Database of Chernobyl Center in Slavutych

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More than two decades after the Chernobyl accident, people living in the affected regions are now taking control of their lives once again [1]. The destroyed nuclear plant, the Chernobyl Nuclear Plant's Unit No.4, is now being covered by the new shelter, while the impacts on human and environment have been assessed and reported at the International Conference, "Twenty years after Chernobyl accident. Future Outlook", held in Kiev in 2006 [2, 3]. In the United Nations Chernobyl Forum Report [4] presented at that conference, about 4,000 cancer deaths were calculated for the rest of the life among the 600,000 most affected populations, while 4,837 thyroid cancers among the child population were observed from 1986 till 2002 and were confirmed as the radiation impacts of the accident.

The International Chernobyl Center of Nuclear Safety, Radioactive Waste and Radioecology (hereinafter, "Chernobyl Center") was established in 1996 under the Cabinet Ministry of Ukraine. Its mission was to study the consequences of the accident, nuclear safety and nuclear facility's decommissioning. The head office was located in Kiev at first, but later the "Slavutych Laboratory of International Research and Technology" was established under the Chernobyl Center in 1997, and then the head office was also moved from Kiev to Slavutych in 2002. The administration of the Chernobyl Center was transferred in 2007 to the "Ministry of Emergencies and Protection of Population from the Consequences of Chernobyl Accident" up until today.

In September 2011, The "World Data Center for Geoinformatics and Sustainable Development" made the agreement on the partnership, cooperation and scientific exchange with the "Executive Committee of Slavutych City Council" and the Chernobyl Center [5]. The numbers of databases are recorded at the Chernobyl Center, including the results of environmental monitoring, health monitoring as well as the information inside the

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sarcophagus for about fifteen years since 1986. These databases are planned to be provided for the international scientific communities for the further scientific researches and the educations upon the catastrophic nuclear accident [5]. The table of contents of those databases is shown in Appendix 1 and 2.

The databases are divided in two categories, the information related to the environmental impacts and the information inside the sarcophagus; while, the first part, the environmental impacts, is further divided in 3 categories, which are the environmental contaminations, the countermeasures, and the health impacts, as shown in Appendix 1. The second part, the sarcophagus, consists of 4 groups as shown in Appendix 2, construction of the sarcophagus, systems and equipments, radiological situation, and nuclear fuels.

Among these databases, the environmental impacts and the countermeasures are of importance for the international scientists' communities in their further uses. Also, the transferability of those databases to the different regions in different climate and environment needs to be considered, and then the database can be helpful not only for the affected regions of Chernobyl accident, but also for the other countries and the regions in the world. In this respect, the following databases with a few examples are selected to demonstrate how the databases can be used for further research activities in the other regions of the world:

1. The transfer of radio-nuclides from soil to foods
2. The improvement of agricultural soil
3. The level of radiation inside the sarcophagus, together with the destroyed nuclear fuels

In the following sections, the results of the sample analysis on these 3 topics are reported.

1. The transfer factor of radio-nuclides from soil to foods

Among the scientists in the field of study on the agriculture in the contaminated soil, there is a general consensus such that the characteristics and the contents of soil influence the process of transferring radio-nuclides from soil to the plants. Investigations on this topic should be able to contribute to the improvement of the agriculture in the contaminated soil for the food productions.

According to the conclusion of the Research Coordinated Programme held in 2003 by the “Joint FAO[2]/IAEA[3] Programme of Nuclear Techniques in Food and Agriculture” on the “classification of soil systems on the basis of transfer factors of radio-nuclides from soil to reference plants”, the values of Transfer Factor (hereinafter, “TF”) of radio-nuclides vary enormously [6]. The main factors which cause this variability for any particular radio-nuclide are the type of crop and type of soil. The length of time that radio-nuclide has been in the soil is also important, particularly for Cs-137. Other factors are crop variety, agricultural practice (especially fertilization) and differences in the weather during the growing season (not overall climate) (Fig 1).

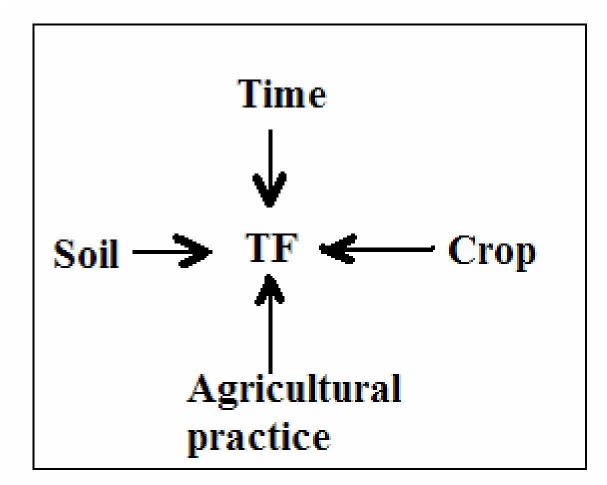

FIG. 1. Main factor affectig TF values **([6] page 2, Fig. 1)**

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[2] FAO: Food and Agriculture Organization is one of the organizations of the United Nations. Its headquarters are located in Rome, Italy

[3] IAEA: International Atomic Energy Agency is one of the organizations of the United Nation, established for the security and the safety of nuclear power in the world. Its headquarters are located in Vienna, Austria

Among varieties of the plant data, the reference plants selected for the sample analysis in this report were the crops for the basic human need, i.e., cereals, winter rye, spring wheat, winter wheat, and oats, while the IAEA [6] reports that the TF within a crop group, such as a cereals, green vegetables, potatoes and root crops for a particular soil and radionuclide are indifferent.

The contamination level of the soil by Cesium 137 (hereinafter, "Cs-137") spans from 75 to 19,000 kBq/m^2 (average, 8,000 kBq/m^2), and 735 to 63,000 Bq/kg (average, 3,000 Bq/kg), and the contamination level of the reference plants also by Cs-137 spans from 35 to 146,000 Bq/kg (average, 6,000 Bq/kg) upon 192 samples. The contamination level of the soil by Strontium 90 (hereinafter, "Sr-90") spans from 1,500 to 8,300 kBq/m^2 (average, 5,300 kBq/m^2), and 5,000 to 28,000 Bq/kg (average, 18,000 Bq/kg), and the contamination level of the reference plants also by Sr-90 spans from 5,000 to 41,000 Bq/kg (average, 20,000 Bq/kg) upon 176 samples.

The characteristics of the soil samples are shown in Table 1 for the Cs-137 contamination and Table 2 for the Sr-90 contamination, including the contents of calcium, magnesium, potassium oxide (K_2O) and phosphorus pentoxide (P_2O_5), the humus[4], granulometric composition[5], nitrogen, pH KCl, pH H_2O, and salt. The correlations between those factors are shown in Table 3. There are stronger correlations between calcium, P_2O_5, nitrogen, K_2O, granulometric composition, and humidity of plants.

The TFs of Cs-137 and Sr-90 ((Bq/kg crop)/(kBq/m^2 soil)) were calculated by the contamination level of the reference plants (Bq/kg) divided by the contamination level of the soil surface (kBq/m^2).

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[4] Humus: The organic matter that has reached a point of stability, where it will break down no further and might, if conditions do not change, remain as it is for centuries.

[5] The content of granules of varying size in rock, soil, or an artificial product, expressed as a percentage of the bulk or of the quantity of granules of the examined sample.

The multi-variable regression analysis was conducted upon the TFs of Cs-137 and Sr-90 separately on the variables that indicate the soil's characteristics, and the results are shown in Table 4 for Cs-137 and Table 5 for Sr-90. The results show that the TFs on Cs-137 are smaller when the contents of phosphorus pentoxide (P_2O_5) and granulometric composition are larger in the soil, and the TFs on Sr-90 are smaller when the contents of calcium and potassium Oxide (K_2O) are larger. This finding suggests the possible ways of improving the agricultural soil that reduces the contaminations of the crops by these radio-nuclides.

