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AN ALTERNATIVE APPROACH TO MEASURE HUMAN DEVELOPMENT IN RUSSIA

ABSTRACT. The article deals with finding optimal ways to measure the level of Human Development in Russia's regions. In the past, it was common to measure the level of regional development by the Gross Regional Income indicator. Nowadays, we shifted to more "humanized" indicators of regional development. The Human Development index is one of them. A way to improve methods of calculating this index to reflect the closest to reality situation is suggested.

KEY WORDS: human development, sustainable development, human development index, Russia regions

INTRODUCTION

Through all the history of human development, there were different accents and aims that people tried to achieve. The first aim was to survive and people were competing on who was stronger physically. The further the human society developed, the more "humanized" were the priorities of development. If we compare different approaches to the final goal of Human Development (HD) in different economic theories (Table 1), we could notice the shift towards human needs.

In the XXI century, humans have achieved a certain acceptable level of wealth. Thus, it was possible to shift to the HD concept. In a simple language, HD is a world development concept, which shows the most important direction of today's development of each country. The final result of different approaches in achieving this goal should be enhancing human capabilities and functioning.

The concept of HD coincides with the concept of Sustainable Development (SD).

Table 1. Different approaches to HD

	Role of people	Final goal	Measurement
Economic growth theory	Production factor	Enlarge output and income	GDP growth rate
Theory of human capital	Proprietors of labor ability	Improve human abilities	Productivity of labor, economic efficiency
Concept of basic needs	Consumers of goods and services	Reduce poverty	Poverty line, basic consumer's basket
Well-being concept	Focus of economic development	Increase standards of living	Income, health, education, employment, environment etc.
Human development concept	Focus of economic development	Create a favorable environment for human development	HDI (Human Development Index)

Table 2. Indicators for the "Classic" and "Alternative" HDI

Dimensions	Classic HDI	Alternative HDI
Long and healthy life	Life expectancy at birth	Life expectancy at birth
Knowledge	1) Adult literacy rate; 2) The rate of people aged 7–24, attending educational institutions	Number of children at the age of 7–18, not attending educational institutions, on 10 000 children of corresponding age
A decent standard of living	GNI per capita (PPP US$)	Share of population with monetary incomes below living standards, %

Initially, the main idea of the SD concept included coexistence of developing and ascending socio-economic indicators with lesser emphasis on environmental and resource supply indicators. Nowadays, the term "SD" has expanded and is used in the meaning of the "direction of HD," in general. The main elements of Sustainable HD could be: 1) sustainable social, 2) sustainable economic, and 3) sustainable environmental development.

INITIAL DATA AND RESEARCH METHODS

The HDI is used to measure and compare the level of the country's achieved conditions for people. Over the years, the index has been improved. Initially it measured three dimensions: 1) long and healthy life, 2) knowledge, and 3) the decency of the living standard. Now, it has four main adjustments:

a) taking into account human poverty,

b) taking into account gender inequalities,

c) taking into account inequalities in distribution of each dimension,

d) avoiding the impact of the largest (or smallest) dimension on the overall aggregated index; it is calculated by geometric mean instead of arithmetic [UNDP. HDR 2010].

It is stated in the "Human Development Report" that there is no fixed list of dimensions of HD. That means that every country, according to its prevailing socio-cultural settings, should develop and adjust the accounting of HD inside the country.

This was the reason to introduce an "Alternative" HDI measurement. The HDI, in all cases, is calculated for the standard HD dimensions proposed in the "UNDP Human Development Report 2010" [UNDP. NHDR 2010]. The "Alternative" HDI is calculated with the means of two different indicators for the same standard HD dimensions (Table 2).

The "Alternative" HDI is associated with measuring different aspects of knowledge and living standard dimensions. For the knowledge dimension, it measures the literacy rate of a narrow but the most important inhabitant group – children. They are the ones who have to proceed through compulsory secondary education. The rest of the adult population could continue their education by correspondence or by new technology means remotely. The "Alternative" HDI for the living standard dimensions measures the poverty rate of people. It indicates the real living standard of people more precisely than the per capita GNI. And it better reflects Russia's realities. For the knowledge and living standard indicators, reverse dimension indices were used.

RESULTS OF THE RESEARCH

The distribution of the HDI calculated by different indices are shown in Fig. 1 and Fig. 2. The "Classic" and "Alternative" HDI rating of Russia's regions appeared to be

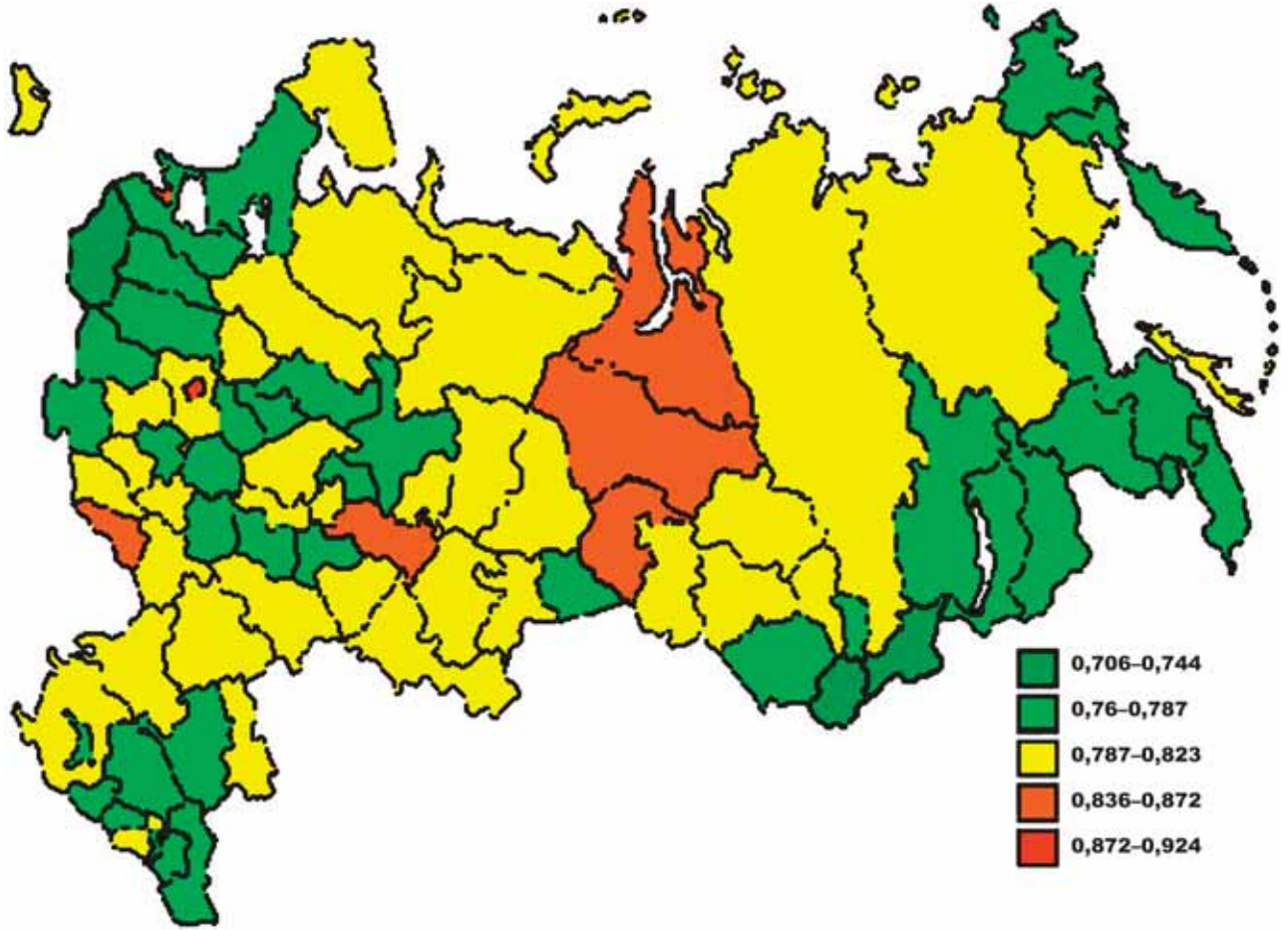

Fig 1. Distribution of the "Classic" HDI

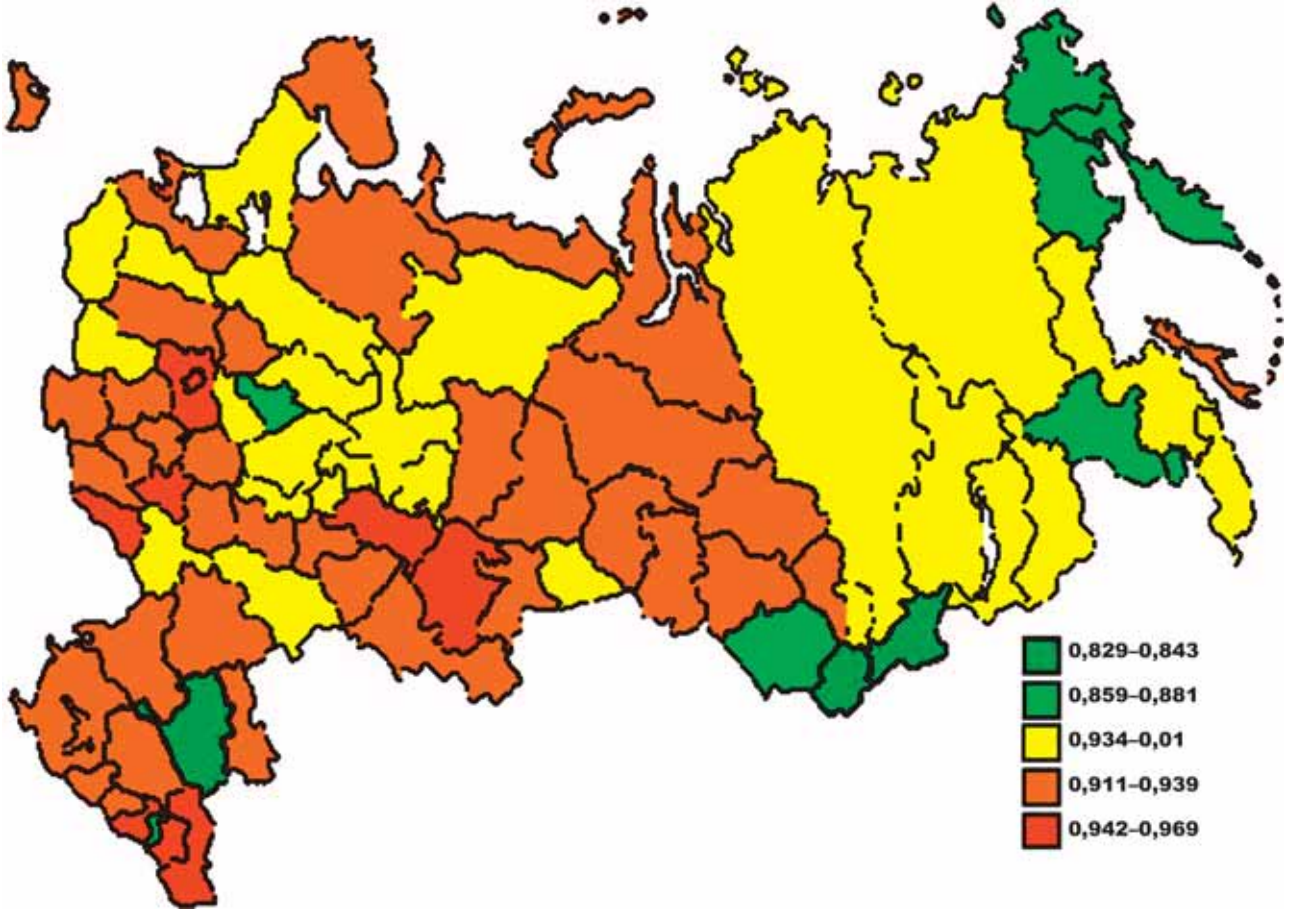

Fig 2. Distribution of the "Alternative" HDI

Table 3. Largest differences between the "Classic" and "Alternative" HDI rating of Russia's regions

	"Classic" HDI rating of Russia's regions	"Alternative" HDI rating of Russia's regions	"Classic" HDI rating – "Alternative" HDI rating
Krasnoyarsk Territory	12	59	–47
Komi Republic	14	57	–43
Republic of Sakha (Yakutia)	20	61	–41
Vologda Region	16	56	–40
Magadan Region	38	76	–38
Tomsk Region	6	41	–35
Udmurtian Republic	25	58	–33
Irkutsk Region	42	72	–30
Sakhalin Region	7	37	–30
Voronezh Region	36	63	–27
Nizhny Novgorod Region	30	54	–24
Orenburg Region	18	42	–24
Saratov Region	26	50	–24
Kamchatka territory	56	79	–23
Samara Region	9	31	–22
Altai Territory	54	75	–21
Novosibirsk Region	17	35	–18
Perm Territory	28	46	–18
Omsk Region	15	30	–15
Republic of Mordovia	37	52	–15
Chukotka Autonomous District	63	78	–15
Smolensk Region	64	49	15
Tver Region	62	44	18
Kaluga Region	40	20	20
Leningrad Region	55	34	21
Penza Region	44	21	23
Tambov Region	47	18	29
Bryansk Region	65	33	32
Republic of Adygeya	70	38	32
Karachaevo-Cherkessian Republic	49	16	33
Republic of North Ossetia-Alania	41	8	33
Republic of Daghestan	43	1	42
Kabardino-Balkarian Republic	67	17	50
Chechen Republic	71	9	62

very different. The largest differences are shown in Table 3.

The "Alternative" HDI appeared much lower in Siberia, Far East, and North Russia's regions. The main cause of that is a very low monetary income of people in these regions despite the high, per capita, GNI. In some of these regions, the rate of children not attending school is also high.

The "Alternative" HDI appeared much higher in the Caucasus republics. The people there have Russia's average income despite a very low, per capita, GNI. School availability has high indicators.

CONCLUSIONS

Any dimension has its own purpose. It could never suit every need and requirement. Moreover, the best the dimension suits and illustrates the phenomena it was created for, the worse it satisfies other requirements.

Measuring HD, we should take into account the indices that compose the final aggregated index. We can change the components according to the priorities and needs of a concrete investigation. However, the result would be a different dimension that indicates different aspects of HD.

In this very research, an alternative approach to measure HD in Russia was implemented. Different indicators for the standard HD dimensions seem to reflect the situation in Russian regions more precisely. As a result, the final "Alternative" HDI should reflect the level of HD of Russia's regions more close to reality than the "Classic" HDI. ■

REFERENCES

1. Education. The central database of the state committee of statistics of the Russian Federation. Online Source. Available from: URL http://www.gks.ru. Accessed 13.09.2011.

2. Social status and standard of living of the population of Russia. 2010: Statistical Yearbook. (2010) Rosstat. M. 507 pp.

3. UNDP (United Nations Development Programme). Human Development Report 2010. The Real Wealth of Nations: Pathways to Human Development. Online Source. Available from: URL http://www.hdr.undp.org. Accessed 13.09.2011.

4. UNDP (United Nations Development Programme). National Human Development Report in the Russian Federation 2010. Millennium Development Goals in Russia: Looking into the Future. Online Source. Available from: URL http://www.undp.ru. Accessed 13.09.2011.

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RUSSIAN RURAL NECHERNOZEMYE: COLLAPSE OR NEW WAYS OF DEVELOPMENT?

ABSTRACT. The article describes the evolution and the crisis of the rural old-developed non-black soil zone (i.e., Nechernozemye), the differences between suburban and peripheral areas as exemplified by the Kostroma and other regions, basic models of economic contraction, as well as prospects for revival by urban residents.

KEY WORDS: non-black soil zone, peripherals, depopulation, rural settlement, agriculture and forestry, development centers, manageable economic contraction, vacationers.

INTRODUCTION

Polarization of space in Russia

In the past 20 years, Russia has gone through a difficult period: reform, crisis, and recovery from the crisis with a change of development paradigm. In recent years, the innovative development has been declared. It involves modernizing the economy, which is always uneven and depends on many factors, primarily, on the human capacity, financial resources, and many other basic factors, including the country's size and nature of its development.

The processes of development of the vast space of Russia in the XX century have been associated with localization of development as a consequence of the concentration of population, infrastructure, and economy in the areas of resource extraction, in cities, suburbs, and the South. As a result, the expansion of development, in general, often also meant the growth of sparsely populated underutilized areas. And even in the European old-developed non-black soil zone of Russia (i.e., Nechernozemye), the area of economic and socio-demographic decline expanded because of the long-term depopulation and migration of the active part of the population to cities.

Growing economic and socio-demographic differences between different parts and spatial objects in Russia suggest its polarization. In this case, most often considered are the differences between the regions – subjects of the Russian Federation. However, differences between municipalities within a single subject are much larger than inter-regional differences.

The criteria for differentiation of Russia's territory may be the nature and intensity of use, level of development and state of the economy, population size and density, the quality of human capital, and infrastructure development. Expanding managed space, the country has been gradually compressed into separate "islands of development". The concentration of population and its activities in certain central areas have led to the formation of the centers (in rural areas, suburbs play the role of centers) and of the periphery. Problems of center-periphery relations in Russia have been a subject of a large volume of scientific research [Gritsay et al., 1991; Kaganskiy, 2001; Pilyasov, 2008; Rodoman, 2002; Treivish, 2003, 2009]. Peripherality (peripherality indicator is

usually a physical distance from some center) can be considered in multi-scale sense [Nefedova, 2008a]: (1) on a small scale – the outer periphery (outskirts of the country far from its major cities); (2) on an average scale – the intra-periphery (areas remote from the centers of regions); and (3) on a large scale – the periphery of the local areas (rural areas, remote from the local centers). In this paper, we focus on the periphery of the inner regions of the old-developed non-black soil regions. This phenomenon is caused by strong intra-regional contrasts in the direction and level of socio-economic development of the territories.

PROBLEMS OF AGRICULTURE OF THE ON-BLACK-SOIL TERRITORIES

In the Soviet period, agriculture has been supported by the state as the main economic sector in rural areas in many parts of the non-black soil territories. During the process of urbanization of the XX century, rural population ebbed, especially in the areas with difficult natural conditions, while the kolkhozy (collective farms) continued to increase livestock and cultivate grain, regardless of the objective natural conditions and, especially, social and economic constraints.

