4. Water resources

Freshwater resources have great ecological and economic importance. In this regard, effective management of water resources is one of the major challenges of sustainable development in general.

Renewable freshwater resources

Renewable freshwater resources of the Republic of Belarus represented by river run-off and groundwater, the volume of which is formed in natural conditions by precipitation in the country (internal flow), as well as the influx of river water and groundwater from neighboring countries. The total annual flow of rivers is determined by measuring the levels and water flow. The natural resources of fresh groundwater is the total flow rate of underground water, which is provided by infiltration of precipitation. The figure of infiltration recharge aquifers active water exchange zone is 10-20% long-term average values of precipitation. In the general flow of rivers of Belarus on the proportion of groundwater accounts for 27%.

The main source of surface water resources of the country are medium and large rivers, the volume of water runoff, which in water average years, usually not more than 57.9 billion m^3 per year. In wet years the total runoff is increased to 92.4 billion m^3 per year, and in dry (95% availability) decreases to 37.2 billion m^3 per year In this case, the rivers of the Black Sea account for 55% of total annual runoff, the Baltic Sea basin – 45%.

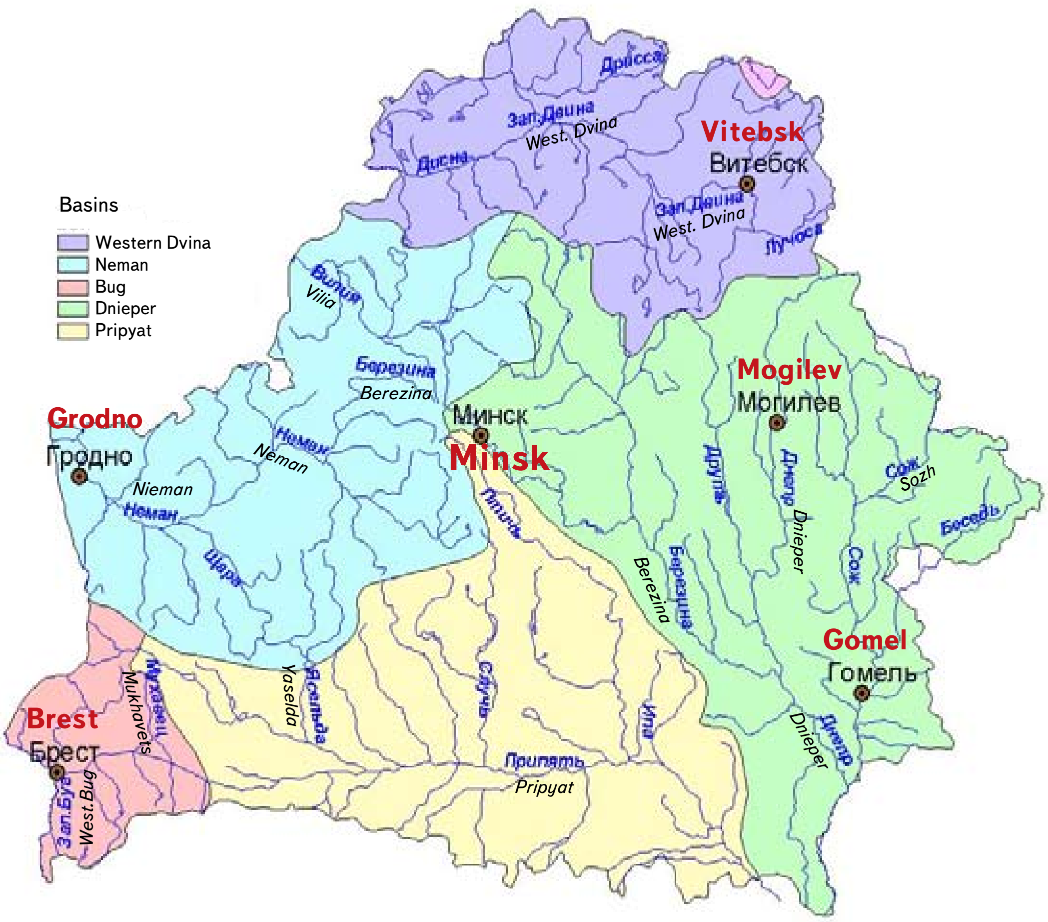


Figure 4.1 – The main rivers of Belarus

Across the country seven major rivers are longer than 500 km: the Western Dvina, the Neman, the Vilia, the Dnieper, the Berezina, the Sozh and the Pripyat, six of them (except for the Berezina) are transboundary ones *(Fig. 4.1)*. There are totally 20.8 thousand rivers of different sizes with the total length of 90.6 km.

Most of the river runoff (34 billion m^3 or 59%) is formed within the country (local stock). Inflow of water from neighboring states (Russia and the Ukraine) is 41% or 23.9 billion m^3 per year *(Table 4.1)*.

The bulk of the local river runoff (73%) is formed in the catchments of the Western Dvina, Neman and the Dnieper. Predominant part of the transit flow enters the Dnieper (32%), the Pripyat (31%) and the Western Dvina (28%).

Distribution of local runoff within the year is very uneven. Over the three spring months on the rivers of western and central parts of the country (the basins of the Neman, the Vilia, the Berezina) takes on average 42-47% of annual flow, while the rest – up to 56-62%.

Irregularity of the annual flow is compensated to some extent, by the construction of reservoirs. Belarus has created 153 reservoirs, the total volume of water is 3.1 billion m^3, useful – about 1240 million m^3, accounting more than 3% of the runoff, formed in the country. Dominated reservoir of the channel (river)-type for water inlet is 35% and lake type – 13% respectively.

In Belarus there are about 10.8 thousand lakes, the vast majority of them (75%) belongs to small, having a surface area up to 0.1 km^2. Resource importance of lake with area over 1.0 km^2, is totaled 6000-7000 million m^3 of water. The largest volume of water enclosed in a lake basins of the Western Dvina (72% of all stocks) and the Neman (20%), followed by basins of the Pripyat and the Dnieper.

Table 4.1

Resources of streamflow

Administrative Regio	Local watershed runoff, million m^3		Total stock, million m^3	
	Average long-term	95% provision	Average long-term	95% provision
Western Dvina	6800	4300	13 900	8600
Neman (without Vilia)	6600	5200	6700	5300
Vilia	2300	1800	2300	1800
Western Bug (incl. Narew)	1400	800	3100	1700
Dnieper (excluding Pripyat)	11 300	7600	18 900	12 800
Berezina	4500	3300	4500	3300
Pripyat	5600	3100	13 000	7000
Total	34 000	22 800	57 900	37 200

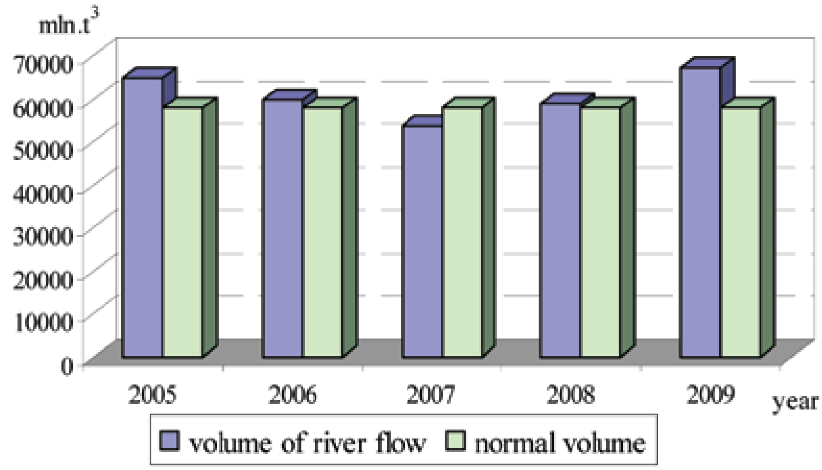


Figure 4.2 – The dynamics of river flow for the period 2005-2009

In 2009 the total in Belarus amounted to 67.6 billion m^3 and was higher long-term average values over 17% *(Fig. 4.2)*.

During the period 2005-2009. total volume of runoff was slightly lower than the average long-term value only in 2007, accounting for 93% of the norm.

Largest water resources of rivers of Belarus ranks the fourth place in Europe after Norway (376 billion m^3 per year), UK (152 billion m^3 per year) and Poland (85.4 billion m^3 per year).

Natural resources of fresh groundwater is 15.9 billion m^3 per year, the forecast – 18.1 billion m^3 per year. Distribution of water resources across the country is very uneven, owing to the nature of the relief capacity of the aeration zone, lithological composition of land and water-bearing rocks. At the level of the administrative regions of the country by the number of natural resources is allocated Minsk region, the least ensured Brest *(Table 4.2)*.

At the level of river basins the most significant amount of water found in the watershed of the Dnieper (including the Pripyat) and the lowest – in the watershed of the Western Bug *(Table 4.3)*.

Sufficiency of water in the world is estimated using specific indicators of water

Table 4.2

Groundwater resources within the boundaries of administrative areas

Administrative Region	Freshwater groundwater mln m^3 /y		ratio of operational resources to the natural,%
	natural	forecast	
Brest	1584	2045	129
Vitebsk	3357	3486	104
Gomel	1929	3094	160
Grodno	2613	2806	107
Minsk	4134	4360	105
Mogilev	2283	2310	101
Total	15 900	18 100	114

Table 4.3

Groundwater resources within the boundaries of basins of major rivers

Basin	Freshwater groundwater, mln m^3/y		Ratio of operational resources to the natural,%
	Natural	Forecast operational	
Western Dvina	2690	2970	110
Neman (without Vilia)	3601	3510	97
Vilia	1330	1670	126
Western Bug	510	662	130
Dnieper (without Pripyat)	5200	5528	106
Pripyat	2559	3750	147
Total	15 900	1810	114

availability (the ratio of average annual runoff to the number of the population).