Considering Fig 1 [6], further investigations are necessary for identifying the actions that should be taken in the contaminated regions for improving the soil and the transfer of the radio-nuclides from the soil to the crops, including:

a. The length of time that radio-nuclide has been in the soil: The dates of sampling and the detection of the radio-nuclides are recorded in the database. Together with the types of the crops, the contact time of the reference plants in the soil should be estimated.
b. The crop varieties that are also included in the database: There are about 10,000 samples including potato, barleys, soy, tanacetum, tansy, timothy, tomatoes, vetch, white mushroom, bilberry, raspberry, strawberry, cabbage, carrot, chanterelle, clover, dandelion, dill, herbage, honey fungus, Lucerne, lupine, maize, mangel, meadow glass, milfoil, oenothera biennis, onion, orangecap boletus, peas, perennial grasses, red fescue, and rough boletus.
c. The differences in the weather during the growing season: The monthly rainfall data is available in the database, therefore weather factor can be analyzed together with the sampling date.
d. Mechanisms that prevent the transfer of the radio-nuclides from the soil to the plants
e. Actual ways/procedures of improving the soils together with potential bi-effects on the crops

Table 1 **Descriptive statistics of the variables for Cs-137 on the selected reference plants (cereals and oats)**

	TFCS	CA	MG	K2O	P2O5	HUMUS	GRANU	N	PH	PHH2O	SALT	HUMIDPL
Mean	1.862	2.898	0.4544	2.467	3.201	1.465	4.715	10.04	5.179	5.876	3.290	19.45
Median	0.435	3.935	0.2400	1.920	1.200	1.386	4.144	8.750	5.210	5.890	3.292	0.5750
Maximum	96.30	4.490	2.800	6.300	13.70	2.474	7.700	21.27	6.100	6.900	4.650	83.54
Minimum	0.028	0.060	0.1000	1.160	0.860	0.5607	2.240	7.440	4.300	5.100	1.920	0.1400
Std. Dev.	8.517	1.735	0.7202	1.079	3.416	0.5618	1.782	2.925	0.5051	0.4365	0.7875	27.47
Skewness	9.018	-0.728	2.864	1.272	1.581	0.2570	0.5536	1.582	-0.05454	0.8391	-0.04083	0.8297
Kurtosis	91.35	1.651	9.494	3.684	4.678	1.961	1.884	4.629	2.255	3.846	1.875	1.8515
Observations	192	192	192	192	192	192	192	192	192	192	192	192

Note: TFCS: Transfer factor from soil to the reference plant of Cs-137 ((Bq/kg)/(kBq/m^2)) , CA: the content of Calcium in the soil (mg./100g), MG: the content of Magnesium in the soil (mg/100g), K2O: the content of Potassium Oxide (K_2O) in the soil (mg/100g), P2O5: the content of Phosphorus pentoxide (P_2O_5) in the soil (mg/100g), HUMUS: the humus (%), GRANU: Granulometric composition (clay less 10mcm (%)), N: nitrogen content in the soil (mg/100g), PH: Acidity pH KCl, PHH2O: Acidity pH H_2O, SOLT: Salt less 1mcm (%), HUMIDPL: the humidity of the reference plant (%).

Table 2 **Descriptive statistics of the variables for Sr-90 on the selected reference plants (cereals and oats)**

	TFSR	CA	MG	K2O	P2O5	HUMUS	GRANU	N	PH	PHH2O	SALT	HUMIDPL
Mean	10.69	3.127	0.4450	2.347	2.854	1.487	4.516	9.860	5.224	5.907	3.291	16.18
Median	3.330	3.955	0.2400	1.875	1.185	1.422	4.074	8.730	5.340	5.900	3.292	0.5400
Maximum	310.8	4.490	2.800	6.300	13.70	2.474	7.700	21.27	6.100	6.900	4.650	83.54
Minimum	0.1800	0.06000	0.1000	1.160	0.8600	0.5608	2.240	7.440	4.300	5.100	1.920	0.1400
Std. Dev.	31.10	1.625	0.7033	1.019	3.257	0.5739	1.705	2.865	0.4745	0.4122	0.7963	26.18
Skewness	7.506	-1.032	2.979	1.597	1.862	0.1746	0.7593	1.828	-0.1322	0.8992	-0.02926	1.135
Kurtosis	65.88	2.215	10.13	4.914	5.665	1.895	2.265	5.561	2.464	4.201	1.863	2.460
Observations	176	176	176	176	176	176	176	176	176	176	176	176

Note: TFSR: Transfer factor from soil to the reference plant of Sr-90 ((Bq/kg)/(kBq/m2))

Table 3 Correlations of the variables

	TFCS	TFSR	CA	MG	P2O5	N	K2O	GRANU	HUMUS	PH	PHH2O	SALT	HUMIDPL
TFCS	1.000	0.1073	-0.2735	0.05193	0.1402	0.008747	0.4633	0.2140	-0.02225	-0.1367	-0.1368	0.01036	0.2891
TFSR		1.000	-0.3779	-0.09210	0.1999	0.05073	0.2084	0.3413	-0.1016	-0.3190	-0.2327	-0.01857	0.3330
CA			1.000	-0.3895	-0.8490	-0.7710	-0.9028	-0.8812	0.1180	0.3380	0.1630	-0.1170	-0.9651
MG				1.000	0.3161	0.5443	0.3442	0.5468	0.2245	0.5551	0.7100	0.3547	0.5055
P2O5					1.000	0.7300	0.7578	0.7845	-0.1306	-0.3210	-0.1388	0.06923	0.8580
N						1.000	0.6186	0.6734	-0.04066	-0.01823	0.1186	0.03067	0.7674
K2O							1.000	0.8274	-0.09885	-0.3229	-0.2283	0.1502	0.8842
GRANU								1.000	-0.07722	-0.1639	-0.01815	0.1605	0.9085
HUMUS									1.000	0.1790	0.3458	0.1050	-0.07316
PH										1.000	0.7167	0.1931	-0.2317
PHH2O											1.000	0.2508	-0.04231
SELT												1.000	0.1578
HUMIDPL													1.000

Table 4 **Regression Analysis on TFCS and the other variables**

Model		Independent Variable	Coefficient (a, b, c..)	T-Statistics	R^2	Durbin-Watson	AIC	Schwartz
1	TFCS= a+b*CA+c*MG +d*K2O+e*P2O5 +f*HUMUS +g*GRANU+h*N +i*PH+j*PHH2O +k*SOLT +l*HUMIDPL	Interception	-16.41	-0.8315	0.3812	0.8452	6.762	6.965
		CA	2.113	1.521				
		MG	0.5140	0.2406				
		K2O	8.434	7.281				
		P2O5	-0.5900	-1.759				
		HUMUS	-0.3183	-0.3216				
		GRANU	-2.519	-3.206				
		N	-1.247	-3.545				
		PH	1.152	0.5815				
		PHH2O	2.198	0.8272				
		SALT	-1.719	-2.379				
		HUMIDPL	0.2380	2.752				
		Numb. of ovs.	192					
2	LogTFCS= a+b*CA+c*MG +d*K2O+e*P2O5 +f*HUMUS +g*GRANU+h*N +i*PH+j*PHH2O +k*SOLT +l*HUMIDPL	Interception	-0.4343	-0.1473	0.2173	1.050	2.960	3.164
		CA	-0.04366	-0.2103				
		MG	0.1040	0.3258				
		K2O	0.1499	0.8660				
		P2O5	-0.2024	-4.037				
		HUMUS	0.03188	0.2155				
		GRANU	-0.2410	-2.052				
		N	-0.05440	-1.035				
		PH	0.2300	0.7771				
		PHH2O	0.04359	0.1097				
		SALT	-0.1529	-1.416				
		HUMIDPL	0.04254	3.290				
		Numb. of ovs.	192					