Problems in these areas have been evident since the 1970s when increased investment in agriculture in much of the non-black soil territories no longer provided an adequate return [Ioffe, 1990, Ioffe; Nefedova, 1997; Nefedova, 2003, pp. 91–99]. But they are even clearer now because, in the new economic conditions, the state has ceased to support their inefficient production. Severe natural conditions are not the only factor of agriculture failure, although fragmentation, waterlogging, and low productivity of land are also significant. However, even before the crisis of the 1990s, yields in the north and the west of the Moscow region were 5–10 kg/ha lower than even naturally conditioned (i.e. obtained at special sites where heat and moisture was typical without applying special measures). It is particularly strongly affected by the consequences of urbanization followed by rural depopulation. Rural populations moved not only to cities, but to the suburbs of the cities also. On the maps of population density in the non-black soil territories, widening socio-demographic hole is seen in the peripheral areas.

Urbanization and rural depopulation of the periphery are global processes. But Russia has had two distinguishing features of the process: a huge space with a relatively sparse network of large cities that create zones of increased economic activity around themselves, and the sluggishness of the state and collective farms not wanting to adapt to new social and geographical realities, including consequences of depopulation. For example, the average distance between cities with a population of more than 100 thousand people (these cities in the non-black soil zone form regions with the best demographic and economic indicators) are more than 180 km even in the European part outside of the Moscow region. With the average radius of suburban districts of 30 to 40 km and shrinking rural population, the rest of the territory turned out to be as if thrown out of an active economic life; the population out-migrated from there especially actively [Nefedova, pp. 298–305].

In contrast with Western European countries, where the density of cities is much higher and agriculture has gradually adapted to the diminishing population, changing organization, technology, reduced acreage, and increased productivity, the Russian state and collective farms expanded agricultural plots and built huge cattle complexes in places lacking manpower. The governing party strictly controlled the process, so that huge subsidies were allocated and decrease of livestock was not allowed even in cases of illnesses and lack of forage. Therefore, everything collapsed overnight when the replacement of administrative and enforcement economy with market economy took place. These processes have been preconditioned over the course of previous development. Hopes for small-scale

farmers in such areas were not fulfilled and people were not ready for independent legal business and preferred to isolate themselves in their individual farms; only occasionally, these farms became commodity producing [Pallot, Nefedova, 2007]. The situation is particularly difficult in the zones of risky agriculture away from the cities where three factors that limit the development of agriculture act together: the complexity of natural conditions, depopulation, and a deep economic crisis.

Since 1999, agriculture in Russia, in general, has been restoring production. But this is not true of many non-black soil areas. The crisis of the 1990s and, especially, its end, were to a large extent regionally differentiated. The first to recover from the crisis were the regions of southern Russia, due to the expansion of grain production and partial recovery of the poultry and swine stock. But even there, the loss of cattle was disastrous. Paradoxically, livestock was better preserved around large cities, as well as in the national republics. The maximal loss of livestock has been registered and continues in the regions of the North, Far East, and the peripheral areas of the non-black soil territories.

Thus, in Russia, there is an apparent paradox: dairy farming drifts away from the non-black soil territories with abundant grasses and succulent feeds. Most businesses there are not profitable. Farmers in these areas are rare, except for individual migrant enthusiasts from other regions and the CIS countries. There are several reasons for that; the major of them is a strong depopulation and the depletion of manpower in the non-black soil territories accompanied by the degradation of the rural social environment. Together with low purchase prices, inability to acquire equipment, and unsettled countryside it impedes any development there. There is also a technological explanation. Where grasses are abundant, winters are long and severe. Thus, additional costs for feed and heating emerge, which increase the cost of livestock products. Therefore, livestock breeding becomes a difficult business possible only for large enterprises gravitating towards the southern districts and suburbs of large cities.

"North-south" and "suburbia-periphery" dichotomies are characteristic of the dynamics of crop production. In Russia, the total gross agricultural production was growing while acreage was declining until 2008, which also indicated the selective nature of crisis recovery. Southern companies were more successful in the early 2000s; in the non-black soil territories and in Siberia, only suburban companies were more successful. The main characteristics of the land loss of two macro-regions: the non-black soil territories and the arid regions of the Volga, the Urals and Siberia are as follows. In the first group, more than half of the cultivated area used in 1990 was abandoned; in the second group, the crop losses amounted to 30–40%. However, in the 2000s, in many regions of the Volga and the Urals, partial cultivation of the abandoned land has begun, largely spurred by the rising profitability of growing corn in steppe areas. In the non-black soil zone, abandoned cultivated area has not been ever recovered and continued to decline on the periphery of the region. The degree of pre-crisis plowing there has been clearly higher than the natural and social opportunities allowed it to be.

PROBLEMS OF FOREST SECTOR OF THE OLD-DEVELOPED REGIONS

Although agriculture was the main industry defining the character of the non-black soil zone and the state and collective farms were the main organizers of local life, reforms in forestry of 1990s-2000s have also significantly affected the rural life. It is especially true because not only in the north of European Russia, but also in the old-developed areas, along the sub-Taiga axis of Novgorod–Kirov–Perm, there was a network of remote forestry settlements, where the sole employer and the organizer of the local life was timber industry. In the agricultural settlements of the non-black soil territories, the use of forests has also had significant value.

Agricultural enterprises received free use of large plots of so-called collective forests, and many unprofitable farms made a profit only from the sale and partial processing of wood, or even from the sale of rights to exploit their forests, thereby recovering losses from agricultural activities.

After several changes in forest legislation in the 1990s and especially with the new Forest Code in 2006, the pattern of the use of forests has changed dramatically. The category of the so-called agricultural forests was eliminated. All users have gained access to the forests on a rental basis (by auctions and tenders). The responsibility of caring for the forests was assigned to tenants. All this have especially exacerbated the situation for small users [Kuzminov, 2011], including agricultural enterprises, small companies and private traders, and individual sawmills.

The elimination of state logging companies and the shift of the responsibility for logging to private companies have significantly reduced the need for employment in logging. Along with the transformation and the crisis of agricultural enterprises, it led to the release of a significant number of workers who had no other jobs, and weak business activity could not provide their employment in rural areas and small towns. Some of them went to cities and other areas; others tried to earn money by temporarily working in major centers or in timber harvesting in other regions or were ruining themselves by drinking trying to escape from idleness and hopelessness of the country life. The most affected are those peripheral areas of the non-black soil territories that are remote from the main routes and do not fall within the area of raw materials supply for large timber processing enterprises.

THE CASE STUDY OF RURAL AREAS OF THE KOSTROMA REGION

The Kostroma region is a typical example of the Russian non-black soil territories. It is located in the north-east of the Central district on the border of the forest zone and southern taiga. Its main characteristics are a strong and long-term outflow of the rural population, production specialization mainly on the lowest technological levels of agriculture and forestry, absence of the deep processing of products, and low investment attractiveness.

Internal socio-economic contrasts are expressed there very clearly. Since 1959, the rural population has not changed only in suburban area of Kostroma, while in all other areas, it decreased by more than two-thirds (Fig. 1).

The rural population density in the suburban district of Kostroma is 22 people per sq km, while, in the surrounding areas, it is only 6–10; at the periphery it is only 2–3. The suburbs have been actively used in the

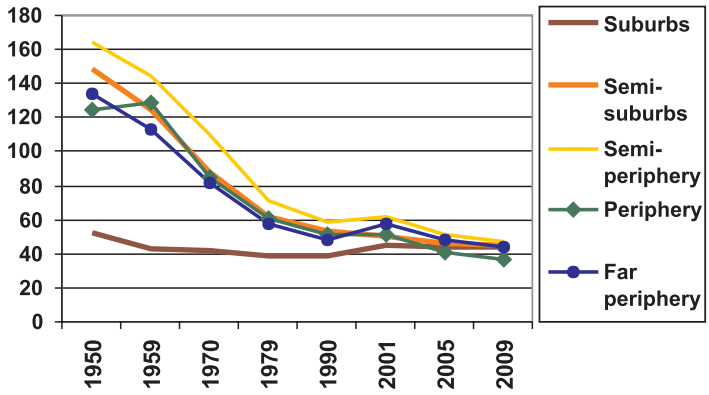

Fig. 1. Rural population of the Kostroma region in zones of varying distance from the city of Kostroma (1950 to 2009, thousand people)

Soviet period, so they have accumulated the production capacity. Local businesses and businesses from large cities, for example, from Vologda and Moscow, have been establishing there. Business managers have more experience than local managers in the peripheries have. There is a consolidation of agribusiness and acquisitions of the weak by the strong, which takes place because the latter have not enough land. Average milk production per cow in the Kostroma region, in 2009–2010, was over 4300 kg, and, in some plants, is almost of Western levels of 6000 kg.

The suburb region, comprising 3.4% of the region size, concentrates one-fifth of its rural population and a quarter of the regional gross agricultural production. Even under relatively unfavorable natural conditions, agricultural production of the north non-black soil territories, in the agricultural center around Kostroma, and in two regions along the Volga River to the south will continue. But the suburban zone has its own features. This, above all, is the competition for better-paying urban jobs, so there is a shortage of workers in agriculture. Strong competition and other resource uses, including recreational, affect the job market in the Kostroma region. In recent years, profitable investments are the investments in land: the price in the suburbs is growing rapidly, so that banks, construction firms, and private traders are actively buying agricultural land. Artificial bankruptcy is increasing practice, so that successful businesses attractive to outside buyers are bankrupted. There remain only major economy actors, firmly occupying a niche market, who create their own branches in more neighboring territories richer in land. There are also a large number of dacha cottages in suburbs owned by Kostroma citizens, but the market for this land is lower. In semi-suburb areas, agribusinesses are somewhat weaker, but there are more farms. In these zones, business is subject to availability of land and is relatively close to the center of the rural environment, so it is not as hopeless as in the periphery.

A completely different situation is in the semi-periphery and the periphery areas that are particularly extensive and, due to the eccentricity of the regional center, have shifted to the south-western outskirts. Large agribusinesses have almost no chance of survival there. Long-term support for unprofitable enterprises, which, in truly market conditions, would not exist, has contributed to the preservation of the Soviet type weak agricultural sector. The milk yield per cow, which serves as an indicator of the state enterprises under similar environmental conditions, with an abundance of pasture, both in the Soviet era and now, is 2–2.5 times lower than in the suburbs (Fig. 2). The crisis is

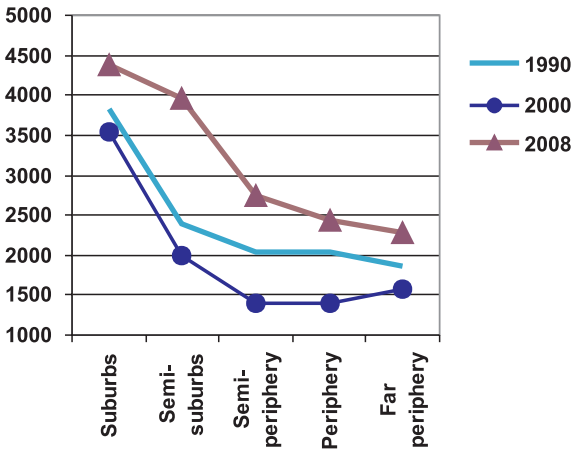

Fig. 2. Milk yield per cow in 1990, 2000 and 2008 in zones of varying distance from the city of Kostroma (kg per year)

only enhanced by the modern reforms. It is rooted much deeper. Sown area started to decline since the 1950s. However, during the implementation of the "boosting of the non-black soil zone" it grew again despite the catastrophic decline in population. A further decline in plantings began in 1980, although the program is still scheduled to increase arable land. By 2009, only third of the Soviet plowed areas remained plowed. Failure of agribusiness to generate revenue from timber sales and, thus, to replenish the capital only exacerbates the crisis in agriculture. Most farms have huge debts. At the same time, they are not yet bankrupt – they simply are not wanted. This has led to a sharp decrease in agricultural employment, except for individual plots. However, this process is dying too as the population is aging and almost all high-school graduates depart to cities.

Social problems in the periphery of the Kostroma region are compounded by a redistribution of property in the forestry sector and the collapse of a number of former state-owned forestry enterprises. It has also led to a strong reduction of employment.

With such a compression of the companies in the periphery and despite the long-term depopulation, an excess of workers has developed. Formally, on average, a third of working-age population is employed in agriculture, forestry, and public sector. One-fifth commutes temporarily to cities for work; another fifth is, in fact, is unable to work due to alcoholism. Others depend entirely on their own farms or conduct criminal activity, including poaching. At the same time, official level of unemployment is very low. However, in recent years, it began to grow due to unnecessary high subsidies (up to 5000 rubles, in 2010), comparable with official salaries. Often, the benefits are even greater than salaries often paid with delays. This further complicates the problem of staffing companies and so they are often on the verge of survival.

Thus, the quantitative deficiency of labor is not the concern. Even in these peripheral depopulated areas, there is a quantitative excess of population in rural areas with insufficient jobs. These jobs are not created because of the competition from urban jobs and the quality of the local workforce. In such areas, as well as virtually in the entire non-black soil territories outside Moscow and the suburbs of big cities, there is an obvious shortage of quality labor, which is associated with the degraded social environment. It pushes the working-age population to cities and suburbs to seek permanent residence or temporary work.

In each peripheral area of the Kostroma region, there are several local points of growth: strong single farms (essentially farms evading taxes), logging companies, and retail outlets. But, as a rule, immigrants from other regions of Russia and the former Soviet republics run these businesses.

OTHER REGIONS OF THE NON-BLACK-SOIL TERRITORIES

The Novgorod oblast is situated between two major centers that, for many years, have been draining the rural population. There are also large suburban-periphery contrasts. For example, the Novgorod region contributes 30% of the agricultural products of the oblast. Promising are the areas along the border with the Leningrad oblast, entering the zone of influence of St. Petersburg. Other areas are characterized by a sharp contraction of acreage and of total care for crops and traditional linen, and a by heavy loss of livestock.

The suburbs of Velykyi Novgorod, as well as of Kostroma, is the only area in the region that has not lost its rural population in the second half of the XX century, while, in other areas, it has declined by more than half or, even, 3–4 fold. Thus, there has been a total decline of agricultural employment resulting in the population decline. Hence, in rural areas, there is high real unemployment rate combined with business leaders lacking

good workforce, as all who are able to work either ran away from this environment or are unwilling to work in agricultural enterprises. The program to attract workers to the Novgorod and Pskov regions conducted in the Soviet period was renewed in 1990, but did not produce the expected results. The peripheral areas are not attractive to workers, while the suburban areas and the areas along mainlines are still used as an intermediate step between Novgorod and St. Petersburg.

Even in the non-black soil areas adjacent to the Moscow region, the crisis of agricultural peripheral territories is becoming more and more severe. However, the areas adjacent to the Moscow region, i.e., a vast metropolis suburb, have several advantages. They are free land with relatively low prices and rental rates. This, coupled with a close proximity to Moscow, attracts investors to the suburban areas. It is there that some agro-industrial firms in Moscow and Moscow oblast place their polluting livestock farms and acquire lands for cultivation and grasslands. Small private farming in the areas around Moscow, even in the nearby areas, is in decline. The exception is the suburbs of Ryazan and Tver, almost adjacent to the borders of the Moscow suburbs, and some businesses that were able to establish links with Moscow or the Moscow region processors of agricultural products. In addition, the highways connecting the neighboring provinces with Moscow are being provided with a growing number of logistics centers and construction materials plants, including those with foreign investment. Outside the main roads, there are mostly suburban cottages of Moscovites (different types and levels). At the same time, there is the onslaught of Moscow and near-Moscow businesses, which are buying land shares of the population and, sometimes, municipal lands, especially along the roads; this process is associated with the trend of continuous growth of land prices.

A growing outflow of personnel of all skill levels to Moscow and the Moscow region from the areas along mainlines, dictated by the excess of the unemployed and the attractiveness of earnings in the metropolitan area, several times exceeding local potential, became a general problem of the "outer ring" suburbs. Out-migrating young people are completely non-returning, while middle-aged people are partially or completely held in place by their families, home, and gardens. Along with the influx of summer residents from Moscow, this leads to higher prices, but not to the development of local services, and only provides an additional incentive to the local population to commute for temporary jobs in the capital and its suburbs, often in a rotational manner.

Shift workers or seasonal workers in the remote regions make up around one-fifth of the workforce. In regions close to Moscow, their share is much larger. These people can represent basic manpower for recovery of rural areas, while relocation of population of cities to the countryside is not the solution to the problem today. Stimulating workers to return to the villages is much more complicated now than before.

RURAL SUPPORT

In Russia, the most popular measures of support are not measures of support of rural areas, but measures of agriculture support through direct subsidies to producers (including fuel, fertilizers, loan rates) and import restrictions. Of course, in order to develop agriculture, manufacturers should have some competitive advantages in the domestic market, which, without state support, cannot be achieved. But there are also competitive advantages of other territories of Russia compared with the non-black soil territories and the new territorial division of labor in the country that began to function in the 2000s. If grain production is several times less expensive in the southern regions of Russia, why was it necessary to have such large areas under crops in the non-black soil territories in the Soviet times? This was only possible with the unprecedented state support (subsidies covering more than 80% of expenses) without taking into

account the natural and social opportunities of different areas.

The average level of budget support to agricultural producers in Russia is estimated by the government to be at 6% (6 kopeks per 1 ruble of output), which is 2.7 and 5.4 times lower, respectively, than in the US and the EU. However, it is difficult to assess the degree of support because, in addition to direct support, some indirect methods exist. For example, in Russia, unlike the EU, the payment for the land of farmers and the total tax burden on them is low. Serova and Shick [2007] assess the level of support in Russia in the middle 2000s at 15–17%, which is quantitatively consistent with the support in the US. Nowadays, it is over 20%.

In recent years, Russia's tendency is in the decentralization of agricultural support and its shifting to regional budgets, which has important territorial implications. Individual rich northern industrial regions may help agrarian regions with favorable natural conditions more than they do now. As a result, the objective market processes of territorial division of labor, in recent years, have begun to falter. Cases of regional "fencing" and bans on the export of subsidized products outside the region, leading to the destruction of a single economic space, have reappeared.

Financing of agriculture under the national projects "Development of Agroindustrial Complex" (2006) and "State Program of Agricultural Development and Regulation of Agricultural Products, Raw Materials, and Foodstuffs" (2008–2012), despite the comprehensive approach, developed within conditions set by objective trends. Loans to modernize production (with most of the interest paid by the state) were given to viable enterprises located, more often, in the suburbs and in the South, which increased the polarization of the industry and lagging of the non-black soil territorial provinces. Increase of the attractiveness of credit resources for private households worked properly only in the areas where employment potential has been preserved.

However, as was discussed above, agriculture in the non-black soil territories has ceased to be a key industry. In many Western countries, regional programs target integrated territorial development, support of the population, infrastructure, and other lucrative activities. In Russia, this process has not yet fully developed. Moreover, since the mid-2000s and especially after the adoption of the Federal Law 131, the powers of local authorities were extended, while local communities (districts, villages) almost lost their own tax and non-tax revenues. The centralization of the cash flow has worsened the situation almost everywhere. At the periphery of the non-black soil areas, prior to the law, grants accounted for slightly more than half of the district budget. In addition, prior to the Forest Code, much of the regional allowances for the lease of forests, for example in the Kostroma region, went to the budgets of districts and settlements. Now transfers from higher budgets constitute about 90%. Local administration concerns are reduced, in essence, to survival, rather than to improving the population's living conditions.

