U.S.A.
	United Nations, Global Fire Monitoring Center, Germany
	Chopivsky Family Foundation, U.S.A.
	U.S. Embassy, Ukraine

National Agriculture University of Ukraine, and Institutes of Agriculture Radiology, Forestry and Landscape Architecture, Silviculture and Park Gardening, Nature Protection and Biotechnology


Atmosphere
Radiation
Concentration_1
Smoke
movement
Atmosphere
Radiation
Concentration_2
Breathing
Breathing
PPT
Animals
Meat
Dairy
Eating
People
Burning
Forest
Eating
Eating
Drinking
Drinking
PPT
Cropland
Growth
Vegetation
Reservoirs
Leaching after fire
Irrigation
Irrigation
Well uptake
Groundwater
movement
Groundwater
Radiation
Concentration_1
Groundwater
Radiation
Concentration_2

Steps in Analysis Process

- Prepare model in consultation with experts in various components
- Obtained lists of expert reviewers
- Sent out requests for review
- Receiving reviews back (requested CV, cover letter, and review)
- Will publish reviews with Report (perhaps amend report according to reviewers comments)

Wildfire in the Chernobyl Exclusion Zone: A Worst Case Scenario

Aaron Hohl, Ph.D.
Andrew Niccolai, Ph.D.

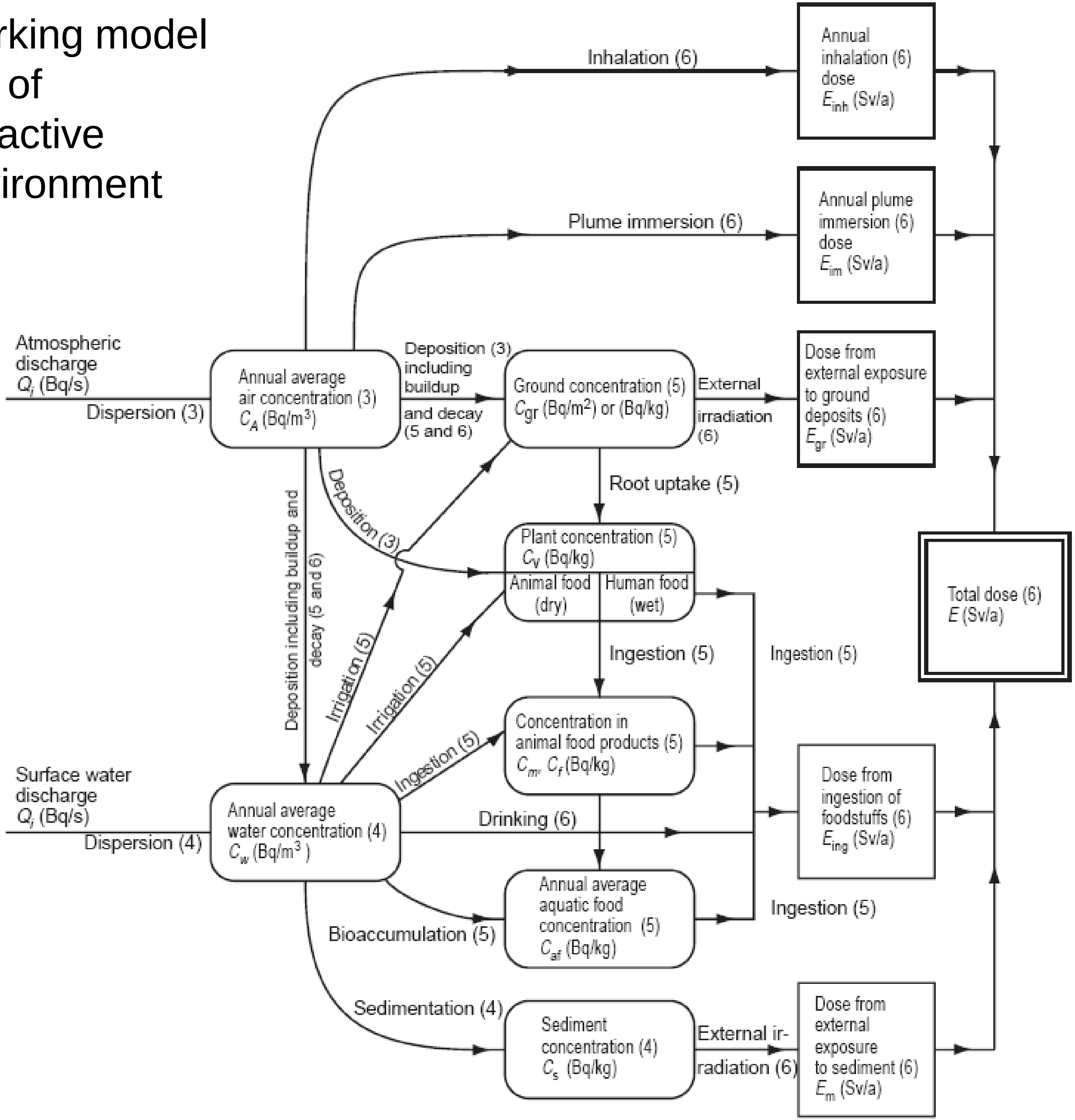
Project Members
Chad Oliver, Ph.D.
Sergiv Zibtsev, Ph.D.
Johann Goldammer, Ph.D.
Volodymyr Gulidov