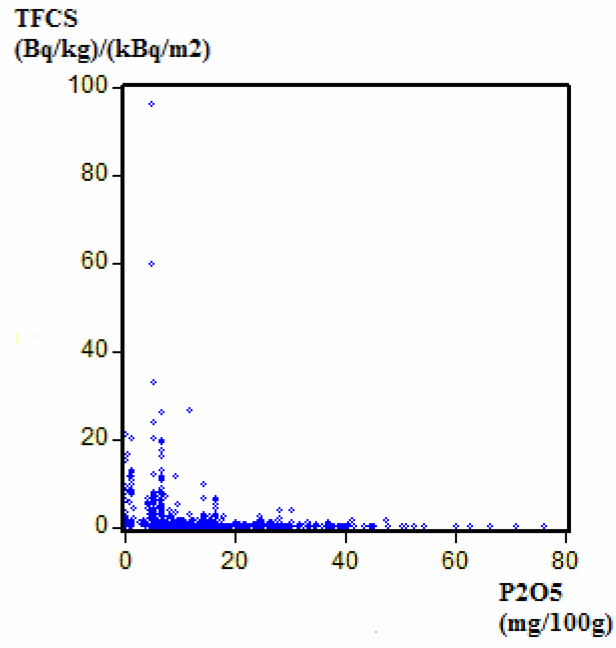

Fig.2 **TFCS and P2O5**

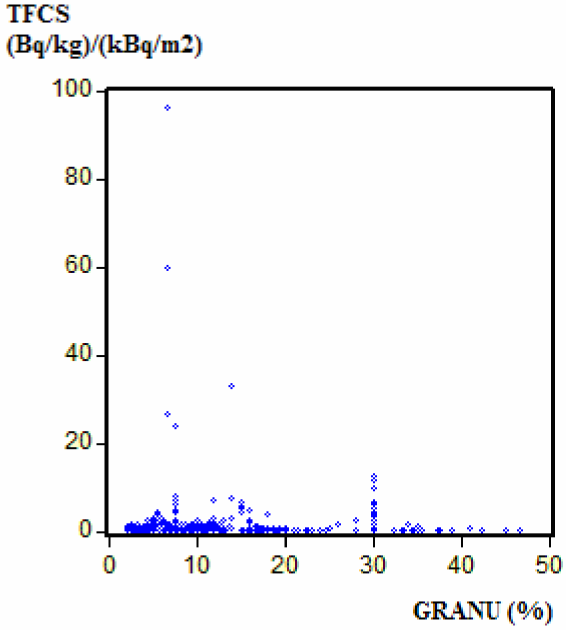

Fig.3 **TFCS and GRANU**

Table 5 **Regression Analysis on TFSR and the other variables**

Model		Independent Variable	Coefficient (a, b, c..)	T-Statistics	R^2	Durbin-Watson	AIC	Schwartz
1	TFSR= a+b*CA+c*MG +d*K2O+e*P2O5 +f*HUMUS +g*GRANU+h*N +i*PH+j*PHH2O +k*SOLT +l*HUMIDPL	Interception	177.9	2.565	0.5383	0.5500	9.070	9.286
		CA	-30.123	-5.667				
		MG	-17.40	-2.425				
		K2O	-32.64	-7.710				
		P2O5	-4.152	-3.730				
		HUMUS	1.443	0.4589				
		GRANU	8.088	3.012				
		N	-6.105	-5.067				
		PH	4.745	0.7532				
		PHH2O	2.381	0.2727				
		SALT	-0.4420	-0.1894				
		HUMIDPL	0.4534	1.414				
		Numb. of ovs.	176					
2	LogTFSR= a+b*CA+c*MG +d*K2O+e*P2O5 +f*HUMUS +g*GRANU+h*N +i*PH+j*PHH2O +k*SOLT +l*HUMIDPL	Interception	3.532	1.847	0.6750	1.178	1.889	2.105
		CA	-0.8805	-6.006				
		MG	-1.249	-6.308				
		K2O	-0.8967	-7.679				
		P2O5	-0.1840	-5.993				
		HUMUS	-0.01219	-0.1405				
		GRANU	0.3562	4.809				
		N	0.03382	1.018				
		PH	-0.1259	-0.7246				
		PHH2O	0.3774	1.567				
		SALT	0.1190	1.849				
		HUMIDPL	0.002912	0.3292				
		Numb. of ovs.	176					

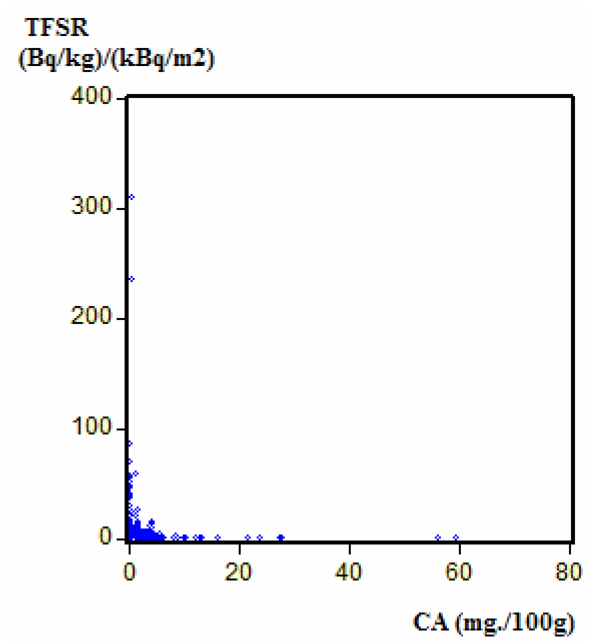

Fig.4 **TFSR and CA**

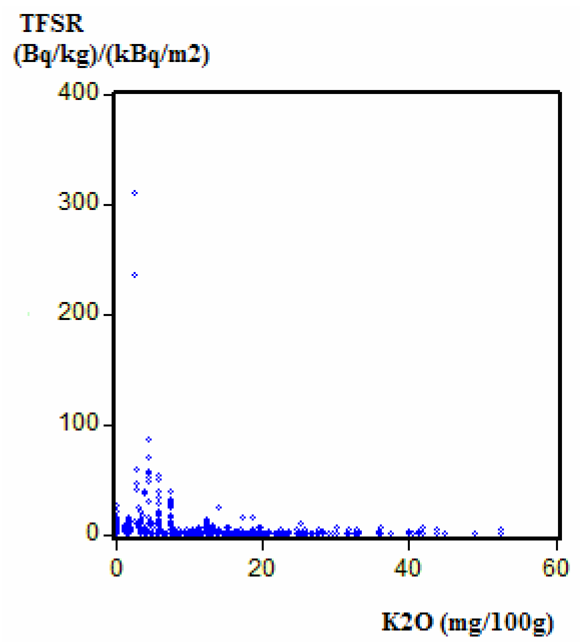

Fig.5 **TFSR and K2O**

2. The improvement of agricultural soil

In addition to the TFs of radio-nuclides from soil to the crops, which are analyzed in the previous section, the database of the Chernobyl Center contains information of the countermeasures to reduce the TFs together with their effects. The database contains over 1,900 attempts of the countermeasure, which were carried out from 1987 till 1999 in 31 settlements.

The size of the reduction of the TF is indicated by the ratio of the TF before the countermeasure ($\frac{(Bq/kg)}{(kBq/m2)}$) and the TF after the countermeasure ($\frac{(Bq/kg)}{(kBq/m2)}$) on each method such as liming, mineral fertilizer, clay minerals, complex application, and select of the crop species. The regression analysis was conducted to identify the effects of the countermeasures. The linear relation between the TFs was assumed upon the scattered plots shown in Figure 6. After the regression analysis, the slope of the TFs before and after each countermeasure was obtained as the coefficients in Table 6 upon 6 different countermeasures.

The coefficient, the ratio of the TFs before and after the countermeasures over all data, is 0.715, which means the TF is reduced by 30 percent with all the countermeasures. Each method of the countermeasure contributed to about 20 to 40 percent reduction of the TF.

