Radiation Situation and Health Statistics of the People in the Tula Region of Russia after the Chernobyl Catastrophe

J. Socorro Delgado Andia

The Federal Assembly - Parliament of the Russian Federation - the State Duma 2, Geogievsky per., r. 1426, Moscow 1-3265, Russia

General view of the situation in Russia after the ChAPS accident

The Chernobyl APS accident was the greatest technogenic catastrophe. According to the latest data of the Ministry of Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (EMERCOM of Russia), over 30 million people living in the territory of 19 subjects of the Russian Federation are undergoing radioactive pollution [7].

Large-scale consequences of the accident profoundly affected the policy, economy and social life of the country. Several principal factors are highlighted:

- \diamond Radiation effects on man and the environment;
- Problems of information about the accident and its consequences - real and imaginary;
- Psychological impact on population, conditioned by information about the accident, implemented countermeasures, social privileges, compensations and so on;
- ♦ Social-economic impact on the whole country and the affected territories.

Regretfully, the processes which took place in the USSR and, later on, in Russia did not promote the successful liquidation of negative effects of the mentioned factors. Moreover, during 11 years after the accident, an increase of negative consequences has been observed.

As a result of the Chernobyl APS accident, the area of territories in Russia polluted with ¹³⁷Cs of higher than 37 kBq/m² (1 Ci/km²) amounted to 57,000 km². Nearly 3 million people are living there. The territories of the Bryansk, the Kaluga, the Tula and the Orel regions suffered most, where nearly 1.8 million people are living. Almost 300 km² of territories with levels over 1,480 kBq/m² (40 Ci/km²) were put out of economic use. All inhabitants there were resettled. Nearly 30,000 km² of agricultural land, including 1,710 km² with 555 kBq/m² (15 Ci/km²) or higher, and nearly 5,900 km² of forest were covered with radioactive pollution [6].

Within the affected territories, a series of protective activities were carried out in different terms after the catastrophe. In the first years after the accident, the radiation-hygienic situation was urgent. High level pollution of local agricultural products was observed: in 1986, 70% of hay and 80% of milk were rejected in the Bryansk region. Part of population received a considerable level of additional irradiation. According to the data of EMERCOM of Russia, as a result of countermeasures and natural processes, the radiation-hygienic situation on the polluted territories became better significantly. Recently contents of radionuclides in food products are below regulation limits in general. Nearly 100,000 people are, however, still subject to additional exposure in doses higher than 1 mSv/year, and in 4 settlements (in the mentioned regions) the average additional irradiation dose exceeds 5 mSv/year [7].

Compensations and supports in the affected areas from the government were sufficient until 1992. However, since the end of 1992, the situation got worse abruptly. Negative consequences of the accident in economic development and social sphere are clearly seen in the Bryansk, the Kaluga, the Orel and the Tula regions. In late years there appear in the affected areas greater reduction of industrial and agricultural production, aggravation of demographic situation, lowering of citizens' income, and slow adaptation to the social-economic changes than in the country on the whole.

According to sociological studies of last years, in spite of the complicated ecological situation in these areas, people are concerned more about heavy living conditions, inflation and the critical state of economy rather than about the environmental and medical problems due to the Chernobyl accident. Objective grounds exist for it. <u>Indices of mean wages and total</u> income are substantially lower there than the <u>Russian average, and the level of salary is lower</u> than the price to buy principal food products.

The social consequences of the accident are also quite significant. Already in first years there appeared a tendency to migration of a part of population from polluted areas; first of all, intelligentsia (teachers, physicians, rural specialists) and youth. This tendency later on became a mass phenomenon. The government activities related to resettlement promoted this trend. The migration process led to a significant aggravation of the demographic situation in rural areas. The share of pension age people in villages of polluted districts reached 40%, and the number of pre-pension age among the able-to-work population reached 30-40%. It should be noted that a new tendency began to appear in early 90's, and since 1994 it become clear. A stable increase of population in rural districts in the polluted regions is observed. In the Bryansk region the migration-related increase is already over 2 times as high as the natural decrease of population. The cause of this phenomenon is related with social processes which are taking place in Russia and CIS countries. Objective causes exist; people are immigrating from northern and eastern territories of Russia, and from zones of racial and military conflicts both inside Russia and in the republics of the former USSR. <u>This considerable</u> influx of population into the radiocontaminated territories can cause new problems including increase of social tension.