December 11, 2010

ACKNOWLEDGEMENTS

We thank Dr. V.A. Kashparov and Dr. V.I. Yoschenko of the Ukrainian Institute of Agricultural Radiology, and Dr. Y. Goksu for critically reviewing previous drafts of this report and Dr. Yeter Goksu for her advice throughout the project and during preparation of the report. This report would not have been possible without the support of Dr. Dmytro Melnychuk, Rector, Rector, National University of Life and Environmental Sciences of Ukraine (NUBiP of Ukraine) and Mr. George Chopivsky, Jr., President, Chopivsky Family Foundation

This is our current working model for assessing impacts of discharges from radioactive substances to the environment



Four Linked Models

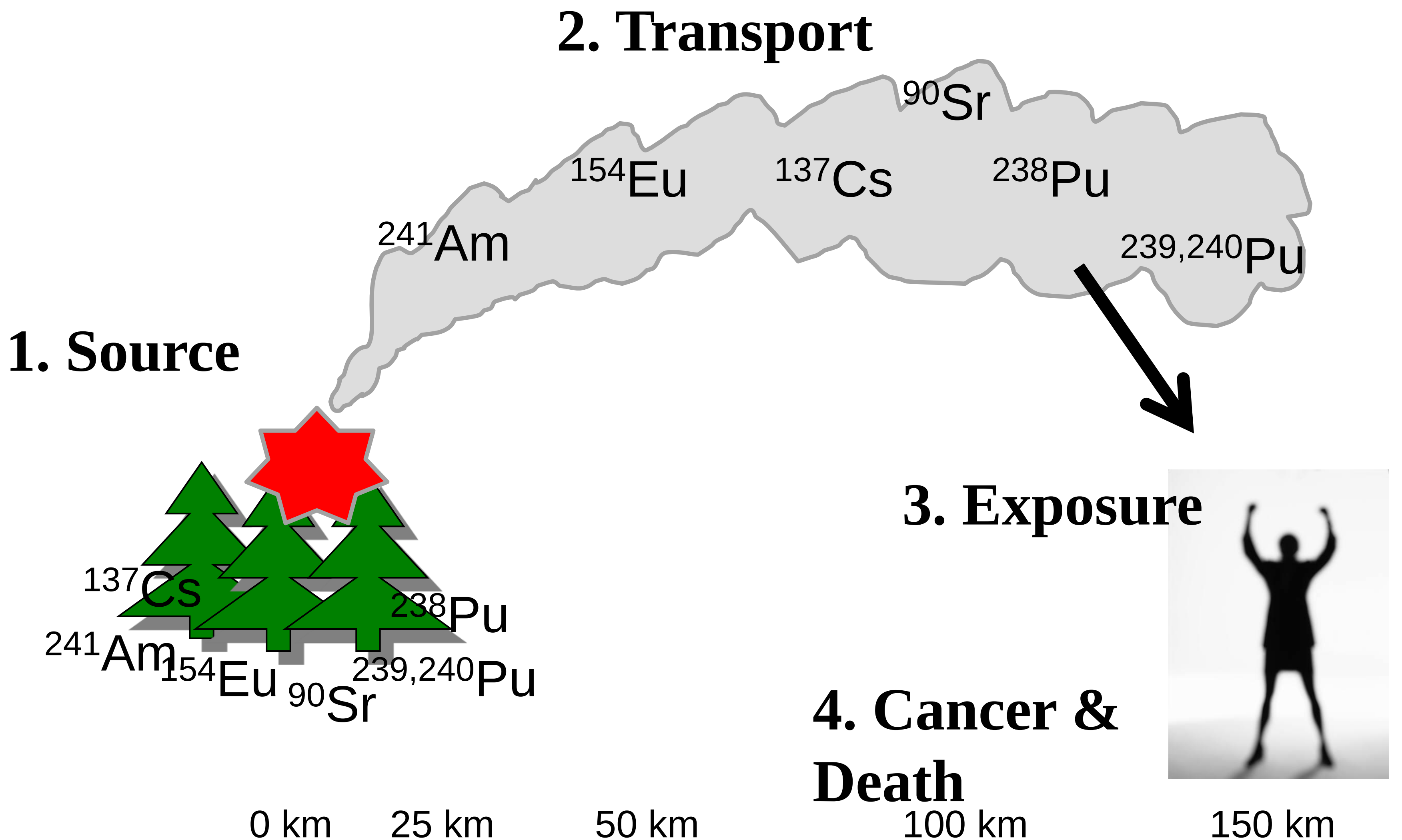
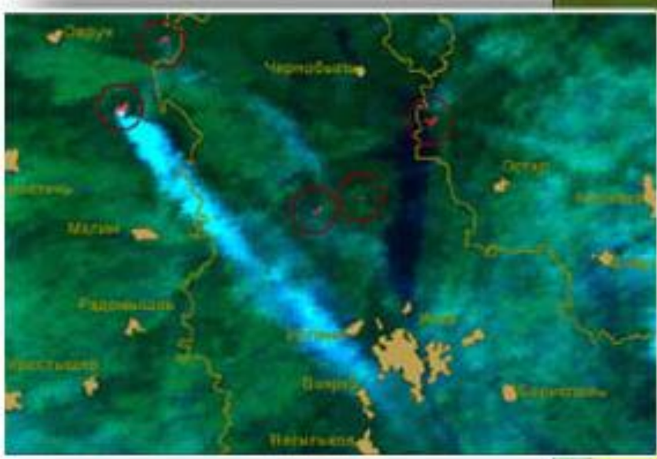