Water availability per capita in Belarus (6,1 thousand m^3/person/year) is close to the average, but significantly higher than in neighboring countries – Poland (1.7 thousand m^3/person) and the Ukraine (4,1 thousand m^3/person).

Freshwater water

Data on water intake coming from enterprises and organizations established by the state reporting form, store in the system water inventory. They are compiled and published in the annual information-analytical publications.

According to the water inventory, total intake of surface and groundwater in 2009 was 1.573 billion m^3 and in comparison with 2008 decreased by 65.5 million m^3. Reducing the quantaty of water is steadily observed over the past five years. In relation to 2005, the total water intake decreased by 200 million m^3, that means more than 10% *(Fig. 4.3).*

From water natural objects are taken 715 million m^3 of water, from underground sources – 858 million m^3. The structure of the total water intake on the proportion of groundwater in all the considered years accounted for more than 50%, and in recent years has tended to reduce groundwater consumption.

Along with the decrease in the amount of consumption of water in general, there was a decrease in the rate of water consumption per capita *(Table 4.4).*

The main quantity of natural water is taken in Belarus for the needs of utilities. In 2009, for the industry, «public utilities and public services» was withdrawn 761 million m^3; for

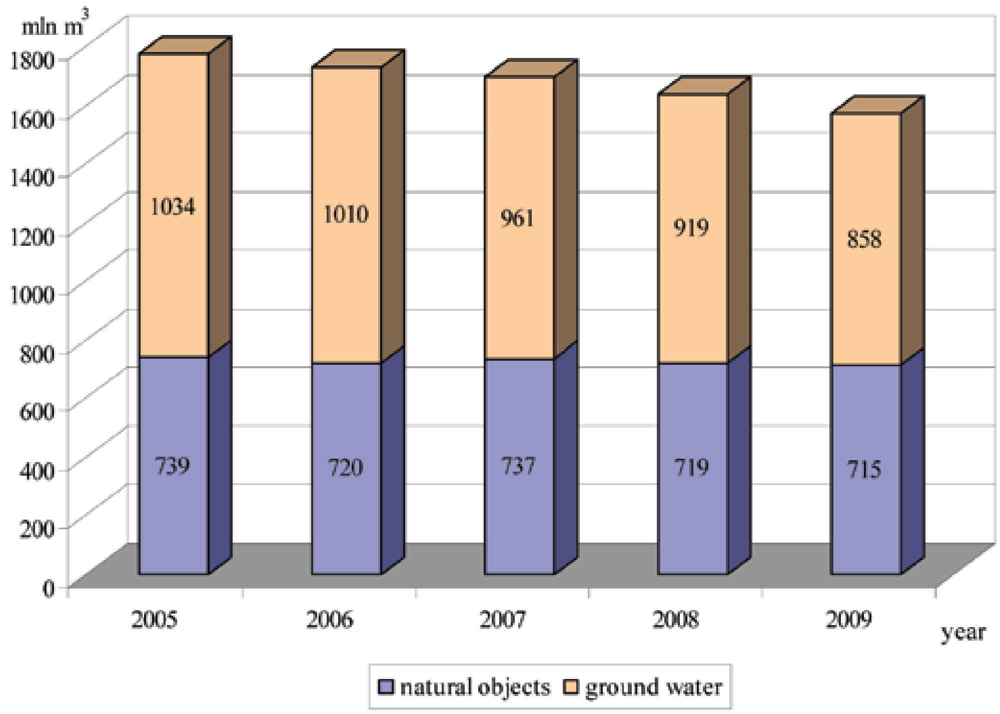


Figure 4.3 – Dynamics of water consumption from natural objects and ground water sources

Table 4.4

Dynamics of water intake per capita over the period 2005-2009

Year	Total abstraction, mln m³	Country's population, ths	Water intake per capita, m³
2005	1773	9800	181
2006	1730	9756	177
2007	1698	9714	175
2008	1638	9690	169
2009	1573	9490	166

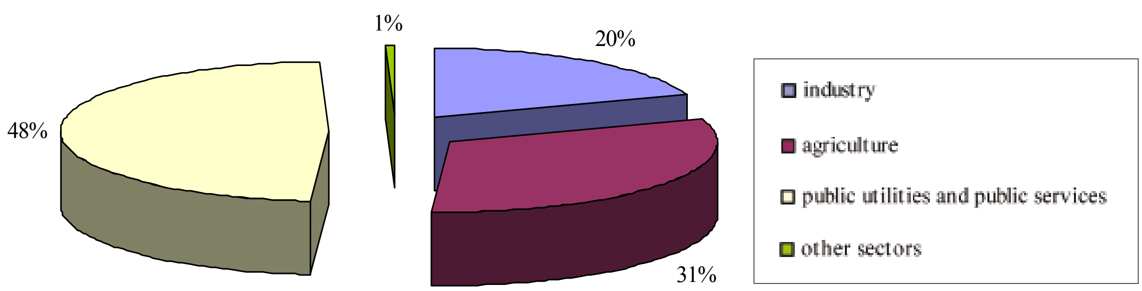


Figure 4.4 – Total water consumption by sector of economic activities

agriculture — 492 million m^3 and the industry — 310 million m^3. Water consumption by sector of economic activity in percentage terms is shown in *Figure 4.4.*

Representation of the pressures on water resources at national and regional levels can get the index of exploitation of water resources (IEVR), which is calculated as the ratio of total annual intake to a multiyear average annual volume of renewable freshwater resources. IEVR threshold value, which is the basis for comparing different countries and regions with a unstressed and water stressed conditions is about 20%. Water stressed conditions are noted in cases where IEVR exceeds 40%.

IEVR in considered years changed very little (2,8-3,0%) at the national level, and the total water consumption for all sectors of economic activity has no significant pressure on available water resources in the country. IEVR values increase somewhat when considering the sampling of natural waters at the river basin.

According to IEVR the most intensively at the regional level, water resources are exploited in the basins of the Berezina river (a tributary of the Dnieper), the Vilia and the Neman, much less — the Western Dvina, the Sozh and the Western Bug. In general, water resources are exploited in a normal mode.

Domestic water consumption per capita

Water consumption for household and drinking purposes by an average of every citizen of Belarus in 2009 did not exceed 145 L/24 hours/person. In comparison with 2005 it decreased by 30% *(Fig. 4.5)* and corresponded to the level of water consumption in most European countries (120-150 L/24 hours/person).

Compared with the average set for Belarus, in the cities of water consumption per capita is still quite high, approaching the European level only in Brest *(Table 4.5)*.

The largest amount of water consumed per capita is in Minsk, however, in recent years,

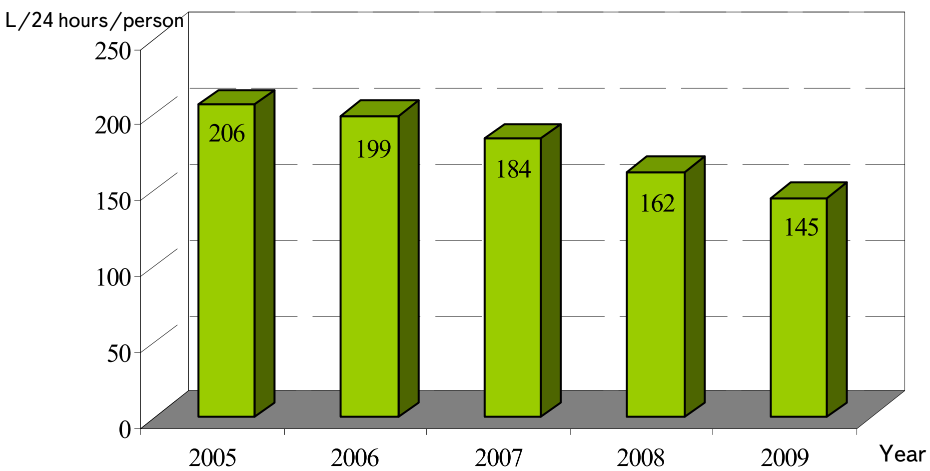


Fig. 4.5 — Water consumption in Belarus in 2005-2009

Table 4.5

Water consumption per capita in major industrial centers of Belarus in 2005-2009, L/24 hours/person

City	Year					Reduced to the level of 2005,%
	2005	2006	2007	2008	2009	
Brest	264	227	204	181	149	44
Vitebsk	250	241	217	185	166	34
Gomel	262	245	228	198	179	32
Grodno	302	265	245	214	193	36
Mogilev	298	275	252	213	176	41
Bobruisk	256	271	238	207	182	29
Borisov	224	216	201	204	153	32
Mozyr	293	231	196	195	165	44
Novopolotsk	255	208	190	170	153	40

domestic water consumption in the capital of Belarus has been reduced. Thus, in comparison with 2005 it decreased by 35%.

A similar situation is typical of other cities, where per capita consumption of water for municipal needs has decreased over the past five years at 29-44%.

Reducing domestic water consumption has become possible due to the introduction of metering of water used in the residential sector of the city, as well as measures aimed at the development of water conservation in the housing and communal services.