One of the latest policies of the authorities is merging of rural communities and remote villages that are losing their population and having less than 200–300 people, into larger settlements. However, if such actions with respect to agricultural enterprises are dictated by the market and are economically justified, socially they are harmful to the countryside.

The idea of classifying villages into the promising and unpromising was launched in the late 1950s and has found reflection in the plans of agricultural division of the regions and districts of the non-black soil territories in the 1960s and early 1970s. In this respect, only one-fifth of villages were recognized as promising [Ioffe, 1990, pp.112]. By the end of 1970, this policy was stated as erratic, but it was already impossible to stop the shrinking of developed territories. Nowadays, the authorities are repeating the same mistake. Merging does not only mean

the transfer of administration to a larger settlement and gradual closing of schools, medical stations, recreation centers, and libraries in distant villages and groups of villages. It also means curtailment of social life and infrastructure. For example, in the periphery of the Kostroma region, the implementation of the plans of merging settlements will increase the distance between local centers and remote villages (whose population can be under hundreds of people) from 5–7 km to 20–25 km in the absence of regular bus services. Meager budget savings, which is referred to as the reason for the reform by the authorities, not only increase the outflow of working population, especially of working people with children, but also encourages the elderly to leave villages to live with their children in cities; this only speeds up the depopulation of the territories and leads to catastrophic shrinkage of developed space.

PROSPECTS OF PERIPHERAL AREAS OF THE NON-BLACK-SOIL TERRITORIES

Prospects of remote areas depend not only on the policy of authorities, but also on businesses, including those located in the cities, and on the activity of the local and migrant populations. Perhaps, the focal recovery of abandoned areas in agriculture and forestry is possible. Particularly promising, in this respect, is inter-regional, regional, and local agro-forestry complexes that, in order to increase resource base, are looking for the most successful farms in the peripheries. However, very few farms can be efficiently integrated into large enterprises.

The main limitation of these areas is socio-demographic factors and the demand for more qualified and able to work people, while there is an excess of the unemployed rural population. We must acknowledge that, in such regions, the economic model of "economic contraction" is still alive. It is accompanied by a decrease of the real working-age population and of the cultivated area. However, disaster can be avoided if the situation is not neglected or is not deteriorated by inappropriate policies of contracting social and infrastructural components. There can be several options of the "economic contraction" model and they are not mutually exclusive.

The first option, "agricultural," implies preservation of agricultural enterprises as long as they are in demand by the local population and entrepreneurs. Direct support for enterprises is carried out on the ground: through the formation of municipal structures and the inclusion of farmers in the local agricultural sector complexes, i.e. the acquisition of their farms by local processing enterprises in order to create a more stable raw material base. The rest, mostly unprofitable farms (former collective farms) experience a strong reduction of crops and livestock and become a kind of farms of their leaders (technically, they employ 20–30 people, but in reality, only the leader and several strong employees work there). The main policy in their respect should be not to push them into bankruptcy. Being suppliers of products to local factories in small towns, they thereby contribute to their survival. Agribusinesses, in the absence of self-organization of the population, often have a locale-building function; they remain, along with the administration of rural settlement, the organizers of local life. Plowing an order of magnitude smaller area than in the Soviet times, they still hold lands around villages in agricultural production preventing forest invasion.

The second option is also associated with agriculture, but small and private, with its increasing commercialization, which is possible in the areas that have preserved human resources, or which were able to attract and retain workers. However, according to polls, in the periphery of the non-black soil territories, percentage of households willing to engage into commodity or semi-commodity production with some support and assistance in marketing, is about 14% [Nefedova, 2008b]. The main factor, in addition to human capital, here is the degree of involvement in the area of economic

relations system (accessibility and availability of wholesale and retail markets and other users, including truckers).

The third option is related to the cease of single-functional agricultural development of rural areas, sometimes accompanied by a noticeable change in the specialization of the area, with tax and credit incentives for activities associated with the use of natural resources, forests, and water (small timber and wood processing enterprises, procurement and processing of mushrooms and berries, hunting, tourism, etc.). The population most often chooses the easiest way, i.e., gathering. Some families, when season comes, go to forest every day as if they were going to work. When large amounts of mushrooms and berries are available and transport infrastructure is sufficient, dealers will certainly find such places and come there every day during the season. Local people also sell berries along the roads to drivers as well as to cottagers.

The fourth option is for small towns and villages, not only having precious historical and cultural monuments, but also having preserved traditional buildings and located in scenic areas. Their development as places of interest can be promoted by special legislation at the national, regional, or district level. And although this practice in Russia is extremely low, even a little extra funding would help preserve the appearance of many villages and farms of their people, as well as man-made landscapes in general, at least around the villages, churches, etc.

If, however, only old people continue living in villages, there arises a need for special social support. Depopulated villages are, essentially, cheap homes for the elderly, some of who can procure food by themselves. However, they need mobile shops, affordable medical care, regular bus routes that reach to all living villages in the neighborhood. Creating such infrastructure can provide additional jobs in the local centers.

NEW WAYS OF DEVELOPMENT OF THE PERIPHERAL AREAS OF THE NON-BLACK-SOIL TERRITORIES

Real momentum for maintaining development of the peripheral areas of the non-black soil territories comes from big cities and is associated with summer cottagers who revitalize the village. Large cities residents' willingness to travel has increased with the car-buying boom. The phenomenon of the far cottages (dachas) in quiet secluded spots instead of the near cottages or structures sandwiched among hedges and apartment houses is becoming more and more common among residents of Moscow and St. Petersburg whose suburban areas connect to each other in the Novgorod region near Lake Valdai (Fig. 3).

Here is an example of the suburban communities in Ugory settlement in the periphery of the Kostroma region which is located as far as 550 km from Moscow [Nefedova, 2008b]. The fewer locals are in the village, the greater the share of houses purchased there by the residents of the cities. In the main node of the settlement, cities residents make up to 30% of the real estate owners; in two adjacent villages with 30–40 local residents, the share of dachas is about 40%; in the dying small villages, it is as much as 70–90% (Table 1).There are also completely deserted villages. There are also places of interest to summer vacationers. When all local residents leave for the winter, plunder in the houses begins. Life of urban residents without support of locals in such remote locations is not possible; so these two communities are closely linked and interdependent.

Country communities in remote areas began to take shape in the 1970s and 1980s spontaneously. The dachas boom has been recorded since the mid-1990s and in the 2000s. These communities are dominated by the citizens of the middle and older age, of the middle-class, and of mostly intellectual professions, partly because of their tastes, as well as because of their relatively free labor regime. Initially, it was characterized by the

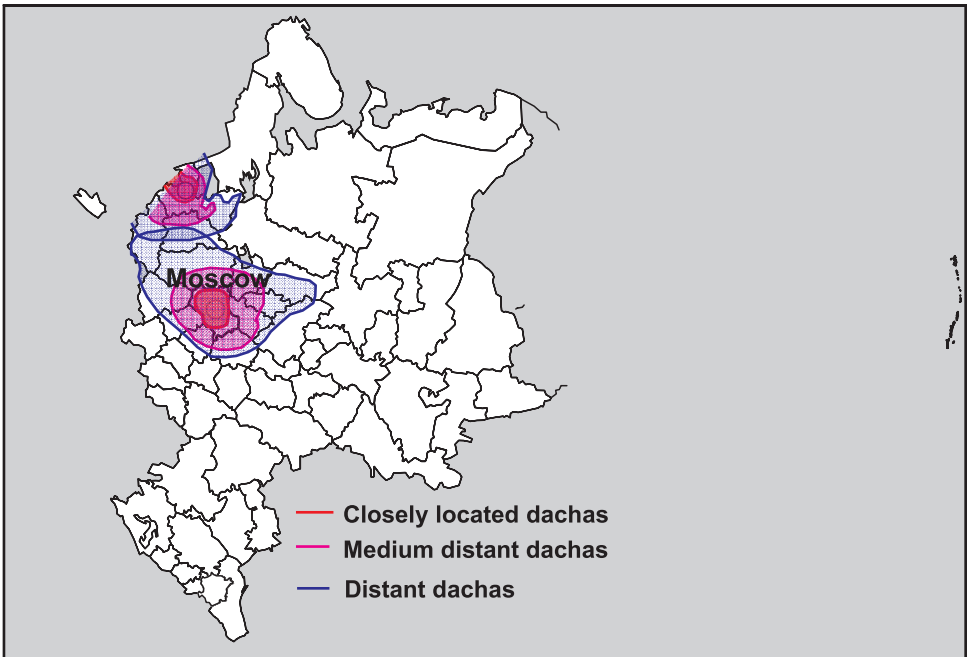

Fig. 3. Area of summer cottages (dachas) expansion around Moscow and St. Petersburg within non-black soil territories

formation of occupational clusters: villages of scientists, artists, journalists, teachers, etc. Subsequently, narrow professionalism has eroded. A survey showed that about 85% of cottagers, even at such a distance from Moscow, are Moscovites. Many young and middle-aged residents of local regional centers come to their parents on weekends

Number of inhabitants of summer cottages and their share in the rural population of Ugory rural settlement (Manturovo municipality, the Kostroma region)

	Number of residents in 2007	Population in 2007 as percentage of 1926	Number of agricultural plots belonging to the locals	Number of agricultural plots belonging to inhabitants of summer cottages	Percentage of summer cottages inhabitants of local population
Ugory	227	34	99	46	32
Davydovo	40	10	16	14	47
Medvedevo	10	5	4	15	79
Hlyabishino	59	14	31	20	39
Dmitrievo	10	4	1	12	92
Zashilskoe	6	5	5	12	71
Bazhino	0	0	0	7	100
Poloma	10	9	4	12	75
Stupino	2	2	1	10	91
TOTAL	386	14	175	161	48

and on vacation; they bring children out of school to live there for summer months; and they are also, in essence, summer residents. However, after death of their parents, they often sell the house in the village, because they live almost in similar conditions in the town.

Summer residents, at this point, do not build new houses and buy relatively strong rural houses. To distinguish between a dacha cottage and a house of a local resident, vegetable gardens can be a criterion. Summer residents are generally not engaged in agriculture, except for mowing grass and planting of ornamental plants. Townspeople come once or twice a year for periods ranging from weeks to several months. Covering the distance by a car can take 8 to 9 hours; by train – a night. Some pensioners live in their cottages all summer. Cottagers gather mushrooms and berries in the woods and go fishing. Many continue doing their professional jobs while in the countryside. But the main occupation is improvement of the country house, while maintaining their almost unchanged appearance. Therefore, even when the village population changes, the village itself retains its traditional look.

Summer residents feel like a kind of a diaspora and try to support each other even in different villages, forming a new social environment. They prefer different lifestyle than locals and find it hard to fit into the local community. Individual local residents work part time for cottagers repairing their houses. But finding workers is not easy. Regardless of high unemployment, there are very few of those who are ready to do carpentry or mow grass for cottagers. Some of the locals sell potatoes and other vegetables to cottagers.

In the Novgorod region, agricultural use of land is being changed by cottage recreational use. Demand for land in the most picturesque villages on the banks of rivers and lakes is particularly high; distant dachas areas of Moscow and St. Petersburg converge and intersect at Valdai. In villages dying according to official statistics, there are whole streets of brand new houses [Ioffe et al., 2006].

Despite the already considerable period of cottage settlement in the non-black soil zone, the municipal, regional, and especially federal government, are not ready for this innovation. Their mentality is very conservative. Local authorities are still hoping that the federal government "will come to their senses", or a miraculous business enterprise will come and restore extensive agriculture. Regional and district authorities do not perceive summer seasonal population as their own and are not interested in maintaining a permanent infrastructure for their sake; but even if they wanted to, they lack the funds. As a result, settlement does not create a stable network of services. The programs of rural development designed by regional and federal authorities do not mention cottagers.

However, the role of such development away from urban areas, not just in the suburbs, is clearly underestimated. The mass nature of the Russian seasonal cottage suburbanization is not recorded statistically, since people tend not to leave cities for permanent residence and buy houses in the rural areas in addition to their city apartments. Thus, the total number of summer visitors cannot be determined. Research of these settlements is possible only by tedious case studying of individual villages.

CONCLUSIONS

Thus, the end of the XX and the beginning of the XXI centuries are characterized by increasing economic polarization present in the rural areas of Russia, both during the crisis of the 1990s and during recovery from it. Selective recovery from the crisis is evident and gives a clear idea of which regions in Russia can be a sound base for agriculture. Focuses of agricultural production and investments are concentrated in the South, around big cities and their suburbs, as well as in some national republics, which have retained the employment potential. It is this process of territorial division of labor and of adjustment of agricultural production to existing natural,

human resources, and investment conditions that can ensure improved food security. However, it exacerbates the problem of survival of agriculture and rural communities in many parts of the non-black soil territories, especially in the peripheral areas.

A consequence of long-term rural depopulation in the interior non-black soil territories is negative social selection of the population that has been developing there. Attempts to stop the process of socio-demographic decline of the rural non-black soil territories fail. Globalization, or rather its informational component, only reinforces this process by destroying the archaic order of life and by minimizing the isolation of villages. Nowadays, high-school graduates no longer continue living in the countryside and are not attracted by higher salaries of free houses in the periphery. Globalization pushed economic criteria into the background, putting forward the problem of the lack of the social environment in the periphery very needed by young people.

Depopulation and negative social selection have created a shortage of quality labor force, often with its quantitative abundance associated with the lack of formal jobs as a result of the crisis. The entrepreneurial activity of local people in outlying areas is low. For the partial conservation of the old-developed territories and for expansion of their functions, the primary measure is to create conditions for the return of migrant workers to the periphery. The main problem there is to promote other activities in addition to agriculture.

The economic model of "economic contraction" accompanied by decrease in agricultural land is inevitable, but it will prevent a total catastrophe for the old-developed territories. Maintenance of existing centers of life is essential at least to maintain social control over a vast territory, "complete savagery" of which is fraught with unpredictable consequences. The main task of the state in conditions of imminent economic polarization, is to mitigate, rather than to reinforce social differences and to maintain social infrastructure in rural areas, including areas where agriculture is dying while the population remains significant in number.

One of the ways to revive the non-black soil rural areas is based on cottagers' revival of the periphery. Cottagers and local communities are closely interconnected and interdependent. Although the cottagers cannot save extensive agriculture, they are the force which preserves individual rural houses and even entire villages from dying out. Cottagers' demand for food produced on individual plots of the locals and demand for the locals' labor to repair houses binds local workforce to their localities. However, the most important influence of the cottagers on the local environment is that they, at least seasonally, create such social environment in depopulating villages that can help binding the local youth to their homes. ■

REFERENCES

1. Gritsay, O.V., Ioffe, G.V., Treyvish, A.I. (1991). Centre and Periphery in Regional Development. Moscow: Nauka, 166 p. (in Russian).

2. Ioffe, G., Nefedova, T. (1997). Continuity & Change in Rural Russia. A Geographical Perspective. WestviewPress, 308 p.

3. Ioffe, G., Nefedova, T., Zaslavsky, I. (2006). The End of Peasantry? The Disintegration of Rural Russia. University of Pittsburg Press, 249 p.

4. Ioffe, G.V. (1990). Agriculture in the Non-Chernozem area: Regional problems. Moscow: Nauka, 162 p. (in Russian).

5. Kaganskiy, V. (2001). Cultural Landscape and Soviet Habitable Space (Collected Articles). Moscow: Novoe Literaturnoye Obozreniye, 576 p. (in Russian).

6. Kuzminov, I.F. (2011). Socio-Economic Challenges to the Timber Industry in the North-European Part of Russia (Case Study of Kostroma Oblast), ISSN 2079-9705, Regional Research of Russia, vol. 1, No. 1, pp. 41–51. (in Russian).

7. Nefedova, T.G. (2003). Rural Russia at the Crossroads. Geographical essays. Moscow: Novoye Izdatel'stvo, 403 p. (in Russian).

8. Nefedova, T.G. (2008a). Russia's Periphery as a Socio-Economic Phenomenon // Regional Studies, № 5, p. 14–31. (in Russian).

9. Nefedova, T.G. (2008b). Russian Remote Places Through the Eyes of their Inhabitants // Ugorsky Project: Environment and People in the Middle North / ed. N.E. Pokrovski. Moscow: Community of Professional Sociologists, p. 98–120. (in Russian).

10. Pallot, J., Nefedova, T. (2007). Russia's Unknown Agriculture. Household Production in Post-Socialist Rural Russia Oxford University Press, 214 p.

11. Pilyasov, A.N. (2008). And the Last will be the First. Northern Periphery on the Route for Knowledge Economy, Moscow, URSS, 542 p. (in Russian).

12. Rodoman, B.B. (2002). The Polarized Biosphere. Smolensk: Oecumene, 336 p. (in Russian).

13. Serova, E.V., Shick, O.V. (2007). World Agrarian Policy. Moscow: State University – High School of Economy, 402 p. (in Russian).

14. Treyvish, A.I. (2003). Centre, Region and Country. Inertia and Novations in the Development of Russia's Big Urban Archipelago // Large Cities and Challenges of Globalization. Smolensk: Oecumene, pp. 54–71. (in Russian).

15. Treyvish, A.I. (2009). City, Region, Country and World. Development of Russia as Viewed by a Regional Geographer) Moscow: Novyi Chronograph, 372 p. (in Russian).

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THE CAUSES OF DEATH IN THE PROVINCE OF ROME BETWEEN 1981 AND 2007: A GEOGRAPHICAL ANALYSIS

ABSTRACT. In this paper we provide an overview of the main causes of death in the province of Rome in 1981 and 2007, showing the most relevant variations which have been recorded over time. Using ArcGIS 9.2 software, we have drawn up several medical-geographical thematic maps and specific land use maps which corroborate the temporal and spatial analysis, and which provide suggestions about the relation between causes of death and certain risk factors. Particular attention is given to the diseases of the circulatory system and neoplasms which caused, respectively, 38.4% and 32.6% of deaths in 2007 and which followed substantially different trends. Then, we focus on the city of Rome, where we examine the evolution of land use between 1980 and 2001 in order to investigate, by means of detailed screening, the changes recorded in a city where, in 2007, 67% of the inhabitants of Rome province lived.

KEY WORDS: causes of death, circulatory system, neoplasms, medical-geographical thematic maps, land use maps, risk factors, GIS.