Схема локалізації осередків пожеж в Київській та Житомирській областях 8 травня 2003 року

Фрагмент космічного знімку із супутника NOAA 08.05.2003, 18-30, наданого Українським центром менеджменту землі та ресурсів



$$C_A = \frac{P_p F Q_i}{u_a} \quad [3]$$

where

C_A is the ground level air concentration at downwind distance *x* in sector *p* (Bq/m^3)[1],

P_p is the fraction of time per event that the wind blows toward the target population,

F is the Gaussian diffusion factor[2] appropriate for a given release height[3] and downwind distance *x* (m^{-2}),

Qi is the average discharge rate per event for radionuclide i (Bq/s),

u_a is the geometric wind speed average at the area of release representative of the duration of the event (m/s).

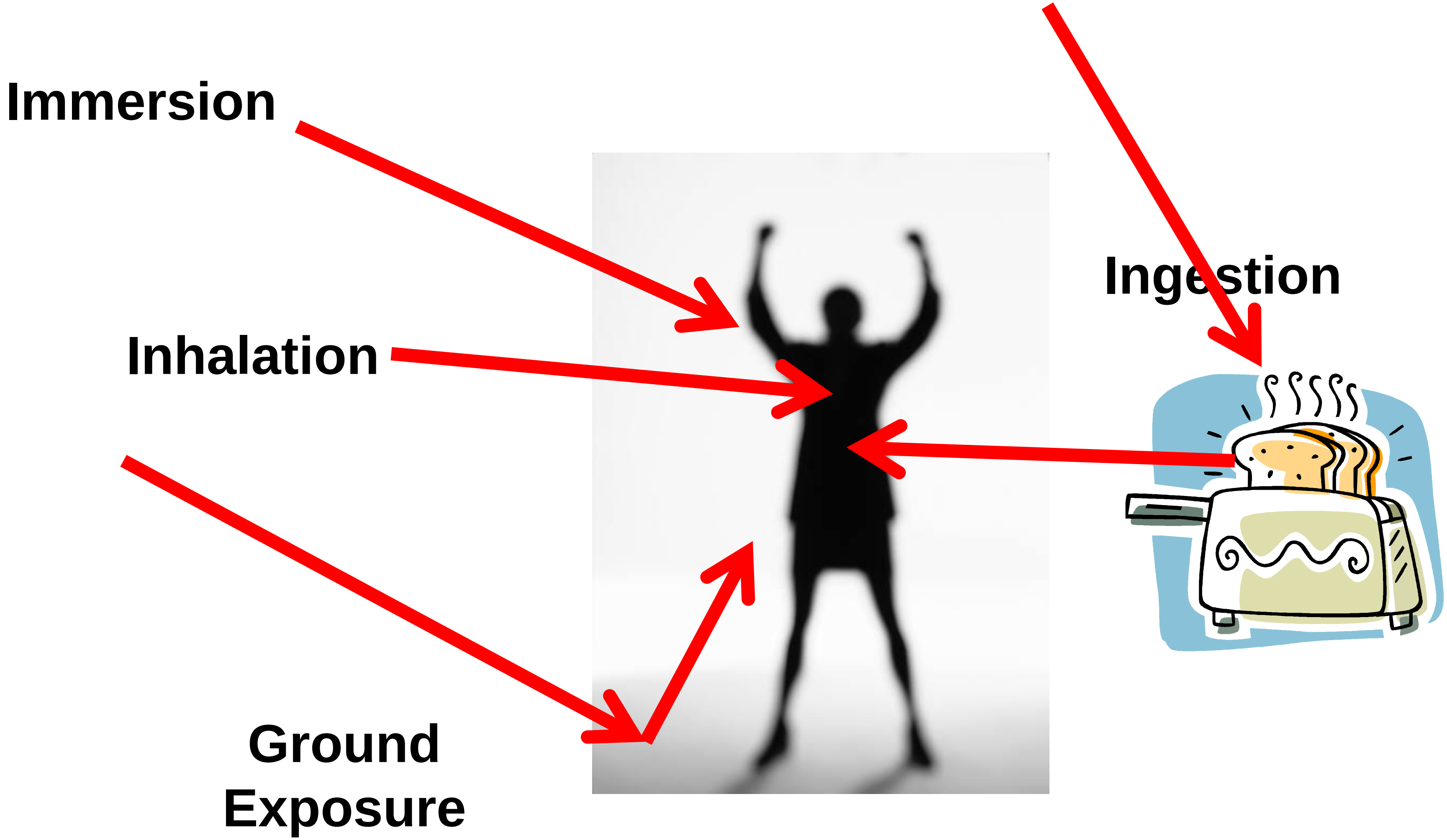

Immersion
Inhalation
Ground
Exposure
Ingestion

Table 4. Element specific transfer factors for terrestrial foods for screening purposes (IAEA 2001).

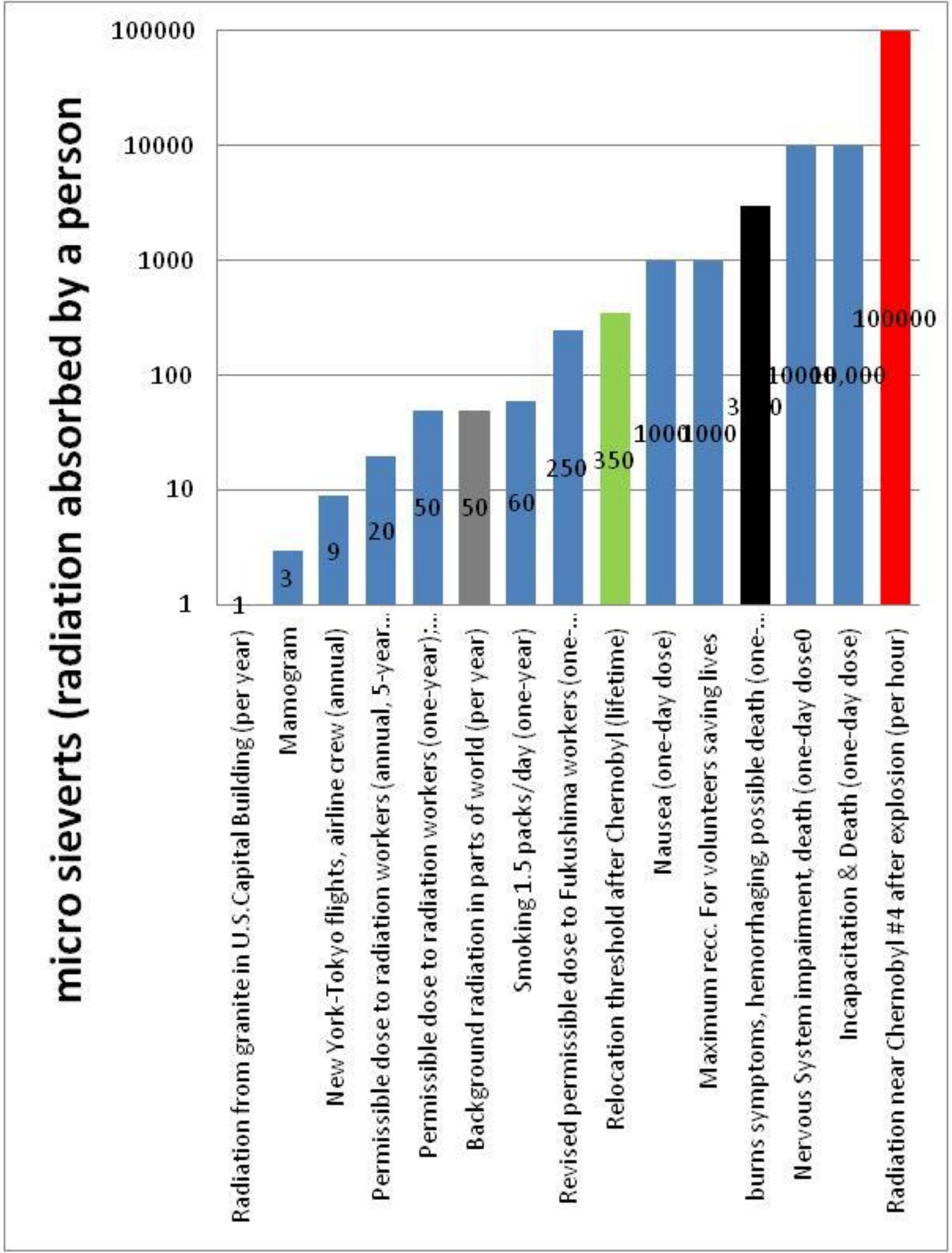
Element	Forage (Bq/ kg plant dry weight)/ (Bq/kg soil dry weight)	Crops (Bq/ kg plant fresh weight)/ (Bq/kg soil dry weight)	Milk (d/L)	Meat (d/kg)
Sr	10	0.3	0.003	0.01
Cs	1	0.04	0.01	0.05
Eu	0.1	2.0E-03	6.0E-05	2.0E-03
Pu	0.1	1.0E-03	3.0E-06	2.0E-04
Am	0.1	2.0E-03	2.0E-05	1.0E-04

Table 2. Effective immersion, surface, inhalation, and ingestion dose coefficients for various radioisotopes (IAEA 2001).

