

CONSEQUENCES OF THE ACCIDENT AT THE CHERNOBYL NPP

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OECD/NEA WORKSHOP
APPROACHES TO ESTIMATION OF THE COSTS OF NUCLEAR
ACCIDENTS

RPI

CONTENTS

- Introduction
- National and international assessments
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- Exposure of individuals
- Thyroid cancer
- Countermeasures and remediation activities
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INTRODUCTION

THE SCENE OF THE ACCIDENT

The Chernobyl Nuclear Power Plant is located in the Kiev region in the north of Ukraine, 7 km south of the Ukrainian-Belarusian border in an area of forest and meadows near the point where the Prypiat river joins the Dneiper.



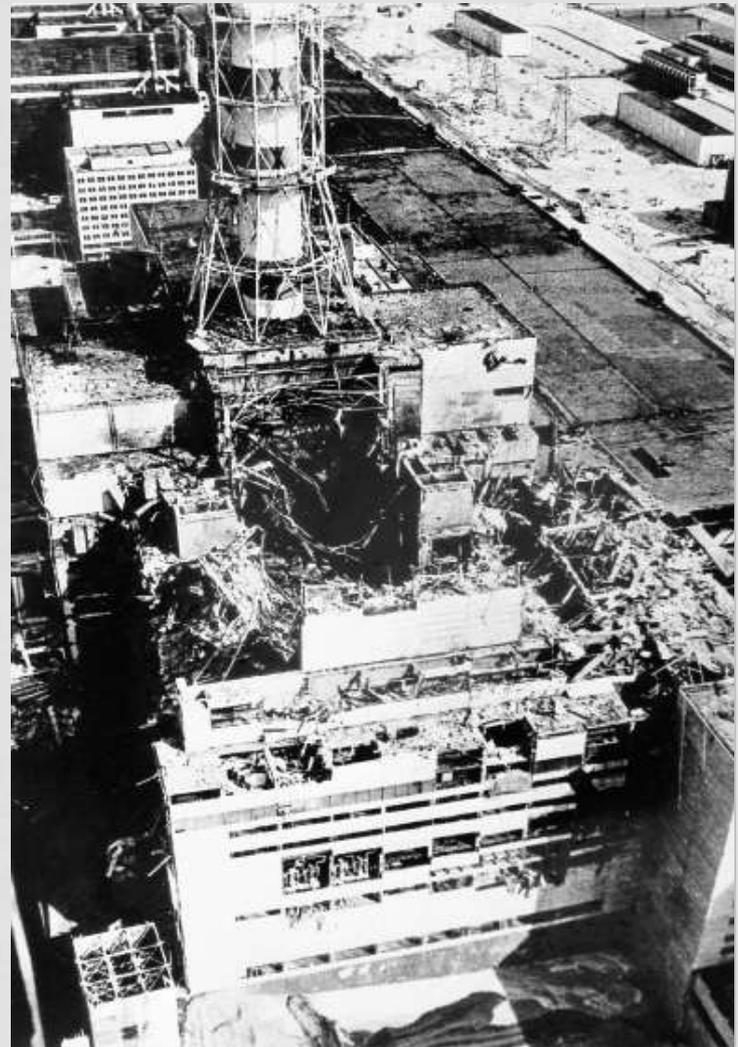
THE CHERNOBYL NPP

- The NPP started the operation in 1977. The fourth reactor unit went into operation at the end of 1983. Units 5th and 6th where under construction.
- Distances to large settlements and their population (as on the time of the accident):
 - Prypiat city: 3 km (49 000)
 - Chernobyl city: 15 km (14 000)
 - Kiev city: 100 km (2.5 mln)
 - Gomel city: 130 km (450 000)

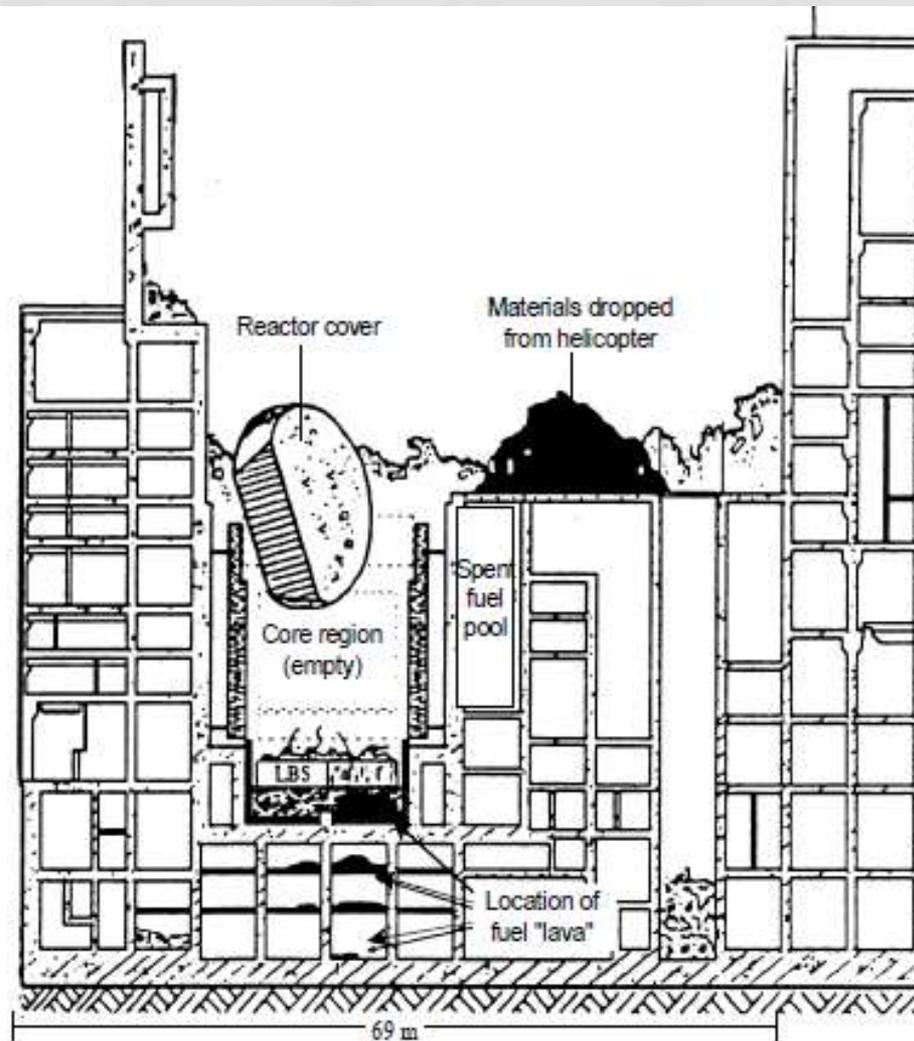


APRIL & MAY 1986

- Between 1 and 2 am on the 26th of April 1986, an accidental explosion during a safety test destroyed the core of Unit 4 and started a powerful fire, which lasted for about 10 days.
- A massive amount of radioactivity was released into the environment during the explosion and the fire.
- The radioactive cloud dispersed over the entire northern hemisphere and deposited substantial amounts of radioactive material.



CROSS-SECTION VIEW OF THE DESTROYED REACTOR BUILDING (UNSCEAR 1988, 2000)



THE CHERNOBYL ACCIDENT

- The accident was the most severe in the history of the nuclear power industry and caused the radioactive contamination of around 200 000 km² in Europe*.
- About 14×10^{18} Bq radioactivity released.
- The most radiologically important radionuclides were ¹³¹I and ¹³⁷Cs.

*Areas where the surface deposition of ¹³⁷Cs exceeded 37 kBq/m².

1986: DEATH TOLL, INJURIES AND EVACUATION

- The accident caused the deaths, within a few weeks, of 30 workers and radiation injuries to over a hundred others.
- The authorities evacuated, in 1986, about 115,000 people from areas surrounding the reactor and subsequently relocated, after 1986, about 220,000 people from Belarus, the Russian Federation and Ukraine.

AFFECTED AREAS

The radioactive fallout primarily affected rural areas largely occupied by forests and wetlands as well as arable land and pastures.



AFFECTED COMMUNITIES AND ECONOMY

- The accident caused serious social and economic disruption for large populations in Belarus, the Russian Federation and Ukraine.
- Prior to the accident rural communities in the area traditionally relied on agriculture (mainly grain, potato and flax production and livestock farming) as well as on harvesting wild products such as mushrooms, berries, game and fish.
- The timber industry and peat extraction were also important components of the local economy.



LACK OF ENERGY SUPPLY



NATIONAL AND INTERNATIONAL ASSESSMENTS

NATIONAL ASSESSMENTS

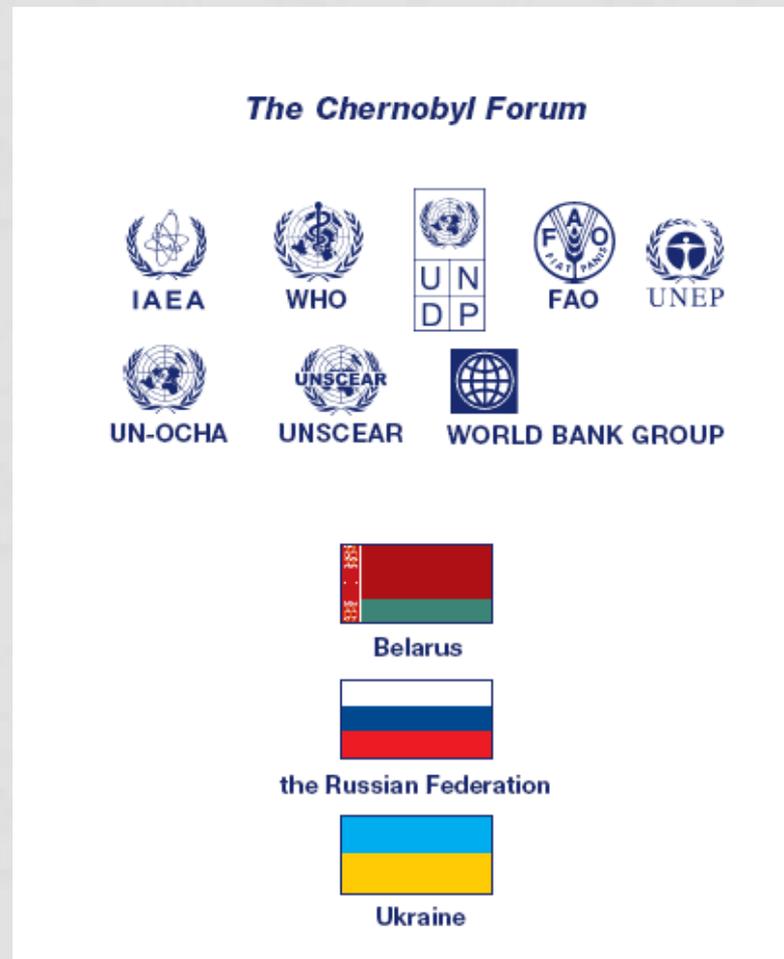
- A number of scientific publications, including:
 - Environmental – Acad. Yu. Izrael
 - Agricultural – Acads R. Alexakhin and B. Prister
 - Health – Acads L. Ilyin, A. Tsyb
 - Social and Economic - Acad. S. Belyaev
- Periodic National reports