For municipal water supply for cities and all other settlements are mainly underground sources, with the exception of Minsk and Gomel, which partly receive drinking water from surface water objects. The provision of population with centralized water supply in Belarus is 86%, including the rural population – 57% (1.4 million people from 2.5 million rural population).

The quality of drinking water

The population of Belarus is provided with drinking water primarily from groundwater sources, sanitary conditions in which basically meet the requirements, except for the high content of iron and manganese, in some cases, boron, fluoride and some other components. This is a consequence of the hydrogeological features of the country.

An increase in the content of ammonium, nitrate, chloride and other components in groundwater is observed in the areas subject to anthropogenic pollution.

In 2009, the results of monitoring the drinking water quality standards established in Belarus, the deviations of microbiological indicators of water supplied by public water

Table 4.6

Specific volume of samples of drinking tap water in 2006 and 2009 which do not meet hygienic requirements,%

Region	Mains municipal water pipes			Departmental pipes		
	on microbiological criteria	for the sanitary-chemical indices (total)	iron (total)	on microbiological criteria	for the sanitary-chemical indices (total)	iron(total)
Brest	0,6	24,9	55,4	1,0	51,9	63,0
Vitebsk	0,2	16,0	15,5	0,7	17,3	16,2
Gomel	1,6	25,6	34,5	1,6	37,8	56,2
Grodno	0,9	19,7	25,2	3,2	33,2	40,7
Minsk	1,0	12,4	19,7	2,2	26,7	37,7
Mogilev	0,7	17,6	18,2	0,6	19,5	19,6
Minsk-city	0,7	5,0	4,3	2,9	13,1	15,0
In total, Belarus	0,8	18,4	22,2	1,4	27,8	36,3

pipes were found in 0.8% of cases, by departmental – 1,4% *(Table 4.6)*.

Obtained figures demonstrate the safety of municipal water supply in Belarus.

On sanitary and chemical standards water in public waterpipes in 2009 did not meet the standards in 18.4% versus 22.4% in 2006, in a departmental pipelines – in 27,8% (30,7% in 2006) from the total number of samples.

According to the guidelines for drinking water quality by WHO, the concentration of iron in water of 2 mg/L is not harmful to human health. At the same time in Belarus, the maximum allowable concentration of iron for drinking water is 0,3 mg/L.

Based on the more stringent requirements for drinking water in Belarus, the number of water samples which do not meet hygienic standards for the iron content of public water in 2009 amounted to 22,2% (28,2% in 2006), departmental water – 36,3% (38,2% in 2006).

Thus, in comparison with 2006 the proportion of water samples that do not meet hygienic requirements decreased in municipal water at 6% for iron and 4% for the sanitary-chemical indicators, in departmental pipelines – on 1,9 and 2,9% respectively.

Despite the considerable amount of work in recent years on the development of centralized water supply and sanitation, about 2 million people in the country continue to use water with iron content higher health standards (0.3 mg/L), adopted in Belarus.

Nowadays non-centralized water supply sources (water wells) are used by 1.4 million people including the rural population – 1.1 million

people. Of the 42.6 thousand controlled sources of uncentralized water supply about 11% do not meet hygienic requirements for the sanitary-chemical and microbiological standards. Discrepancy on chemical indicators is recorded in almost 40% of samples, and microbiological – 16%.

Deterioration of water quality in water wells due to both agricultural activities (introduction of organic and mineral fertilizers), and lack of hygiene rules when locating, equipment and operation of wells.

Despite some difficulties with the quality of drinking water, according to the report of the UN/UNDP «Human development indicators», Belarus is a member of the 34 countries whose population is 100 per cent sustainable access to improved water sources (quantity, quality and proximity of finding water sources).

Water loss

The efficiency of water use plays a key role in balancing the performance of water supply and water consumption. This can be achieved by reducing losses of water during transportation to the places of use and maintenance of pipe systems in good technical condition.

In 2009 losses of water during transportation to the places of use reduce as compared with 2008 for 47 million m^3 и was 84 million m^3. In this case, the amount of loss does not include the number of unaccounted-for water from public water supply systems, which accounted for 56 million m^3. Water loss during transportation in different years varies from 5 to 8 % *(Fig. 4.6)*.

Water losses during transport within the region varies from 7 to 17 million m^3: the greatest loss of water observed in the Vitebsk and Mogilev regions. The lowest quantity of losses is observed in Grodno region. The number of loss in Minsk accounts for more than 30% of the reported loss of water. However, there is a tendency to reduce water leakage in Minsk, as well as in all regions of Belarus.

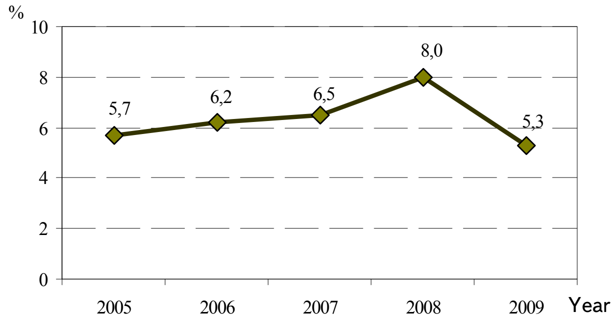


Figure 4.6 – Share of loss of fresh water in transit in 2005-2009

Re-use and recycling of freshwater

The index «re-use and recycling of fresh water» describes sharing of reusable and recycled water in the total volume of water consumed for industrial purposes. It determines the percentage of water saved through the use of recycling and reuse of water in the whole country and by sectors of economic activity.

In 2009, as compared with the previous year, the decline in water use is noted by 8,4% in the systems of recycling and re-using of water supply *(Table 4.7)*.

Reduction of the absolute values of this indicator was noted in all regions and

Table 4.7

Dynamics of water in the recycling and re-supply

The dimension of the index	Year				
	2005	2006	2007	2008	2009
million m³	6369	6522	6349	6697	6134
%	93	94	94	94	94

Minsk. Reasons for reduction of reusable and recycled water, usually caused by a change of technological parameters of the enterprises, changes in production technology, etc. At the same time the proportion of water used in the systems of recycling and re-using water used for production practically unchanged over the five year period.

Waste water discharge into water objects

The index «wastewater into water bodies» determines the level and nature of the load on the rivers and reservoirs of the country, provides information to improve the mechanisms for the protection of water bodies and evaluation of measures taken to improve the level of wastewater treatment.

The total amount of wastewater collected in the rivers of Belarus in 2009 increased compared with 2008 to 6 million m^3 and reached 996 million m^3. In this case, at the regional level, the amount allocated to water waste water increased only in the Brest and Minsk regions. Here, with respect to 2008, it increased by 26% and 10% respectively In comparison with 2005 the number of discharged wastewater in these areas increased by 21 and 4% respectively *(Table 4.8)*.

For the remaining regions and Minsk a tendency to reduce the amount of allocated in the river of sewage is noted. Compared with 2005 the volume of wastewater in the Vitebsk region decreased by 32%, Gomel – 26, Mogilev – 13, Minsk – 26%.

In the sectoral structure of wastewater is the largest amount of wastewater, usually falls on housing and communal services (HCS) and personal services. Thus, in 2009, the share of housing accounted for 60% of wastewater; for industry and agriculture – on 16 and 24% *(Fig. 4.7)*.

In industrial production the major suppliers of wastewater into water bodies are chemical and petrochemical industry, and electricity *(Fig. 4.8)*.

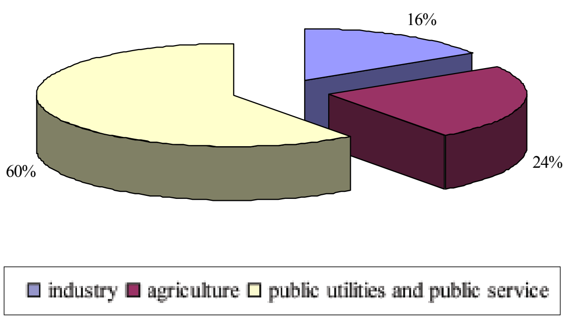


Figure 4.7 – Waste water discharge into water sectors of the economy in 2009

Table 4.8

Waste water discharge into water bodies in the regions and Minsk in 2005 – 2009, mln. m³

Region	Year				
	2005	2006	2007	2008	2009
Brest	160	154	157	154	194
Vitebsk	172	141	134	132	117
Gomel	189	173	170	156	140
Grodno	97	97	97	94	89
Minsk	159	158	151	151	166
Mogilev	115	111	106	106	100
Minsk-city	254	248	223	197	188
Total, Belarus	1146	1082	1038	990	996,6

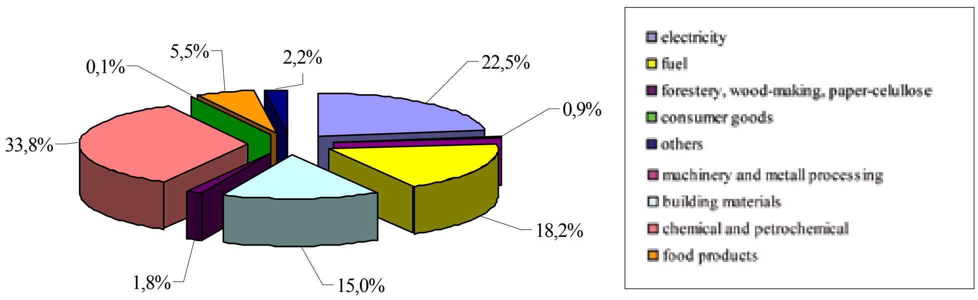


Figure 4.8 – Waste water discharge into water by industries in 2009

Among the categories of wastewater discharged into water objects, as previously, regulatory purified water quantitatively dominated, although its volume in comparison with the previous year decreased by 25 million m³. At the same time significantly (by 39 million m³) increased the number of legal and clean (unpurified) water. The volume of water without purificatin and inadequately purified, reduced to 3 million m³ if compared to 2008 it decreased by 3,7 times *(Fig. 4.9)*.