It used to be considered that medical consequences of the accident are dominating factors. In fact, more than 100 cases of thyroid cancer were discovered in Russia among those who had been children and adolescents at the time of the Chernobyl accident. This index exceeds by tens of times the average. However, the health state is determined not only by radiation exposure or the ecological situation, but also by the totality of social-economic factors and tendencies of their changes. All these factors determine the observed multiple health disturbances of the population living on the polluted territories. Perspectives of liquidation of the accident consequences are indissolubly connected with perspectives overcoming the current economic crisis in Russia. An optimistic forecast says that the medico-demographic after-effects of the accident can be overcome in 10-15 years on all polluted territories. A pessimistic forecast says that the medico-demographic situation in the polluted districts will get worse far more quickly than in Russia on the whole.

It is necessary to mention that a substantial loss of the health of the people was caused not only as a result of irradiation, but also due to the absence (in the first stage after the ChAPS accident) of information about radiation pollution and, later on, its imperfection and distortion. Consequently, psychological disadaptation is observed in the overwhelming majority of adults living on polluted areas. The insufficient and imperfect information to the public and to medical personnel about irradiation effects on organism and prophylactic methods also worsened the harmful consequences of the ChAPS accident.

These can be seen through the analysis of the health state of residents in the Tula region, significant part of which is polluted with radiostrontium and radiocesium from Chernobyl.

TULA REGION

Radioactive pollution in the Tula region

The Inter-institutional Commission on radiation control of the environment at the USSR Goskomgidromet approved the map of radiation situation in the region for the first time on 26.12.1990. 17 districts and Donsk city entered the zone of radiocontamination (>1 Ci/km² with ¹³⁷Cs) as a result of the Chernobyl APS accident. These are districts of Arsenievsk, Belevsk, Bogoroditsk, Venevsk, Volovsk, Efremov, Kamensk, Kimovsk, Kireevsk, Kurkinsk, Novomoskovsk, Odoevsk, Plavsk, Teplo-Ogarevsk, Uzlovsk, Chernsk and Shchekino. In total: 2,048 settlements with 930 thousand population (including 750.6 thousand adults and 165.6 thousand children). At present, the number of population constitutes near 916,000 including 159,689 children. Various districts of the Tula region are situated at 500-600 km from the Chernobyl APS. The total area of radioactive pollution constitutes 14.5 thousand km², i. e. 56% of the region area (Table 1).

By 01.01.1997, 16 settlements were excluded from the category of radiocontaminated as compared with 1991; 3 of them - in the zone of 5-15 Ci/km², and 11 - in the zone of 1-5 Ci/km². The number of residents of the above mentioned districts decreased for the observed period by 23,667: 340 of them - in the zone of 5-15 Ci/km², and 23,324 - in the zone of 1-5 Ci/km² [1].

It is also noted that, within separate settlements, there are spots which are not representative for all the area of the given settlement and show high levels of pollution areas even from one to several square meters. As a rule, such increased pollution are observed under drains from roofs, in places of storage of manure or ashes, in low parts of earth etc.

The area of agricultural land in the region, polluted with radionuclides is $8,950.77 \text{ km}^2$, details of which are as follows.

- 1) <u>1-5 Ci/km²</u> 7,685.55 km² of agricultural land (50.1% of total area) including 6,269.23 km² of ploughland, 185.87 km² of hayfield, 1,230.45 km² of fodder land.
- 2) <u>5-15 Ci/km²</u> 1,260.82 km² of agricultural land (8.2% of total area) including 1,044.92 km2 of ploughland, 32.31 km² of hayfield, 183.59 km2 of fodder land.
- 3) <u>15-40 Ci/km²</u> 4.40 km² of agricultural land (0.003% of total area), all of which belong to ploughland. The districts with the largest polluted areas are the next: Plavsk (2.20 km²), Uzlovsk (2.20 km²).

The radioactive pollution of forest (State Forest Fund) in the Tula region amounts to 707.13 km^2 , over a quarter of the total forest (2,706.14 km²) of the region. Out of them, 109.31 km² and 597.82 km² are situated in the zones of 1-5 Ci/km² and 5-15 Ci/km², respectively.