INTERNATIONAL ASSESSMENTS

- Post-accident review meeting – IAEA, August 1986
- International Chernobyl Project – IAEA, 1990
- **UNSCEAR reports** – 1988, 2000 and **2008**
- IPHECA – WHO, 1991-1995
- EC + FSU joint research projects – 1992-1999
- International Conference “One Decade after Chernobyl: Summing up the Consequences” - IAEA, WHO and EC, 1996
- The Human Consequences of the Chernobyl Nuclear Accident – **A Strategy for Recovery, 2002**
- **The Chernobyl Forum – 2003-2005**

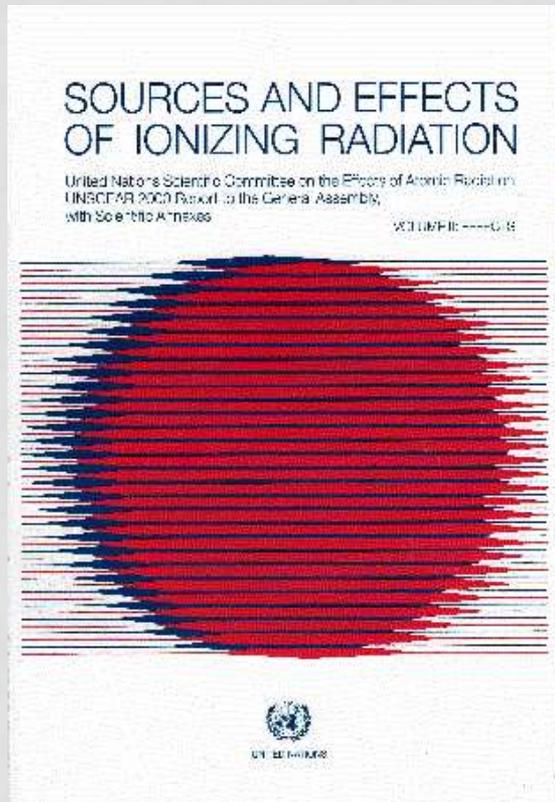
THE UN CHERNOBYL FORUM

- Initiated by the IAEA and contributed to the implementation of the UN “Strategy for Recovery”;
- 8 UN organizations + Governments of Belarus, Russia and Ukraine involved;
- The results endorsed by 60th UN General Assembly, 2005.

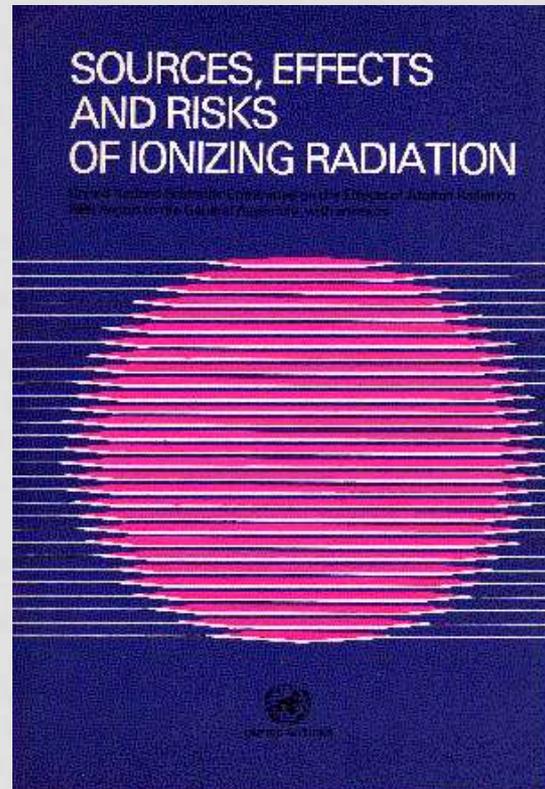


CHERNOBYL-RELATED UNSCEAR REPORTS

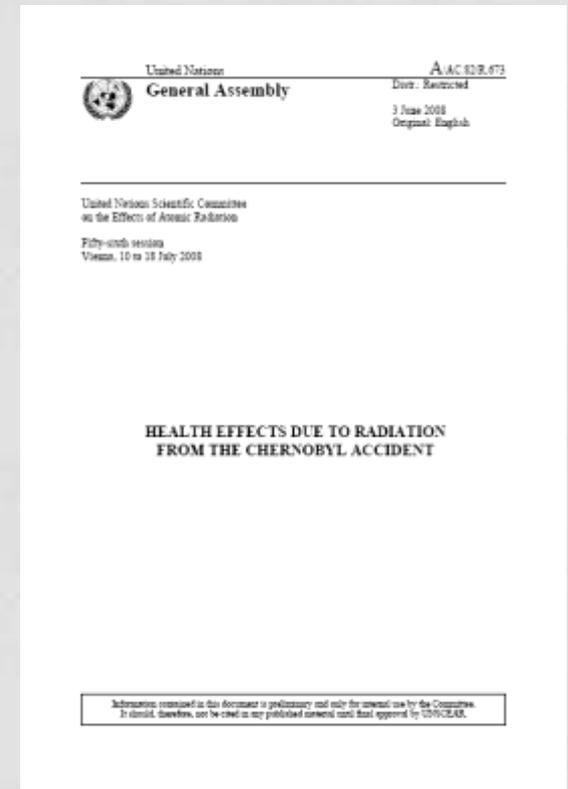
1988



2000



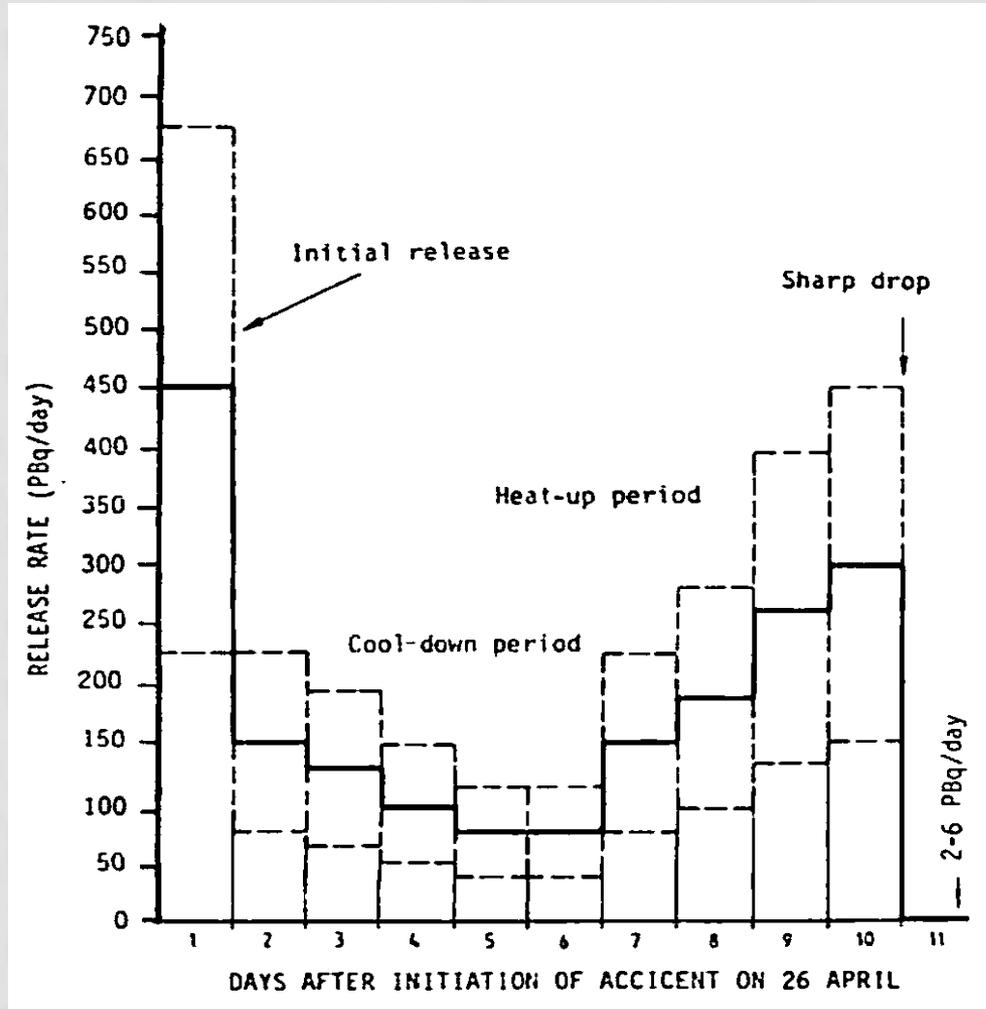
2008



ENVIRONMENTAL CONTAMINATION

UN AND UNSCEAR

DAILY RELEASE RATE TO THE ATMOSPHERE EXCLUDING NOBLE GASES, DECAY-CORRECTED TO MAY 6, 1986



1 PBq = 10^{15}

REVISED ESTIMATES OF THE TOTAL RELEASE OF PRINCIPAL RADIONUCLIDES TO ATMOSPHERE (UNSCEAR 2008)

<i>Radionuclide</i>	<i>Half-life</i>	<i>Activity released (PBq)</i>
Inert gases		
⁸⁵ Kr	10.72 a	33
¹³³ Xe	5.25 d	6 500
Volatile elements		
^{129m} Te	33.6 d	240
¹³² Te	3.26 d	~1 150
¹³¹ I	8.04 d	~1 760
¹³³ I	20.8 h	910
¹³⁴ Cs	2.06 a	~47 ^b
¹³⁶ Cs	13.1 d	36
¹³⁷ Cs	30.0 a	~85

REVISED ESTIMATES OF THE TOTAL RELEASE OF PRINCIPAL RADIONUCLIDES TO ATMOSPHERE (CONTD.)