INTRODUCTION

For some years experts in health research "have been successful in re-establishing interest in the role of place in shaping health and health inequalities". Experts in epidemiology, sociology and geography consider this role of space significant, because they recognise "that there is a mutually reinforcing and reciprocal relationship between people and place". These academics "argue that these approaches to understanding how place relates to health are important in order to deliver effective, 'contextually sensitive' policy interventions" [Cummins et al., 2007, p. 1825].

In a more recent paper Rainham et al. [2010, p. 668] introduce "the need to move beyond conventional place-based perspectives in health research, and invoke the theoretical contributions of time geography and spatial ecology as opportunities to integrate human agency into contextual models of health". They also introduce the concept of *healthscape* "as an approach to operationalizing context as expressed by the spatial and temporal activities of individuals".

In a previous paper other researchers explored the links between (perceived) environmental risk and community (re)action in a urban industrial neighbourhood in Hamilton, Ontario, Canada. The analyses "were conducted with residents of an area with a documented history of adverse air quality, in order to determine the relative

influence of *social capital* (networks, norms, and social trust) and *place attachment* (sense of belonging in a neighbourhood) in deciding to take civic action around this particular environmental issue" [Wakefield et al., 2001, p. 163].

The above papers present some interesting approaches for our international project *Medical and geographical analysis of urban agglomerations in different natural and socioeconomic conditions,* whose main goal is to establish the role both of space and time in the distribution of the diseases in two different areas of Europe, i.e. the province of Rome and the oblast of Moscow.

For this purpose, we evaluate:

- the relationship between people, health and space;
- the importance of time geography and spatial ecology;
- the effective "contextually sensitive" policy intervention;
- the contextual models of health;
- health in the industrialized areas;
- health in green areas close to and in cities and towns;
- the influence of immigration on health.

As far as regards methods and tools used, we have employed ArcGIS 9.2 software in order to draw up and analyse various maps, which show the distribution of some diseases in relation to selected particulars of municipalities in the province of Rome. Recently, in our book *La salute nel mondo. Geografia medica e qualità della vita,* we have already explored the possibility of introducing GIS in our researches on medical geography, discussed many practical applications and showed the added value of analysis at different scales [Palagiano, Pesaresi, 2011, pp. 315–318]; here we have used GIS to organise a wide database which can be progressively updated and upgraded and can produce a number of superimposed layers. For the purposes of our project and thanks to the characteristics of GIS, the maps and the problems shown for the province of Rome [Pesaresi, Marta, in press] will be comparable with those of the oblast of Moscow produced by colleagues of the Faculty of Geography, Lomonosov Moscow State University, Russia [Malkhazova et al., 2007], for the same project. In this way, we provide input for communal reflections and analysis.

In the geographic literature, however, this kind of comparative study has already been carried out. For example, in 1963, Ortolani (in collaboration with Mounfield) made a comparison between two industrial regions, Lombardy in Italy and Lancashire, in the UK. Likewise, in 2004, Cristaldi and Darden analysed the demographic structures and social networks among Filipino immigrants in Rome and Toronto. We intend to refer to these projects to show the differences and similarities of the relationship between the health situation in two different areas of Europe, the province of Rome and the oblast of Moscow.

THE MAIN PHASES AND AIMS OF THE RESEARCH

"Empowerment" is a process of social activity which allows people, communities and local administrations to acquire information and competences in order to change and improve the features of their environment and of their quality of life [Italian Ministry of Health, 2010, p. 14]. One of the key components in the acquisition of this information is knowing the main causes of death and the related risk factors on a large scale. With the aim of encouraging a similar process, and the development of adequate socio-sanitary facilities, besides a continual reflection on the techniques of planning [Morelli, 1983, p. 510], in this paper we evaluate the changes which have been recorded between 1981 and 2007 regarding the main causes of

death in the municipalities of the province of Rome; subsequently, we indicate which are the axes and the macro-areas currently showing the highest values for: diseases of the circulatory system; neoplasms; diseases of the respiratory system; injury, poisoning and certain other consequences of external causes; endocrine, nutritional and metabolic diseases. On the other hand, many years ago the relevance of recording the provincial and municipal mortality data over time was demonstrated, such as the importance of making analysis and follow-up studies involving local communities which are exposed to particular risk factors [Rubino et al., 1983, p. 78].

In practice, using GIS we created many medical-geographical maps which facilitate temporal and spatial analyses and help to investigate the potential risk factors. In this way, through map making, we can encourage "map *thinking*, the method by which assumptions embedded in an analytic process are understood and employed in the researcher's response to a problem" [Koch, Denike, 2007, p. 76]. Moreover, after defining general frameworks at the scale of the municipality and showing the effective land use by employing a specific legend, we focus our attention on the city of Rome, for which we analyse the evolution of land use between 1980 and 2001 in order to examine the eventual relation between causes of death and proximity to certain activities or pollution sources; this surgical screening allows us to evaluate the most important changes which could have contributed to the increase or decrease in mortality due to particular diseases.

Therefore, the digital cartographic elaborations produced form a cognitive basis useful for:

- discovering anomalous or notable modifications recorded over time;
- identifying the areas which present the highest values for specific causes of death;
- observing in which municipalities there is a relation between causes of death and some risk factors (industries, mining activities, waste, etc.) and the municipalities where this relation is not very strong;
- drawing an analytic framework of the potential dangerous elements which are present in the city of Rome, deriving this qualitative data from a re-elaboration *ad hoc* of the official land use maps;
- avoiding program faults during the planning phases, above all in areas with high population density.

THE MAIN CAUSES OF DEATH IN 1981 AND 2007

In 2007 – the last year for which the National Institute of Statistics (ISTAT) provided the data for municipalities – 35,849 deaths were recorded in the province of Rome.

Diseases of the circulatory system were the primary cause of death (13,758 deaths) and neoplasms were the second (11,684), as was the case in 1981 (Fig. 1). Nevertheless, comparing the data of 2007 with that of 1981, we can observe a significant reduction in the distance between them, because the trend of neoplasms shows a marked and regular increase [Pesaresi, Marta, in press]. In third place we continue to find diseases of the respiratory system, while diseases of the digestive system have moved from fourth to sixth place and injury, poisoning and certain other consequences of external causes[1] have passed from sixth to fourth position. Endocrine, nutritional and metabolic diseases are always in fifth place, while symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified, are no longer found in the first ten places. Presently in seventh place we find diseases of the

[1] We would point out that the ISTAT code (V01-Y89) for injury, poisoning and certain other consequences of external causes is different from that of the International Statistical Classification of Diseases and Related Health Problems 10th Revision Version for 2007 (S00-T98). See http://apps.who.int/classifications/apps/icd/icd10online.

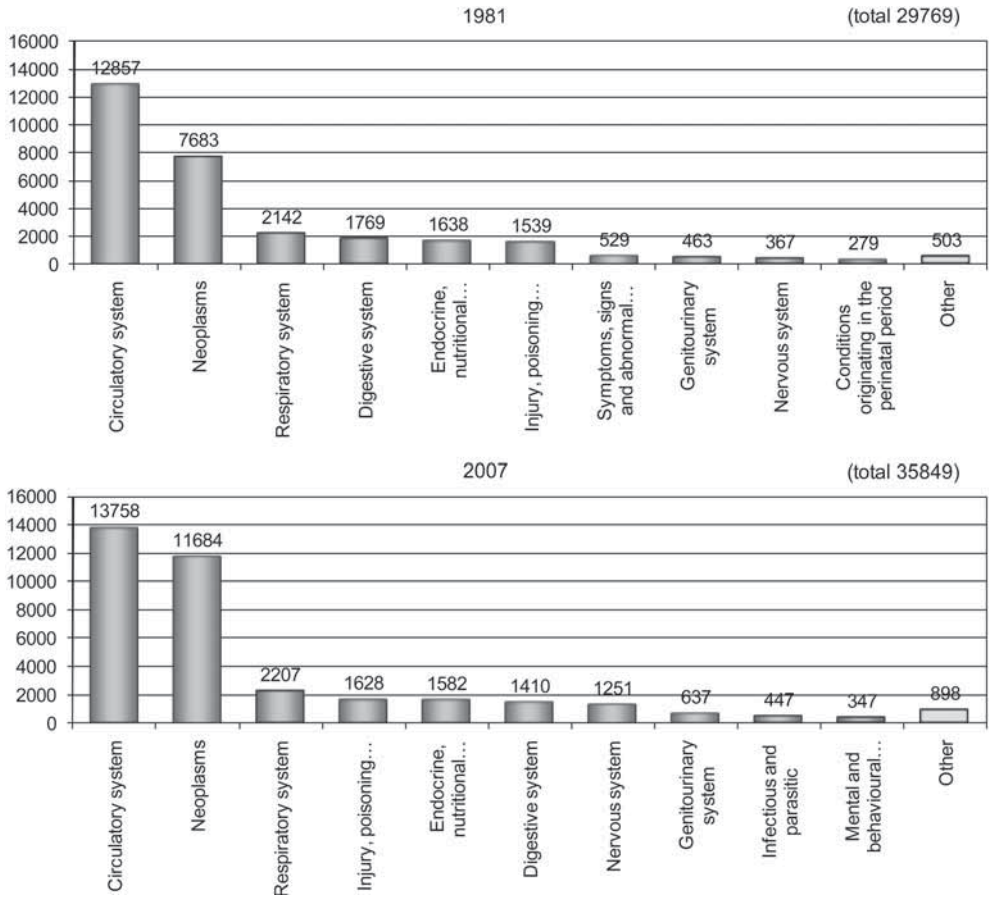

Fig. 1. The mortality due to the different causes of death, in 1981 and 2007, in the province of Rome.

Source: elaboration on data ISTAT

nervous system[2], which were in ninth place in 1981. The diseases of the genitourinary system continue to be in eighth position, while conditions originating in the perinatal period are no longer in the first ten places because important progresses have been made in this field (as confirmed also by the zero deaths due to pregnancy, childbirth and the puerperium). In ninth and tenth positions we find respectively infectious and parasitic diseases, which can be also related to the substantial increase in immigrants living in Rome city and in nearby municipalities, and mental and behavioural disorders, to which have to be added an increase in diseases of the nervous system caused by stress, traffic and other day to day tense conditions.

Regarding the percentage of mortality due to the main six causes of death, we can affirm the following (Fig. 2):

- the relevance of diseases of the circulatory system decreased by almost five percentage points (from 43.2% to 38.4%), while the relevance of neoplasms increased by almost seven percentage points (from 25.8% to 32.6%). Consequently, the gap which amounted to 17.4 percentage points in 1981 is now reduced to 5.8 percentage points and it suggests a possible closer convergence within the next 30 years [Pesaresi, Marta, in press];

[2] The ISTAT code (G00-H95) for diseases of the nervous system is different from that of the International Statistical Classification of Diseases and Related Health Problems 10th Revision Version for 2007 (G00-G99). See http://apps.who.int/classifications/apps/icd/icd10online.

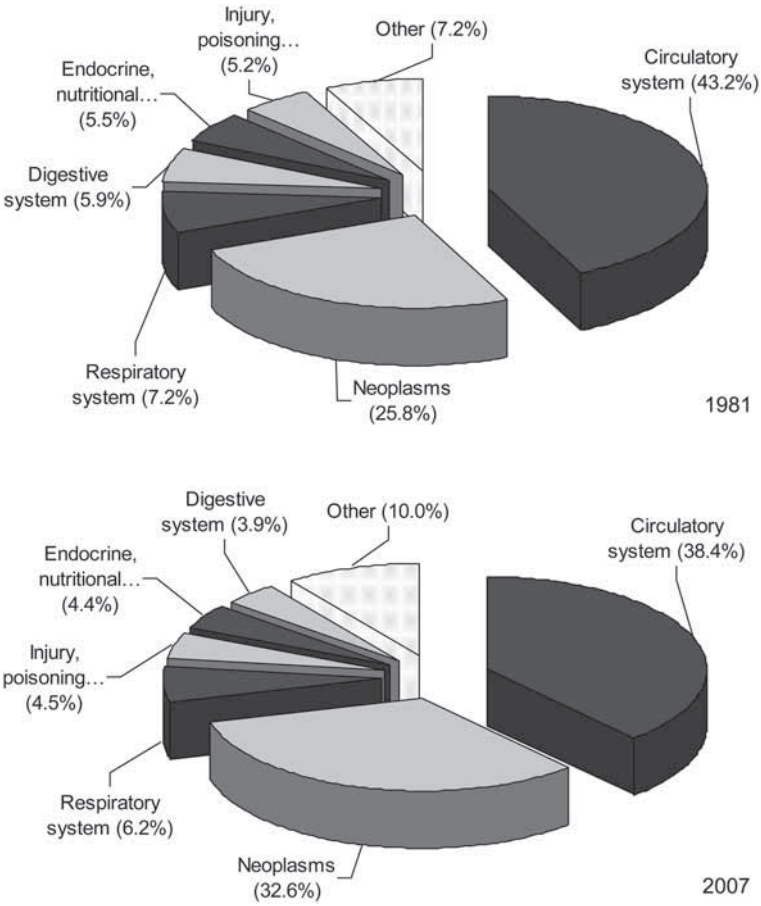

Fig. 2. The percentage of mortality due to the main six causes of death, in 1981 and 2007, in the province of Rome.

Source: elaboration on data ISTAT

- the relevance of diseases of the respiratory system decreased by one percentage point, the relevance of diseases of the digestive system decreased of two percentage points, endocrine, nutritional and metabolic diseases decreased by 1.1 percentage points and injury, poisoning and certain other consequences of external causes decreased by 0.7 percentage points;

- the dynamic of the main causes of death in the province shows, on percentage, a general reduction, with the exception of neoplasms which appear to be becoming the most problematic disease of the 21st century.

THE MAIN CAUSES OF DEATH IN 1981 AND 2007 PER MUNICIPALITY

For the five main causes of death, we have drawn up a map for the percentage data of 1981[3] and another for 2007, in order to illustrate which municipalities have recorded the principal changes. Thus, we have drawn up several specific thematic maps adopting a standard scheme. We have always considered five classes and the central one has been thought to include the provincial values of 1981 and 2007. For each cause of death, the five classes are the same for 1981 and 2007, in order to facilitate the comparisons and to see immediately which modifications are the most relevant.

[3] In the maps of 1981 the municipality of Rome includes the present municipality of Fiumicino.

Diseases of the circulatory system

The comparison between the thematic map of 1981 and that of 2007 shows an overall marked decrease in the percentage of mortality due to diseases of the circulatory system (Figs. 3–4). In fact, in 1981 the diseases of the circulatory system caused more than 45% of deaths in 62 municipalities while in 2007 they caused more than 45% of deaths in 26 municipalities. At the same time, in 1981 the diseases of the circulatory system provoked more than 55% of deaths in 26 municipalities while in 2007 the number of municipalities with such a high value fell to 11, mostly in the east of the province (Fig. 5), with the addition of Allumiere (65.9%) in the north-west. The maximum values are recorded in Marano Equo (80.0%), Affile, San Gregorio da Sassola, and Vallepietra (66.7%).

In order to show more clearly the amount of difference between the percentage data of 1981 and 2007 (Fig. 6), we have elaborated another map to indicate which municipalities have shown: a large reduction (values less than –20 percentage points), a fair reduction (between –20 and –3.1 percentage points), a not appraisable variation (conventionally between –3 and 3 percentage points), a fair increase (between 3.1 and 20 percentage points), and a large increase (more than 20 percentage points). The main results are the following: 81 municipalities recorded a substantial decrease (17 municipalities are in the class with values less than –20 percentage points, and 64 between –20 and –3.1 percentage points), 14 municipalities recorded a not appraisable variation and 23 a substantial increase (15 between 3.1 and 20 percentage points, and 8 more than 20 percentage points).

The maximum decreases were in: Sambuci (–56.1 percentage points), Vallinfreda (–50.0), Roviano (–49.4), Filacciano (–46.4), San Polo dei Cavalieri (–42.6), Gorga (–38.3), Civitella

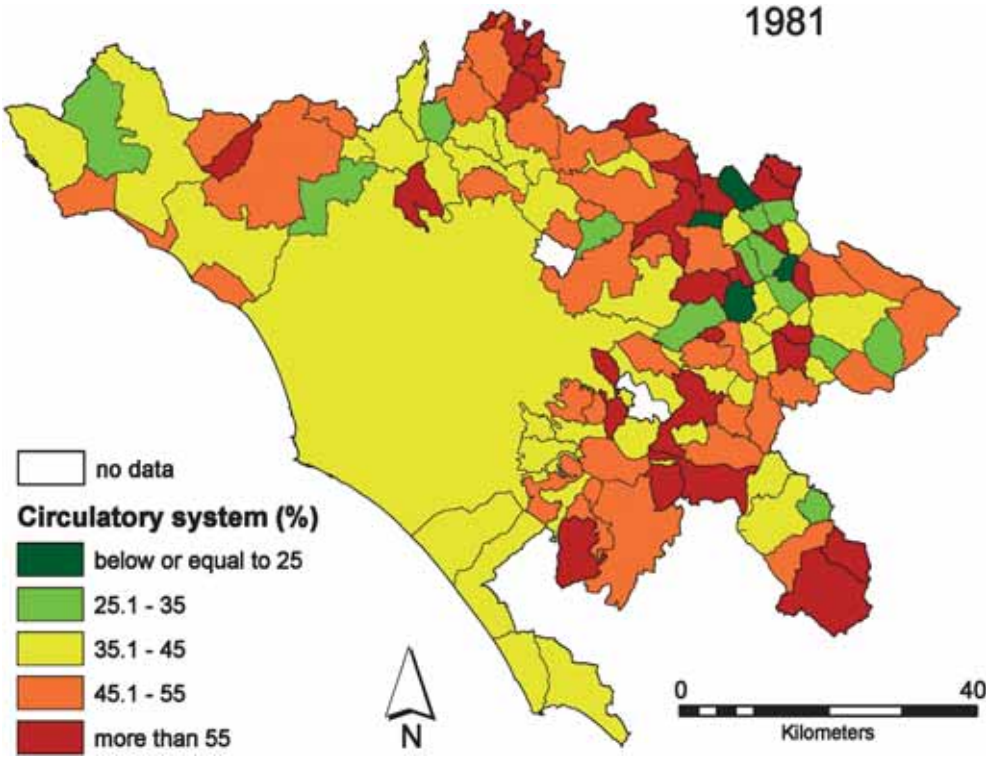

Fig. 3. The percentage of mortality due to diseases of the circulatory system, in 1981, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

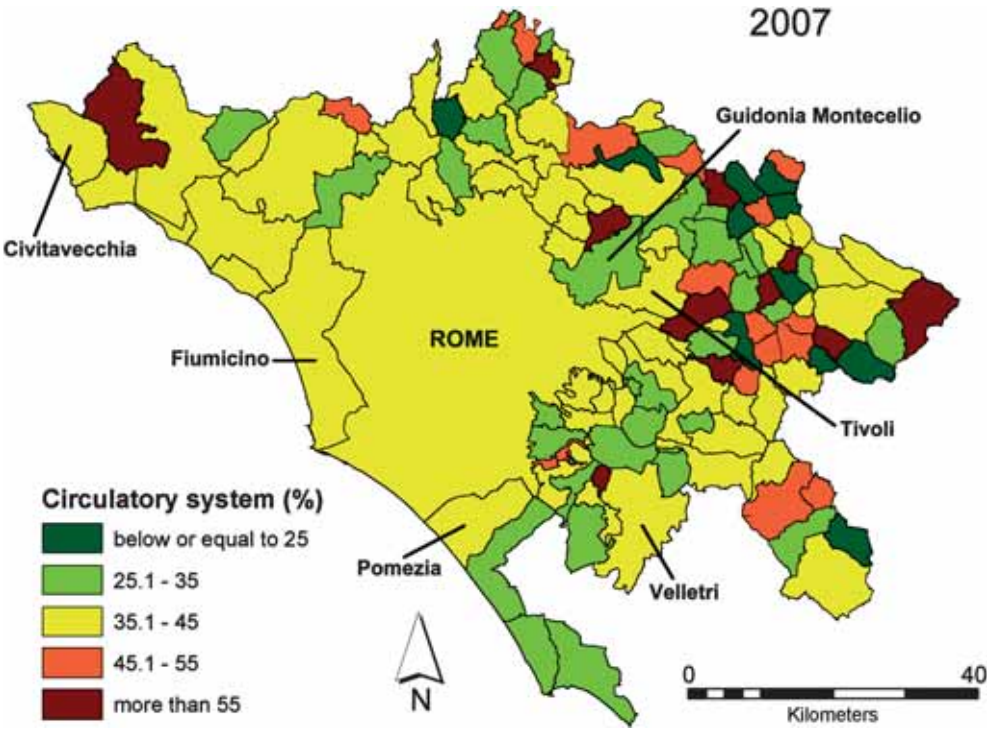

Fig. 4. The percentage of mortality due to diseases of the circulatory system, in 2007, in the municipalities of the province of Rome. The municipalities with more than 40,000 inhabitants (on the basis of the Census data of 2001) are indicated in the map to provide some geographical information.