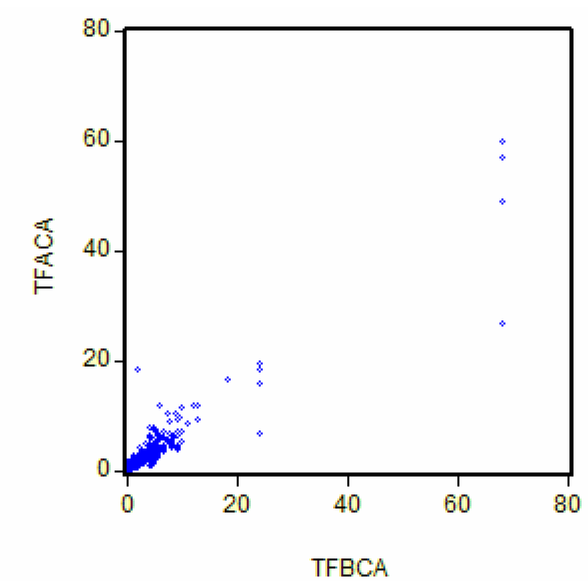

Fig.6 TFs before and after the countermeasures (6 methods included)

TFBCA: Factor of radionuclide transfer in the main plant product before countermeasure application ((Bq/kg) / (kBq/m^2))

TFACA: Factor of radionuclide transfer in the main plant product after countermeasure application ((Bq/kg) / (kBq/m^2))

Table 6 The ratios of the TFs before and after the countermeasures

Countermeasure		Coefficient	T-statistics	R^2	Obs. Numb.	AIC	Schwartz	Darbin-Watson
Liming	Interception	0.0700	1.325	0.9577	45	0.4658	0.5461	1.995
	TF before measure	0.6708	31.22					
Mineral fertilizer	Interception	0.2426	7.062	0.8808	695	2.561	2.574	1.300
	TF before measure	0.5790	71.57					
Organic fertilizer	Interception	0.1615	2.121	0.7730	129	2.072	2.117	1.580
	TF before measure	0.7141	20.80					
Clay minerals	Interception	0.0425	0.5772	0.9805	178	2.715	2.751	1.266
	TF before measure	0.8470	94.02					
Complex application	Interception	0.000531	0.01013	0.7283	510	2.847	2.864	1.538
	TF before measure	0.7541	36.90					
Select of the crop species	Interception	0.0611	2.083	0.6963	74	-0.2352	-0.1730	1.628
	TF	0.5536	12.85					
Total of 6 measures	Interception	0.1054	3.967	0.8867	1631	2.868	2.874	1.368
	TF before measure	0.7150	112.9					

Obs. Numb.: Number of observations, AIC: Akaike Information Criterion, Complex application: mixtures of different methods

Regression Model: TFACA=constant (interception) + coefficient * TFBCA

Upon the above results, the followings are concluded:

1) The relation between the TFs before and after the countermeasures is linear, therefore the coefficients of the linear multi-variable regression analysis is recognized as the reduction of the TFs after the countermeasures.
2) The TFs before the countermeasures and after the countermeasures are on the same order of magnitude, and 20 to 40 percent of the TF is reduced after each countermeasure.

Also, the further investigations are necessary on the following issues:

a. The relation between the TFs and the level of radio-nuclides in the soil: It may be analyzed upon different levels of the contaminations of the settlements and/or upon the different times when the countermeasures were taken.

b. The effects on the yield increase after the countermeasures (the data of the yield increase is available in the database of the Chernobyl Center).
c. The mechanisms to reduce the TFs, in connection with the results of the study made on the soil contens and the TFs, which are reported in the previous section.

3. Radiation levels caused by the destroyed nuclear fuels inside of the sarcophagus

The destroyed nuclear fuels, which are left inside of the sarcophagus, emit high-level radiation. The radiation would prevent the activities in future for the decommissioning of the sarcophagus. Those materials are called as the fuel contained material (hereinafter, "FCM"), and are categorized in 4 groups, the core fragments, the fuel dust, the Uranium salts in water, and the lava like fuel containing materials (hereinafter, "LFCM"). The core fragments are those of fuel assemblies, fuel rods, fuel tablets (pellets), and graphite blocks, which were released from the damaged reactor during the explosion. The fuel dust is the fine dispersed nuclear fuel, and the Uranium salts in water are Uranium compounds dissolved in the water inside the sarcophagus. The LFCM was formed during the active stage of the accident. The first LFCM was found in autumn 1986 which looked like black-colored glass in giant solidified drop from the melted reactor core, and it was called as "elephant foot".

The database of the Chernobyl Center contains the dose rate (the radiation level), the radio-activities of Pu-238, Pu-239, Pu-240, Cs-137, and Sr-90 in 33 rooms of the sarcophagus, as shown in Table 7. In the most of the rooms, the radiation level deviates from 200 to 1,200 (R/h), which is fatal for a human even for one hour of staying. In this report, the relations between the radiation levels and the radio-activities of the FCM over those rooms are analyzed. The purpose of this analysis is to demonstrate the potential usefulness of the database that may be used for considering the strategy of decommissioning works of the destroyed nuclear fuels.

Table 8 shows the descriptive statistics of the radio-activities of Cs-137, Sr-90, Pu-238, Pu-238/Pu-239/Pu-240, and Pu-239/Pu-240. The maximum values of 1,550 MBq/g for Cs-137, 1,350 MBq/g for Sr-90, 10 MBq/g for Pu-238, and 15.4 MBq/g for Pu-239/Pu-240.

Table 9 shows the correlations of these variables, and Table 10 shows the result of the regression analysis between the dose rate of each room and the radio-activities of those radio-nuclides accumulated in the same room[6]. The correlations between the radio-activities of the radio-nuclides in MBq/g are high, but the correlation between the dose rate in R/h and those radio-activities is weak, which means that the amount of radio-nuclides doesn't directly influence the radiation level in the same room, as Fig.7 shows the relation between Pu-238 and the dose rate. Except Pu-238, the other radio-nuclides show negative correlation with the dose rate. One implication of this result is that there are other factor that influences the dose measurement such as geometry inside the rooms; and, other possibility is the difficulty of the measurement and/or sampling at the environment of very high radiation, which might have prevented the precise measurements. This issue leaves the necessity of the further research in future.

[6] **Pu-238/Pu-239/Pu-240 was excluded from the correlation analysis and the regression analysis because this data group doesn't have common rooms where other data groups were obtained.**

Table 7 Dose rate and the radio-activities of the FCM in the Sarcophagus

	Type of FCM	Object name	Room	Max. Dose Rate (R/h) '88-'00	Cs-137 (MBq/g)	Sr-90 (MBq/g)	Pu-238, 239, 240 (MBq/g)	Pu-239, 240 (MBq/g)	Pu-238 (MBq/g)
1	Core fragments	No. 1	305/2	10	X			X	X
2	Core fragments	No. 2	305/2	10	X	X		X	X
3	Core fragments	No. 3	305/2	10	X	X		X	X
4	Core fragments	No. 5	305/2	810					
5	Core fragments	No. 7	305/2	810					
6	Core fragments	CH, No. 1	914/2	330					
7	Core fragments	CH, No. 2	914/2	330					
8	Core fragments	CH, No. 3	914/2	330					
9	Core fragments	CH, No. 4	914/2	330					
10	Core fragments	CH, No. 5	914/2	330					
11	Core fragments	CH, No. 6	914/2	330					
12	Core fragments	CH, No. 7	914/2	330					
13	Core fragments	CH, No. 8	914/2	330					
14	Core fragments	SDC	804/4						
15	Core fragments	NDS	804/3						
16	Core fragments	Fuel assemblies in the SDS	914/2	330					
17	Core fragments	Control room	2005/2		X	X		X	X
18	FCM in Water	Water 1	001/3		X	X	X	X	
19	FCM in Water	Water 2	009/4		X	X	X		
20	FCM in Water	Water 3	013/2			X	X		
21	FCM in Water	Water 4	014/2						
22	FCM in Water	Water 5	017/2						
23	FCM in Water	Water 6	018/2						
24	FCM in Water	Water 7	012/5		X	X	X		
25	FCM in Water	Water 8	012/6			X	X		
26	FCM in Water	Water 9	012/7			X	X		
27	FCM in Water	Water 10	012/8			X	X		
28	FCM in Water	Water 11	012/5			X	X		
29	FCM in Water	Water 12	012/6			X	X		
30	FCM in Water	Water 13	012/7			X	X		
31	FCM in Water	Water 14	012/8			X	X		
32	FCM in Water	Water 15	01/3		X	X	X		
33	FCM in Water	Water 16	012/13		X	X		X	
34	FCM in Water	Water 17	012/14		X	X		X	
35	FCM in Water	Water 18	012/15		X	X		X	
36	FCM in Water	Water 19	012/16		X	X		X	
37	FCM in Water	Water 22	012/15			X	X	X	
38	FCM in Water	Water 23	012/16			X		X	
39	FCM in Water	Water 24	012/13			X		X	
40	FCM in Water	Water 25	012/14			X		X	
41	FCM in Water	Water 26	012/15			X		X	
42	FCM in Water	Water 27	012/16		X	X		X	
43	FCM in Water	Water 28	01/3		X	X	X		
44	FCM in Water	Water 29	101/2		X	X		X	
45	FCM in Water	Water 30	219/2			X		X	
46	FCM in Water	Water 31	223/2		X	X		X	
47	FCM in Water	Water 33	207/5		X	X		X	
48	FCM in Water	Water 34	207/5		X	X		X	
49	FCM in Water	Water 35	406/2		X	X		X	
50	FCM in Water	Water 36	405/2		X	X		X	
51	Fuel Dust	Dust in CH	914/2	330	X	X		X	X
52	Fuel Dust	Dust in SDS	804/3		X	X		X	X