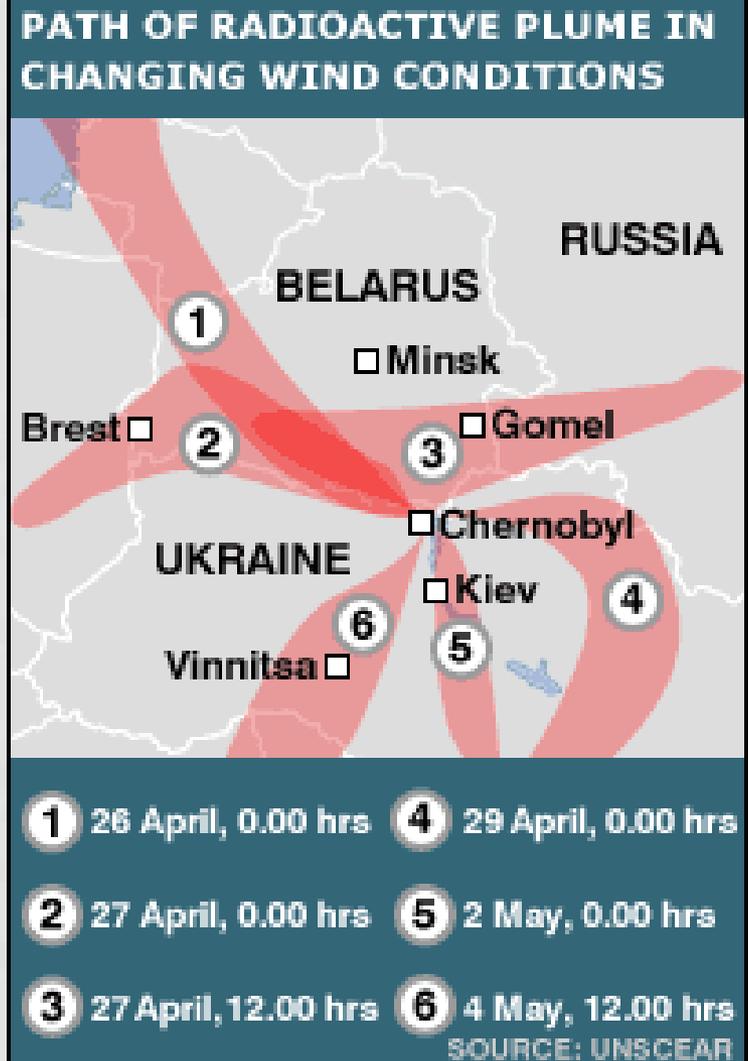
Elements with intermediate volatility		
⁸⁹ Sr	50.5 d	~115
⁹⁰ Sr	29.12 a	~10
¹⁰³ Ru	39.3 d	>168
¹⁰⁶ Ru	368 d	>73
¹⁴⁰ Ba	12.7 d	240
Refractory elements (including fuel particles)^c		
⁹⁵ Zr	64.0 d	84
⁹⁹ Mo	2.75 d	>72
¹⁴¹ Ce	32.5 d	84
¹⁴⁴ Ce	284 d	~50
²³⁹ Np	2.35 d	400
²³⁸ Pu	87.74 a	0.015
²³⁹ Pu	24 065 a	0.013
²⁴⁰ Pu	6 537 a	0.018
²⁴¹ Pu	14.4 a	~2.6
²⁴² Pu	376 000 a	0.00004
²⁴² Cm	18.1 a	~0.4

INITIAL DISPERSION AND DEPOSITION

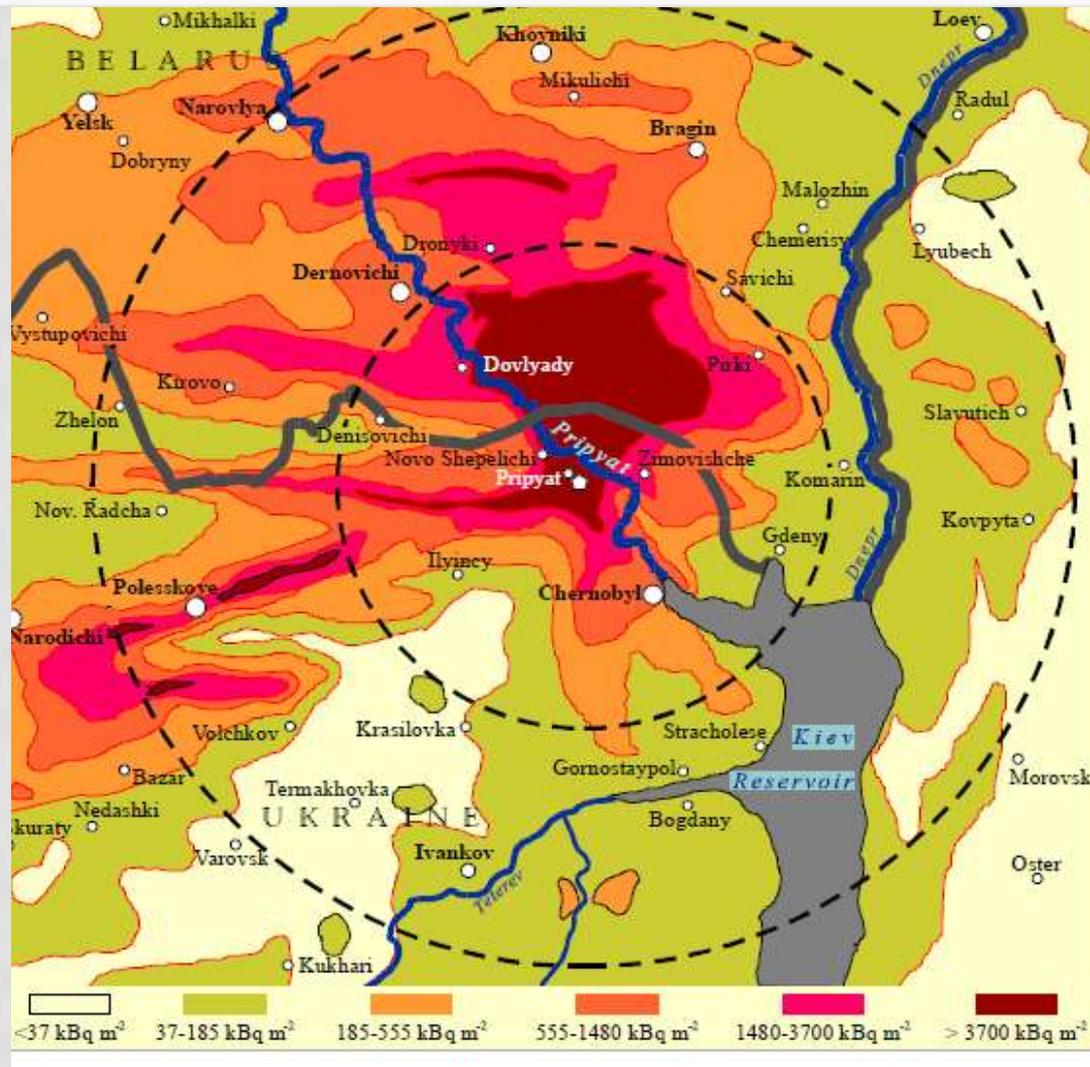
- Contamination was most intense around the stricken reactor.
- The bulk of the radioactive material significant for the current environmental situation was released to the atmosphere.
- This material was carried by the wind and gradually fell out over large areas of Belarus, Russia, Ukraine and beyond.
- During the fire the wind and other climatic conditions changed several times.

ATMOSPHERIC DISPERSION

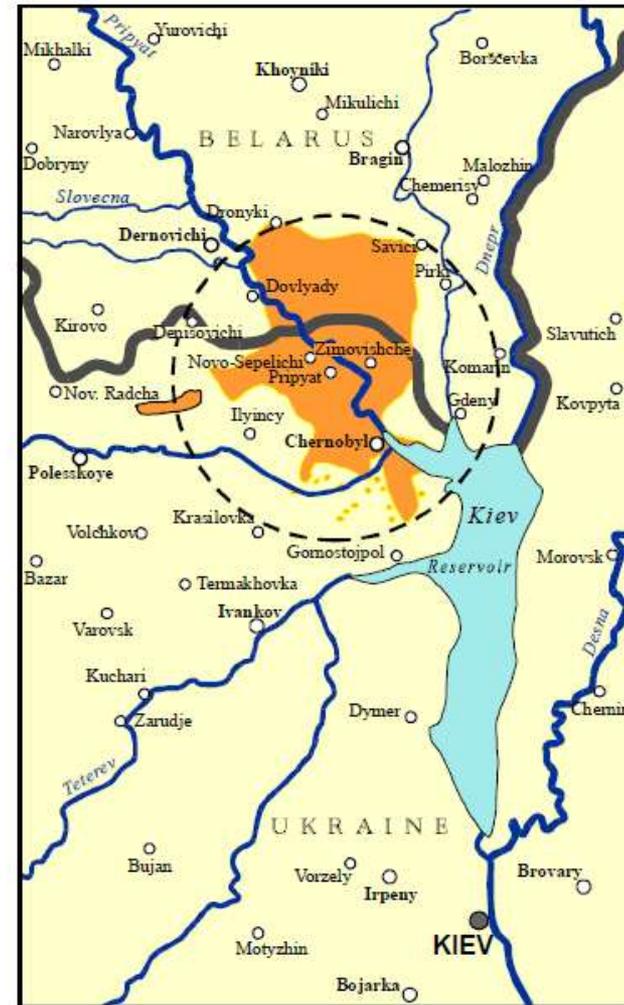
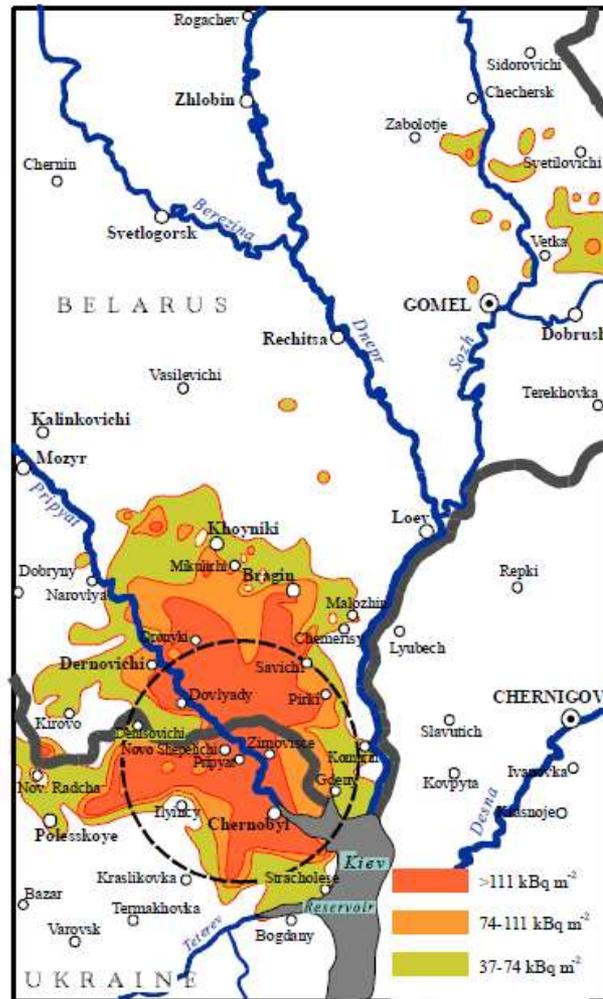
- Initially the radioactive plume was blown westwards across northern Ukraine and southern Belarus.
- Subsequently the winds came from all directions.
- Material was deposited mainly because of rainfall, in a complex pattern.