The basic amount of wastewater discharged into water bodies, formed in seven cities (Brest, Vitebsk, Gomel, Grodno, Mogilev, Bobruisk and Novopolotsk) and in Minsk, its share in the total amount of wastewater in 2009 was 48% and in the volume of norm-and purified water – 66%.

Surface water

In Belarus there is a well-formulated network of surface water monitoring, which in 2009 totaled 276 sites of observations located at 142 water bodies (81 of rivers and 61 of the lakes) in the basins of the Western Dvina, the Neman, the Western Bug, the Dnieper and the Pripyat. In addition, the observations covered 35 areas of transboundary watercourses located in areas of the state border.

The basic standard for river water quality in Belarus is the maximum permissible concentration of chemicals (MPC) established for the fishery.

Assessment of surface water in the basins of the Western Dvina, the Neman, the Western Bug, the Dnieper and the Pripyat was

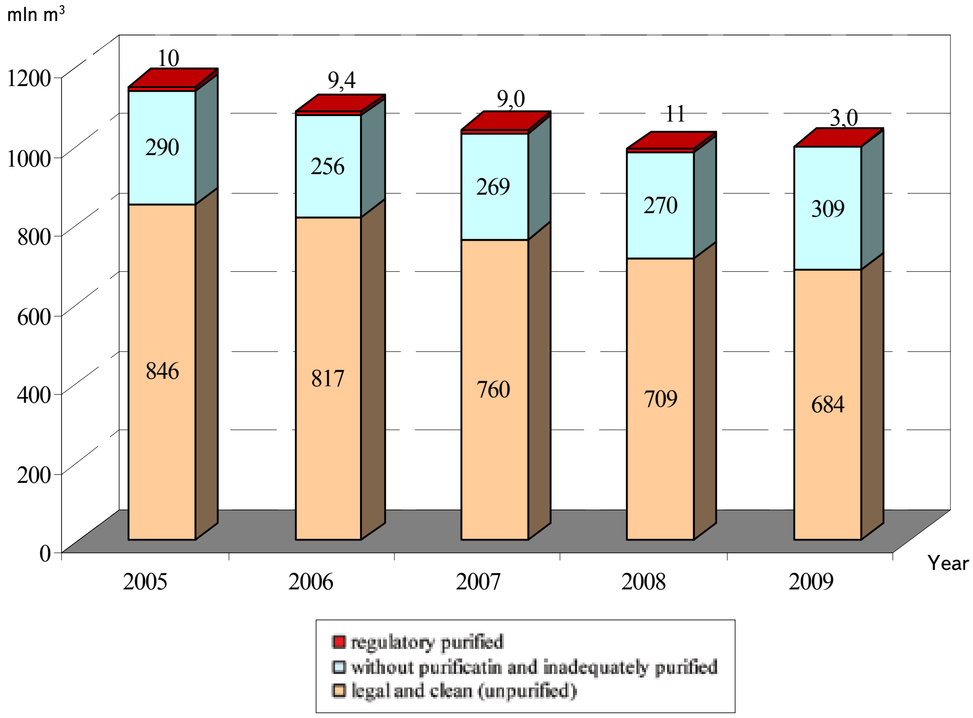


Figure 4.9 - Dynamics of wastewater into water bodies for 2005-2009

conducted according to the analysis of average values of BOD_5 (biochemical oxygen demand), annual average concentrations of ammonia nitrogen and nutrients (nitrate and phosphate phosphorus).

Biochemical oxygen demand in river water

Determination of biochemical oxygen demand (BOD_5) in rivers is necessary for assessment of biochemical oxidation of organic matter, water species conditions of living and as an integral index surface water pollution. This indicator is very sensitive to the level of water pollution. The value of BOD_5 in the range of 3,00-3,90 mgO_2/L identifies polluted waters, 4,00-10,0 mgO_2/L – dirty waters. In Belarus, for the assessment of river water pollution with organic substances adopted by the maximum permissible concentration values for BOD_5, which amounts to 3.00 mgO_2/L.

According to the data *(Table 4.9)* annual average BOD_5 exceeding the MPC in long-term series of observations are set out in the water of the Western Bug on virtually all controlled part of the river, some sections of rivers the Mukhavets, the Dnieper and the Svisloch. By the rivers, the annual average concentration of organic substances in water which during the period was below the MPC include the Western Dvina, the Berezina, the Pripyat.

Contamination of the Dnieper with organic matters for the entire observation period, according to the values of BOD_5 (3,13-4,55 mgO_2/dm^3) was observed only on the

Table 4.9

Minimum and maximum values of the average annual values of BOD_5 in the water of the main rivers of Belarus in the period 2005-2009., mgO_2/L

River	2005		2006		2007		2008		2009	
	min	max	min	max	min	max	min	max	min	max
Western Dvina	2,00	2,44	2,08	2,60	1,56	2,08	1,66	2,51	1,51	2,49
Neman	1,63	3,36	2,16	2,90	1,40	2,79	1,39	2,86	1,67	3,24
Western Bug	3,76	4,68	3,09	4,54	2,86	4,23	2,75	4,42	3,57	4,72
Mukhavets	2,54	3,55	2,75	3,50	2,56	3,25	2,66	3,32	2,43	3,53
Dnieper	1,25	3,56	1,35	4,55	1,33	4,10	1,06	4,24	1,50	3,13
Berezina	1,46	2,32	1,74	2,29	1,57	2,70	1,76	2,50	1,53	2,19
Svisloch	1,52	6,63	2,01	5,57	1,43	4,57	1,81	7,04	2,15	5,68
Pripyat	2,33	3,67	2,21	3,77	1,77	2,87	1,91	2,74	1,86	2,96
MPC	3,00									

segment of the river below Loyev. And in 2009 the situation has improved, the annual average organic matters content decreased to 3.13 mgO_2/dm^3.

Based on the average figures of BOD_5, the situation for the rivers the Pripyat, the Neman on the content in river water organic matters seems to be quite normal. Thus, in the last three years in the water of the Pripyat organic substances do not exceed the MPC. With regard to the Neman, the contamination of organic substances in 2009, recorded in the upper parts of the river, near the town of Stolbtsy.

Heavy pollution of river water, according to the annual average BOD_5 is typical for the Svisloch river below Minsk (site of Korolischevichi).

The concentration of ammonia nitrogen in the river water

Ammonium nitrogen is included in the list of priority pollutants of the rivers in Belarus. Measured concentrations of the pollutant can determine the level of change in river water quality.

As the data in the *table 4.10*, the average concentration of ammonia nitrogen excessed the level of MPC is found in water of all rivers and considered to be the evidence of pollution of river water, which is expressed differently for each water objects as for years, and in the areas of the pollutant spreading.

The average content of ammonia nitrogen in water of the Western Dvina exceeding MPC installed in all the years of a five-year period, mainly on the segment of the river from Polotsk to Verhnedvinsk, with the observed decrease in the concentrations of the pollutant: in 2006 they exceeded the guideline data in 1,6-2,0 times, in 2009 — 1,3-1,4 times, which indicates a slight

Table 4.10

Minimum and maximum values of annual average concentrations of ammonia nitrogen in the water main river in Belarus in 2005-2009, mgN/L

River	2005		2006		2007		2008		2009	
	min	max	min	max	min	max	min	max	min	max
Western Dvina	0,23	0,51	0,15	0,77	0,14	0,44	0,17	0,60	0,16	0,56
Neman	0,23	0,51	0,37	0,51	0,17	0,35	0,16	0,34	0,18	0,62
Western Bug	0,24	0,53	0,28	0,59	0,26	0,51	0,26	0,53	0,21	0,51
Mukhavets	0,26	0,38	0,38	0,64	0,35	0,61	0,40	0,52	0,34	0,88
Dnieper	0,37	0,78	0,34	0,83	0,26	0,70	0,22	0,77	0,26	0,89
Berezina	0,65	1,15	0,69	1,49	0,45	1,89	0,53	1,37	0,58	1,06
Svisloch	0,28	3,82	0,32-	4,46	0,31	4,08	0,18	3,06	0,28	2,38
Pripyat	0,37	1,32	0,45	1,57	0,35	1,39	0,25	0,77	0,26	0,75
MPC	0,39									