According to the data of Committee for Liquidation of Radiation Catastrophes Consequences of the Tula region, the pollution of forests is something higher than that of open places and adjacent settlements. This is attributed to lesser migration of radionuclides due to the existence of leaf litter in the forest.

District	Number of settlement				Population (persons)				Area (1000 km ²)			
	District total	Zone of contamination				Zone of contamination				Zone of contamination		
		Total	Cs-137 level		District		Cs-137 level		District		Cs-137 level	
			5-15 Ci/km ²	1-5 Ci/km ²	total	Total	5-15 Ci/km ²	1-5 Ci/km ²	total	Total	5-15 Ci/km ²	1-5 Ci/km ²
Arsenievsk	106	106	94	12	13015	13015	6799	6216	1.099	1.099	0.993	0.106
Belevsk	177	151	50	101	30200	28999	3730	25269	1.19	1.078	0.295	0.783
Bogoroditsk	80	80	13	67	68558	68558	5089	63469	0.94	0.94	0.095	0.845
Venevsk	201	33	-	33	39100	9789	-	9789	1.88	0.063	-	0.063
Volovsk	125	125	-	125	18550	18550	-	18550	1.07	1.07	-	1.07
Efremov	205	147	-	147	81900	75587	-	75587	1.6	0.785	-	0.785
Kamensk	100	66	-	66	11100	7518	-	7518	0.934	0.327	-	0.327
Kimovsk	152	147	-	147	59100	58754	-	58754	1.45	1.23	-	1.23
Kireevsk	176	176	39	137	93619	93619	12624	80995	0.930	0.930	0.072	0.858
Kurkinsk	119	61	-	61	15600	10975	-	10975	0.95	0.482	-	0.482
Novomoskovsk	99	65	-	65	172300	169355	-	169355	0.69	0.357	-	0.357
Odoevsk	135	88	-	88	15500	5185	-	5185	1.18	0.637	-	0.637
Plavsk	108	108	54	54	29418	29418	23553	5865	1.02	1.021	0.624	0.397
T-Ogarevsk	116	116	-	116	15628	15628	-	15628	1.01	1.01	-	1.01
Uzlovsk	103	103	22	81	102400	102400	84081	18319	0.617	0.617	0.122	0.495
Chernsk	270	270	21	249	22283	22283	3129	19154	1.62	1.62	0.027	1.593
Shchekino	239	198	18	180	129600	122950	1484	121466	1.39	1.181	0.23	0.951
Donsk (city)	8	8	-	8	77200	77200	-	77200	0.03	0.03	-	0.03
Total	2519	2048	311	1737	995071	929783	140489	789294	19.6	14.477	2.458	12.019

Table 1 Radioactive contamination in 17 districts and Donsk city of the Tula region by the Chernobyl accident (01.01.1991) [1].

In 1996, the pollution of agricultural land decreased something as compared with preceding years, and it decreased by more than 100 times as compared with the situation in 1986 (for ten years). Radiocesium transfer to agricultural crops decreased notably both for account of natural decay of radioactivity and due to agrochemical activities (soil liming, introduction of phosphoric and potash fertilizers). According to the data of radiation surveillance of food products and animal fodder on 01.01.1997, the maximum concentrations of cesium radionuclides in milk, meat, vegetables and fruits were 38.4, 22.6, 17.0 and 6 Bq/l(kg), respectively. All of them did not exceed values of TAL-93 (Temporarily Admissible Level) for milk (370 Bq/l) and for meat, vegetables and fruits (600 Bq/kg). By the spectrometric data, the maximum concentration of strontium radionuclides in food products was 0.4 Bq/l(kg) against admissible levels from 37 to 100 Bq/l(kg).

Last year, however, an increase of cesium radionuclides was registered in 5 out of 26 samples of mushrooms collected in autumn in neighborhoods of the following settlements:

♦ village Krasnopolskoe of the Kimovsk district,

 \diamond village Lugovoe of the Kimovsk district,

♦ village Bogoroditsk (Dachi station);

♦ farm Beloozero of the Kimovsk district.

Two-times excess over TAL-93 was observed in samples.