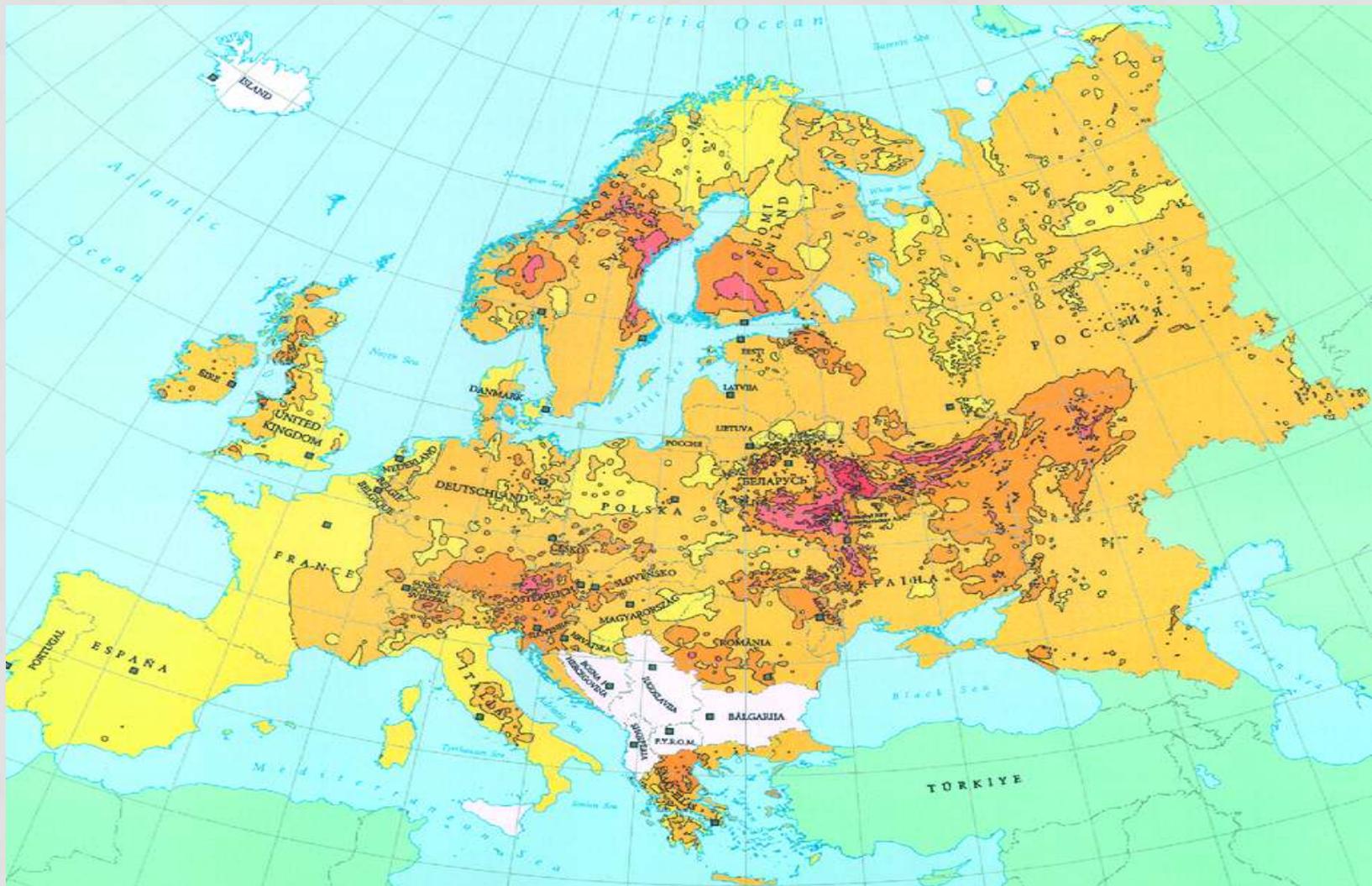
GROUND DEPOSITION OF CS-137 IN THE IMMEDIATE VICINITY OF THE CHERNOBYL NPP (UNSCEAR 2000)



GROUND DEPOSITIONS OF SR-90 (LEFT) AND PU-239 (RIGHT) RELEASED IN THE CHERNOBYL ACCIDENT



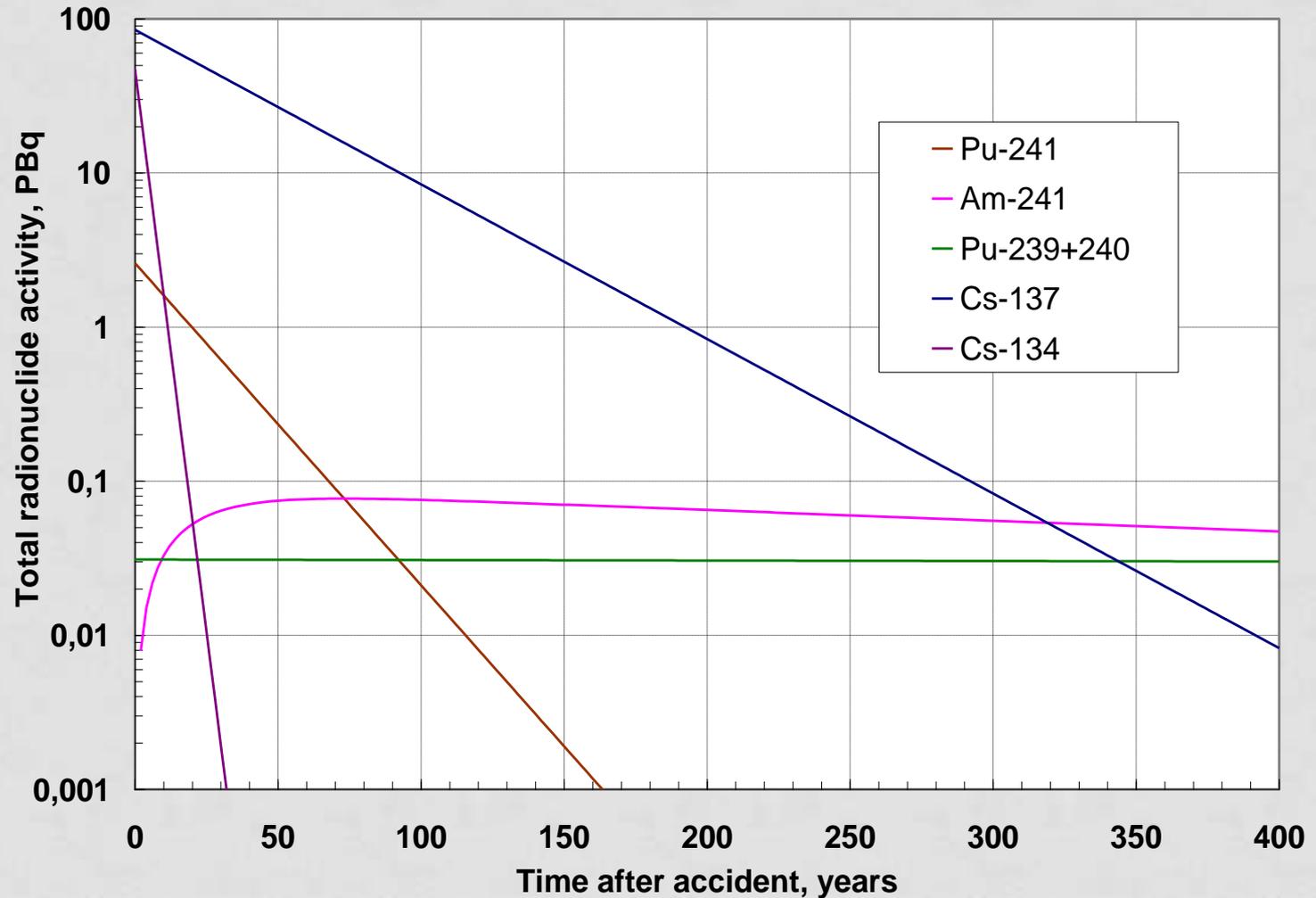
DEPOSITION OF ^{137}CS IN EUROPE (ATLAS 1998)



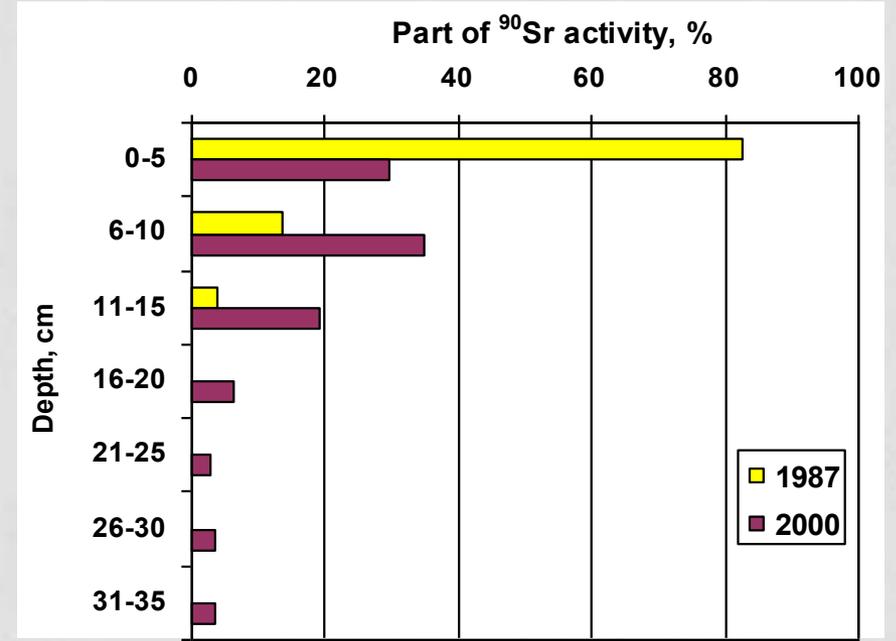
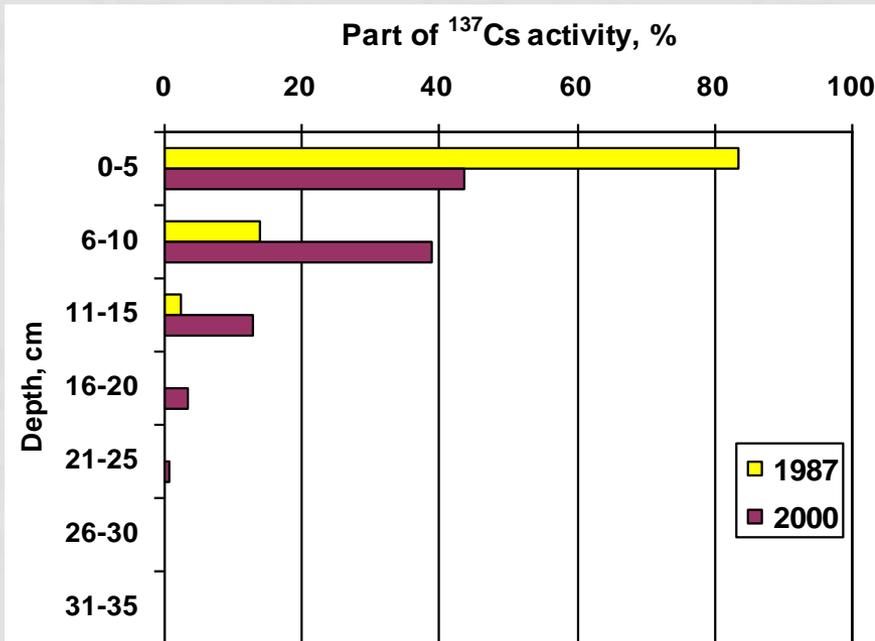
CONTAMINATED AREAS IN EUROPEAN COUNTRIES FOLLOWING THE ACCIDENT