Radionuclide	Immersion (Sv/a per Bq/m^3)	Surface (Sv/a per Bq/m^2)	Inhalation (Sv/a per Bq/m^3)		Ingestion (Sv/a per Bq/kg)	
			Adult	Infant	Adult	Infant
^{90}Sr	3.1E-09	3.5E-09	1.6E-07	4.0E-07	2.8E-08	7.3E-08
^{137}Cs	8.7E-07	1.8E-08	4.6E-09	5.4E-09	1.3E-08	1.2E-08
^{154}Eu	2.0E-06	3.8E-08	5.3E-08	1.5E-07	2.0E-09	1.2E-08
^{238}Pu	1.7E-10	2.9E-11	4.6E-05	7.4E-05	2.3E-07	4.0E-07
^{239,240}Pu	1.6E-10	2.8E-11	5.0E-05	7.7E-05	2.5E-07	4.2E-07
^{241}Am	2.6E-08	8.9E-10	4.2E-05	6.9E-05	2.0E-07	3.7E-07

Table 8. Estimated effective dose for the critical population after a catastrophic wildfire.

Radionuclide	Distance (km)	Immersion (Sv/a)	Ground.Exposure (Sv/a)	Inhalation (Sv/a)		Ingestion (Sv/a)		Total (Sv/a)	
				Adult	Infant	Adult	Infant	Adult	Infant
^{90}Sr	25	1.7E-09	6.8E-04	7.2E-04	3.0E-04	1.3E-02	2.4E-02	1.4E-02	2.5E-02
	50	5.8E-10	2.4E-04	2.5E-04	1.1E-04	4.5E-03	8.3E-03	5.0E-03	8.6E-03
	100	2.1E-10	8.5E-05	8.9E-05	3.7E-05	1.6E-03	2.9E-03	1.7E-03	3.0E-03
	150	1.1E-10	4.6E-05	4.9E-05	2.0E-05	8.5E-04	1.6E-03	9.5E-04	1.7E-03
^{137}Cs	25	1.8E-07	1.4E-03	8.0E-06	1.6E-06	8.2E-04	5.2E-04	2.2E-03	1.9E-03
	50	6.3E-08	4.8E-04	2.8E-06	5.5E-07	2.9E-04	1.8E-04	7.7E-04	6.6E-04
	100	2.2E-08	1.7E-04	9.9E-07	1.9E-07	1.0E-04	6.5E-05	2.7E-04	2.3E-04
	150	1.2E-08	9.2E-05	5.4E-07	1.1E-07	5.5E-05	3.5E-05	1.5E-04	1.3E-04
^{154}Eu	25	6.1E-10	4.2E-06	1.4E-07	6.4E-08	1.2E-09	2.8E-09	4.4E-06	4.3E-06
	50	2.2E-10	1.5E-06	4.8E-08	2.3E-08	4.1E-10	9.9E-10	1.5E-06	1.5E-06
	100	7.6E-11	5.3E-07	1.7E-08	8.0E-09	1.4E-10	3.5E-10	5.4E-07	5.3E-07
	150	4.1E-11	2.9E-07	9.2E-09	4.3E-09	7.8E-11	1.9E-10	3.0E-07	2.9E-07
^{238}Pu	25	5.2E-14	3.2E-09	1.2E-04	3.1E-05	4.5E-08	2.9E-08	1.2E-04	3.1E-05
	50	1.8E-14	1.1E-09	4.1E-05	1.1E-05	1.6E-08	1.0E-08	4.1E-05	1.1E-05
	100	6.4E-15	4.0E-10	1.5E-05	3.9E-06	5.6E-09	3.6E-09	1.5E-05	3.9E-06
	150	3.5E-15	2.2E-10	7.9E-06	2.1E-06	3.0E-09	2.0E-09	7.9E-06	2.1E-06
$^{239,240}Pu$	25	1.2E-13	7.4E-09	3.0E-04	7.8E-05	1.2E-07	7.3E-08	3.0E-04	7.8E-05
	50	4.1E-14	2.6E-09	1.1E-04	2.7E-05	4.1E-08	2.6E-08	1.1E-04	2.7E-05
	100	1.4E-14	9.1E-10	3.8E-05	9.6E-06	1.4E-08	9.1E-09	3.8E-05	9.6E-06
	150	7.8E-15	5.0E-10	2.0E-05	5.2E-06	7.9E-09	4.9E-09	2.0E-05	5.2E-06
^{241}Am	25	4.4E-11	5.5E-07	6.0E-04	1.6E-04	6.6E-05	8.8E-05	6.7E-04	2.5E-04
	50	1.6E-11	1.9E-07	2.1E-04	5.8E-05	2.3E-05	3.1E-05	2.3E-04	8.9E-05
	100	5.5E-12	6.9E-08	7.4E-05	2.0E-05	8.2E-06	1.1E-05	8.3E-05	3.1E-05
	150	3.0E-12	3.7E-08	4.0E-05	1.1E-05	4.5E-06	5.9E-06	4.5E-05	1.7E-05
Total	25	1.8E-07	2.1E-03	1.7E-03	5.7E-04	1.4E-02	2.5E-02	1.7E-02	2.7E-02
	50	6.4E-08	7.2E-04	6.1E-04	2.1E-04	4.8E-03	8.5E-03	6.2E-03	9.4E-03
	100	2.2E-08	2.6E-04	2.2E-04	7.1E-05	1.7E-03	3.0E-03	2.1E-03	3.3E-03
	150	1.2E-08	1.4E-04	1.2E-04	3.8E-05	9.1E-04	1.6E-03	1.2E-03	1.9E-03