In this connection, <u>further and permanent</u> laboratory studies are necessary for samples of <u>mushrooms</u> that are now the principal path of internal exposure of the population in radiocontaminated areas, as well as development of recommendations on their consumption.

Dosimetric surveillance of population

The results of radiation surveillance of the environment on 01.01.1997 show that the level of gamma-background has stabilized in last years and is within the limits of fluctuations of natural characteristic in middle latitudes of the Russian Federation (15-25 μ R/h). Exceptions are some settlements of the Arsenievsk, the Uzlovsk, and the Plavsk districts where the average level of gamma-background is up to 30-40 μ R/h (the temporarily admissible value: 60 μ R/h). There are also separate local spots in these districts where the level of gamma-background exceeds 60 μ R/h, reaching up to 260 μ R/h.

Regretfully, the specification of radiation situation in 118 settlements planned in 1996 by the Tula Center on Hydrometeorology and Monitoring of Environment was not implemented due to the lack of finance from the Federal budget.

According to the data of the State Sanitarian-Epidemiologic Inspectors, cesium content in organisms of residents in the Arsenievsk, the Novomoskovsk, the Uzlovsk and the Shchekino districts does not exceed the level of preceding years and is lower than the admissible levels (122.1 kBq for adults). The average and the maximum values of cesium content in the organisms of adults were 0.96 k Bq and 9.3 kBq, respectively. For children, they were 0.74 kBq and 4.4 kBq, respectively.

A group of persons (machine-operators, cattle-breeders, plant cultivation workers) has been examined with direct measurements of external irradiation doses with thermoluminescent dosimetry in the Plavsk, the Arsenievsk, the Uzlovsk, the Chernsk districts and Donsk city. The mean external dosage of the examined people, including the contribution from the natural background (2.2 mSv/year), was 2.32 mSv/year.

According to calculation of the St. Petersburg Research Institute of Radiation Hygiene and the Regional Centre of Gossanepidnadzor, the average annual effective dose of population in 1996 (in 2,041 settlements of the radiocontaminated zone) was not higher than the admissible level of 1 mSv/year. The maximum value of the average annual effective dose (0.71 mSv/year) was registered in Rozhdestveno-1 village of Samozvanovsk rural administration of the Plavsk district.

Health statistics of population

Large-scale industrial centers are situated on the polluted territories of the Tula region, including chemical ones. These are as follows: "Tula-Chermet" company, Kasacharsk Metallurgical Group, "Novomoskovskij Bytkhim" company, Aleksinsk Chemical Group, "Azot" (Novomoskovsk and Shchekino), Efremov Chemical Group, Efremov Synthetic Rubber Plant, and others. <u>These enterprises</u> pollute the environment with heavy metals, dioxins, oxides of nitrogen, sulfur, carbon, aromatic hydrocarbons, volatile organic compounds, cyanides, pesticides, herbicides etc. [3].

It was noted in the State Report "On the State of the Natural Environment of the Russian Federation" of 1994-1996: "...Moscow and Tula regions are characterized by the largest releases of pollutants into the atmosphere. Their contribution constitutes respectively 24% and 21% of the total release in central regions of the Russian Federation", "...from the substances polluting the natural water resources in the Tula region the followings can be noted: nitrogen and phosphorus compounds, iron (8.5% of total release in the RF), aromatic hydrocarbon (26% of total release in the RF)...". "Azot" company (Novomoskovsk) was noted as the biggest enterprise polluting the surface reservoirs; 51.4 mln m³ of polluted waste waters were released by it [3]."

All the above mentioned factors undoubtedly have been influencing the health state of the population and demographic indices, together with radiation factors due to the Chernobyl accident

Birth rate and death rate in the Tula region

In Fig. 1 are shown the dynamics of birth rate (thick lines) and death rate (thin lines) observed during 1985 - 1995. The data are divided into three groups: the whole region, 18 contaminated areas (17 districts + Donsk city), and 7 clean districts. In this case, 'clean' merely means that the level of contamination is below 1 Ci/km² of 137 Cs

As can be seen from Fig. 1, there are observed continuous opposite trends of increase of death rate and decrease of birth rate in all three groups. Natural increase of population in the region turned to minus since 1988 and the minus trend continues to become larger with time. At first, this trend can be explained by the change in the age structure of population. The Tula region is becoming "older": nearly 30% of inhabitants are now over 60. One of the reasons for such change of

the age structure is considered emigration of young people from the contaminated areas. This trend is influencing indices of various diseases.