	Type of FCM	Object name	Room	Max. Dose Rate (R/h) '88-'00	Cs-137 (MBq/g)	Sr-90 (MBq/g)	Pu-238, 239, 240 (MBq/g)	Pu-239, 240 (MBq/g)	Pu-238 (MBq/g)
53	Fuel Dust	Dust in NDS	804/4		X	X		X	X
54	LFCM	FCM (hypothetically)	012/6	60					
55	LFCM	Heap BB1	012/7	800	X	X		X	X
56	LFCM	FCM in the pipe 1	012/7	800	X	X		X	X
57	LFCM	FCM in the pipe 2	012/7	800	X	X		X	X
58	LFCM	FCM in the pipe 3	012/7	800	X	X		X	X
59	LFCM	FCM in the pipe 4	012/7	800	X	X		X	X
60	LFCM	FCM in the pipe 5	012/7	800	X	X		X	X
61	LFCM	FCM in the melted pipe	012/13	120					
62	LFCM	FCM in the pipe 1	012/14	260					
63	LFCM	FCM in the pipe 2	012/14	260					
64	LFCM	FCM in the pipe 3	012/14	260					
65	LFCM	FCM in the pipe 4	012/14	260					
66	LFCM	FCM (hypothetically)	012/14	260					
67	LFCM	Heap BB2	012/15	1200	X	X		X	X
68	LFCM	FCM in the pipe 1	012/15	1200	X	X		X	X
69	LFCM	FCM in the pipe 2	012/15	1200	X	X		X	X
70	LFCM	FCM in the pipe 3	012/15	1200	X	X		X	X
71	LFCM	FCM in the pipe 4	012/15	1200	X	X		X	x
72	LFCM	FCM in the pipe 5	012/15	1200	X	X		X	X
73	LFCM	Non covered FCM	210/6	530	X	X		X	X
74	LFCM	Non covered FCM	210/7	820	X	X		X	X
75	LFCM	FCM Fragments	017/2		X	X		X	X
76	LFCM	Elephant's foot	217/2	200	X	X		X	X
77	LFCM	Stalactites	217/2		X	X		X	X
78	LFCM	Drop	217/2	200	X	X		X	X
79	LFCM	None covered LFCM	304/3	400	X	X		X	X
80	LFCM	FCM under concrete	303/3	13	X	X		X	X
81	LFCM	FCM under concrete	301/5	290	X	X		X	X
82	LFCM	None covered FCM	301/5	290	X	X		X	X
83	LFCM	FCM under concrete	301/6		X		X	X	
84	LFCM	No. 1	305/2	810					
85	LFCM	No. 2	305/2	810					
86	LFCM	No. 3	305/2	810					
87	LFCM	No. 4	305/2	810					
88	LFCM	No. 5	305/2	10	X	X		X	X
89	LFCM	No. 6	305/2	810					
90	LFCM	No. 7	305/2	10					
91	LFCM	CH, No. 5	914/2	80	X	X		X	X
92	LFCM	CH, No. 6	914/2	80	X	X		X	X

X: it means that the data exists, but it cannot be shown in this table because of too large number of data.

Table 8 Descriptive statistics of the radio-nuclides inside of the sarcophagus

	Pu-238	Pu-239/Pu-240	Cs-137	Sr-90
Mean	0.6891	1.342	75.65	106.2
Median	0.4000	0.7900	25.40	57.00
Maximum	10.00	15.40	1550	1350
Minimum	0.000369	0.000808	0.0510	0.2100
Std. Dev.	1.465	2.275	244.9	218.0
Skewness	4.988	4.379	5.301	4.384
Kurtosis	28.26	23.44	29.88	22.11
Observations	165	165	165	165

Table 9 Correlations of the radio-nuclides inside of the sarcophagus

	Pu-238	Pu-239/Pu-240	Cs-137	Sr-90
Pu-238	1.000	0.9391	0.9338	0.8858
Pu-239/Pu-240		1.000	0.9008	0.8614
Cs-137			1.000	0.8897
Sr-90				1.000

Table 10 Result of regression analysis on dose rate and the radio-nuclides

Model		Independent Variable	Coefficient (a, b, c..)	T-Statistics	R^2	Durbin-Watson	AIC	Schwartz
1	DOSE= a+b*Pu238 +c*Pu239/Pu240 +d*Cs137 +e*Sr90	Interception	304.4	2.947	0.2521	0.9564	15.06	15.28
		Pu-238	-223.8	-1.276				
		Pu-239/Pu-240	237.1	2.542				
		Cs-137	-1.210	-2.034				
		Sr-90	-0.4155	-0.5033				
		Numb. of ovs.	35					
2	Log DOSE= a+b*Pu238 +c*Pu239/Pu240 +d*Cs137 +e*Sr90	Interception	2.814	3.907	0.2610	2.600	5.125	5.347
		Pu-238	-2.231	-1.825				
		Pu-239/Pu-240	1.891	2.909				
		Cs-137	-0.007	-1.635				
		Sr-90	-0.001	-0.192				
		Numb. of ovs.	35					

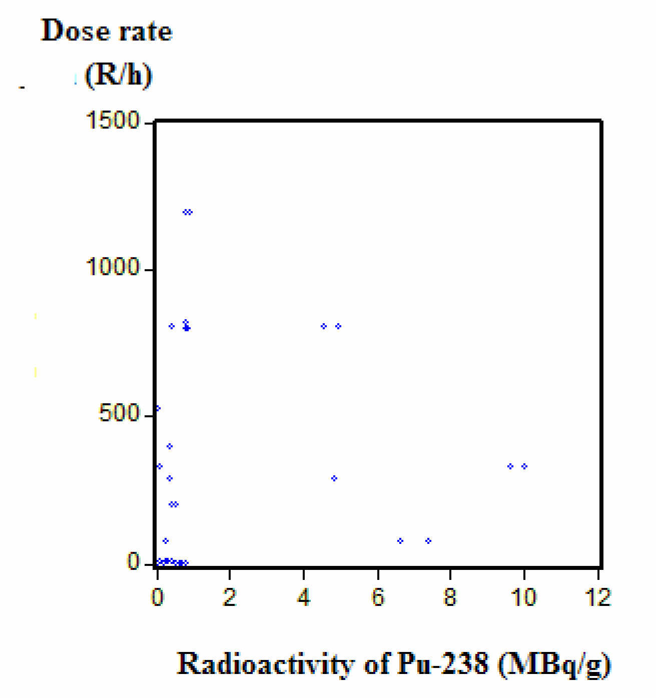

Fig.7 Relation between the dose rate and the radioactivity of Pu-239 in the Sarcophags

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Appendix 1: Content of the Databases on Radiological consequence