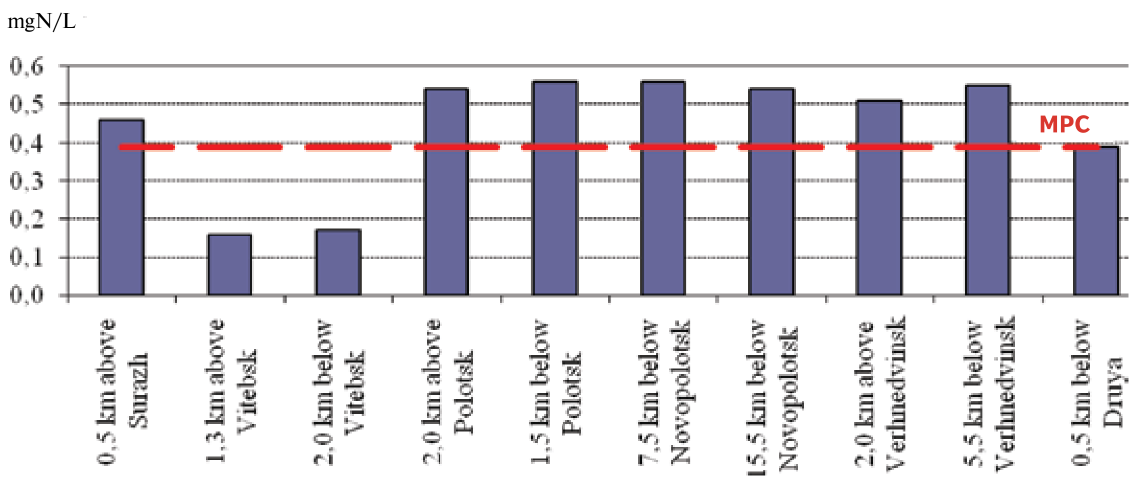
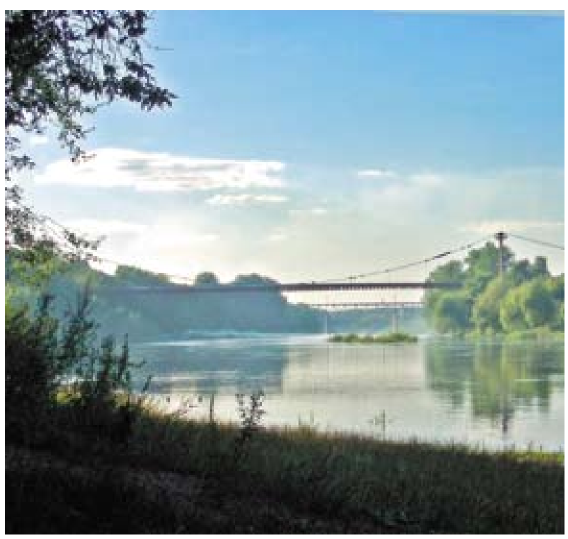


Figure 4.10 – The average content of ammonia nitrogen in water Western Dvina in 2009

improvement in river water. At the same time a new hotbed of ammonium nitrogen pollution of the river formed in the area of cross-border point (p. Surazh), which controls the flow of contaminants of the river waters from the territory of Russia *(Fig. 4.10)*.

To a greater degree of contamination of ammonium nitrogen is expressed for the tributaries of the Western Dvina – r. Polota around and Polotsk, r. Ushachi southwest Novopolotsk *(Fig. 4.11)*.

According to the annual average concentrations, good state of the Neman river



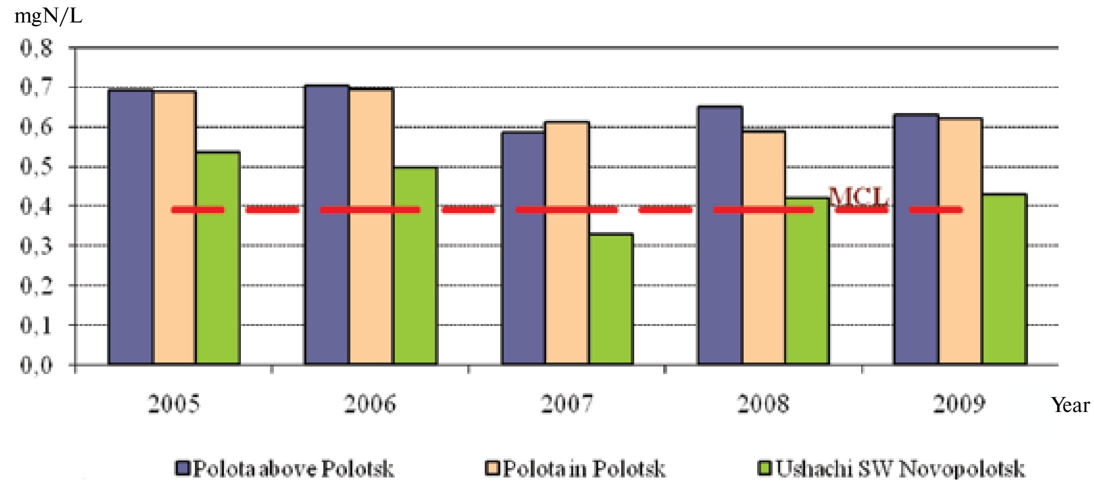


Figure 4.11 – Change in annual average concentrations of ammonia nitrogen in water r.Poloty around and Polotsk, r.Ushachi southwest Novopolotsk in 2005-2009

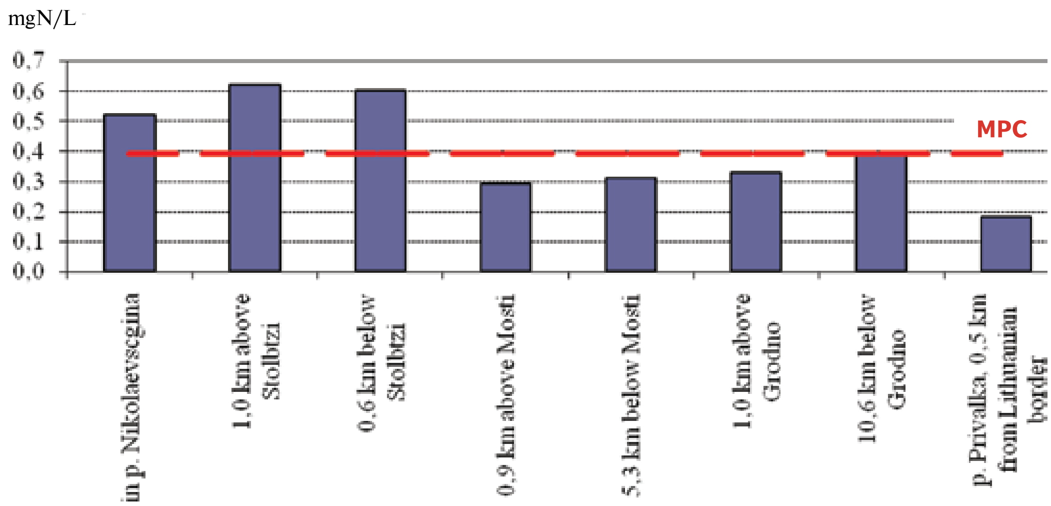


Figure 4.12 – The average content of ammonia nitrogen in water Neman river in 2009

on the content of ammonia nitrogen in water, set in 2007-2008 was broken in 2009. The upper part of the Neman river water is characterized by a yearly average of contaminants in 1,1-1,6 times the maximum allowable concentration *(Figure 4.12).*

Analysis of longitudinal data on the annual average content of ammonia nitrogen in the water of the Western Bug showed a tendency for reduction of spreading of halo of pollution below the stream.

During 2006-2009 elevated concentrations of ammonia nitrogen in almost all observation

Table 4.11

Average content of ammonia nitrogen in water r. Muhavtsa in 2006-2009, mgN/L

Point	Year			
	2006	2007	2008	2009
1.8 km above Kobrin	0,77	0,52	0,49	0,76
1.7 km below Kobrin	0,69	0,61	0,52	0,88
1.0 km upstream. Zhabinka	0,84	0,51	0,50	0,59
2.0 km downstream. Zhabinka	0,81	0,50	0,48	0,59
0.8 km upstream from Brest	0,64	0,52	0,49	0,55
within the boundaries of Brest	0,38	0,35	0,40	0,34
MPC	0,39			

points was in the Muhavets *(Table 4.11)*.

The content of ammonia nitrogen in the water of the Dnieper in concentrations exceeding the maximum allowable concentration, was observed in almost all observation points in the controlled section of the river in 2006 and 2007, with an average concentration of the element more normative level in the 1,6-2,1 and 1,3-2,3 times, respectively. In subsequent years, the state of river water has improved significantly *(Table 4.12)*.

Nowadays ammonium nitrogen pollution of the Dnieper River is most clearly manifested in the lower segment of the controlled part of the river *(Figure 4.13)*.

Table 4.12

Average annual concentrations of ammonia nitrogen in water of Dnieper River in 2006-2009, mgN/L

Point	Year			
	2006	2007	2008	2009
in p.Sarviry	0,34	0,26	0,35	0,29
1.0 km above Orsha	0,68	0,51	0,50	0,37
0.5 km below Orsha	0,83	0,60	0,43	0,34
1.0 km above Shklov	0,70	0,54	0,28	0,29
2.0 km below Shklov	0,67	0,50	0,31	0,30
1.0 km above Mogilev	0,70	0,52	0,22	0,26
25.6 km below Mogilev	0,70	0,60	0,36	0,27
1.0 km above Bykhov	0,63	0,57	0,43	0,27
2.0 km below Bykhov	0,75	0,56	0,46	0,28
0.8 km above Rechitsy	0,80	0,70	0,70	0,85
5.6 km below Rechitsy	0,79	0,63	0,61	0,89
0.8 km above Loev	0,76	0,68	0,77	0,81
8.5 km below Loev	0,83	0,67	0,68	0,53
MPC	0,39			