Country	Area in deposition density ranges (km ²) ^a			
	37- 185 kBq m ⁻²	185- 555 kBq m ⁻²	555- 1 480 kBq m ⁻²	>1 480 kBq m ⁻²
Russian Federation	49 800	5 700	2 100	300
Belarus	29 900	10 200	4 200	2 200
Ukraine	37 200	3 200	900	600
Sweden	12 000	-	-	-
Finland	11 500	-	-	-
Austria	8 600	-	-	-
Norway	5 200	-	-	-
Bulgaria	4 800	-	-	-
Switzerland	1 300	-	-	-
Greece	1 200	-	-	-
Slovenia	300	-	-	-
Italy	300	-	-	-
Republic of Moldova	60	-	-	-

LONG-LIVED RADIONUCLIDES IN THE ENVIRONMENT AS A FUNCTION OF TIME

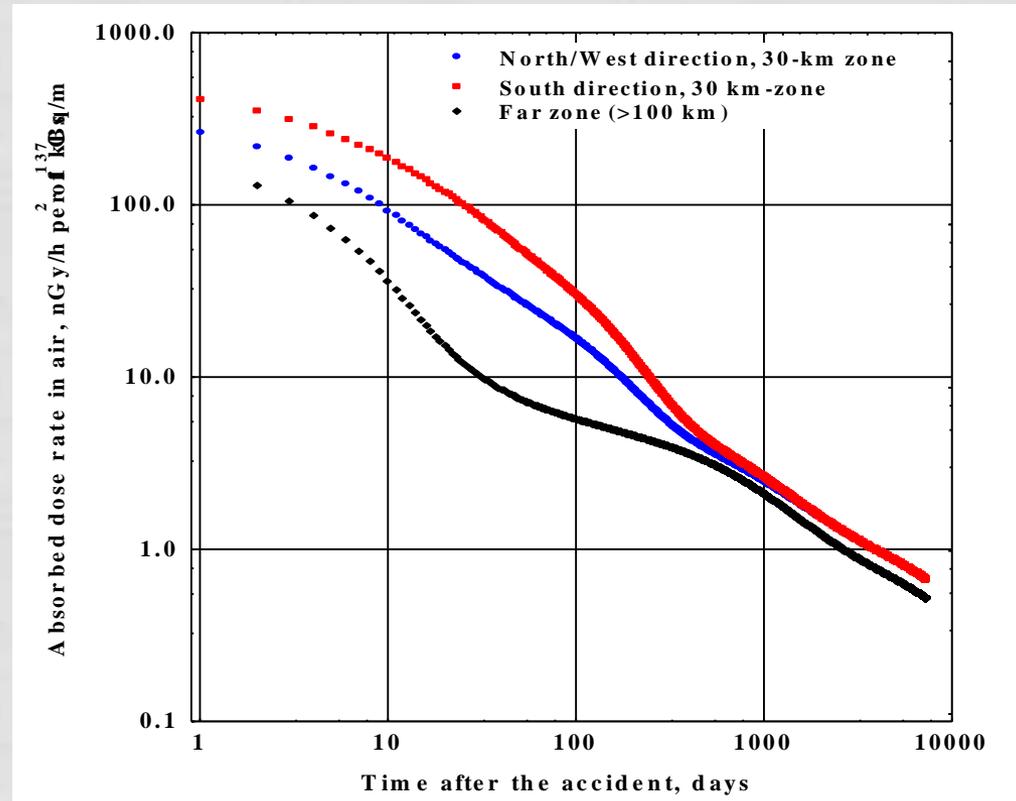


DEPTH PROFILES FOR CS-137 AND SR-90 MEASURED IN 1987 AND 2000 IN A SODDY-GLEY-SANDY SOIL

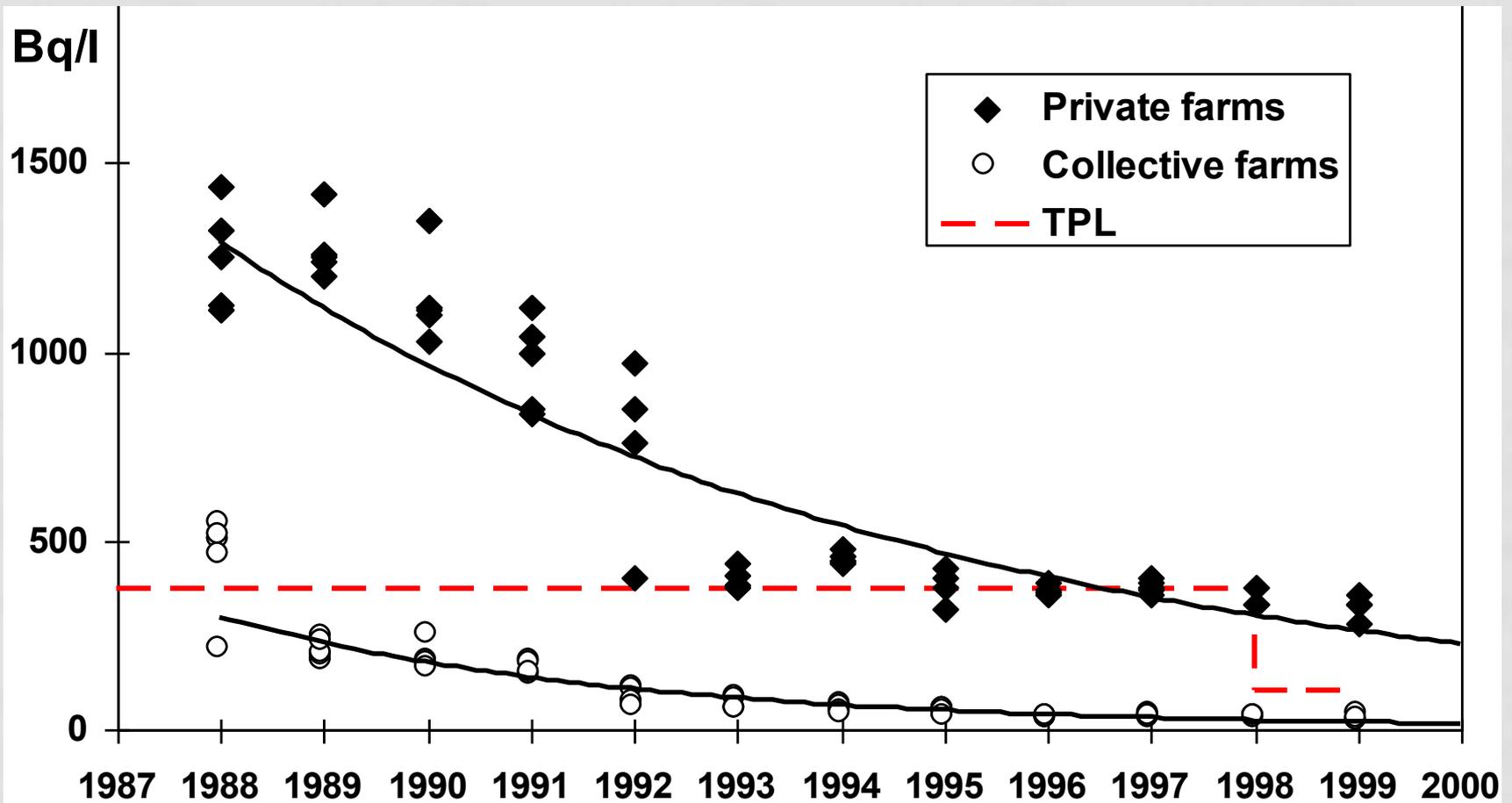


ENVIRONMENTAL RADIATION LEVELS

- Radiation levels in the environment have reduced by a factor of several hundred since 1986 due to natural processes and countermeasures.
- Therefore, the majority of the land that was previously contaminated with radionuclides is now safe for life and economic activities.



TYPICAL DYNAMICS OF CS-137 ACTIVITY CONCENTRATION IN MILK WITH A COMPARISON TO TPL, RIVNO REGION, UKRAINE



EXPOSURE OF INDIVIDUALS

UNSCEAR

MAIN RADIONUCLIDES

- The radionuclides released from the reactor that caused exposure of individuals were mainly iodine-131, caesium-134 and caesium-137.
- Iodine-131 has a short radioactive half-life, but it can be transferred to humans relatively rapidly from the air and through consumption of contaminated milk and leafy vegetables.
- For reasons related to the intake of milk and dairy products by infants and children, as well as the size of their thyroid glands and their metabolism, the radiation doses are usually higher for them than for adults.

RADIOACTIVE ISOTOPES OF CAESIUM AND OTHER RADIONUCLIDES

- The isotopes of caesium (caesium-134 and caesium-137) have relatively longer half-lives.
- These radionuclides cause longer-term exposures through the ingestion pathway and through external exposure from their deposition on the ground.
- Many other radionuclides were associated with the accident, which were also considered in the exposure assessments.

RECOVERY OPERATION WORKERS

- About 600 workers responded on site within the first day to the immediate emergency.
- In 1986 and 1987 some 440,000 recovery operation workers worked at the Chernobyl site and more such workers were involved between 1988 and 1990.

DOSE TO WORKERS INVOLVED IN RESPONSE AND RECOVERY (UNSCEAR 2000)

- The average effective dose received by the recovery operation workers between 1986 and 1990, mainly due to external irradiation, is now estimated to have been about 120 mSv.
- The recorded worker doses varied from less than 10 mSv to more than 1,000 mSv, although about 85% of the recorded doses were in the range 20–500 mSv.
- The collective effective dose to the 530,000 recovery operation workers is estimated to have been about 60,000 man Sv.

DOSES OF EVACUEES (UNSCEAR 2000)

- Within a few weeks of the accident, 116 000 persons had been evacuated from the most contaminated areas of Belarus and Ukraine.
- The thyroid doses received by the evacuees varied according to their age, place of residence and date of evacuation.
- For the residents of Pripyat town, who had been evacuated within 40 h after the accident, the thyroid doses ranged from 0.07 Gy for adults to 2 Gy for infants.
- For the entire population of evacuees, the average thyroid dose was estimated to be 0.47 Gy.