		Content	Period	Number of data	Information included
1	Environment				
	1	Contamination of Soil by Cs-137	1986 to 1998 in Ukraine, 1986 to 1999 in Russia	16,578 samples from Ukraine, 1,114 samples from Russia	Levels of radiological contamination by Cs-137 (kBq/m^2) of the soil with the information on the dates of samplings, and the names of country, oblasts, districts and the settlements as well as their longitudes and latitudes.
		Contamination of ground by Cs-137, Sr-90, Ce-144, and Ru-106	1986 to 1990	2,004 samples in 6 settlements in Ukraine, Russia and Belarus	Levels of radiological contamination by Cs-137 (kBq/m^2) , Sr-90 (kBq/m^2), Ce-144 (kBq/m^2), and Ru-106 (kBq/m^2) of the ground with the information on the dates of samplings, and the names of countries, oblasts, Rayons the settlements, the streets, the types of the surface such as glass or asphalt as well as information of the sampling places such as shops, kindergarten, etc.
	2	Meteorology in Ukraine	From 25 April 1986 till 15 May 1986	1,344 samples taken at 16 observatories every 6 hours	Air temperature, air pressure, wind direction, wind speed, quantity of precipitation
			From January 1986 till December 1999	2,667 samples at 16 observatories	Monthly precipitations
		Precipitations in major cities in Ukraine Russia and Belarus	From 26 April 1986 till 31 May 1986	876 samples at 18 settlements in Belarus, 22 settlements in Russia and 9 settlements in Ukraine	The dates of the observations, the time-periods of the observations, the names of the countries, oblasts, rayon, and their heights (altitudes), longitudes and latitudes
		Meteorology in Belarus	From 1 April 1986 till 31 July 1986	4,270 samples in 35 settlements once everyday	The maximum, average and minimum temperatures, wind directions, wind speeds and precipitations on each day, with the information of the latitudes and longitudes
	3	The transfer factor of Cs-137 and Sr-90 from soils to reference plants (crops)	1986 to 1999 (the dates of gamma spectrometry)	6,574 plant samples over 5,857 soil samples	- the contamination levels of the soil surface (kBq/m^2) - the radio-activities of the soil samples (Bq/kg) - the radio-activities of the plant samples (Bq/kg) - the transfer factors from the soil surface to the reference plants ((Bq/kg)/(kBq/m2)) - the accumulation ration between the soil samples and the reference plants ((Bq/kg)/(Bq/kg)) - the types of soils, contents of the soils such as calcium, magnesium, potassium oxide, phosphorus pent-oxide, humus, granulometric composition, nitrogen content, pH, salt and humidity of the reference plants, the types of reference plants such as cereals, potato, barleys, soy, tanacetum, tansy, timothy, tomatoes, vetch, white mushroom, bilberry, raspberry, strawberry, cabbage, carrot, chanterelle, clover, dandelion, dill, herbage, honey fungus, Lucerne, lupine, maize, mangel, meadow glass, milfoil, oenothera biennis, onion, orangecap boletus, peas, perennial grasses, red fescue, and rough boletus - the biological yields of the plants (kg/m2)

					- the methods of plant samplings, the dates of the samplings - the stages of development such as the 2nd cut - the parts of the plants such as green mass - place in landscape of the sampling points such as dry farmland - soil sampling methods - the depth of soil samplings - the dates of soil samplings - the dates of agrochemical analysis.
		The transfer factor of Cs-137 and Sr-90 from the daily diet of animals to the meat on long consumption of fodder with constant specific radio-nuclide activity (TF forage – meat)	1990 to 1997	- 554 samplings of beef and pork for radio-activities of Cs-137 and Sr-90 in those meats - the radio-activity of Cs-137 and Sr-90 in the soils at 695 observation points in Ukraine, Russia and Belarus	- the information includes the radio-activities of Cs-137 and Sr-90 in beef and pork samples - the dates of samplings - the weights of the livestock - the names of the livestock farms - the transfer factor from the soil to the meats.
		The ratio of Cs-137 and Sr-90 in milk and in the cow's daily diet (TF fodder – milk)	1987 to 1998	607 milk samples and 1,953 fodder samples with radio-activity of Cs-137 and Sr-90 in the soils at 695 observation points in Ukraine, Russia and Belarus	- the dates of the sampling, the radio-nuclides of Cs-137 and Sr-90 in the milk samples and the fodder samples - the milk yields - the mass of the fodders, and the names of the milk farms.
		The ratio of Cs-137 and Sr-90 in wild animals tissues and the surface soil nearby the place of animal shooing (game) (TF soil – meat)	1988 to 2000 for the wild animals 1992 to 1998 for the fodders (plants)	934 meat samples of wild animals, 797 fodder (plant) samples at 797 observation points	- the dates of sampling of the wild animals - the dates of the sampling of the fodders (plants) - the name/type of the wild animal - the age, the gender - the name of the sampled organ of the animal - the radio-activities in the meat of the wild animals - the radio-activities in the fodder (plants) - 934 transfer factors from the soil to the meat - 797 transfer factors from the soil to the plants.
		The transfer factor of Cs-137 from soil to hays and to the private cow's milk	1990 to 1999	5,059 milk samples	- the dates of sampling - the radio-activity of Cs-137 in milk, in the hay - the transfer factors from the hay to milk, from the soil to the hay, and from the soil to milk.

	4	Information of waste storage sites	1992 to 2000 for radiation dose measurements, 1992 to 2001 for radio-activity measurements, 1986 to 1998 on the starting dates of filling, 1987 to 2001 for finishing dates of filling, 1986 to 2000 for the measurements of the ground surface contaminations.	429 storage sites Ukraine, Russia and in Belarus, 426 points of the measurements of the radio-activities, 390 points of the measurements of the radiation-doses, 426 points of groundwater measurements, 429 measurement points of surface contaminations	1) Storage sites: the names of the storage sites, locations (country, oblast, rayon, longitudes and latitudes), the years when the filling operations started, the years when the filling operations finished, thicknesses of the top covers, the volumes of the waste (m^3), the mass of the wastes (kg), the areas of the storage site (m^2). 2) Underground water: the gradient (slope) of the underground water (m/km), the depths of the wastes, the depths of the underground water under the bottom of the waste (m), the types of soil. 3) Activities of the radio-nuclides: α-activity (including Pu-239, Pu-240 and Am-241 activity (Bq)), Cs-137 activity (Bq), Sr-90 activity (Bq), Pu-239 and Pu-240 activities. 4) Radiation doses: average and the maximum dose rates at 1m from the surface (Sv/sec). 5) Contamination of the surface: The level of surface contamination by Cs-137, Sr-90 Pu-239 and Pu-240 (Bq/m^2).
	5	Water samples from the Dnieper River on Cs-137 and Sr-90 in Bq per unit volume The temperature of the Dnieper River	1) The physical and chemical characteristics of Pripiat River: 1987 to 1994 2) The level of contamination by radio-nuclides and physical/chemical characteristics of the Pripiat and Uzh: 1987 to 1988 3) Soil of the river systems in Dnieper, Pripiat, Braginka: 1986 to 1999 4) Contamination of water by Cs-137 and Sr-90 in Pripiat River, Uzh River, and Il'ia River: 1986 to 1998 5) Temperature of Braginka, Pripiat, and Dnieper: 1986 to 2000	1) The physical and chemical characteristics of Pripiat River: 32 samples 2) The level of contamination by radio-nuclides and physical/chemical characteristics of the Pripiat River, Uzh River: 105 samples 3) Soil of the river systems in Dnieper, Pripiat, and Braginka: 3,202 samples 4) Contamination of water by Cs-137 and Sr-90 in Pripiat River, Uzh River, and Il'ia River: 614 samples 5) Temperature of Braginka, Pripiat, and Dnieper: 34,635 samples	1) The physical and chemical characteristics of Pripiat River: The information contains pH, CO_2, O_2, HCO^{3-}, $(SO_4)^{2-}$, Cl^-, Ca^{2+}, Na^+, and K^+. 2) The level of contamination by radio-nuclides and physical/chemical characteristics of the Pripiat River and Uzh River: The information includes the location of the sampling points, the sampling date and the time, concentration of Cs-137 (Bq/l), Sr-90 (Bq/l), the suspended matters, pH, Ca (mg/l), K (mg/l), Mg (mg/l), and Na (mg/l). 3) Soil of the river systems in Dnieper, Pripiat, and Braginka: The information includes the location of the sampling points, the sampling date, the sampling methods, the concentration of Cs-137 (kBq/m^2 layer), Sr-90 (kBq/m^2 layer). 4) Contamination of water by Cs-137 and Sr-90 in Pripiat River, Uzh River, and Il'ia River: The information includes the location of the sampling points, the sampling date and time, the concentration of Cs-139 (Bq/l), Sr-90 (Bq/l), the suspended matter, pH, I, K (mg/l), Mg (mg/l), and Na (mg/l). 5) Temperature of Braginka, Pripiat, and Dnieper: the maximum, the minimum and the average temperatures of the rivers as well as the amount of the precipitations.
	6	Run off, temperature, consentration of Cs-137 in the Pripyat River, in the Dnieper River and in the Kiev Reservoir	1987 to 1994	96 samples (once a month) of the Pripyat River, 96 samples of the	- run off (m^3) - temperature (^oC), turbidity (mg/l) - the concentrations of Cs-137 (Bq/m^3)