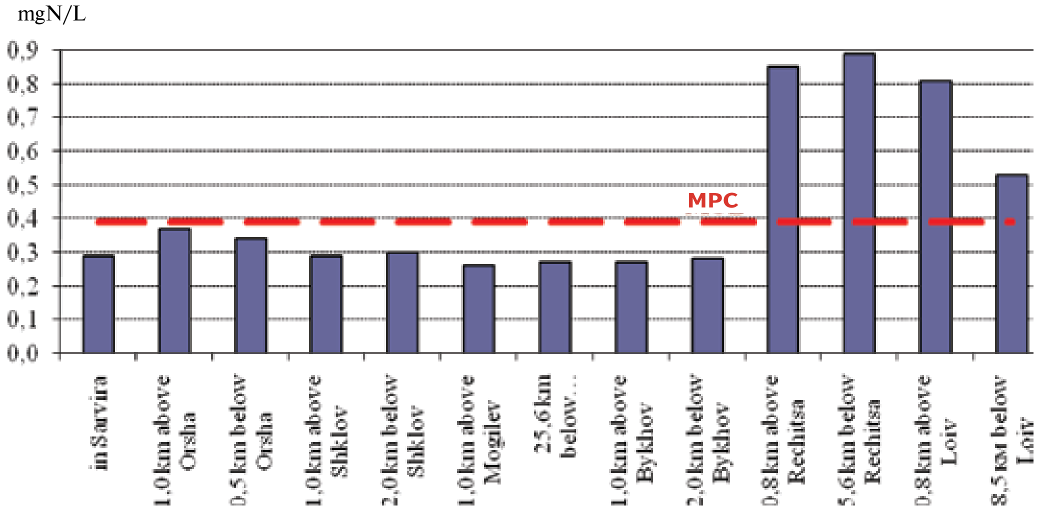


Figure 4.13 – The average content of ammonia nitrogen in the water in the Dnieper River in 2009

The quantity of ammonia was formed here on the background of its elevated concentrations throughout the year. In the vast majority of water samples (90%) sampled in 2009 in the river by Rechitsy to p. Loev, found excessive amounts of ammonia nitrogen.

Analysis of annual average concentrations of ammonia nitrogen in water of the large left tributary of the Dnieper – the Sozh showed that the most unfavorable hydrochemical situation occurring in the region of Gomel, where during the period from 2006 to 2009, there is large contamination of river.

However, it should be emphasized that the overall condition of the river as compared to 2006 significantly improved: significantly space boundaries of contamination reduced .

The chemical composition of water which is formed in conditions of considerable anthropogenic pressure among the rivers of the country in the first place is the Svislach in the watershed of which Minsk is located. The part of the Svisloch below Minsk Purification Station (MPS) is most vulnerable to the negative effects of water quality here is assessed as unsatisfactory.

Annual average concentrations of ammonia nitrogen in water the Svisloch river below the MPS (p.Korolischevichi), exceeding the MPC 10,5-11,4 times in 2006-2007 in recent years decreased to 3,06-2,38 mgN/L (7,8-6,1 MPC).

According to *table 4.13* pollution of the Pripyat by ammonium nitrogen is well expressed in 2006: Annual mean concentrations of the element were more than MPC in 1,2-4,0 times, contamination enveloped almost the entire segment of the controlled river.

Nowadays the content of ammonia nitrogen in water of the Pripyat characterized by considerable variability in annual average concentrations (0,26-0,7 mgN/dm^3) *(Table 4.13).*

Higher average concentrations of ammonia nitrogen observed in 2009 in the water of number of tributaries of the Pripyat – rivers the Cna, the

Table 4.13

Average annual concentrations of ammonia nitrogen in water p. Pripyat River in 2006-2009., mgN/L

Point	Year			
	2006	2007	2008	2009
0.5 km NE p.B.Dikovichi	0,33	0,45	0,37	0,46
1.0 km above Pinsk	0,67	0,53	0,42	0,47
3.5 km below Pinsk	1,57	1,39	0,77	0,75
1.0 km above Mozyr	0,45	0,35	0,25	0,26
1.0 km below Mozyr	0,45	0,37	0,27	0,26
45.0 km below Mozyr	0,47	0,38	0,29	0,29
2,0 km E p.Dovlyady	0,51	0,39	0,34	0,40
MPC	0,39			

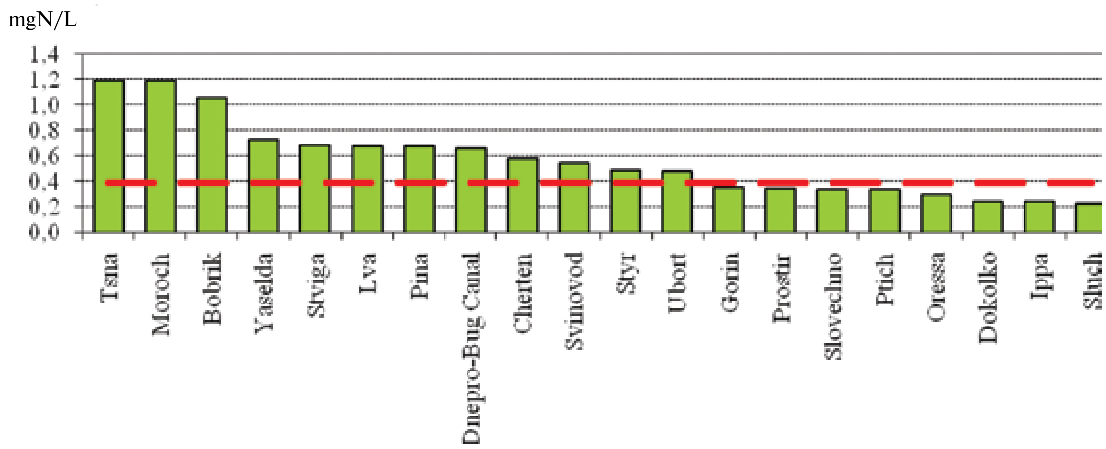


Figure 4.14 — average concentrations of ammonia nitrogen observed in 2009 in the water of number of tributaries of the Pripyat

Morochi, the Bobryk, the Yaselda, the Stviga, the Lva, the Pina, etc. *(Fig. 4.14)*. The most stressful situation was revealed for the rivers the Bobryk, the Morochi, the Pina, the Stviga, the Cna and the Dnieper-Bug Canal, where the process of «ammonia» contamination was stable throughout the year.

Thus, analysis of annual average concentrations of ammonia nitrogen in the water of the rivers of the country allows to mark the main features of pollution of rivers in Belarus in recent years.

Pollution of the Western Dvina by ammonium nitrogen is clearly traced to a segment of the river from Polotsk to Verhnedvinsk. In 2009, the annual average content of ammonia nitrogen pollution of the river varied in the range 0,51-0,56 mgN/dm^3.

Elevated concentrations of ammonia nitrogen (up to 2.2 MPC) in water of Polota is observed through the year, that means the steady pollution of the Western Dvina.

For the Western Bug river water pollution from ammonium nitrogen clearly detected in the area p. Rechitsy, some years it is noted in the vicinity of Brest and further downstream. With regard to the Mukhavets, its water is polluted by ammonium nitrogen from Kobrin to Brest.

Water pollution of the Dnieper by ammonium nitrogen in 2009 was observed mainly in the cities Rechytsa and Loev, the Sozh river – in the Gomel region.

Contamination of the Berezina was observed throughout the controlled area of the river, it is most clearly manifested lower Borisov and Svetlogorsk, where the content of ammonia nitrogen in the water exceeded the MPC, respectively, 3,2 and 2,7 times.

Contamination of the Pripyat is marked only in the river near Pinsk.

Nutrients in rivers

Nowadays the problem of pollution of river water with nutrients is a key in protecting aquatic ecosystems from eutrophication, which causes ecological changes in aquatic ecosystems and have an adverse impact on the use of water for human needs and business.

This indicator includes the values of average concentrations of nitrates and phosphates (phosphorus phosphate), which compares with the national water quality standards (MPC).

Average annual concentrations of nitrates in the water of rivers, according to data

Table 4.14

Minimum and maximum values of annual average concentrations of nitrates in the water main river in Belarus in 2005-2009., mgN/L

River	2005		2006		2007		2008		2009	
	min	max	min	max	min	max	min	max	min	max
Western Dvina	0,29	1,74	0,49	1,95	0,22	1,73	0,22	2,13	0,22	1,73
Neman	0,58	6,16	0,53	5,18	2,66	6,55	3,94	6,24	4,30	8,10
Western Bug	3,86	4,57	4,65	8,19	6,07	8,06	5,09	6,38	4,12	5,09
Mukhavets	3,18	5,17	2,70	6,91	4,03	6,51	3,99	6,55	3,85	5,76
Dnieper	2,34	5,90	2,21	7,44	2,61	8,15	2,13	7,93	1,06	6,11
Berezina	2,67	9,78	3,28	8,41	2,35	9,61	2,66	12,44	1,24	9,08
Svisloch	2,29	14,27	2,48	14,08	2,75	17,23	1,64	16,52	2,35	13,91
Pripyat	1,35	36,42	1,52	31,79	1,64	27,86	2,57	2,88	1,33	2,88
MPC	40,0									

presented in *Table 4.14*, change in a very wide range, but exceedings of the maximum allowable concentration are not established.

The most serious situation exists in respect of phosphate phosphorus, annual average content in a number of rivers exceeds the MPC. The rivers with a busy multi-mode phosphates are primarily the Western Bug and Mukhovets. Prosperous enough environment is characteristic for the Western Dvina and the Neman in part *(see Table 4.15)*.

Based on annual average concentrations of pollution of the Western Bug phosphorus phosphate is observed to weaken in recent years (2006-2009). In 2009, the annual average phosphorus content of phosphate exceeded the MPC in 1,8-2,7 times, while in 2007 the excess amounted to 2,6-3,4 times.