micro sieverts (radiation absorbed by a person
100000
10000
1000
100
10
1
1
3
9
20
50
50
60
250
350
1000
1000
10000
10,000
100000
Radiation from granite in U.S.Capital Building (per year)
Mamogram
New York-Tokyo flights, airline crew (annual)
Permissible dose to radiation workers (annual, 5-year...
Permissible dose to radiation workers (one-year):...
Background radiation in parts of world (per year)
Smoking 1.5 packs/day (one-year)
Revised permissible dose to Fukushima workers (one-...
Relocation threshold after Chernobyl (lifetime)
Nausea (one-day dose)
Maximum recc. For volunteers saving lives
burns symptoms, hemorhaging possible death (one-...
Nervous System impaiment, death (one-day dose0
Incapacitation & Death (one-day dose)
Radiation near Chernobyl #4 after explosion (per hour)

The analysis showed that the estimated exposure of populations **<u>25 or more kilometers</u>** from the source of the fire through inhalation, immersion, and surface exposure pathways **<u>is below the critical thresholds that would require evacuations</u>** by greater than an order of magnitude.

On the other hand, the potential dosage derived from the **<u>consumption of contaminated foodstuffs could exceed acceptable levels</u>** set by the Ukrainian government—a prevented internal irradiation dose exceeding 5 mSv or a prevented average annual dose exceeding 1 mSv. For both adults and infants these levels could be almost met or exceeded by consuming food produced at distances as great as 150 km from the center of the CEZ.   These highest levels of contamination would occur directly along the trace of the plume. As one moved away from the trace, contamination levels would decline, so the actual amount of agricultural land that would need to be taken out of production would be limited.

From an epidemiological standpoint, the worst case scenario would be if the trace of the plume intersected with a major population center, such as Kiev. If we assume:

1) the entire population of Kiev **(2.7 million)** was exposed to the trace;

2) the population had a sex ratio of 1:1 at the time of the fire; and

3) the average age of the population was 20 at the time of the fire; and

4) residents successfully avoided exposure through ingestion;

then we would expect **168 additional cancers** to be diagnosed over the lifetime of the residents based on the exposure during the first year after the fire. We would expect **81 additional cancer deaths** to occur.

In 2005, 11% of deaths among females in Ukraine and 13% of deaths among males were attributable to cancer. Calculated for Kiev, this means 324,000 deaths attributable to cancer.


Introduction
Fires widespread and frequent
Both pine plantation and former agricultural lands susceptible
Used screening model to assess exposure pathways
SPORTS

Media Coverage of Forest Fires nearby in Russia

If Chornobyl forests burn, what's the harm to Kyivans?
Aug 11, 2010 at 18:02 | Alexa Chopivsky
According to international experts, a potential wildfire in the exclusion zone around the closed Chornobyl nuclear power plant would not be a cause for panic in Kyiv.

As Russia's forest and peat fires continue to burn for at least the seventh consecutive week, flames kicked up in neighboring Ukraine, including two fires in Chernobyl's 2,826 square kilometer exclusion zone, which is highly radioactive. The blazes were swiftly extinguished. And they are not unusual.Up to 70 fires break out every year near the scene of the 1986 disaster, the world's worst nuclear accident.

But this summer's atypical weather pattern -- temperatures topping 40 degrees and humidity at one-third of normal levels -- is creating conditions conducive to far wider fire outbreaks. If unsuppressed near Chornobyl, about 90 kilometers northwest of Kyiv, fires could release radionuclides into the air.

Nonetheless, a team of international experts argues that the particles would be diluted enough to not cause harm to people in Kyiv.

"**According to our preliminary analysis**, our worst-case scenario proved to be not that bad," said professor Chad Oliver,director of the Global Institute of Sustainable Forestry at America's Yale University."The amounts of radioactivity that would be released would not be cause for panic," Oliver said. "Nevertheless, it's important to be prepared."