Source: elaboration on data ISTAT

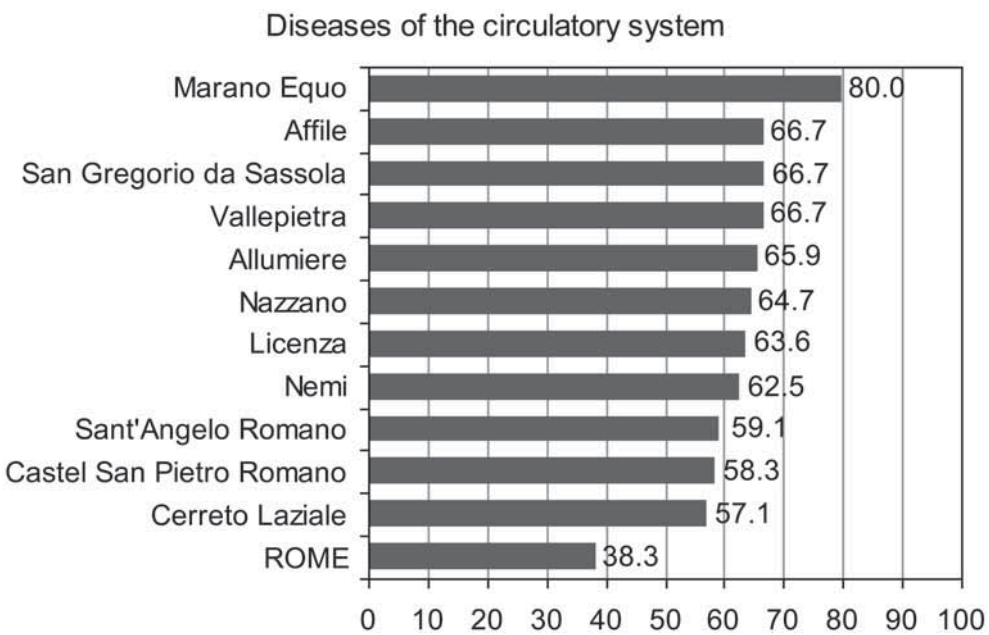

Fig. 5. The municipalities of the province of Rome with the highest percentage of mortality due to diseases of the circulatory system, in 2007, with the addition of Rome city.

Source: elaboration on data ISTAT

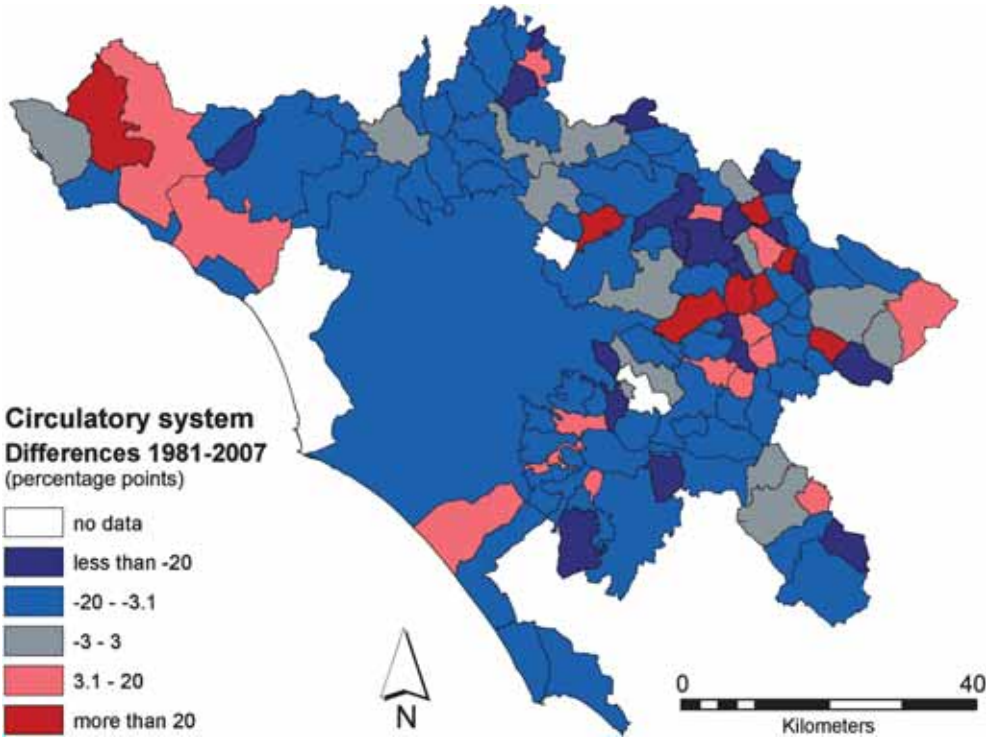

Fig. 6. The differences between the data of 1981 and 2007 for the percentage of mortality due to diseases of the circulatory system in the municipalities of the province of Rome (percentage points).

Source: elaboration on data ISTAT

San Paolo (–37.7), Agosta (–32.2). Instead, the most worrying increases have been recorded in: Marano Equo (55.0 percentage points), San Gregorio da Sassola (39.4), Allumiere (35.1), Affile (32.2), and Sant'Angelo Romano (31.8).

As for the city of Rome, the data shows that mortality due to diseases of the circulatory system has decreased from 42.5% to 38.3%, denoting a reduction slightly smaller with respect to the province. Thus mortality due to diseases of the circulatory system evaluated in percentages in Rome city and in its province is practically the same.

Neoplasms

Unlike the situation for diseases of the circulatory system, the comparison between the thematic map of 1981 and that of 2007 shows a generally remarkable increase in the percentage of mortality due to neoplasms (Figs. 7–8). Particularly, in 1981 neoplasms caused more than 35% of deaths in 10 municipalities while in 2007 neoplasms caused more than 35% of deaths in 47 municipalities. Contemporarily, in 1981 neoplasms were the cause of more than 45% of deaths only in 2 municipalities while in 2007 the number of municipalities with such a high value had increased to 11, all distributed in the east, where a longitudinal axis can be traced with various municipalities aligned along it. The maximum values (Fig. 9) are recorded by Mandela, Roccagiovine, and Vallinfreda (66.7%).

In the same way as for the diseases of the circulatory system, we have created a map of the differences between the percentage data of 1981 and 2007 (Fig. 10), and the main results are the following: 14 municipalities recorded a substantial decrease (4 municipalities are in the class with values less than –20 percentage points, and 10 between –20 and –3.1 percentage points), 11 municipalities

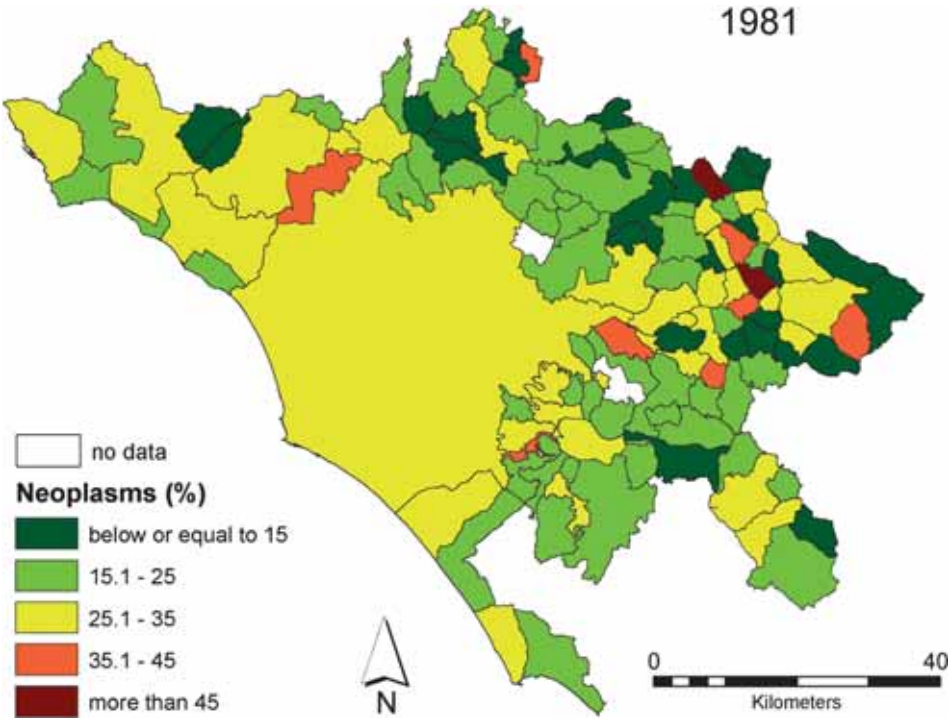

Fig. 7. The percentage of mortality due to neoplasms, in 1981, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

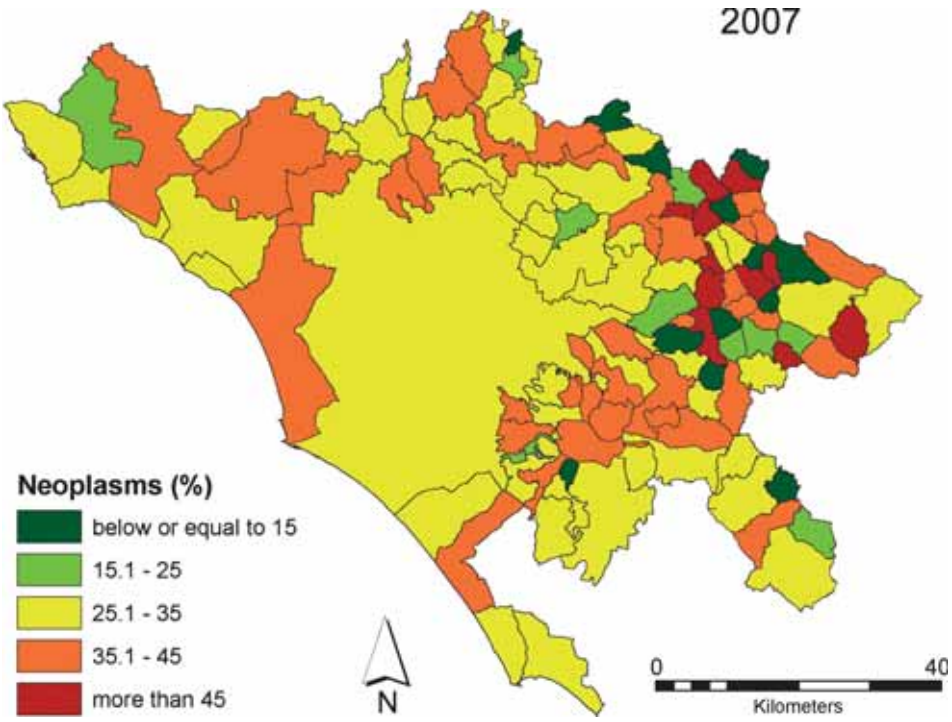

Fig. 8. The percentage of mortality due to neoplasms, in 2007, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

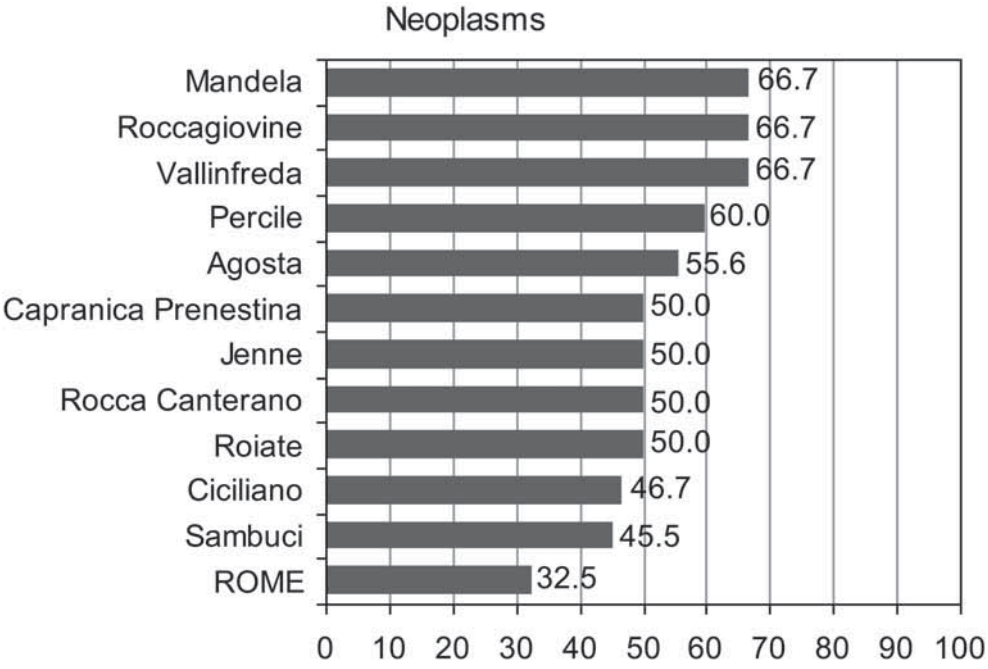

Fig. 9. The municipalities of the province of Rome with the highest percentage of mortality due to neoplasms, in 2007, with the addition of Rome city.

Source: elaboration on data ISTAT

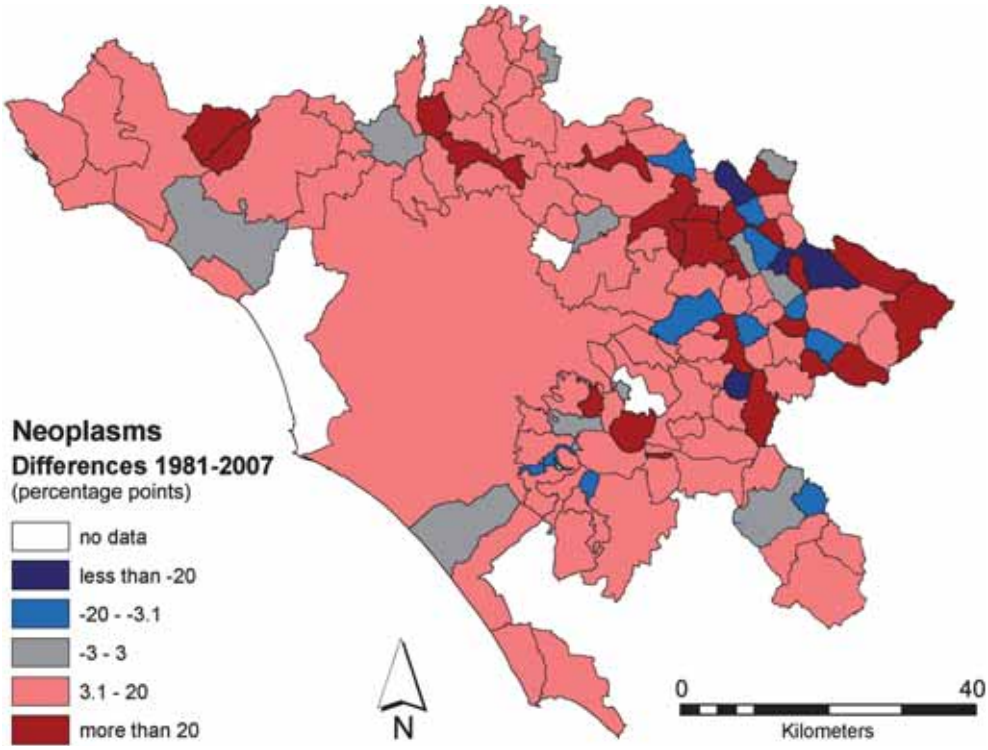

Fig. 10. The differences between the data of 1981 and 2007 for the percentage of mortality due to neoplasms in the municipalities of the province of Rome (percentage points).

Source: elaboration on data ISTAT

recorded a not appraisable variation and 93 a substantial increase (71 between 3.1 and 20 percentage points, and 22 more than 20 percentage points). The municipalities with the most appreciable decreases were: Percile and Rocca di Cave (–40.0 percentage points), Cervara di Roma (–33.3), Marano Equo (–25.0). The municipalities with the most relevant increases were: Vallinfreda (55.6 percentage points), Roccagiovine (46.7), Sambuci (45.5), San Polo dei Cavalieri (44.4), and Agosta (40.6).

In practice, the maps of the differences between the data of 1981 and 2007, for diseases of the circulatory system and neoplasms, show two opposing conditions and in some aspects one can seem the "negative" of the other.