However, contamination of the Western Bug in 2009 was more significant compared to other rivers. In this case, the sharpness of the situation regarding «phosphate» pollution increased downstream the river *(Fig. 4.15)*.

The average annual phosphorus concentration of phosphate recorded in the water of the Dnieper, show a decrease in the level of pollution of the river and on the reduction of

Table 4.15

Range of average phosphorus content of phosphate in the water of rivers of Belarus for the period 2005-2009, mgP/L

River	2005	2006	2007	2008	2009
Western Dvina	0,017–0,051	0,027–0,047	0,014–0,039	0,014–0,044	0,020–0,050
Neman	0,015–0,046	0,025–0,060	0,024–0,043	0,021–0,040	0,020–0,080
Western Bug	0,148–0,177	0,147–0,186	0,169–0,225	0,157–0,212	0,120–0,180
Mukhavets	0,046–0,090	0,051–0,124	0,059–0,139	0,036–0,108	0,070–0,140
Dnieper	0,061–0,166	0,071–0,169	0,062–0,169	0,056–0,151	0,040–0,150
Berezina	0,017–0,152	0,016–0,152	0,011–0,205	0,016–0,106	0,015–0,150
Svisloch	–	0,008–0,416	0,012–0,578	0,007–0,417	0,020–0,720
Pripyat	0,036–0,135	0,032–0,155	0,010–0,064	0,023–0,134	0,030–0,050
MPC	0,066				

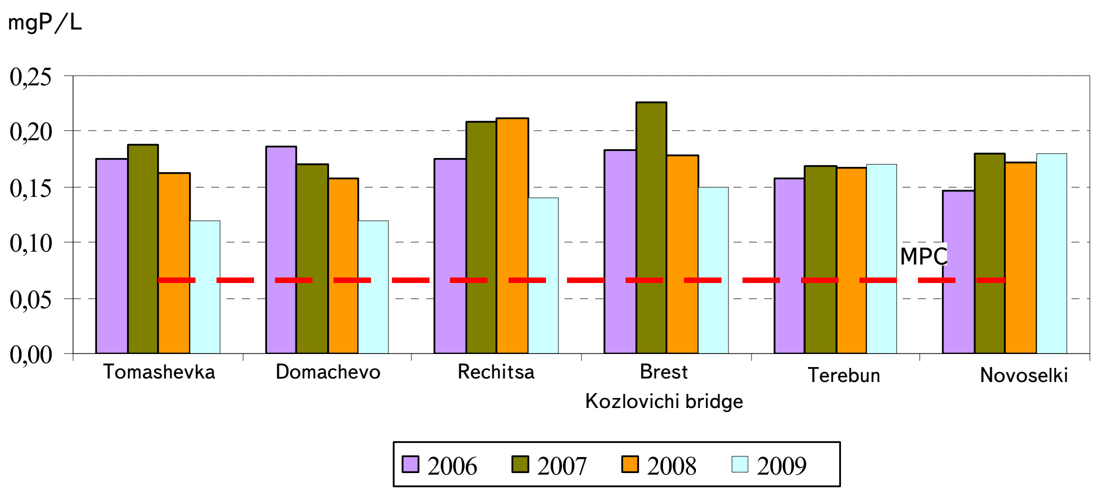


Figure 4.15 – Average phosphorus content of phosphate in water of the Western Bug in 2006-2009

area of contamination. In 2005-2007 pollution of the river was noted everywhere, the average figure of an item exceeded the MPC to 2,6 times.

A high phosphorus content of phosphate in the water of the Dnieper remains in Loev, with an annual mode of pollutant clearly increased the concentration of it in all phases of the hydrological regime.

Annual average phosphorus content of phosphate in water-controlled part of the Pripyat river pollution was found just below the Pinsk *(Figure 4.16)*.

Thus, the most the Dnieper the situation with phosphorus of phosphate is typical at present for the Western Bug, the Muhavets, the Dnieper below Loev, as well as for the Berezina – on the part of the river below the city of Borisov-above Svetlogorsk. Pollution of the waters of the Western Dvina and the Neman by phosphorus of phosphate has not been established.

Waste water

Indicator «waste water» determines the level and nature of the pressures on surface waters, to evaluate the measures taken to improve the level of wastewater treatment. The volume of wastewater containing pollutants decreased in comparison with 2005 by 11% *(Fig.4.17)*.

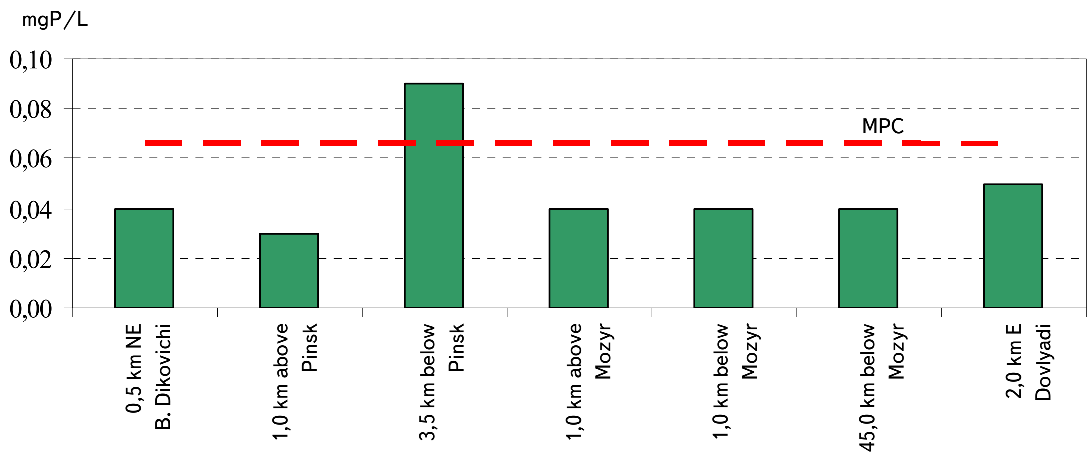


Figure 4.16 – Average phosphorus content of phosphate in water of the Pripyat in 2009

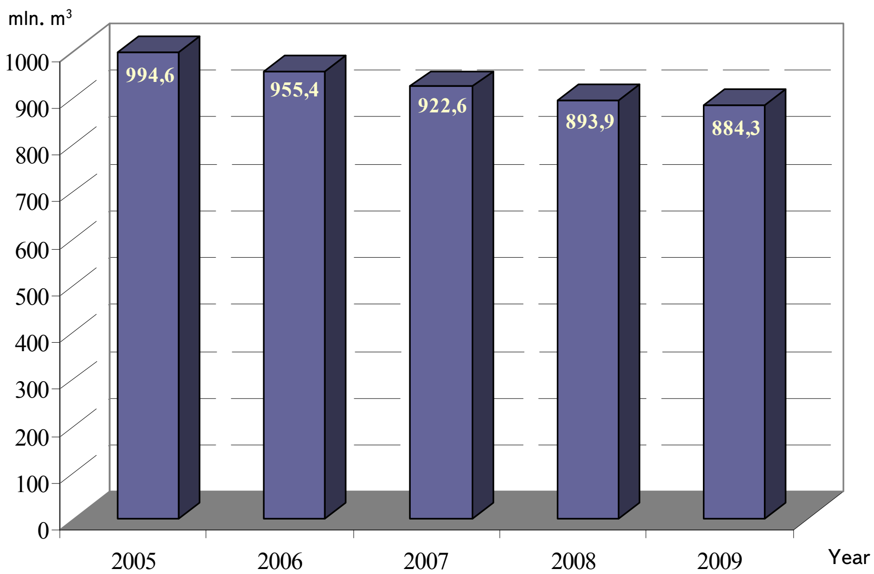


Figure 4.17 – Dynamics of wastewater containing pollutants in 2005-2009

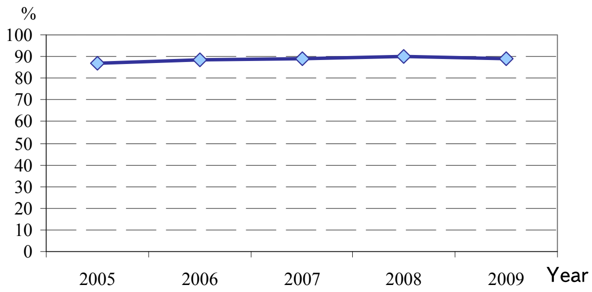


Figure 4.18 — Percentage of wastewater containing pollutants in the total volume of water abstraction

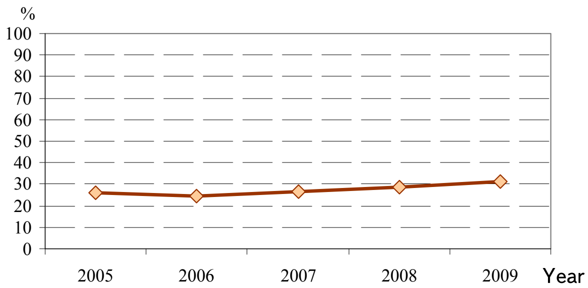


Figure 4.19 — Percentage of waste water allocated to water bodies without treatment at wastewater treatment plants

At the same time the share of wastewater containing pollutants in the total volume discharged into water bodies of wastewater during the reporting period of five years has not changed *(Figure 4.18).*

With regard to waste water allocated in the river of the country without any treatment, there is a tendency to a slight increase in their volume *(Fig. 4.19).*

Reducing the amount of waste water containing contaminants, has not resulted in a significant reduction of certain pollutants

Table 4.16

Discharge of pollutants in the wastewater into water bodies of Belarus in 2006-2009

Index	Dimension	Year				
		2005	2006	2007	2008	2009
Organic matter (BOD_5)	Tons, ths	9,0	8,9	8,3	8,1	7,9
Petroleum products	Tons, ths	0,16	0,20	0,15	0,14	0,13
Particulate matter	Tons, ths	13,8	14,6	13,6	12,0	12,6
Sulfates	Tons, ths	63,7	62,7	59,5	60,7	63,5
Chlorides	Tons, ths	73,9	74,4	71,3	72,8	72,9
Ammonia nitrogen	Tons, ths	6,0	6,4	6,0	5,6	5,4
Nitrogen nitrite	Tons, ths	0,59	0,34	0,25	0,20	0,19
Nitrate nitrogen	Tons, ths	2,9	3,7	3,4	3,7	3,7
Copper	Tons	9	9,8	10,0	7,6	6,7
Other metals (Iron, zinc, nickel, chromium)	Tons	415	518,0	449,0	438,0	421,1

collected in natural water bodies of Belarus *(Table 4.16).*

Basic amount of wastewater containing pollutants formed in the housing and communal services (HCS) (in 2005 they accounted for 75%, 2009 – 66,9%).