Steps in Analysis Process

- **Prepare model in consultation with experts in various components**
- **Obtained lists of expert reviewers**
- **Sent out requests for review**
- **Receiving reviews back (requested CV, cover letter, and review)**
- **Will publish reviews with Report (perhaps amend report according to reviewers comments)**
- **(May consider submission to journal)**

Reviews Received to Date

1	Department of Radioactive Ecology of Forests, All-Russian Research Institute of Silviculture and Mechanization of Forestry (VNIILM), Moscow.
2	Radiation Protection Division, United States Environmental Protection Agency
3	Office of Nuclear Studies and Analysis, Atomic Energy of Canada Ltd
4	International Atomic Energy Agency, Vienna, Austria
5	Division of Forest and Biomaterials Sciences, Graduate School of Agriculture, Kyoto University, Japan
6	Independent, recognized expert, California, U.S.A.

Lessons Learned

- **The value of a solid, conscientious, well funded, and <u>diversified</u> scientific community**
- **The importance of <u>both</u> specialized and integrative research at many levels**
- **The importance of a <u>responsible</u> press**
- **The need to distinguish scientific expertise from advocacy <u>*and*</u> inexpertise**
- **The need for policies to address <u>transboundary</u> environmental issues**


ТИМ ХТО
ВРЯТУВАВ
СВІТ

ТИМ ХТО
ВРЯТУВАВ
СВІТ

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

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	

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+).

2007	July 26-27	International Meeting on "Reducing Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forests"
	November 20	UN Resolution: "Resolution adopted by the General Assembly" 62/9: Strengthening of international cooperation and coordination of efforts to study, mitigate, and minimize the consequences of the Chernobyl disaster
2008	February 25	Ad hoc meeting in Washington, D.C.--Yale University Global Institute, Chopivsky Family Foundation, European Insurance, World Bank
	September 22-23	"presentation at "Public authorities and civil society together for a safe European nuclear future" sponsored by the Council of Europe
	October 6	"National Round Table: Reduce Risk of Disaster from Catastrophic Wildfires in the Chernobyl Irradiated Forest" (25 participants)
	November 21	"UN Action Plan on Chernobyl to 2016: Final Version"
2009	April 1	"Viktor Yushchenko--Accomplishments on Chernobyl" (President of Ukraine)
	October 6-8	"Wildfires and Human Security: Fire Management on Terrain Contaminated by Radioactivity, Unexploded Ordnance (UXO) and Land Mines'
2010	August	"Presentation on findings" by Dr. Aaron Hohl, Yale University; Pentennial, World Meeting of IUFRO, Seoul
	Sept 30 - Oct 2	"Education, research, and innovations in forestry and park management in Ukraine at the context of regional and global challenges"
2011	April	"Presentation at "25 Year Anniversary of the Chernobyl Catastrophe"
	May	"Presentation at "Wildfire 2011: The 5th International Wildland Fire Conference." South Africa

October 6-8, 2009

"Wildfires and Human Security: Fire Management on Terrain Contaminated by Radioactivity, Unexploded Ordnance (UXO) and Land Mines'

Introductions:

National University of Life and Environmental Sciences of Ukriane

Ministry of Ukraine of Emergencies

State Forestry Committee of Ukraine

United Nations Global Fire Monitoring Center, and UNISDR Wildland Fire Advisory Network, Germany

Yale University, School of Forestry and Environmental Studies, Global Institute of Sustainable Forestry

Council of Europe

OSCE, ENVSEC

Countries participating:

Ukraine
Germany
United States
France
Macedonia
Croatia
Turkey
Georgia
Armenia
Austria
Russia
Azerbaijan

Sponsored by Council of Europe, Organization for Security and Cooperation in Europe, Environment and Security Initiative. Organized by United Nations Global Fire Monitoring Center and UNECE, FAO; UNISDR; and OSCE/ENVSEC. Hosted by the National University of Life and Environmental Sciences of Ukraine, Ministry of Emergencies and Affairs of Population Protection for the Consequences of Chernobyl Catastrophe, Yale University Global Institute of Sustainable Forestry, and Chopivsky Family Foundation, U.S.A.

Wildfires and Human Security

"Fire Management on Terrain Contaminated by Radioactivity, Unexploded Ordnance (UXO) and Land Mines"

Kyiv / Chornobyl, Ukraine, 6-8 October 2009

Conducted by the Global Fire Monitoring Center (GFMC)
in the frame of the activities of the Council of Europe (CoE) and the joint project "Enhancing National Capacity on fire Management and Risk Reduction in the South Caucasus" (Environment and Security Initiative [ENVSEC], the UNISDR Regional Southeast Europe / Caucasus and Central Asia Wildland Fire Networks and the UNECE / FAO Team of Specialists on Forest Fire)

The Seminar is hosted by the
National University of Life and Environmental Sciences of Ukraine
and
the Ministry of Ukraine of Emergencies and Affairs of Population Protection from the Consequences of Chernobyl Catastrophe
and supported by
the Yale University Global Institute for Sustainable Forestry, U.S.A., and
the Chopivsky Family Foundation, U.S.A.