Neoplasm in adults

Morbidity of neoplasm in adult population is shown in Fig. 2. In addition to the data of two groups (18 contaminated areas and 7 clean districts), separate data in 4 districts are plotted. Districts of the Plavsk and the Uzlovsk are chosen from the most contaminated districts, while the Venevsk has the least level of contamination within the 18 contaminated areas (Table 1). The Novomoskovsk is the district where heavy industries are located. All data in Fig. 2 have a slight trend of increase of neoplasm morbidity. The morbidity in the 7 clean districts is somewhat larger than in the 18 contaminated areas. Within the 4 districts, the data of the Novomoskovsk tends to show a higher value.



Fig. 1 Birth rate and death rate in the Tula region (1985-1995): all districts, 18 contaminated areas and 7 clean districts [5].



Fig. 2 Morbidity of neoplasm in adults in the Tula region (1988-1996): 18 contaminated areas, 7 clean districts and 4 districts (Plavsk, Uzlovsk, Novomoskovsk, Venevsk) [4].



Fig. 3 Total morbidity of children in the Tula region (1985-1996): 18 contaminated areas, 7 clean districts and 4 districts (Plavsk, Uzlovsk, Novomoskovsk, Venevsk) [5].







Fig. 5 Incidence rate on congenital anomaly of newborns in the Tula region (1988-1996): 18 contaminated areas, 7 clean districts and 4 districts (Plavsk, Uzlovsk, Novomoskovsk, Venevsk) [5].

Total morbidity in children

Total morbidity in children is shown in Fig. 3. There are also seen apparent trends of increase. The averages both in the 18 areas and the 7 districts show a similar trend of increase, while the values in 4 districts are at different levels. As a whole, the statistical data indicates that the number of ill children has doubled over 11 years. The Venevsk keeps the least level, and

the Novomoskovsk and the Uzlovsk are at the highest level.

Anemia in children

Fig. 4 shows morbidity of anemia in children. The increase in the Uzlovsk after the Chernobyl accident is remarkable as compared with increases in other data. On the other hand, the level in the Plavsk decreased after the accident. The difference between the Uzlovsk

and the Plavsk is about ten times in 1994-1996 although both districts are heavily contaminated.

Congenital anomaly in newborns

Incidence of congenital anomaly in newborns is shown in Fog. 5. Remarkable and stable increases are observed in the Uzlovsk and the Novomoskovsk after 1991. Until 1991, the average in the 18 contaminated areas was the same level as in the 7 clean districts, then the former showed a departure from the latter. It is also noted that values in the Plavsk and the Venevsk remain at the stable levels.

All data shown above about the health statistics in the Tula region are telling us that the health state of the people are worsening, including the health of children and newborns. It is difficult at present to prove the causes of these deteriorating trends because, as described before, there are a lot of factors that are influencing the health state of the people. Besides, the quality of the data for health statistics should be also reviewed; some statistics among ordinary diseases show unbelievable difference of morbidity between districts, sometimes reaching several tens of times.

Liquidators

A large number of specialists from the Tula region participated in the liquidation of the ChAPS accident, including groups of volunteers - miners who worked in drifting tunnel under the 4th reactor of the ChAPS.

The total of 2,240 persons are registered as liquidators in the Tula region. The data of external exposure dose established with 1,826 liquidators indicates the following distribution of external exposure (cGy): 732 men (0-5), 224 men (5-10), 170 men (15-20), 702 men (over 20) [1].

According to the data of the State Report "About the State of Health of Population of the Russian Federation", morbidity among the liquidators is 2-3 times as high as that in ordinary population [2]. The most frequent diseases among this category of citizens

Table 2 Death causes of liquidators in the Tula region (1986-1995) [5].

Cause of death	Cases	%
Injury and poisoning	54	43
Disease of respiratory organ	11	8.7
Malignant neoplasm	17	13
Disease of urine system	3	2.4
Disease of blood circulating system	35	28
Disease of nervous system	1	0.8
Disease of ingestion system	2	1.6
Disease of endocrine system	1	0.8
Others	3	2.4
Total	127	100

are the following: diseases of blood circulation organs (38.4%), functional encephalopathy (37.7%), neurocirculatory dystonia with mental disorders (10.2%), neoplasm (2.5%).