In 2009, the water bodies of the country received 91% of all dumped into the rivers of ammonia nitrogen, 89% nitrite nitrogen, 90% phosphorus phosphate, 81% organic matter, 83% surfactants, 82% chloride, 85% oil, 72% suspended solids and 48% sulphate.

In agriculture, through large volumes of wastewater leads pond fish farming, which accounts for 87% of sulfates, chlorides 93%, 87% organic matter, 91% of suspended solids and 67% of ammonia nitrogen from the total amount of pollutants generated in the branch of industry.

Nowadays the main chemical pressure on the rivers of the country is due to such local sources of pollution, as provincial towns and city of Minsk, which accounted for 63% of the total load on water bodies of nitrate nitrogen, 61% for ammonium nitrogen, 54% of suspended solids, 54% petroleum, 52% organic matter,

42% of nitrite nitrogen and 37 % of heavy metals (iron, nickel, zinc, chromium).

In general, the country's 20 major enterprises with sewage purification plants, divert about 58% of the total volume of wastewater containing pollutants. In their structure contains 71% organic compounds, 83 % – petroleum products, 82 % – ammonia nitrogen and 57% of basic metals.

Typical pollutants in the discharged wastewater is phosphate-phosphorus, ammonia nitrogen, nitrite nitrogen and organic matter (BOD_5). Excessive concentrations of them are found in the waters of many rivers of the country *(Table 4.17).*

Table 4.17

Discharge of pollutants in the wastewater into the main basin of Belarus in 2009, t

Basin	Organic matter (BOD_5)	Nitrogen ammonia	Nitrogen nitrite	Phosphorus phosphate
Dnieper	5140	3240	140	650
Pripyat	1300	600	20	150
Berezina	2600	2130	70	340
Svisloch	2010	1420	60	210
Sozh	740	190	10	100
Neman	1400	860	40	190
Vilia	140	100	10	50
Western Dvina	770	500	20	120
Western Bug (including Narew)	620	790	0	160
Mukhavets	40	40	0	20
Belarus	7930	5390	200	1120

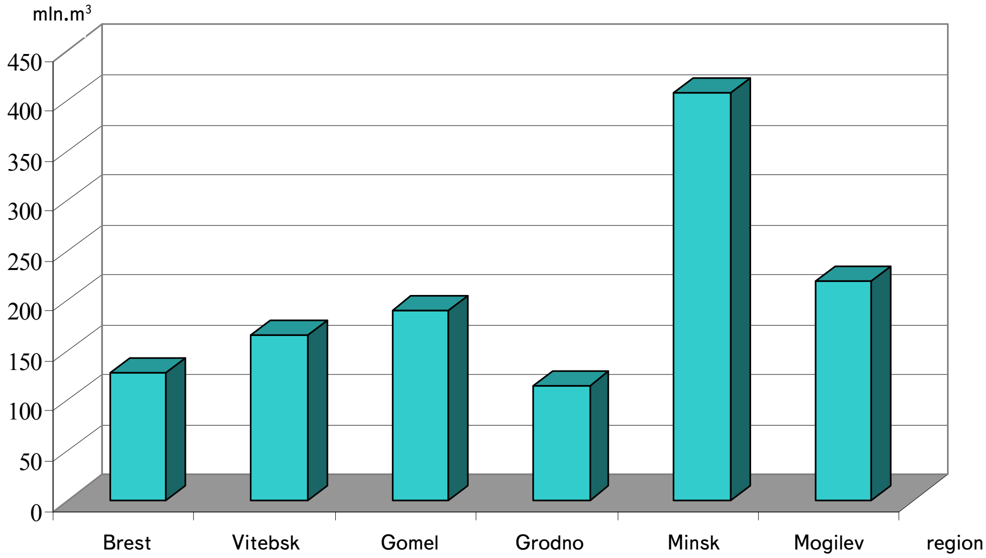


Figure 4.20 — Capacity of sewage purification plants in the fields (million m³ per year)

In order to reduce pollution of rivers measures to intensify the cleaning and purification of wastewater, primarily from nitrogen and phosphorus, heavy metals, petroleum products, and organic surface-active substances are necessary.

Capacity of purification facilities

A modern sewerage system provides, as a rule, the joint wastewater purification of industry

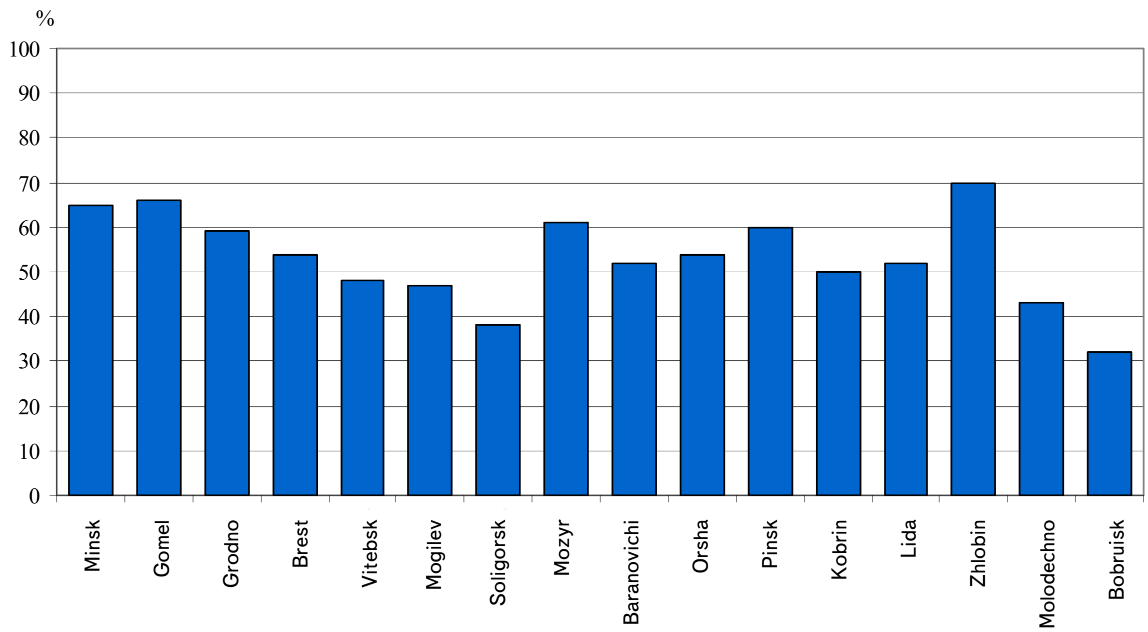


Figure 4.31 — The load on purification facilities in cities across the country, %

and housing and communal services of cities of Belarus on the uniform purification plants, total capacity of which is 1,532,800,000 m^3. At the same time, the actual amount of regulatory peeled and insufficiently treated waste water collected in water bodies in 2009, does not exceed 687 million m^3.

Capacity of purification facilities for the administrative regions of Belarus is shown in *Figure 4.20.*

Wastewater purification facilities in cities across the country, as a rule, are not used to full capacity. The load on purification facilities in cities across the country varies from 32 to 70% *(Fig. 4.21).*

Many purification facilities accept waste water with a concentration of some ingredients, exceeding the norm data. In addition, there are cases of overloading of purification facilities that require renovation or are in the process of reconstruction, (e.g., in Grodno). As a result, insufficiently pured wastewater containing various pollutants come in water bodies.

Municipal and industrial waste water entering the drainage system before discharge into water bodies are usually cleaned in artificial (about 90% of the total waste water) or in natural conditions in the fields of filtration (up to 1,5% of the total volume of wastewater), followed by filtration in the soil. Up to 30% of biologically treated wastewater subjected to further purification in natural

conditions (in biological ponds of additional purification).

Since all operated by the city's sewage purification facilities designed to purify municipal wastewater, waste water of industrial enterprises on the specific ingredients and reduced concentrations of contaminants of toxicological parameters must be carried out local purification plant enterprises.

However, more than 80% of the local sewage purification facilities built in the 1970's and 1980's, is largely required reconstruction and transition to new, more effective methods for wastewater purification. To improve the efficiency of sewage purification, reducing the discharge of pollutants into water bodies and reduction of groundwater contamination from leach fields must continue building new and upgrading of the existing sewage purification plants, pumping stations and sewerage networks in urban and rural settlements, including in agro-towns.