In the case of Rome city, the mortality due to neoplasms increased from 26.5% to 32.5%, just a few less than in the province and also the percentage of mortality caused by this disease is nearly the same in the city of Rome and in its province.

Diseases of the respiratory system, injury, poisoning and certain other consequences of external causes, and endocrine, nutritional and metabolic diseases

A comparative analysis of the percentage data of 1981 and 2007 for diseases of the respiratory system (Figs. 11–12) shows several municipalities with important decreases. In fact, 60 municipalities recorded a decrease in values (at least –1.1 percentage points) and many of them showed significant diminution, especially: Vallepietra (–50.0 percentage points), Saracinesco (–33.3), Ciciliano (–30.0), Marano Equo (–25.0), Nazzano (–24.1), Torrita Tiberina (–18.2), Rocca Canterano (–16.7), Cineto Romano (–16.4) and San Vito Romano (–15.8) plus another six municipalities with values less than –10 percentage points. A few more than half (35) were the municipalities

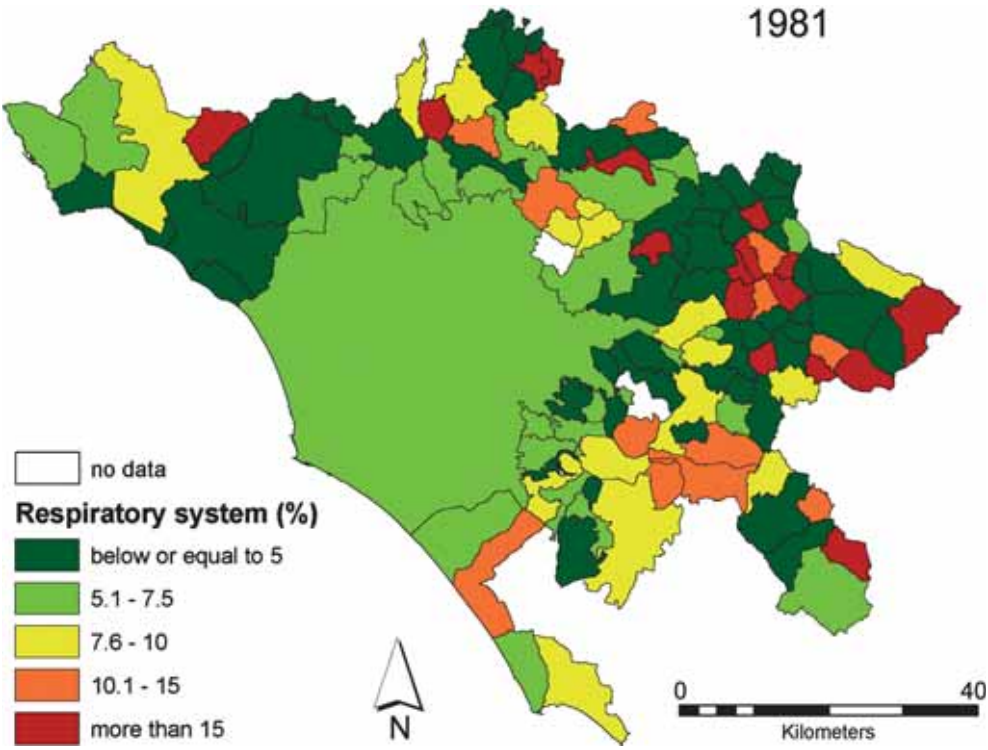

Fig. 11. The percentage of mortality due to diseases of the respiratory system, in 1981, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

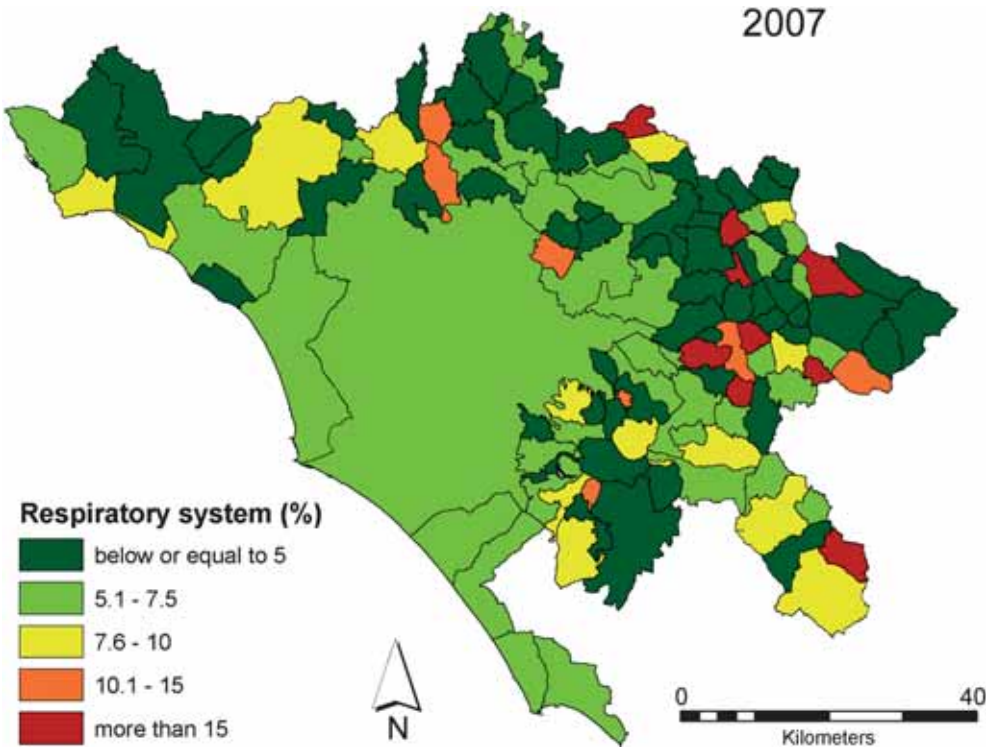

Fig. 12. The percentage of mortality due to diseases of the respiratory system, in 2007, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

with increases in values (at least 1.1 percentage points), and the most significant values have been recorded in: Rocca di Cave (50.0 percentage points), Cervara di Roma and Pisoniano (20.0), Mandela (16.7), Capranica Prenestina and Nemi (12.5). Finally, there were 23 municipalities with very slight changes (conventionally between –1 and 1 percentage points).

The general picture of 2007 shows a situation of mainly low (below or equal to 5%) and medium-low (between 5.1% and 7.5%) values. The coastal zone especially includes municipalities with medium-low values, while the east of the province has a considerable number of municipalities with low or medium-low values but also some municipalities with high (more than 15%) or medium-high values (between 10.1% and 15%).

In the city of Rome, mortality caused by diseases of the respiratory system decreased from 7.3% to 6.3%, and the values continue to be strictly aligned with those of the province.

As regards injury, poisoning and certain other consequences of external causes (Figs. 13–14), a comparison between the percentage data of 1981 and that of 2007 indicates that 45 municipalities showed a decrease in values (at least –1.1 percentage points), 34 recorded increases (at least 1.1 percentage points) and 39 showed very little change (between –1 and 1 percentage points). The municipalities with the most significant variations were: for decreases, Vivaro Romano (–20.0 percentage points), Mazzano Romano (–18.8), Nemi (–15.4), Castel San Pietro Romano (–14.3), Colonna (–12.1), Fiano Romano (–11.7) and Poli (–11.1), and, for increases, Filacciano (42.9), Percile (20.0), Torrita Tiberina (16.7), Ciciliano (13.3), Canterano (12.5) and Gorga (11.7). Therefore, in comparison with diseases

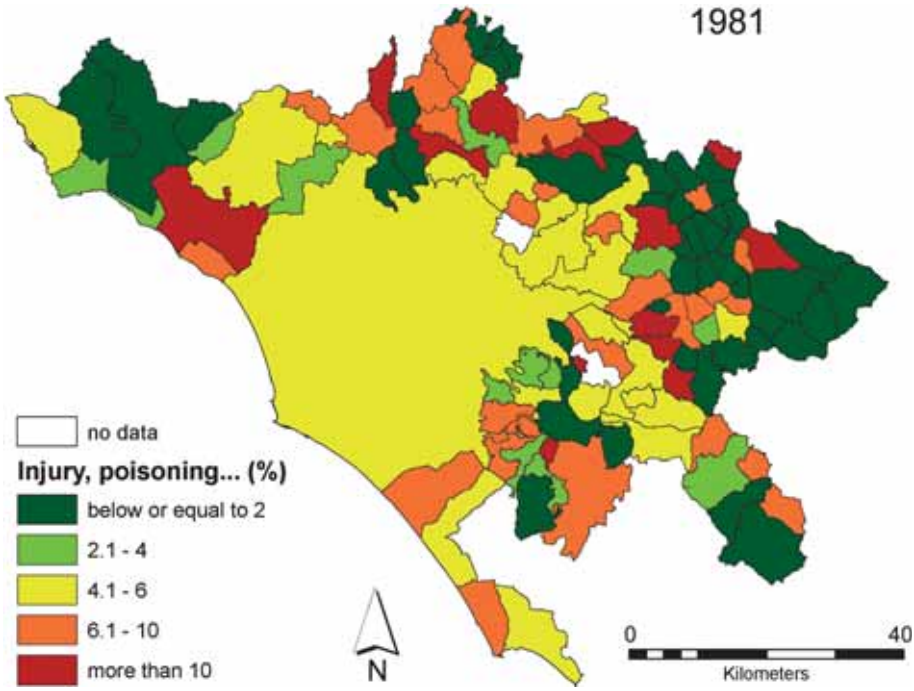

Fig. 13. The percentage of mortality due to injury, poisoning and certain other consequences of external causes, in 1981, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

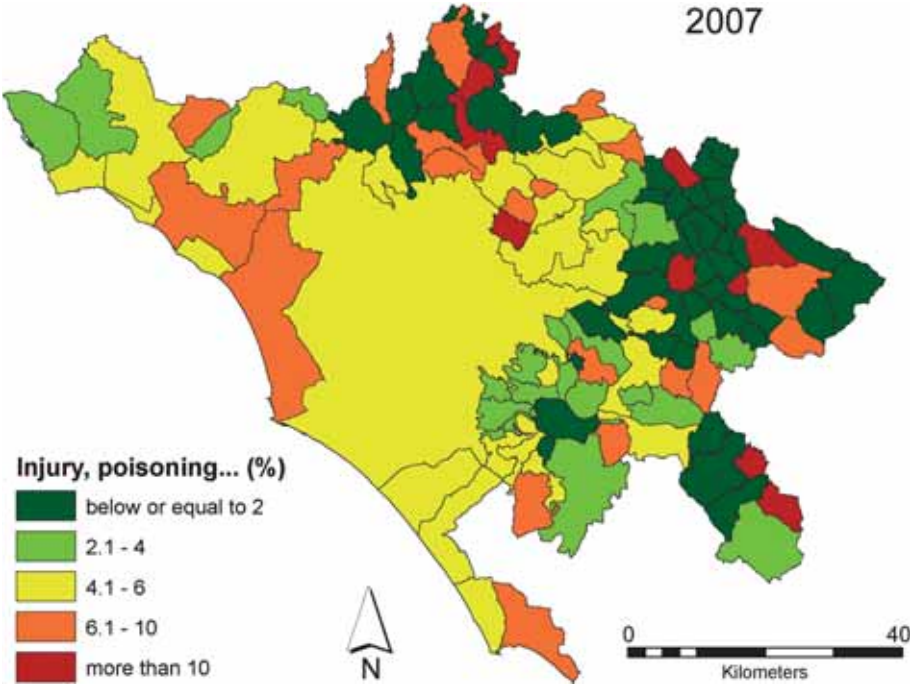

Fig. 14. The percentage of mortality due to injury, poisoning and certain other consequences of external causes, in 2007, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

of the respiratory system, the number of municipalities with high variations (values more than 10 percentage points and less than –10 percentage points) is smaller and the amount of these changes is generally less remarkable.

The map for 2007 shows a more variegated situation compared to that of diseases of the respiratory system. The municipalities of the coastal zone show almost exclusively medium (between 4.1% and 6%) or medium-high (between 6.1% and 10%) values, while all the most divergent cases were recorded in the eastern part of the province, where aggregations of municipalities with low (below or equal to 2%) values were interspersed with municipalities with high (more than 10%) or medium-high values.

In the city of Rome, the mortality due to injury, poisoning and certain other consequences of external causes decreased from 5.2% to 4.4%, in close parallel with the values of the province.

As regards the percentage of mortality due to endocrine, nutritional and metabolic diseases (Figs. 15–16), the thematic maps of 1981 and 2007 show a situation which in some aspects is the opposite to that of injury, poisoning and certain other consequences of external causes. In fact, a similar high number of municipalities, that is to say 40, continued to record values close to those of the past. Then, 35 municipalities showed a decrease in values (at least –1.1 percentage points) and 43 municipalities showed an increase (at least 1.1 percentage points), that more or less is the opposite of the previous situation. As particular cases, we indicate: for decreases, Roccagiovine (–40.0 percentage points), Roiate (–25.0), Castelnuovo di Porto (–18.4), Camerata Nuova (–18.2), Mandela (–14.3) and Riofreddo (–13.3); for increases, Monteflavio (25.0 percentage points),

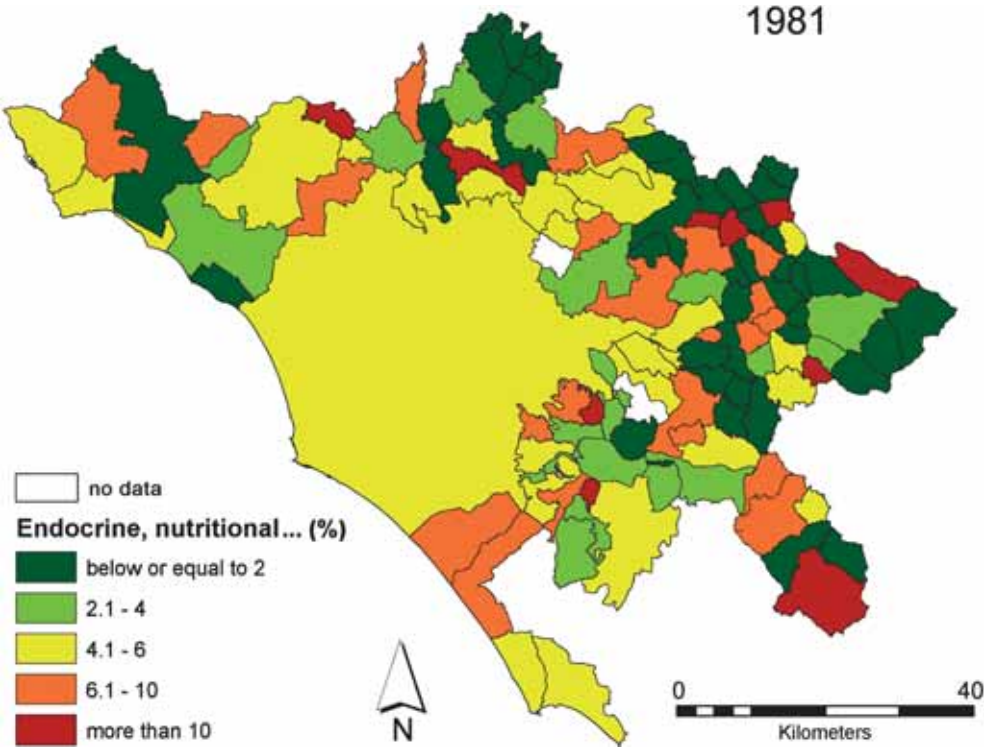

Fig. 15. The percentage of mortality due to endocrine, nutritional and metabolic diseases, in 1981, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

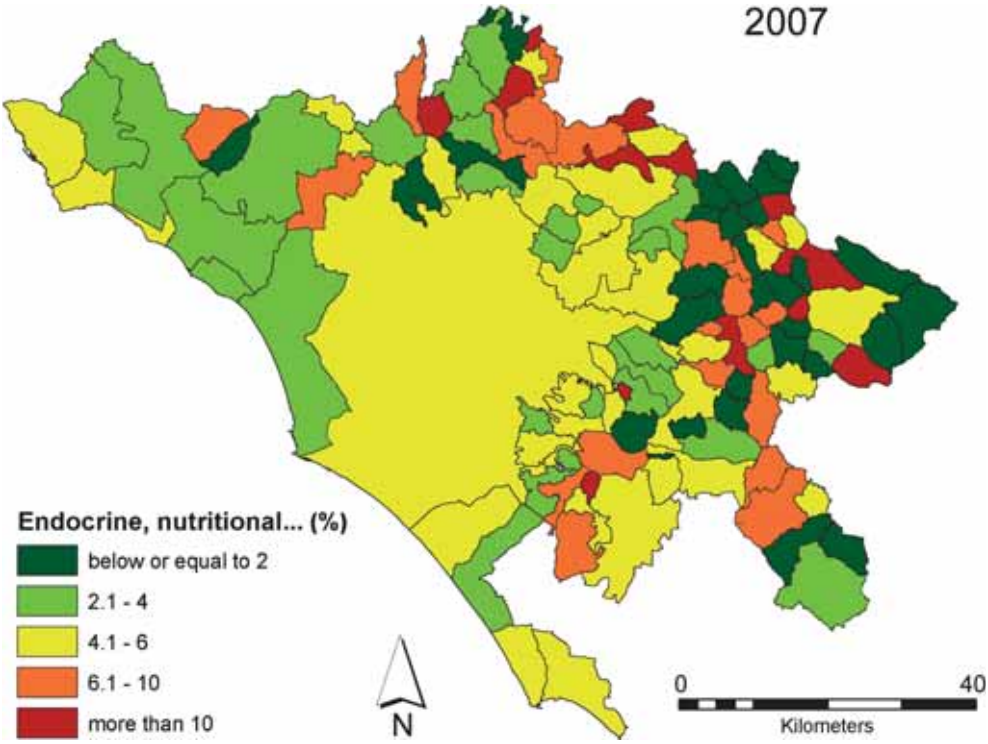

Fig. 16. The percentage of mortality due to endocrine, nutritional and metabolic diseases, in 2007, in the municipalities of the province of Rome.

Source: elaboration on data ISTAT

Cervara di Roma and Marano Equo (20.0), Arcinazzo Romano and Filacciano (14.3), Civitella San Paolo (13.6) and other five municipalities with values more than 10 percentage points.

The map for 2007 shows a variegated situation, but the coastal zone featured only medium (between 4.1% and 6%) and medium-low values (between 2.1% and 4%), while all the different cases were recorded in the east, where a certain number of municipalities with medium-high (between 6.1% and 10%) or high (more than 10%) values were to be seen, also in close proximity to municipalities with low (below or equal to 2%) values.

In the city of Rome, the mortality due to endocrine, nutritional and metabolic diseases decreased from 5.7% to 4.3%, showing once again values very near to those of the province.