Long-term psychological stress caused rise both of psychological, somatic diseases and of physical disadaptation. This led to the formation of syndromes such as headache, giddiness, lowering of memory and quickness of wit, depression, obtrusive disorders, phobias, pain in muscles, bones, metallic smack in mouth, and absence of ability to work in the second half of day.

Structural changes in thyroid appeared after 4-6 years. They are manifested by latent hypothyroidism without changes in thyroid hormones. The autoimmune thyroidites are the earliest consequences of Chernobyl accident.

Out of 2,240 liquidators registered in the Tula region, 127 persons had died until the end of 1995, including 19 deaths 1995. Causes of their deaths are shown in Table 2. The percentage of suicides and accidents connected with abuse of alcohol is high and constitutes 50% of these deaths.

By the end of 1995, 1,176 liquidators (53 % of the total) were recognized as disabled persons. In Fig. 6 are



Fig. 6 The number of liquidators recognized as the disabled in the Tula region [5]

seen the dynamics of their registration. Drastic increase of the number of the disabled is observed since 1990. It can be said that all liquidators may soon fall into the category of the disabled.

Conclusion

Long-term programs are necessary in order to minimize the medical consequences and to increase the efficiency of medical assistance to those who have undergone radiation action as a result of the Chernobyl catastrophe. It is also necessary to evaluate objectively the state of health of the sufferers, to obtain scientifically grounded conclusions on effects of "low" radiation doses on human organism, and to estimate the genetic consequences for future generations. These programs must foresee the implementation of various activities, including:

- 1. Provision of further monitoring of persons attributed to the groups of risk, especially:
- those whose thyroid was irradiated when they were children and adolescents;
- ♦ children born by mothers whose thyroid was irradiated in their children-adolescent age;
- children whose thyroid was irradiated in pre-natal period;
- \diamond pregnant women;
- ♦ liquidators of 1986-1987 and their children born after 1986.
- 2. Provision of medical-prophylactic institutions on the polluted territories (of district and regional levels) and clinics of research centers with modern medico-diagnostic equipment, as well as regular supply of necessary reagents and medicines to hospitals and clinics.
- 3. Development of system of rehabilitation medical activities and sanatorium bases for the Chernobyl sufferers, especially for children.
- 4. Supply of food products with radioprotective properties; fresh vegetables, fruits etc., especially for children in the polluted territories.
- 5. Scientific study of radiation action combined with action of other carcinogens including chemical pollutants.

- 6. Implementation of educational programs on problems of environmental and radioecological safety, and introduction of ecological knowledge and skills which promote self-adaptation of different age groups to stress factors.
- 7. All above mentioned recommendations will not have positive results without improvements of social, ecological and economic situations in the country.

References

- Reports about countermeasures to mitigate the consequences of the Chernobyl APS accident in the territory of the Tula region in 1991, 1992, 1993, 1994, 1995, 1996. Tula region administration. Committee for mitigation of radiation catastrophe (in Russian).
- 2. Government report, "Health status of the population in the Russian Federation in 1995 and 1996 (in Russian).
- 3. Government report, "Current situation of the environment in the Russian Federation", 1994, 1995, 1996 (in Russian).
- 4. Information bulletin of principal indices of pediatristics in the Tula region, Statistical handbook, Department of Health and Medical Industry of the Tula Region, Tula, 1997 (in Russian).
- 5. Information bulletin of the population health in 18 contaminated territories and medical help to liquidators of the Chernobyl consequences in 1985-1996, Department of Health and Medical Industry of the Tula Region, Tula, 1997 (in Russian).
- 6. L.I.Anisimovsa, R.M.Barfdorov, P.I.Linge, Ecological, social and demographic aspects of the Chernobyl accident, Chernobyl and other catastrophes: humanitarian collaboration of sufferers by the technogenic natures, UN seminar, Moscow 1997 (in Russian).
- Results and problems in eliminating the consequences of Chernobyl accident in Russia. Emercom of Russia. Final report. Moscow. 1997ã.