				Dnieper River, and 96 samples of the Kiev Reservoir	
	7	Hydrochemistry of Pripyat River, Dnieper River, and Kiev Reservoir	1987 to 1994	33 samples of the Pripyat River, 55 samples of the Dnieper River, and Kiev Reservoir, and 65 samples of the Kiev Reservoir	pH, CO_2, O_2, HCO_3^-, SO_4^{2-} Cl^-, Ca^{2+}, Mg^{2+}, Na^+, K^+, and Mineralization in mg/l.
	8	C-137 in the bottom sediment of Kiev Reservoir	August 1992, March 1993	3 samples (cores): 21 layers in the core 1, 19 layers in core 2, 27 layers in core 3.	- the dates of the sampling - the dry weight (kg/m2) - the activity (Bq/g) for each layer.
	9	C-137 concentration in fish of Kiev Reservoir	April 1987	166 samples	- the date of sampling, the sampling region - the names of the species, age, length (cm), weight (g), - the activity of Sr-90 (Bq/kg) - the activity of Cs-137 (Bq/kg) - the gender
	10	Cs-137 Activity in the Water, Lake Kozhanovskoe	1992 to 1999	31 samples	- the date of sampling - the depth of sampling (in descriptions such as surface or near bottom) - concentration of weighted matter (mg/l) - dissolved Cs-137 activity (Bq/l) - weighted Cs-137 activity (Bq/l)
	11	Cs-137 Activity in bottom sediments of Lake Kozhanovskoe, by the gamma-spectrometry	1993 to 1999	Total 34 samples: 23.04.93 (7 layers), 27.04.93 (6 layers), 24.02.99 (10 layers), 24.02.99 (11 layers)	- the date of sampling - the depth of each layer (cm) - dry weight (kg/m^2) - wet weight (kg/m^2) - activity (Bq/g) - sampling method in description.
	12	Cs-137 activity in silver carp (Carassius Auratus Gibelio). Lake Kozhanovskoe	1990 to 1999	160 samples	- the date of sampling, the weight of fish (g) - the length of fish (mm) - the activity of Cs-137 in the fish muscles (Bq/kg).
	13	Cs-137 activity in pike of Lake Kozhanovskoe	1993 to 1998	39 samples	- the date of sampling - the weight of fish (g) - the length of fish (mm) - the activity of Cs-137 in the muscles (Bq/kg)
	14	Transparency of Lake Svyatskoye	1987 to 1998	43 measurements	- the date of sampling - the transparency of the water (m)
		Temperature of Lake Svyatskoye	1994 to 1999	19 measurements	- the date of sampling

					- the temperature (°C) in 16 different depths (m)
	15	Oxygen of Lake Svyatskoye	1987 to 1999	60 measurements in mg/l, 51 measurements in %	- the date of sampling - the oxygen (mg/l) in 16 different depths (m) - the oxygen saturation (%) in 16 different depths (m).
	16	pH of Lake Svyatskoye	1992 to 1998	10 measurements	- the date of sampling - pH in 16 different depths (m).
	17	Phosphrous, pH, Nitrogen in Lake Svyatskoye	1993 to 1998	68 measurements	- the date of sampling, pH, Phosphorus (mgP/l), Nitrogen (mgN/l) in different depths.
	18	Concentration of Cs-137 in Lake Svyatskoye	1988 to 1995	102 measurements	- the date of sampling - the depth of the sample - the concentration of Cs-137 (Bq/l).
	19	Concentration of Cs-137 in near bottom water and interstitial water in Lake Svyatskoye	1990 to 1999	18 measurements	- the data of sampling - the depth of the sample - the concentration of Cs-137 (Bq/l) in near bottom water and in interstitial water.
	20	Cs-137 dynamics (monthly collection, Bq/l) in water of coastal zone of Lake Svyatskoye	1996 to 1998	22 samples	- the date of sampling - Cs-137 dynamics (monthly collection, Bq/l) in water of coastal zone.
	21	Seston concentration of Lake Svyatskoye	1987 to 1999	26 samples	- the date of sampling - seston concentration (dry weight (mg/l) in 16 different depths.
	22	The activity of Cs-137 in seston of Lake Svyatskoye	1987 to 1998	67 samples	- the date of sampling - the depth of sampling - the concentration of seston (mg/l) - the activity of Cs-137 (kBq/kg) in seston.
	23	The transfer factor of Cs-137 from water to seston of Lake Svyatskoye	1994 to 1999	57 samples	- the date of sampling - the depth of sampling - the temperature of water - oxygen (mg/l) - the dissolved Cs-137 in water (Bq/l) - the suspended Cs-137 in water (Bq/l) - the activity of seston (kBq/kg)

					- the transfer factor from the water to the seston.
	24	Seston sedimentation of Lake Svyatskoye	1987 to 1998	18 samples	- the date of sampling - the sedimentation of the seston (g m^{-2} $month^{-1}$)
	25	Primary plankton production and destruction of Lake Svyatskoye	1987 to 1998	33 samples	- the date of sampling - the gross production - the destruction of the plankton (dry weight gm^{-2} day^{-1})
	26	Chlorophyll of Lake Svyatskoye	1987 to 1998	64 samples	- the date of sampling - the crolophyll (mkg/l) in 16 different depths.
	27	Phytoplankton of Lake Svyatskoye	1986 to 1995	162 samples	- the date of sampling - the depth of sampling - the total counts of phytoplankton, chlorophyta, cyanophyta, bacillariophyta, chrysophyta, dynophyta, and crytophyta.
	28	Cs-137 in periphyton of Lake Svyatskoye	1986 to 1999	16 samples	- the date of sampling - characteristics of periphyton in description - the activity of Cs-137 (kBq/kg of dry weight)
	29	Cs-137 in macrophytes of Lake Svyatskoye (above-ground part)	1987 to 1999	57 samples	- the date of sampling - the concentration of Cs-137 (kBq/kg of dry weight) in 12 different types of macropytes.
	30	Cs-137 in macrophytes of Lake Svyatskoye (underground part)	1992 to 1999	35 samples	- the date of sampling - the concentration of Cs-137 (kBq/kg of dry weight) in 5 different types of macrophytes.
	31	Cs-137 in dead macrophytes of Lake Svyatskoye	1987 to 1996	26 samples	- the date of sampling - the concentration of Cs-137 (kBq/kg of dry weight) in 6 different types of macrophytes.
	32	Zooplankton, species composition and dimensions of animals of Lake Svyatskoye	1992 to 1999	102 samples	- the date of sampling - the types of species - size (mm) and its standard deviation
	33	Quantity and biomass of zooplankton of Lake Svyatskoye	1987 to 1999	173 samples	- the date of sampling, the depth of sampling - the count (count/m^3) - the biomass (g/m^3) of 3 types of zooplankton.
	34	Cs-137 in zooplankton of Lake Svyatskoye	1987 to 1999	76 samples	- the date of sampling, - the characteristics of samples - % biomass, length (mm) - the activity (kBq/kg of dry weight)
	35	Bacterioplancton of Lake Svyatskoye	1987 to 1998	112 samples	- the date of sampling the depth (m) of sampling station - the number of bacterioplancton in an inter-relation of free living and detrite attached cells.
	36	Cs-137 in invertebrates of Lake Svyatskoye	1987 to 1999	51 samples	- the date of sampling

					- the activity of Cs-137 (kBq/kg of dry weight) in 11 types of invertebrates.
	37	Cs-137 in fish of Lake Svyatskoye	1987 to 1999	29 samples	- the date of sampling - the activity of Cs-137 (kBq/kg of dry weight) in 5 types of fish.
	38	Cs-137 in fish of different sizes of Lake Svyatskoye	One day, June 23, 1998	28 samples	- the date of sampling - length of fish (mm) - its wet weight (g) - the activity of Cs-137 (kBq/kg of wet weight) and (kBq/kg of dry weight) - the ratio of the wet weight and dry weight.
	39	Cs-137 in the bottom sediments of Lake Svyatskoye	1987 to 1998	182 samples	- the date of sampling - the depth (m) - the layers (cm) - the activity of Cs-137 (kBq/m^2)
	40	Spatial distribution of ammonium in pore (porous) water of Lake Svyatskoye	One day, September 19, 1995	15 samples	- the types of zone, such as littoral, intermediate depth and pelagial - the ammonium (mg N/l).
	41	Vertical distribution of $N\text{-}NH_4$ in bottom water and pore water of the Lake Svyatskoye	One day, June 2, 1998	5 samples	- the depth (m) - thickness (cm) and weight (mgN/l) of the bottom water, - thickness (cm) and weight (mgN/l) of pore water.
	42	Physico-chemical structure of bottom de-posits of Lake Svyatskoye	1994 to 1998	34 samples	- the date of sampling - the depth (m) - the thickness (cm) - the characteristics of the bottom sediments in descriptions - the density (g/cm^3) - the weight loss on drying (%), ash (%), and the porosity (%).
	43	Chemical structure of bottom deposits of Lake Svyatskoye	Not recorded	8 samples	- the depth (m) - ash (% of dry weight) - organic carbon from ash and from bichromate (% of dry weight) - total nitrogen (mkg/mg) - total phosphorus (mkg/mg) - C.N.P in weight ratio.
	44	Organic carbon and total phosphorus in bottom deposits of Lake Svyatskoye	Not recorded	21 samples (7 layers, 1 cm thickness each, at each of 3 depths, 3.5, 4.0 and 4.5 m)	- the depth (m) - the thickness (cm) - ash (%) - organic carbon (%) from ash and from bichromate - the total phosphorus (mkg/mg of dry weight).
	45	Coefficients of diffusion of phosphrus of Lake Svyatskoye	1994 to 1996	6 samples	- the date of sampling - characteristics of the sample in description - total flux of phosphorus ($mgP.m^2.day$) - soluable P (mg/l) in bottom water and in pore water - boundary layer (m)