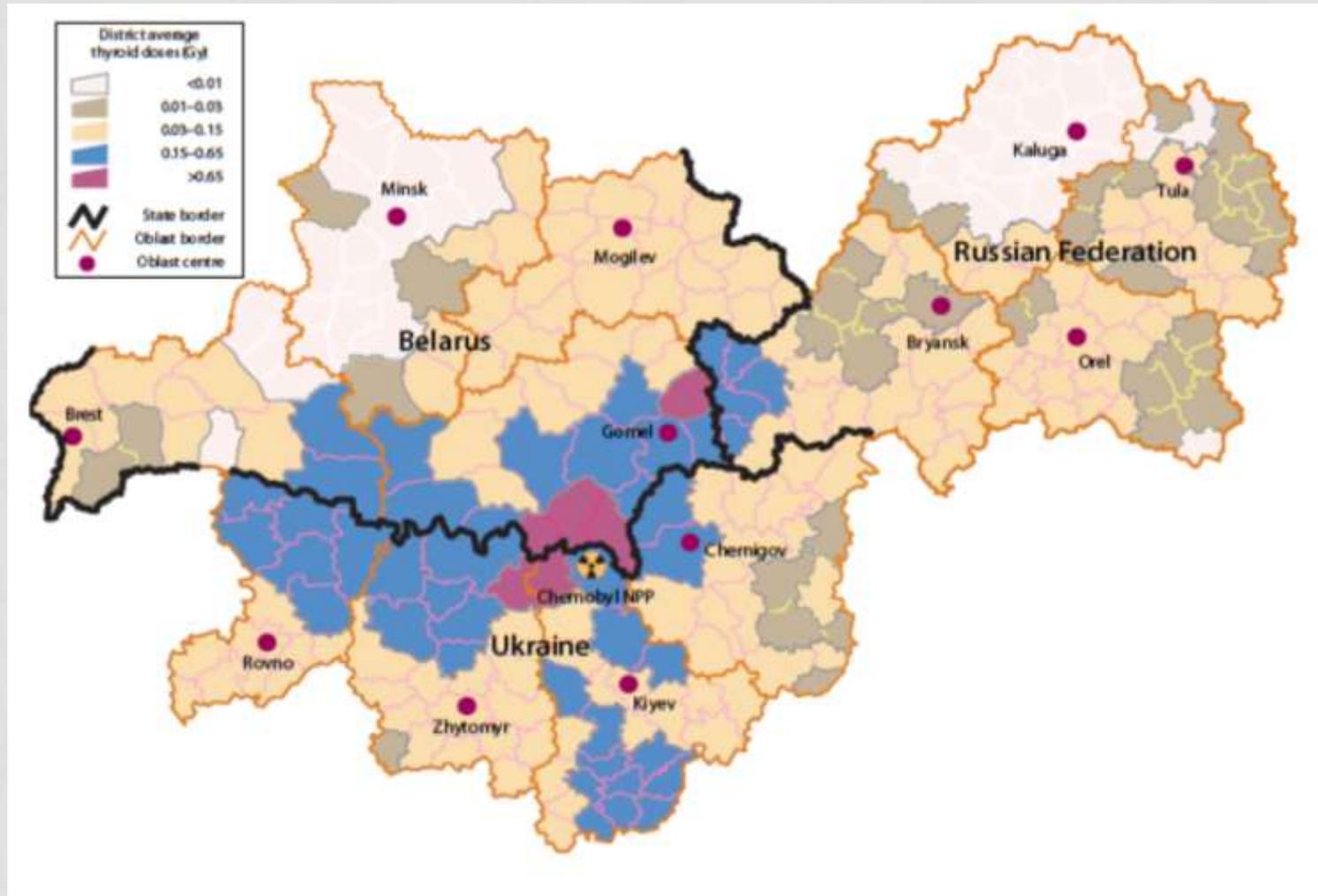
WHOLE BODY DOSES OF THE GENERAL PUBLIC (UNSCEAR 2000)

- The average effective doses that had been received during the first 10 years after the accident by the residents of ‘contaminated’ areas were estimated to be about 10 mSv.
- About 10,000 people were estimated to have received doses greater than 100 mSv.
- The lifetime effective doses were expected to be about 40% greater than the doses received during the first 10 years following the accident.

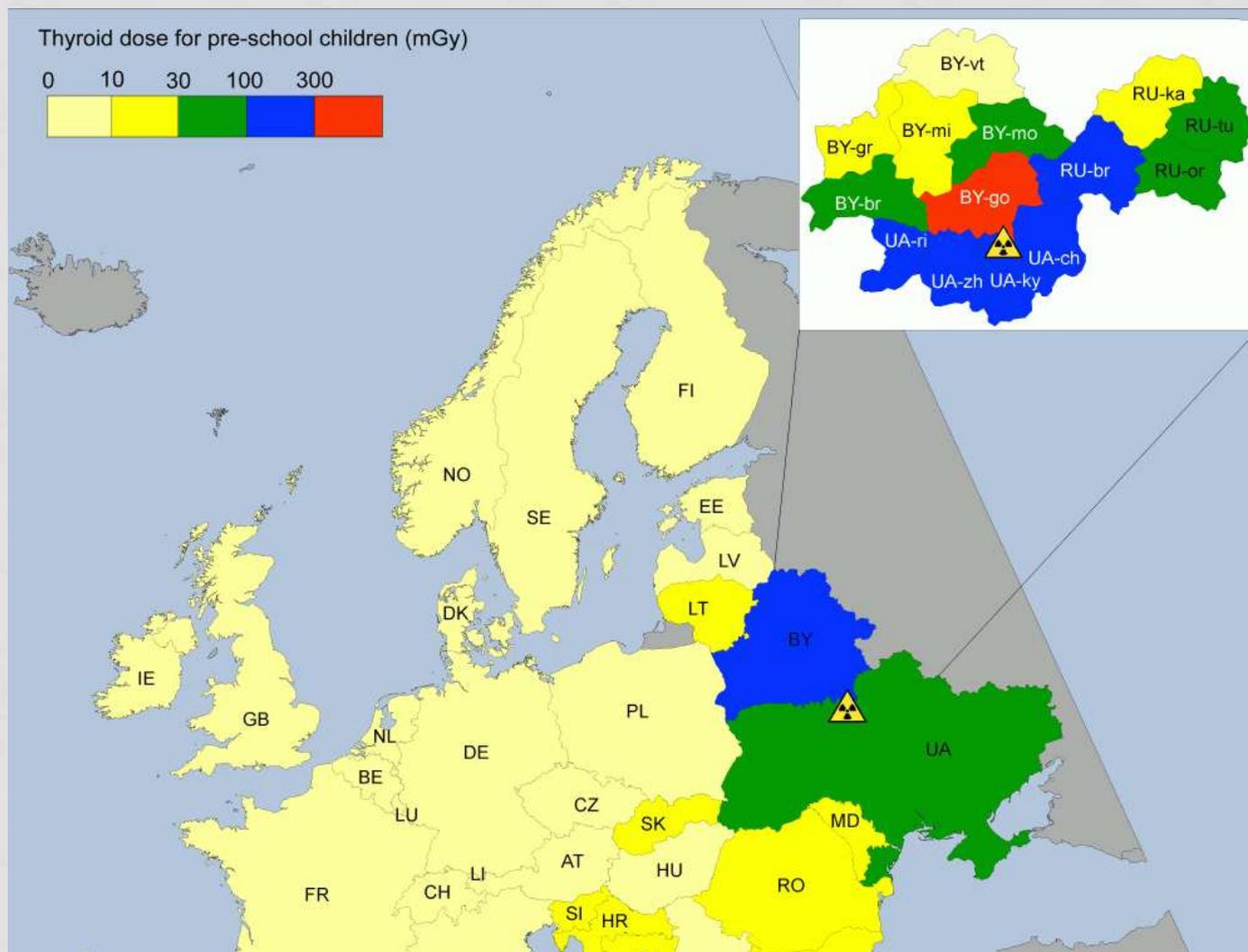
INDIVIDUAL THYROID DOSES OF THE GENERAL PUBLIC (UNSCEAR 2008)

- The average thyroid dose to the evacuees is estimated to have been about 500 mGy.
- For the six million residents of the 'contaminated areas' of the former USSR, the average thyroid dose was about 100 mGy, while for about 0.7% of them, the thyroid doses were more than 1,000 mGy.
- The average thyroid dose to pre-school children was 2 to 4 times greater than the population average.

AVERAGE THYROID DOSE TO CHILDREN AND ADOLESCENTS (UNSCEAR 2008)



AVERAGE THYROID DOSES TO THE PRE-SCHOOL CHILDREN IN EUROPE (UNSCEAR 2008)



INDIVIDUAL WHOLE BODY DOSES OF THE GENERAL POPULATION IN 1986–2005

- The six million residents of the 'contaminated areas' of the former USSR received average effective doses of about 9 mSv, a third of which was received in 1986.
- For the 98 million people considered in the three countries, the average effective dose was 1.3 mSv.
- Over the 20-year period, about 70% of the population received effective doses below 1 mSv and about 20% received effective doses between 1 and 2 mSv.
- However, about 150,000 people living in the contaminated areas received an effective dose of more than 50 mSv over the 20-year period.
- About three-quarters of the dose was due to external exposure, the rest being due to internal exposure.
- About 80% of the lifetime effective doses had been delivered by 2005.

UNSCEAR: ESTIMATES OF MEAN DOSES OF VARIOUS POPULATION GROUPS

Population group	Number (thousands)	Mean thyroid dose (mGy)	Mean effective dose in 1986-2005 (mSv)
Workers (1986-1990)	530	N/A	117
Evacuees (1986)	115	490	31
'Area of strict control' (in B, R, U)	216	N/A	61
Inhabitants of 'contaminated' areas	6 400	102	9
Belarus, Ukraine and 19 Russian regions	98 000	16	1.3
Distant European countries	500 000	1.3	0.3



THYROID CANCER

UNSCEAR -2008

A MAJOR PUBLIC HEALTH IMPACT

- Among the residents of Belarus, the Russian Federation and Ukraine, there had been up to the year 2005 more than 6,000 cases of thyroid cancer reported in children and adolescents who were exposed at the time of the accident, and more cases can be expected during the next decades.
- Apart from this increase, there is no evidence of a major public health impact attributable to radiation exposure two decades after the accident.

UNSCEAR ABOUT THE IMPACT OF THE ACCIDENT

- In the FSU, the contamination of fresh milk with I-131 and the lack of prompt countermeasures led to high thyroid doses, particularly among children.
- In the longer term, mainly due to radiocaesium, the population was also exposed to radiation.
- However, **because of countermeasures taken, the resulting radiation doses were relatively low and should not lead to substantial health effects that could be attributed to radiation exposure from the accident.**
- The sever disruption caused by the accident cofounded with the remarkable political changes resulted in major social and economic impact and great distress for the affected population.

COUNTERMEASURES AND REMEDIATION ACTIVITIES

UN AND EBRD

IMMEDIATE RESPONSE (1986)



Immediate action to tackle the consequences of the accident focused on protecting the population from exposure. This was achieved through urgent evacuation of the town of Prip'yat (within the first two days) and ...



IMMEDIATE RESPONSE (1986 - 1991)



...the surrounding settlements were evacuated soon after (a total of 115,000 local people evacuated in 1986). Subsequently, further 220,000 people were resettled.

Evacuation was initially applied on an obligatory basis to the population of the Exclusion Zone (extending 30 km in all directions from the Chernobyl Plant).



IMMEDIATE RESPONSE (1986 - 1991)

- Later, the primary criteria became the density of contamination of the area by the radioactive isotope of caesium and the average individual doses for particular settlements.
- Clean-up works involved washing off buildings and streets, removing topsoil and burying contaminated equipment.



ON-SITE ACTIVITIES

- To prevent further release of radioactivity, a structure - the so-called Shelter or sarcophagus - was fabricated around the stricken reactor. Construction of the Shelter by November 1986.
- Highly contaminated soil in the vicinity was removed. A system of dams and other waterworks was erected to reduce the run-off from contaminated territories.