All in all, the continuing similarity between the values of the city of Rome and its province lead us to the conclusion that the data of Rome city strongly influences the provincial data as an effect of the "giant" role played by the city (both in surface area and above all for number of inhabitants). Consequently, to carry out a screening on the city of Rome, and in particular on the land use and its evolution over time, a knowledge of the peculiar features, the risk factors and the location of pollution sources or noxious economic activities in a city where, in 2007, 67% of the inhabitants of its province lived, would be of primary importance.

HEALTH THREATS AND ENVIRONMENTAL RISKS IN URBAN AREAS: THE CASE OF ROME PROVINCE

Health is one of the fundamental prerequisites for a sustainable lifestyle in cities. Nowadays cities house more than half

of the world population but the amount of urban population will continue to increase in the future [UN-Habitat, 2006]. This is the reason why urban areas have an important role in promoting better conditions for their inhabitants (from an economic, social and environmental point of view) and healthy ways of living. The recent rate of urban growth, especially in the developing world, is unprecedented, with vast implications for human well-being and the environment [WHO, 2007].

Among industrialized nations, city dwellers already account for nearly three-quarters of the population. Cities of the developing world, on the other hand, will absorb roughly 95 percent of the total population growth expected worldwide in the next two decades, a result of rural to urban migration, the transformation of rural settlements into urban places, and natural population increases. Megacities, those with more than ten million inhabitants, will continue to grow in size and number.

However where cities pose environmental problems they are expected also to offer solutions. The aim of a healthy city is not only about minimizing adverse factors such as traffic, the pollution of air, soil, water, or social problems. It is about actively creating certain conditions that promote the health, safety and well-being of people in the city.

Different types of hazard affect the city and the province of Rome including biological pathogens, chemical pollutants (air pollution, water pollution, hazardous wastes), physical hazards (traffic hazards, natural and human accidents because of inadequate attention to prevention and mitigation), heat island effects and thermal inversions, resource degradation (soil erosion; deforestation; water pollution; ecological damage from acid precipitation and ozone plumes); land or water pollution from waste dumping; loss of biodiversity; loss of non-renewable resources, greenhouse gas emissions, stratospheric ozone-depleting chemicals. One of the more urgent issue in Rome, as in many other vast urban areas, is air pollution. Rome experience severe forms of air pollution as the result of the increased private transport.

Apart from the different forms of pollution affecting the city, the problem of Rome is the lack of effective and cross-cutting goals and policies to protect the environment and prevent its degradation. Many cities all round the world are experimenting environmental best practices through the initiative of Local Agenda 21. This is also the case of Rome. The main issues addressed by the Local Agenda 21 of Rome province and municipality are: innovations in building construction, improve of energy efficiency and waste management, increase of public transportation. With proper planning and long-term vision Rome, as other dense settlement patterns, can offer economies of scale to reduce pressures on natural resources from population growth and make life in city mores sustainable.

The effort needed for Rome in the future is to include environmental concerns in all the other policies in order to make environment a concrete priority. This effort is necessary to increase the health and life quality of Rome citizens and to protect the landscape of Rome, one of the most important resources of the city.

LAND USE CHANGE AND ENVIRONMENTAL QUALITY: THE CASE OF ROME PROVINCE

Land use and land cover change is gaining recognition as a key driver of environmental change [Dale, 1997; Turner, 1994]. With the awareness of the importance of land-use change on global change, the study of land use and land cover change has become the focus of much scientific endeavour and international organizations. Human activities are altering the land use at an unprecedented rate and scale. Changes in land use affect

environmental quality because of the different implications of land use practices on environment. Changes in land cover have important consequences for natural resources through their impacts on soil and water quality, ecosystem processes and functions, and global climatic systems [Meyer, Turner, 1991]. The modification and conversion of land use and land cover are directed by the interaction in space and time between environment and human activities. In particular there is a growing concern on the sprawl affecting urban areas all over the world and the progressive conversion of rural and natural areas into built-up areas.

The analysis of land use can, indeed, be a useful tool to study the environmental quality of urban areas while the analysis of land cover change can help in investigating whether the environmental quality has decreased or increased.

Since we want to analyse the relationship between health and city and since environmental quality is a key element in promoting human well-being in urban areas, we decided to study the land cover of Rome province, which is our case study, to try to evaluate the environmental quality of Rome as a result of land cover analysis.

As a second step we analysed the evolution of land use in the city of Rome between 1980 and 2001 to find out if the environmental conditions of the city are becoming better or worse. We focused the attention on the city of Rome because human pressures and human activities are much stronger in this area and can have a greater effect on the health of inhabitants.

Today artificial land use covers 14.37% of the total surface of Rome province while rural areas cover 50.46% and natural areas 35.17%. In comparison with other metropolitan areas the amount of built-up areas is not particularly high (Tab. 1, Fig. 17). In addition it is worth noting that more than half of the total surface is covered by agricultural areas. The most critical areas are the coastal zones, in the western part of the area, the city of Rome and the south-east area of the province, the area of the Alban Hills. During the last few decades these areas have been affected by urban sprawl determining an unprecedented growth of built-up areas and commercial areas, an increase in traffic flows, the fragmentation and loss of rural and natural areas, often resulting in marginal areas, and the increase of human pressure on the physical environment.

Table 1. The main land use types of Rome province

Land cover classes	%
Continuous urban fabric	4.49
Discontinuous urban fabric	4.39
Non irrigated arable land	26.05
Permanently irrigated land	5.46
Olive trees	7.74
Deciduous forest	23.48
Coniferous forest	5.13
Total surface	76.64

Some parts of the Rome province, especially in the city area of Rome, host sites for activities with high pressure on human health, such as industrial units, dump sites, mineral extraction areas (Fig. 18). The environmental impacts of these activities are not sufficiently taken into account in land planning and management. The consequence of this lack of planning is often a concentration of health risks in some areas.

On the other hand, a significant amount of natural areas, often included in protected areas, have an important role in preserving a high level of environmental quality in Rome province (Fig. 19). It is worth noting that the area features a high percentage of forests which lessen air pollution and mitigate the effects of climate change.

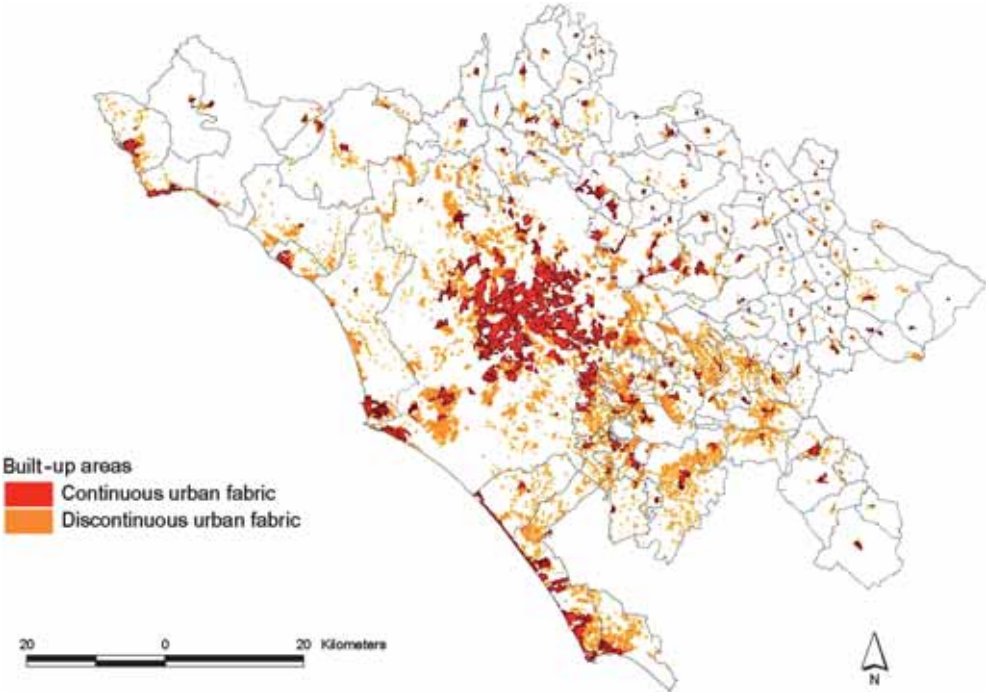

Fig. 17. Built-up areas of Rome province.

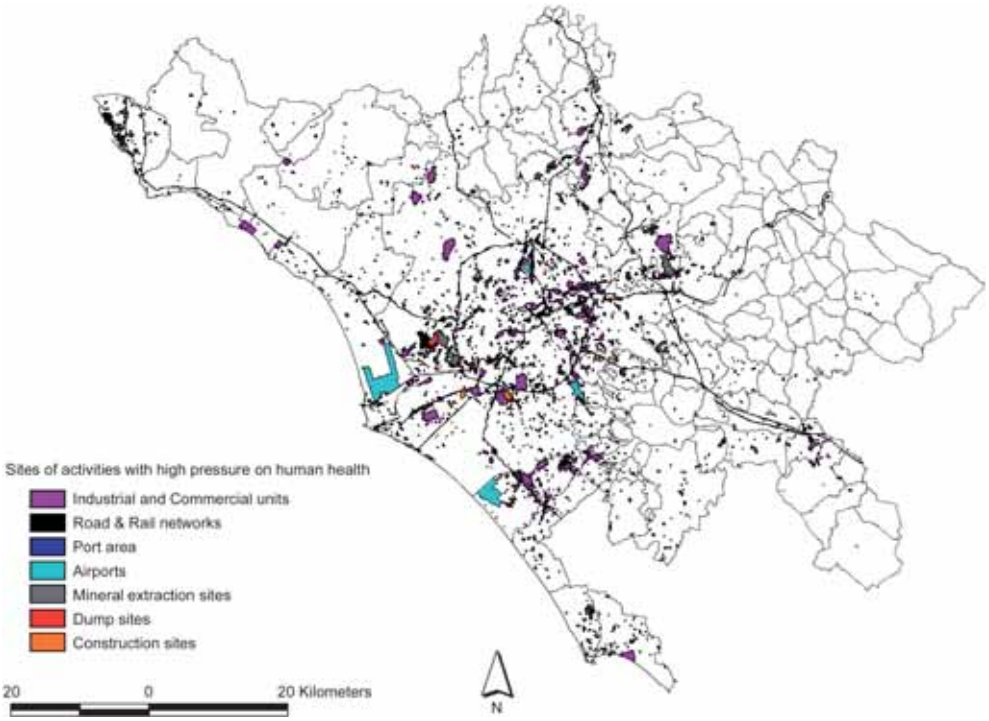

Fig. 18. Sites of activities with high pressure on human health.

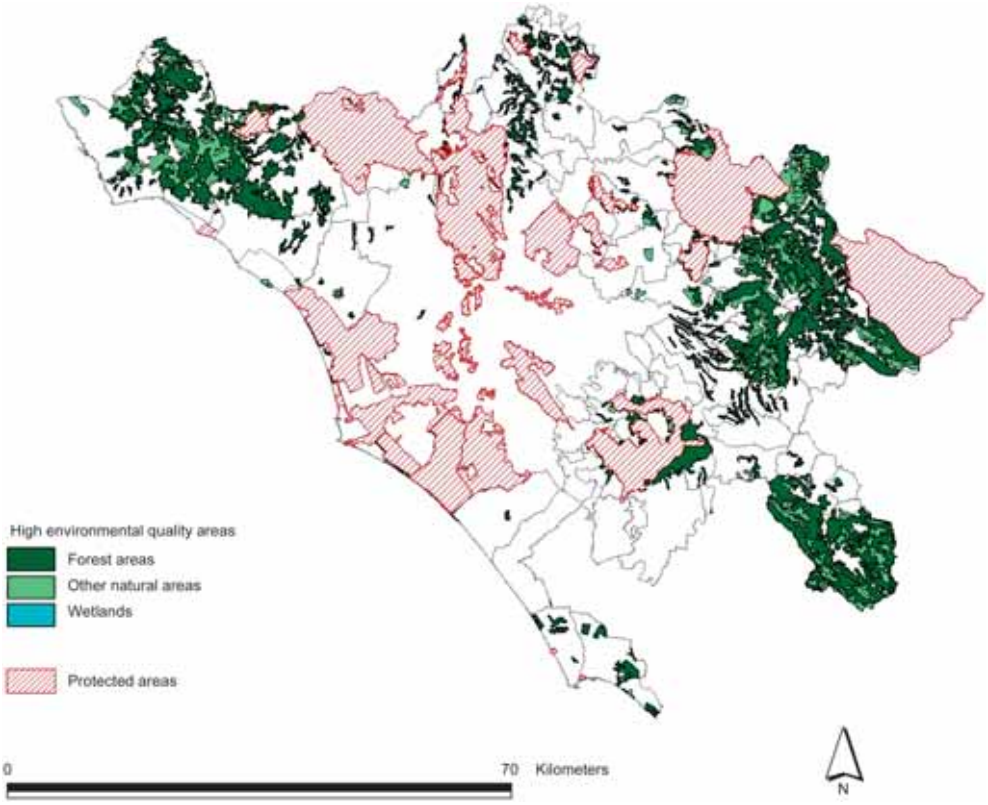

Fig. 19. High environmental quality areas.

Table 2. Different land use types in 1980 and 2001 and % variation (80-01) in the city of Rome

Land use classes	hectars 1980	hectars 2001	% var. 80-01
Road and rail networks	8865.24	10884.70	23
Continuous urban fabric	11539.66	14672.43	27
Discontinuous urban fabric	9912.28	12635.97	27
Green areas	1178.12	1405.33	19
Sports and leisure facilities	696.97	1386.77	99
Cemeteries	200.08	251.90	26
Non irrigated arable land	71669.76	61557.24	–14
Permanently irrigated arable land	2658.36	3253,.31	22
Complex cultivation patterns	5514.86	3771.46	–32
Sparsely vegetated areas	119.59	100.41	–16
Reforestation areas	2400.71	2964.84	23
Transitional woodland shrubs	1185.99	1853.89	56
Sclerophyllus vegetation	1235.51	1296.75	5
Coniferous forest	2361.33	2457.96	4
Broad-leaved forest	7522.65	8543.76	14
Hygrophilous forest	680.24	707.44	4
Inland waters	43.19	20.20	–53
Water bodies	833.91	859.26	3

Land cover change in Rome city between 1980 and 2001

The situation of environmental quality in the city of Rome is today very similar to other metropolitan areas of the developed world. The city is affected by air, land and water pollution, hazardous wastes, traffic hazards, heat island effect, resource degradation, loss of biodiversity, loss of non-renewable resources, greenhouse gas emissions. In comparison with other European cities (www.urbanaudit.org) the city presents higher levels of traffic and resources consumption (water, energy). On the other hand, Rome has a significant amount of protected areas, representing almost one third of the whole municipality, and a relevant coverage of green areas (15%) and agricultural lands (50%). The environmental quality of the city is today compromised by the development of new residential and commercial areas, both sprawling processes accelerated by the approval of the New Master Plan (2005). Building and tourist activities are, in fact, the main economies of the city.

The land use change occurring in the city of Rome is determining the progressive conversion of agricultural lands into built-up areas. Non irrigated arable lands decreased, between 1980 and 2001, by 14%, while complex cultivation patterns decreased by 32% (Tab. 2). In the same period, artificial lands showed a growth of 77%. However, it is worth noting that some vegetation types are also increasing in terms of surface area (Figs. 20–21).

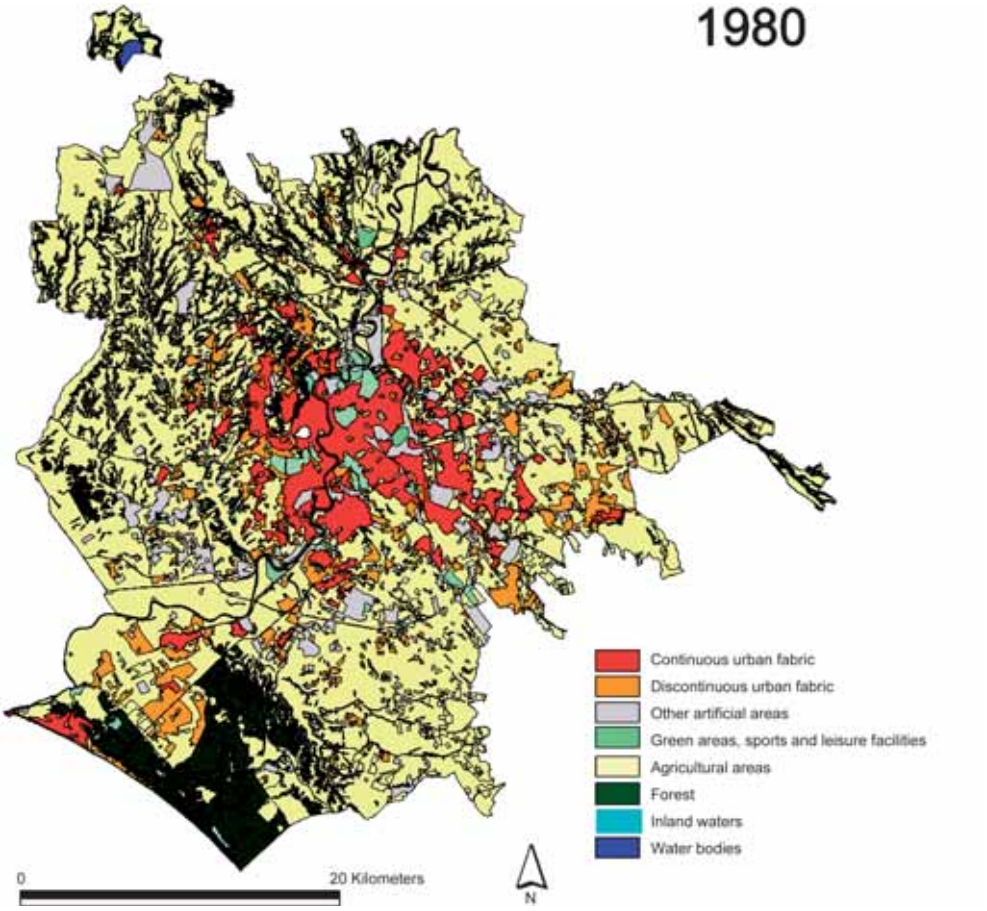

Fig. 20. Land cover in Rome in 1980.