					- porosity.
	46	Coefficients of diffusion of Ammonium of Lake Svyatskoye	1996 to 1998	5 samples	- the date of sampling - characteristics of the sample in description - total flux of $N-NH_4^+$ ($mgN.m^2.day$), $N-NH_4^+$ (mgN/l) in bottom water and in pore water - boundary layer (m) - porosity.
	47	Coefficients of diffusion of Radio-Cesium of Lake Svyatskoye	1995 to 1998	6 samples	- the date of sampling - characteristics of the sample in description - total flux of Radio-Cesium ($Bq/m^2.day$) - $N-NH_4^+$ (mgN/l) in bottom water and in pore water - boundary layer (m) - porosity.

2	Environmental Impacts				
	1	The level of contaminations in fish bodies by Cs-137 in Kiev	1887 to 1995	211 fish samples (47 breams, 42 roaches, 61 pike perches, 61 pikes)	- the types of fish - the dates of measurements - the concentration of Cs-137 in fish bodies (Bq/kg) - the ages of fish from 2 to 12 years.
3	Countermeasures in Environment				
	1	The types and the effectiveness of the countermeasures to reduce the transfer of the radio-nuclides from the soils to the plants	1987 to 1999	1,716 attempts to reduce the transfer factors of radio-nuclides from the soil to the plant, carried out in Ukraine, Russia and Belarus	- the factor of the radionuclide transfer from the soil to the main plant product before countermeasure application (TFBCA) ((Bq/kg) / (kBq/m^2)) - the factor of radionuclide transfer in the main plant product after countermeasure application (TFACA) ((Bq/kg) / (kBq/m^2)) - Reduction factor (times) (TFBCA/TFADA) - Yield increase factor (times) - the locations where the countermeasures were attempted with the name of the settlements and the longitudes and the latitudes, the descriptions of the countermeasures, and the names of the countermeasures such as liming, mineral fertilizer, organic fertilizer, clay minerals, select of the crop species and the complex application.
	2	The types and the effectiveness of the countermeasures to reduce the transfer of the radio-nuclides from the soils to the forest products.	1987 to 1999	98 attempts to reduce the transfer factor from the soil to the forest products, carried out	- the factor of radionuclide transfer from the soil to the forest product before countermeasure application (TFBCA) ((Bq/kg) / (kBq/m2)) - the factor of radionuclide transfer in the forest product after countermeasure application (TFACA) ((Bq/kg) / (kBq/m2)) - the reduction factor (TFBCA/TFACA) (times) - the locations where the countermeasures were attempted with the name of the settlements and the longitudes and the latitudes, the descriptions of the countermeasures

					- the names of the countermeasures such as ban on mushroom picking, ban on berry picking, ban on animal grazing and hay making on forest pastures, ban on cutting, use of ferrocyn compounds, mineral fertilizers, and liming.

	Content		Period	Number of data	Information included
4	Health Impacts				
	1	Statistics of the illness and abnormalities found in infant population	1983 to 1999	Gomel oblast, Mogilev oblast, Minsk oblast, Minsk city, Vitebsk oblast in Belarus (total 5 oblasts/city x 17 years from 1983 to 1999)	- the number of birth, its age distribution - the number of spina bifida, the number of polydactyly - the number of ORCM - the number of oesophagal atresia - the number of multiply congential malformation - the number of limb reduction - the number of down syndrome and its age distribution - the number of cleft lip - the number of anencephaly - the number of anal astresia.
	2	Thyroid cancer	1980 to 1999 in each Oblast	Total 1,186 data of each of male, female, observation years, and 14 age groups in 68 Rayons and 1 city	- the year of observation - the number of thyroid cancers observed in each year in each Rayon, in category of male and/or female, over 14 age groups.
	3	Leukemia	1980 to 1999	Total 236 data of each of male, female, year of observation, chronic leukemia, acute leukemia, other leukemia, 15 age groups, and each of different Oblasts.	- the year of the observation - gender distribution - difference of chronic leukemia, acute leukemia, or other leukemia - the number of leukemia observed in 15 different age groups.
	4	Solid cancers	1980 to 1999	Total 1,244 data of each of different solid cancers (bladder, cervixutery, colon, corpus utery, female breast, kidney, lung, prostate, rectum, skin other than Melanoma, stomach), each of male, female, 15 age groups, each year, and in Chernobyl (evacuated), Ivankov, Narodichi, Ovruch, Polesskoe.	

Appendix 2: Content of the Databases on Sarcophagus

	Contents	Period	Number of data	Information included
1	Structure	---	(1) 4,413 objects (2) 174 boreholes (3) 281concrete objects (4) 1,041 objects of the parts of the sarcophagus such as ceilings and beams (5) 499 objects of the roof structure (6) 3.251 information of the rooms (7) 978 information of the rooms (8) 36 information on the shaft objects (9) 572 information on site architectures	(1) the objects' rows, axis, names and identification numbers (2) the objects' identification numbers, the locations of the holes, the directions of the holes, dates of beginning of boring, and the dates of the finishing boring (3) the objects' identification numbers, the elevation (4) the identification number, the name of the object, the description of the object (5) the identification number, the location and the coordinates of the roof structures (6) the room number, the identification number of the object, the descriptions of the objects such as corridor, and the serviceability (7) the identification number, the type of the room, the presence of water in the room, the trace of fire during the accident, vertical deviations of the fire, the load carrying capacity (kg/m^2), the maximum vertical deviation of the fire (cm), equipment load, payload (8) the identification numbers, the object's name, the type of the object, the serviceability (9) the identification numbers, the starting date of the construction, the coordinates, the height and the identification names of the row and the axis.
2	Systems and Equipments		- 2,652 equipment	- the equipments' identification number, the name, the type of the equipment
3	Radiological Situation	(1) from Jan 1998 to May 2001 (2) from December 2000 to June 2005 (3) from April 1991 to May 2001	(1) 685 samples of Cs-137 or Sr-90 (2) 9,573 semples of Cs-137, Sr-90, Pu-238, Pu-238/Pu-239/Pu-240, Pu-239/Pu-240 and other materials (3) 5,164 samples from the wells and the structures	(1) the identification number, the starting date of the measurement, the result of the measurement, type of the radio-nuclide, and the unit of the measurement such as Bq/m^3 (2) Measured values, the name of the material such as Cs-137, Cupper and Magnesium, the units of the measurements such as R/h and Bq/g, the starting date of the measurement, the identification number of the object such as FCM, the object's identification number (3) the measured values, the name of the measured subjects such as Am-241, calcium, their units (such as Bq/kg and mg/l), the starting date of the measurement, the name of the sampling place, the identification number
4	Fuel Contained Material (FCM)		(1) 92 FCM (2) 30,368 FCM room descriptions	(1) the identification number, the object's name, the type of the FCM, the room number where the FCM is situated. (2) the identification numbers of the room, the description of the room (3) the identification numbers, the object's name, the type of the FCM, the description of the

			(3) 149 information on the water FCM (4) 197 information on the water FCM	FCM such as how the FCM is located in the water (4) the identification numbers, the object names, the type of the FCM, the volume of the object (m^3) of the density of the object (g/cm^3)