RESTRICTIONS ON LAND-USE AND ECONOMIC ACTIVITIES

- Restrictions on land-use economic activities were implemented and controls of radioactive contamination in foodstuffs and other produce strengthened.
- In the years following the accident, standards for contamination by radioactive substances were made progressively stricter.
- The restrictions on land use were supplemented by the application of agricultural countermeasures to prevent the migration of radio-nuclides from soil to food stuffs.
- A strong research and development capacity was created to achieve this purpose. Dozens of countermeasures were tested and some were introduced in routine practice.

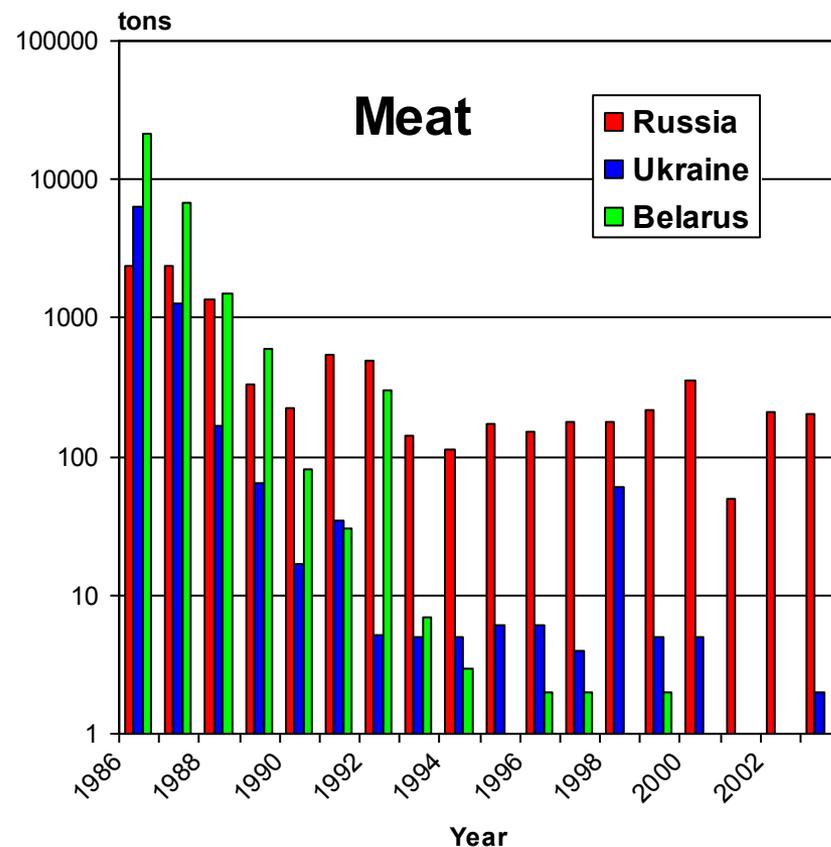
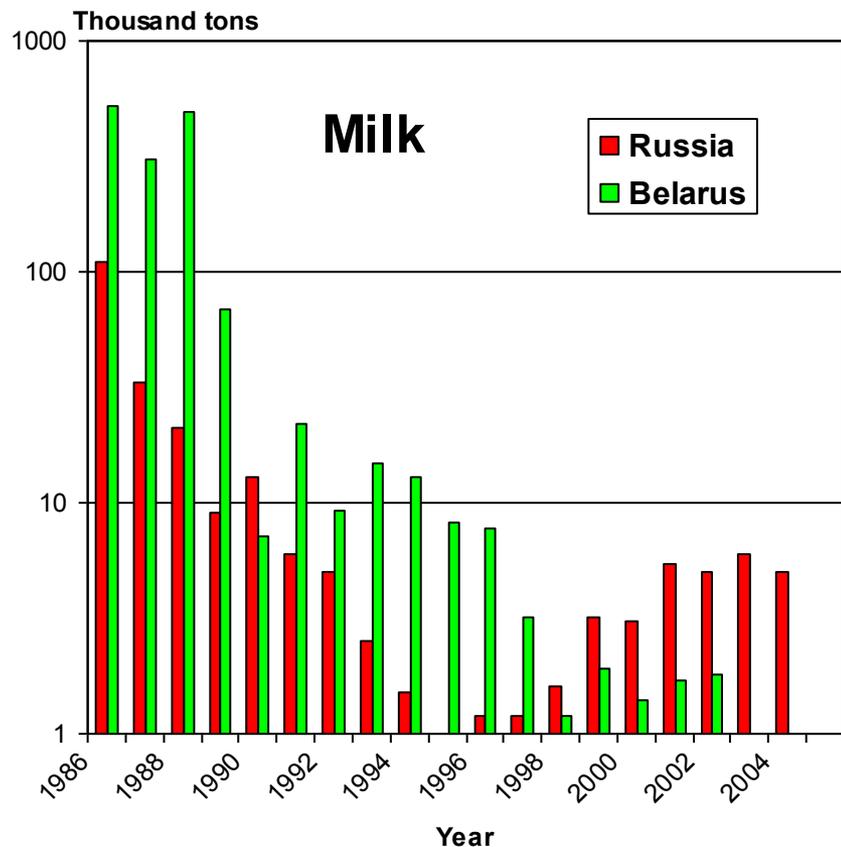
EARLY AGRICULTURAL COUNTERMEASURES

- In the first few weeks, management of animal fodder and milk production (including prohibiting the consumption of fresh milk) would have helped significantly to reduce the doses to the thyroid due to radioiodine.
- However, implementation of countermeasures in the former Soviet Union was flawed (except of some towns) because timely advice was lacking, particularly for private farmers.
- Many European countries changed their agricultural practices and/or withdrew food, especially fresh milk, from the supply chain. That generally reduced thyroid doses in those countries to negligible levels.
- In Poland, iodine prophylaxis was promptly organized that also reduced thyroid doses.

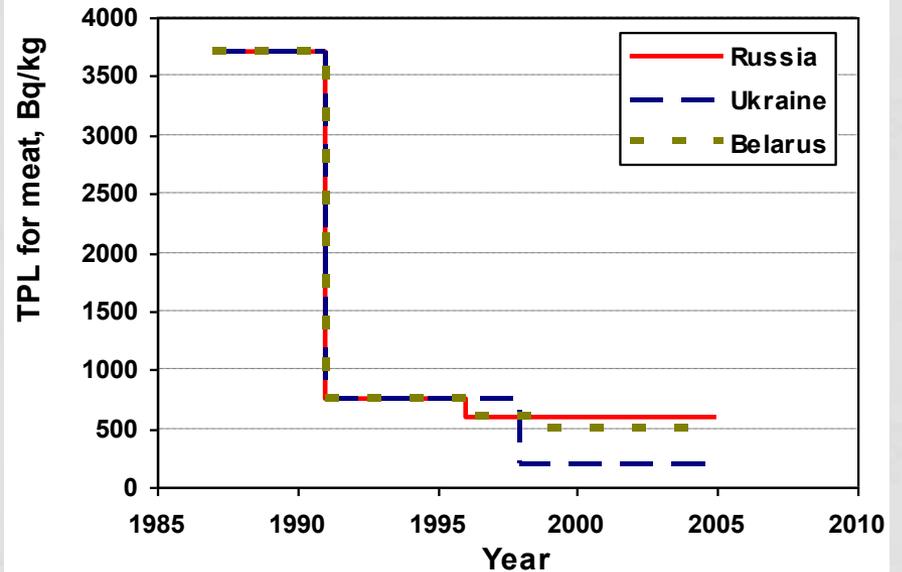
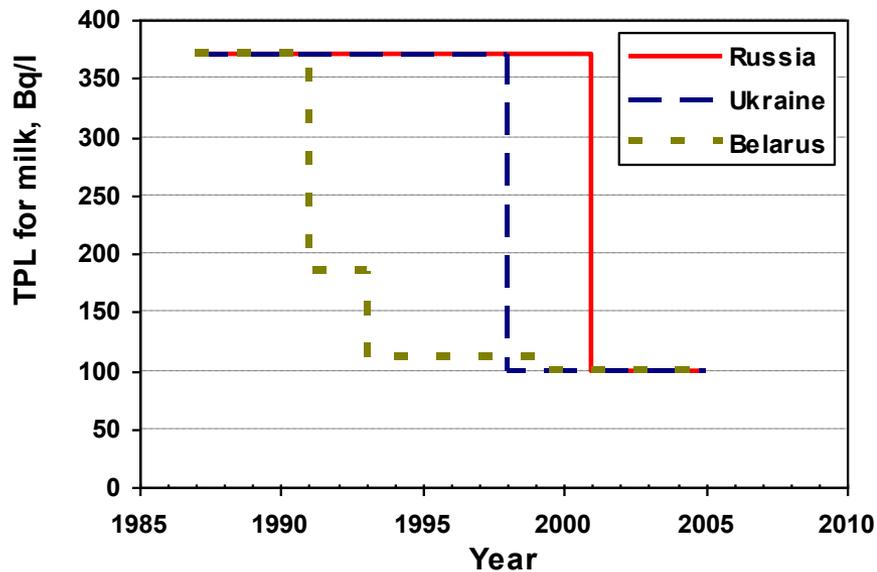
LONG-TERM AGRICULTURAL COUNTERMEASURES

- Over the months and years after the accident, the authorities of the former Soviet Union introduced an extensive set of agricultural countermeasures, involving major human, economic and scientific resources.
- These helped to reduce the long-term exposures from the long-lived radionuclides, notably radiocaesium.
- During the first few years, substantial amounts of food were removed from human consumption because of concerns about the radiocaesium levels, especially in milk and meat.
- In addition, pasture was treated, and clean fodder and caesium binders were provided to livestock, resulting in considerable reductions in dose.