Precautionary Principle

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.” January, 1998

Wingspread Statement of the Precautionary Principle
January, 1998

Table 7. Estimated concentration of radioactive material in crops. Deposition is the concentration on plant surfaces estimated immediately after a catastrophic wildfire. Soil uptake and adhesion is estimated for the growing season immediately following a catastrophic wildfire.

		Crop Contamination (Bq/kg)	
Radionuclide	Distance	Deposition	Soil Uptake and Adhesion
^{90}Sr	25	52000	230
	50	18000	79
	100	6400	28
	150	3500	15
^{137}Cs	25	20000	12
	50	7000	4.1
	100	2500	1.4
	150	1400	0.78
^{154}Eu	25	30	8.6E-04
	50	10	3.0E-04
	100	3.7	1.1E-04
	150	2	5.8E-05
^{238}Pu	25	29	4.3E-04
	50	10	1.5E-04
	100	3.6	5.3E-05
	150	2	2.9E-05
$^{239,240}Pu$	25	70	1.0E-03
	50	25	3.6E-04
	100	8.7	1.3E-04
	150	4.7	6.8E-05
^{241}Am	25	170	4.8E-03
	50	58	1.7E-03
	100	20	5.9E-04
	150	11	3.2E-04

Half Life of Radioisotopes in CEZ Forests

90 SR	19.9-28 years
137Cs	30 years
238Pu	87.7 years
239 Pu	24,400 years
154Eu	8.593 years
241Am	432.2 years
240Pu	6,500 years

Table 6. Estimated concentrations of radioactive materials in the environment after a catastrophic wildfire.

Radionuclide	Distance (km)	Air Concentration (Bq/m^3)	Ground Concentration (Bq/m^2)	Food Concentration (Bq/kg)		
				Vegetation	Meat	Milk
^{90}Sr	25	39	2.0E+05	230	1800	720
	50	14	6.9E+04	79	630	250
	100	4.8	2.4E+04	28	220	89
	150	2.6	1.3E+04	15	120	49
^{37}Cs	25	15	7.6E+04	12	350	93
	50	5.3	2.7E+04	4.1	120	33
	100	1.9	9.4E+03	1.4	43	12
	150	1	5.1E+03	0.78	23	6.3
^{154}Eu	25	2.2E-03	110	8.6-04	2.1E-02	8.3E-05
	50	7.9E-03	39	3.0E-04	7.2E-04	2.9E-05
	100	2.8E-03	14	1.1E-04	2.5E-04	1.0E-05
	150	1.5E-03	7.5	5.8E-05	1.4E-04	5.6E-06
^{238}Pu	25	2.2E-02	110	4.3E-04	2.0E-04	4.1E-06
	50	7.8E-03	39	1.5E-04	7.2E-05	1.4E-06
	100	2.7E-03	14	5.3E-05	2.5E-05	5.1E-07
	150	1.5E-03	7.5	2.9E-05	1.4E-05	2.8E-07
^{239,240}Pu	25	5.3E-02	260	1.0E-03	4.9E-04	9.7E-06
	50	1.9E-02	93	3.6E-04	1.7E-04	3.4E-06
	100	6.5E-03	33	1.3E-04	6.0E-05	1.2E-06
	150	3.5E-03	18	6.8E-05	3.3E-05	6.5E-07
^{241}Am	25	1.2E-01	620	4.8E-03	2.0	5.3E-01
	50	4.4E-02	220	1.7E-03	7.0E-01	1.9E-01
	100	1.5E-02	77	5.9E-04	2.5E-01	6.5E-02
	150	8.4E-03	42	3.2E-04	1.3E-01	3.6E-02

Table 9. Lifetime attributable risk of cancer incidence and mortality per 100,000 people for various levels of exposure.

Distance (km)	Dose (mSv)	Age at time of exposure	Incidence (occurrences/100,000 people)		Mortality (occurrences/100,000 people)	
			Female	male	female	male
25	2.7	0	127.6	68.4	47.3	29.3
	3.8	20	62.6	37.1	29.0	19.4
	3.8	40	33.7	24.6	19.3	14.3
	3.8	60	22.3	18.6	15.5	12.1
	3.8	80	8.1	6.6	7.2	5.8
50	0.9	0	44.4	23.8	16.4	10.2
	1.3	20	22.0	13.1	10.2	6.8
	1.3	40	11.8	8.7	6.8	5.0
	1.3	60	7.8	6.5	5.5	4.3
	1.3	80	2.9	2.3	2.5	2.0
100	0.33	0	15.6	8.4	5.8	3.6
	0.47	20	7.8	4.6	3.6	2.4
	0.47	40	4.2	3.1	2.4	1.8
	0.47	60	2.8	2.3	1.9	1.5
	0.47	80	1.0	0.8	0.9	0.7
150	0.18	0	8.4	4.5	3.1	1.9
	0.26	20	4.2	2.5	1.9	1.3
	0.26	40	2.3	1.7	1.3	1.0
	0.26	60	1.5	1.2	1.0	0.8
	0.26	80	0.5	0.4	0.5	0.4