AMOUNTS OF MILK AND MEAT EXCEEDING THE TEMPORARY PERMISSIBLE LEVELS (TPLS) IN RUSSIA, UKRAINE AND BELARUS

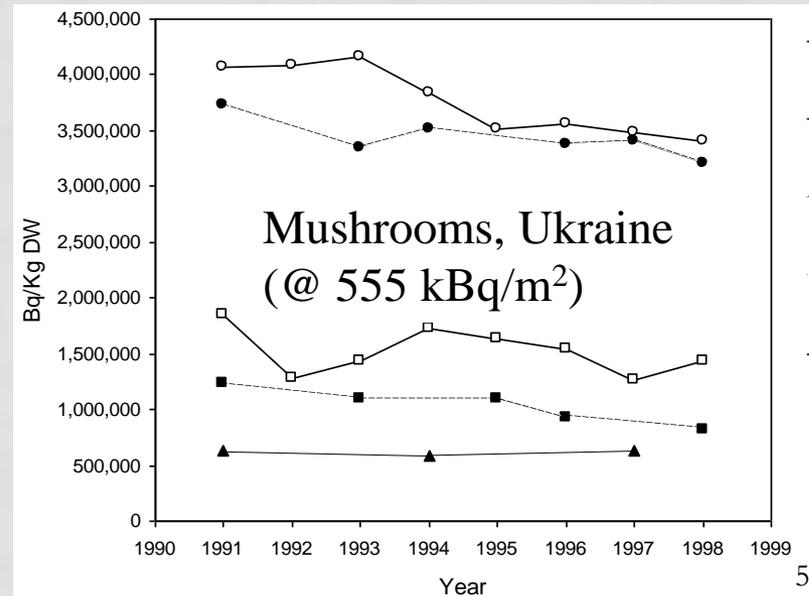
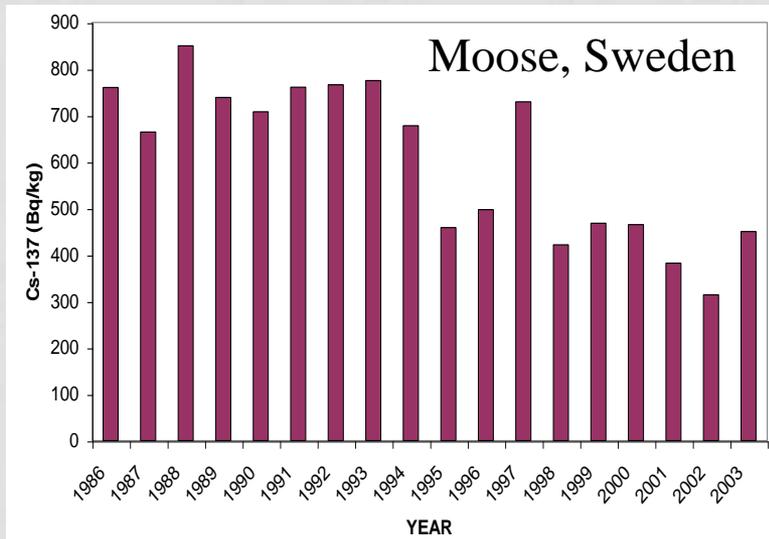


CHANGES WITH TIME IN PERMISSIBLE LEVELS (TPL) IN THE FORMER USSR AND LATER IN THE THREE INDEPENDENT COUNTRIES



RADIONUCLIDES IN 'WILD FOODS'

- Particularly high ^{137}Cs activity concentrations have been found in mushrooms, berries, lake fish and game.
- This peculiarity is explained with slow migration of ^{137}Cs in undisturbed natural soils and bottom sediments.
- The high ^{137}Cs levels in wild foods have persisted for two decades, and this can be expected to continue for several more decades.



FOREST COUNTERMEASURES

- Countermeasures were instigated to reduce exposures from living and working in forests and using forest products.
- They included:
 - restrictions on access;
 - restrictions on harvesting of forest foods, such as game, berries and mushrooms;
 - restrictions of the gathering of firewood; and
 - alteration of hunting practices.

AQUATIC COUNTERMEASURES

- Early restrictions on drinking water and changing to alternative supplies reduced internal doses from aquatic pathways in the initial period.
- Restrictions on the consumption of freshwater fish from some lakes also proved effective in Scandinavia and Germany.
- Other countermeasures to reduce the transfer of radionuclides from soil to water systems were generally ineffective.

CURRENT LEVELS OF RADIONUCLIDES IN FOODSTUFFS AND NEED IN COUNTERMEASURES

- In 2008, owing to both natural processes and agricultural countermeasures, the activity concentrations of ^{137}Cs in agricultural food products were generally below national, regional (EU) and international action levels.
- However, in some limited areas with high radionuclide deposition (Belarus, Russia) or with poor organic soils (Ukraine) the activity concentrations of ^{137}Cs in food products, especially milk, still exceeded the national action levels of about 100 Bq/kg.
- Thus, there remains need in application of agricultural countermeasures in some limited areas of the three countries.

EXPECTED FUTURE TRENDS

- There has been only a slow decrease in activity concentrations of ^{137}Cs in most plant and animal foodstuffs during 1998–2008.
- This indicates that radionuclides must be close to equilibrium within the agricultural ecosystems.
- However, continued reductions with time would be expected owing to continuing migration down the soil profile and to radioactive decay.
- Given the large uncertainties in quantifying long-term effective half-lives, it is not possible to conclude that there will be any further substantial decrease over the next decades, except as a consequence of further radioactive decay of both ^{137}Cs and ^{90}Sr , each with half-lives of about thirty years.

THE NEW SAFE CONFINEMENT



THE NEW SAFE CONFINEMENT





SOCIO-ECONOMIC DIMENSIONS

UN

DIRECT LOSSES AND EXPENSES

- For the period of 1986–1989, the total sum of direct losses and expenses was about 9200 million rubles, i. e. about **US\$ 12.6 billion**.
- This information was officially presented at the meeting of the Economic and Social Council of the UNO by delegations of the USSR, Belarus and Ukraine (the letter to UNO General secretary No. a/45/342, E/1990/102).

1986 NATIONAL ECONOMY CAPITAL LOSSES IN THE EXCLUSION ZONE (UA)

National economy capital losses in the exclusion zone on the territory of Ukraine, which were taken out of use due to the catastrophe in 1986

The name of the capital object lost due to the Chernobyl catastrophe	The year of estimation of key assets and the material circulating asset value	The value of production key assets and of material circulating assets	
		thousands of rubles	₴ thousands
Objects and expenses concerning the stopped building of the Chernobyl NPP (III turn)	1986*	99.028	136.120
The fourth block of Chernobyl NPP	1964**	201.000	223.330
The object «Chernobyl - 2»	1984***	97.700	137.027
Enterprises of the communication industry (1)	1986	51.070	70.199
Enterprises of metallurgy industries (1)	1986	44.700	61.443
Enterprises of the building materials industry (1)	1986	7.750	10.653
Enterprises of river transport (2)	1986	21.050	28.935
The highways with hard surfaces (353 km)	1986	60.550	83.230
Enterprises of the woodworking industry (1)	1986	4.720	6.498
Enterprises of the feed mill industry (1)	1986	4.550	6.254
Enterprises of primary processing of agricultural raw materials(1)	1986	4.900	6.735
Enterprises of the food industry	1986	5.010	6.887
Enterprises of repair of tractors and agricultural machines (1)	1986	760	1.045
Enterprises of woodlands (1)	1986	4.700	6.490
Collective farms (14)	1986	79.693	109.544
State farms (2)	1986	18.659	25.648
Co-agricultural enterprises	1986	18.694	25.696
Infrastructure and network of water-supply	1986	4.405	6.055
Infrastructure and networks of sewerage	1986	3.850	5.292
Electrical networks for lighting	1986	315	433
Infrastructure and networks of heat supply	1986	3.390	4.600
The available housing:			
– state (402)	1986	209.750	288.316
– private (2.278)		7.101	9.761
– rural houses (9.050)		28.200	38.763
Recreation departments (10); medical stations (44); Schools; trade schools (3); secondary schools (34); musical schools (2); Palaces of culture (16); cinemas (2); clubs (30)	1986	29.104	40.005
TOTAL		1010.649	

* Course in April of 1986: \$1 – 72,75 kop.

** Course in October of 1984: \$1 – 71,3 kop.

*** Course in 1964: \$1 – 90 kop.

POLICY OF COMPENSATION

- A policy of compensation for various categories of Chernobyl victims was also introduced. The eligible groups included people who had been involved in the post accident clean-up, people who had been resettled and people who continued to live in areas with above a certain level of contamination.
- Compensation took the form of welfare payments and free and priority access to such things as medicine, travel and health recuperation holidays.
- The cost of these measures rapidly became a significant factor in the national budget. According to the Ukrainian national report “15 Years after the Chernobyl Catastrophe” **the Soviet Union spent \$18 billion on Chernobyl rehabilitation between 1986 and 1991.** Of this, 35% went on “social assistance to affected people” and 17% on resettlement.

POLITICAL CONTEXT (1)

- Important features of the policies adopted and continued by the Governments of Belarus, Russia and Ukraine, can only be properly understood in the context of Soviet conditions and practices and the politics of the transition.
- Soviet legislation gave high priority to the protection of the welfare of the citizen but, because of the absence of market based pricing, planners lacked the means to estimate opportunity costs effectively.
- Exchange of information and dissent were limited, while the State possessed very considerable powers of compulsion.

POLITICAL CONTEXT (2)

- After the Soviet Union broke up in 1991, Chernobyl became a key factor in domestic politics and in relations between the three new states. Belarus and Ukraine demanded compensation from Russia for the effects of the accident.
- Political institutions and procedures were immature. Politicians took up the issue of Chernobyl energetically on behalf of their constituents and in some cases parliaments agreed benefits without adequate regard to the resources available.
- As a result, some commitments could not be fully met. Especially in the case of Belarus and Ukraine, Chernobyl benefits came to represent a heavy burden on the national budgets and drained resources away from other areas of public spending.

COUNTRIES' PRIORITIES

- Faced with limited resources, the three countries each adopted different priorities.
- In Belarus priority was given to improving conditions in communities situated in contaminated areas, or which received large numbers of resettlers. Substantial resources were also allocated to assisting collective farms to grow clean products.
- The Russian government continued to pay comparatively high allowances to Chernobyl victims, but in the late 1990s virtually stopped resettlement even from the most severely contaminated areas. Support for protective measures for pasture and arable land also declined steeply.
- The government of Ukraine spent heavily on resettling people and improving living conditions and also faced the burden of making the Chernobyl power plant safe and preparing it for closure.

NATIONAL PROGRAMMES 1991-2001

- Strategy for post-Chernobyl rehabilitation is spelt out in National Programmes.
- The first of these was adopted in 1990 by the Soviet parliament. Later each country produced its own programme. These are based on legislation passed by the national parliaments.
- The scale of rehabilitation actions undertaken by Belarus, Russia and Ukraine from 1986 to the year 2000, is indicated by the official statistics on the number of houses, schools and hospitals built, as shown in table.
- Very large investments were also made in physical infrastructure such as roads, water and electricity supply and sewerage. Because of the risk that was believed to be involved in burning locally produced wood and peat, many villages were provided with access to gas supplies for heating and cooking. This involved laying down a total of 8,980 kilometres of gas pipeline in the three countries in the fifteen years following the accident.

HOUSING AND SOCIAL PROVISION DURING 1986 - 2000

	Belarus	Russia	Ukraine	Total
Houses and flats	64,836	36,779	28,692	130,307
Schools (number of places)	44,072	18,373	48,847	111,292
Kindergartens (number of places)	18,470	3,850	11,155	33,475
Outpatient health centres (visits/day)	20,922	8,295	9,564	38,781
Hospitals (beds)	4,160	2,669	4,391	11,220

SOCIAL PROTECTION

- The system of compensation payments established after the accident reflected a Soviet practice of, in effect, compensating exposure to risk rather than actual injury.
- Belarusian and Russian legislation provides more than seventy, and Ukrainian legislation more than fifty, different privileges and benefits for Chernobyl victims, depending on factors such as the degree of invalidity and the level of contamination.
- In all three countries, each family member is paid a monthly bonus for living on contaminated territory, but the size of the payment depends on circumstances.

CONCLUSIONS

- The accident at the Chernobyl nuclear power plant in 1986 was a tragic event for its victims, and those most affected suffered major hardship.
- The national economy and the social life have been seriously affected.
- A number of the people who dealt with the emergency lost their lives. Although those exposed as children and the emergency and recovery workers are at increased risk of radiation-induced effects, the vast majority of the population need not live in fear of serious health consequences due to the radiation from the Chernobyl accident.