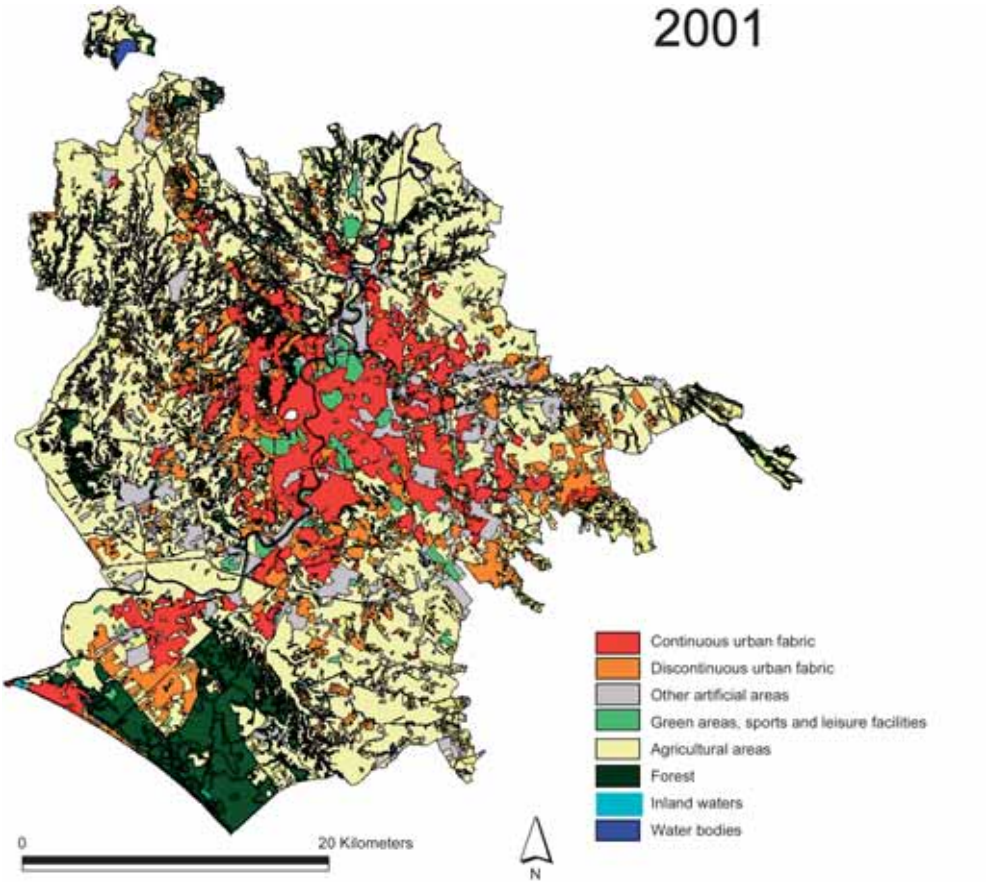

Fig. 21. Land cover in Rome in 2001.

The significant amount of green and forest areas of the city of Rome has an important rule in improving the environmental quality of the urban area. However it is necessary to make an effort to increase the safeguarding and restoration of natural and agricultural areas, in order to offset the negative effects of urban sprawl.

The improvement of urban sustainability has to become the main goal of future land use and city planning in order to offer better living conditions for city dwellers and healthier ways of living.

CONCLUSIONS

The analysis of quantitative data regarding the main five causes of death in the province of Rome allows us to produce detailed spatial and temporal frameworks, which may be useful for:

- sanitary and geo-medical purposes, since these frameworks show the local and provincial characteristics and induce to search the possible risk factors;
- social purposes, in order to improve the environment and to increase the quality of life of the city inhabitants and the level of services for sick person;
- future planning of economic activities, in order to decrease risks for human health and their impacts on other local problems.

For what it concerns the diseases of the circulatory system and neoplasms, which are respectively the first and the second causes

of death in Rome province and in Italy too, we observed two very different trends. First of all, the relevance of diseases of the circulatory system decreased from 43.2%, in 1981, to 38.4%, in 2007, while the relevance of neoplasms in the same years increased from 25.8% to 32.6%. Therefore, the gap between the relevance of diseases of the circulatory system and neoplasms recorded an important reduction. Then, through various medical-geographical thematic maps, we showed the distribution and evolution of the data at the scale of the municipality; for example the results derived by the maps regarding the amount of difference between the percentage data of 1981 and 2007 are synthetically the following:

– for the diseases of the circulatory system, 81 municipalities recorded a substantial decrease, 14 municipalities recorded a not appraisable variation and 23 a substantial increase;

– for neoplasms, 14 municipalities recorded a substantial decrease, 11 municipalities recorded a not appraisable variation and 93 a substantial increase.

In the next step, we produced some maps derived from a re-elaboration *ad hoc* of the legend of the official land use maps. Our maps were elaborated to show:

– the spread of built-up areas, with the most critical areas represented by the coastal zones, the city of Rome and the area of the Alban Hills;

– the location of sites of activities with high pressure on human health;

– the high environmental quality areas (above all forest, other natural areas and protected areas), which characterise a large part of the Rome province.

In fact, these are elements which can threaten or preserve the integrity of ecosystem and have an influence on human health.

Finally, we focused the attention on the land cover change in Rome city between 1980 and 2001 to provide an exemplification of analysis at very large scale in a context where important increases are recorded both in built-up areas, i.e. along the axe between Via Portuense and Via Cristoforo Colombo (in the southwest part of the city, near the River Tiber), and some vegetation types. These changes above all if analysed for several municipalities and progressively updated may provide neuralgic inputs to investigate the variations recorded in the causes of death and to conduct interdisciplinary researches where geography and medicine may advantageously collaborate.

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REFERENCES

1. Cristaldi, F., Darden, J.T. (2004) Similarities and differences in demographic structures and social networks among Filipino immigrant women in Rome and Toronto, in G. Cortesi, F. Cristaldi, J. Fortuijn Droogleever (eds.), Gendered Cities: identities, activities, networks. A life-course approach, IGU-Home of Geography Publication Series, Società Geografica Italiana, Rome, 4, pp. 211–225.

2. Cummins, S., Curtis, S., Diez-Roux, A.V., Macintyre, S. (2007) Understanding and representing 'place' in health research: A relational approach, in "Social Science and Medicine", 65 (9), pp. 1825–1838.

3. Dale, V.H. (1997) The relationship between land use change and climate change, in "Ecological Application", 7, pp. 753–769.

4. Danida Workshop Papers (2000) Improving the Urban Environment and Reducing Poverty, Copenhagen.

5. Koch, T., Denike, K. (2007) Aaron's Solution, Instructor's Problem: Teaching Surface Analysis Using GIS, in "Journal of Geography", 106 (2), pp. 69–77.

6. ISTAT (1981) Censimento generale della popolazione, Istituto Nazionale di Statistica, Rome.

7. ISTAT (2007) Bilancio demografico e popolazione residente, http://demo.istat.it.

8. Italian Ministry of Health (2010) Piano Sanitario Nazionale 2011–2013, Bozza provvisoria, 5 Novembre 2010, http://www.salute.gov.it.

9. Malkhazova, S.M. et al. (2007) Medical-demographic atlas of the Moscow oblast, Lomonosov Moscow State University, Moscow.

10. Meyer, W.B., Turner B.L. (1991) Changes in land use and land cover: a global perspective, Cambridge University Press, Cambridge.

11. Morelli, P. (1983) Riforma sanitaria e sviluppo a Roma, in G. Arena (ed.), Atti del Primo Seminario Internazionale di Geografia Medica, RUX, Perugia, pp. 505–512.

12. Ortolani, M. [in collaboration with P.R. Mounfield] (1963). Lombardia e Lancashire. Saggio di geografia industriale comparata, in "Memorie di geografia economica e antropica", Naples.

13. Palagiano, C., Pesaresi, C. (2011) La salute nel mondo. Geografia medica e qualità della vita, Carocci, Rome.

14. Pesaresi, C., Marta, M. (in press) Peculiarità geografiche delle cause di morte nella provincia di Roma.

15. Rainham, D., Mcdowell, I., Krewski, D., Sawada, M. (2010) Conceptualizing the healthscape: Contributions of time geography, location technologies and spatial ecology to place and health research, in "Social Science and Medicine", 70 (5), pp. 668–676.

16. Rubino, G.F. et al. (1983) Analisi di alcuni fattori che possono influenzare la distribuzione geografica dei tumori in Italia, in G. Arena (ed.), Atti del Primo Seminario Internazionale di Geografia Medica, RUX, Perugia, pp. 69–78.

17. Turner, B.L. (1994) Global land use/land cover change: towards an integrated study, in "Ambiology", 23, pp. 91–95.

18. UN-HABITAT (2006) State of the world cities, Earthscan, London.

19. UNEP (n.d.) Environmental Pollution and Impacts on Public Health, Report Summary, www.unep.org.

20. Wakefield, S.E.L., Elliott, S.J., Cole, D.C., Eyles, J.D. (2001) Environmental risk and (re)action: air quality, health, and civic involvement in an urban industrial neighbourhood, in "Health and Place", 7 (3), pp. 163–177.

21. WHO (2007) Our cities, our health, our future, Report of the Knowledge Network on Urban Settings.

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ENVIRONMENT IN THE HUMAN PERCEPTION: GEOGRAPHICAL ASPECTS

ABSTRACT. The present work highlights the different aspects of human perception of environment, specific characteristics of the subjective estimation of its state and attitudes to environmental quality. The authors claim more scientific awareness for the understanding of the motivations determining human behavior during interaction with the environment and knowledge about the objective functional system "perception – action" as part of complex geoecological analyses. Furthermore the populations view on the further development of the landscape to improve its living conditions etc. is a crucial part of this concept.

KEY WORDS: human perception of environment, state of the environment, "human-environment" interactions, complex geoecological analysis.

INTRODUCTION

Environmental problems and difficulties in protecting landscapes are widely discussed and studied by various academic institutions, universities and other scientific organizations. Many books and articles are published and international conferences are held on these problems. However, wide part of this discussion is driven by positions which can be called technocratic or "top down" while there is a lack in studies on the human perception of environment. The attitude of local populations to different types of their land-use, the meaning of their territory to them and their participation in managing and developing should be of particular interest [Dushkova et. al., 2010].

The aim of the paper is to evaluate the perception and assessment of the environment by the population and to promote research approaches which focus on the analysis of the human perception of the landscape as a part of the interaction between humans and the environment, especially in a comparative perspective in Russia and Germany

RESULTS AND DISCUSSION

The first analysis of current geoecological methods to assess the geo-ecological state of territories shows a wide variety of approaches to tackle problems which are situated in ecology or the safety of a territory. Most of them do not take into account the opinions and attitudes of the local population to the environmental state or its changes. Of great importance is the evaluation of the human perception (including people from various social and

professional groups) of appropriate living conditions, ecological risk factors and connected to them people's choices of where to live, make a living etc.

The term "environment" is widespread in scientific literature, official papers of Russia, Germany and international organizations – the United Nations organization, UNESCO, etc. This term was introduced by the German-speaking Estonian-Russian biologist J. von Uexkuell [1921], who analyzed the interdependence and united system of organisms and their habitat. He considered the environment itself as part of the area, where organisms live and which is perceived by their receptors. Through adaptation the organisms and environment undergo mutual changes sharing chemical agents, energy and information.

Since the 1960s and 1970s, when the state of the natural environment was identified as endangered, this term has been used in nature protection legislation in developed countries (the USA, Japan, Great Britain, Germany, France, etc.). In Russia this term started to be used later, with the acceptance of the Federal Law "About preservation of the environment" [1991].

According to the classical Russian geographical definition of N. Rejmers [1992], the environment is a complex system of biotic and abiotic components, e.g. the combination of natural and anthropogenic factors, which influences humans and their economy.

Thus the environment where humans live and act consists both of natural and man-made materials, includes natural and technogenic environment, e.g. elements made from natural materials by man and having no analogues in nature (artifacts like buildings, constructions etc.).

Environmental quality, then, is defined by objective measurement of environmental parameters (i.e. compliance with guidelines like they are fixed for protection of nature reserves) and subjective estimation as well, which are both of a special interest in this research. Commonly, if the mainly quantitative results for the parameters which describe the state of the environment match with values determined by humans and other species' needs, the environment is considered as positive, recognized by people as satisfactory for their needs, although some subjective assessments of the human population do not confirm this fact.

Human influence on the environment is not one-sided; people are also affected by external factors. Transformation of the environment is connected to the organization of the territory and the formation of new spatial forms of nature management.

Nowadays almost all environment which usually is considered as "natural" has undergone direct or indirect influence from human activity [Matthiesen et. al., 2006]. On the basis of a constructivist perspective, every landscape as a part of the human environment is a culturally and subjectively defined object of perception and estimation [Tzschaschel, Micheel, 2007]. An essential part of this concept is made up by the attitudes of acting persons (actors, agents) since they constitute and create "their" environment as landscape by conferring meaning to the natural conditions of which they are surrounded [Lentz, 2001; Matthiesen et.al., 2006]. So, Landscape is thought of as an area and as well as the appearance of an area, which has both material and representational aspects.

Following the reflections of I. Kant [Kant, 1786], actors assess and define landscape in many cases through their own perception of beauty and aesthetics. Kant declared nature as an unquenchable source of emotional wealth as well as physical and mental human health. F. Hegel also studied landscape aesthetics and considered, contrary to Kant, that nature cannot be called beautiful without man – the subject of perception. In other words Kant claimed beauty in nature as an immanent universal truth, whereas

Hegel perceived it as the subjective human feeling.

The main principles of the ecological and technical perception of environment as a spatial subject were developed by A. Humboldt, who was influenced by German classical philosophy (especially by the philosophy of I. Kant, 1786). According to A. Humboldt [1808] the understanding of integrity of nature is an important aesthetic principal. According to his thinking nature "… is unity in multiplicity, combination of diverse in the form and blending, is the concept of natural things and forces as the idea of a living whole" [Nikolajev, 2005].

The term "perception" is wide spread in German-language geography and connected to the works of Reiner Krueger [Krueger, 1987] who started researching perception in geography in the 1980s. Environmental (landscape) perception as an important geographical point was stated in Russia by W. Semjenov-Tjan-Shanskij [1928]. He discussed the phenomenon of the landscape and interactions between art and geography, because geography is based on a viewer's impressions and "permeated" by them. In the 1960s D. Armand [1975] referred to the aesthetic values of the natural environment, returning to the ancient idea of the utility of the beautiful (and the beauty of the rational) and appealing to keep the beauty of nature. Following him, A. Issatschenko [1953] marked the aesthetic points of the landscape as an important characteristic of the territory.

Perception of the environment depends on the employment of its parts. There is a connection between the function of the territory and the images produced by that territory; every function produces its own landscape. It was shown by G. Isatchenko [1988] that territories can have symbolic meaning: every nation has its own landscapes-symbols, recognized by their population.

From a philosophical point of view one might ask if the ontological starting point of mankind was the distinction of man from nature. Before, mankind as a part of the environment completely adapted to it and perceived it as a continuation of itself. Thus perception of the environment developed as a result of centuries of adaptation to it, reflecting the complicated system of human attitudes to the visual manifestations of the natural processes. It was detected in the form of the subconscious (instincts).

So, environment becomes a historical base which has formed human perception, including aesthetic perception. W.N. Nevsky [2007] contended that mentality is fed by the environment. The way of life, the character and the appearance of humans are then influenced by the environment. Ju. N. Golubchikov [2003] discussed the examples of relativity and (dependence) of aesthetic perception.

Perception depends on a person's qualification through his cultural and educational traits and associative thinking as he interacts with a landscape. The process of perception includes the intussusceptions/inversion of material forms and the measurable processes of a human activity as well as meanings and symbols given to the territory by a human consciousness [Lavrenova, 1998].

Man as a part of a created cultural landscape identified himself with it and thought of it as home (rodina/Heimat). Home (rodina/Heimat) and self-identification of a man with a certain territory are determinant categories of connections between them [Krueger, 1987; Hasse, 1999; Nohl, 2006]. Yet, the interaction of agents in the process of identification has not become fully clear.

Aesthetics, symbols and emotional content of the human environment have been studied from the 1980s. Yi Fu Tuan [1984] in his work «Topophilia» marked diverse emotional attitudes of humans to landscape as his environment. Simultaneously P. Juengst [1984] studied symbolic meanings and emotional definitions of a landscape.

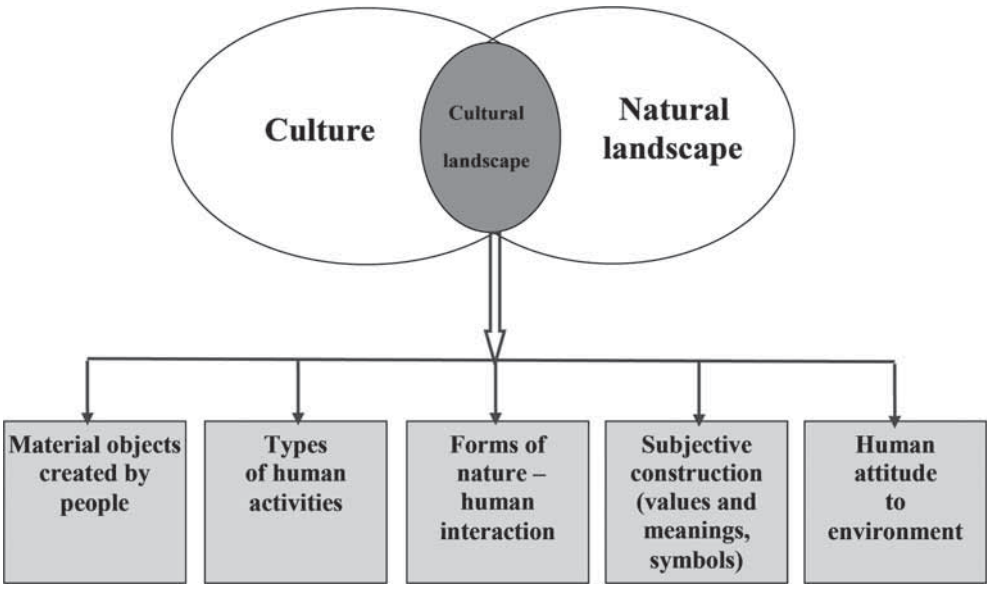
A person identifies a territory through symbols not only as a result of co-interacting with significant events, but also with his assumptions of the objects which obtain the definite character of relations in the process of socialization.

New approaches to the investigation of territory have been developed in world geography from the end of the 1990s, its symbolic content and obtained meanings are the most important. The estimation of the territory from the position of a subject (representative of population) has become popular world-wide [Kemper, 2003; Mitchell, 2000; Robertson and Richards, 2003; Tilley, 1994]. German studies concentrate on the role of the cultural environment in the formation of national, regional and transnational identification, where the construction of mental maps takes place [Natter, Wardenga 2003].

The territory is understood as a precondition and a result of intentions and results of actors' everyday activity [Werlen, 1997]. Therefore territory coding is produced by social actions or, relating to a landscape, forming cultural landscape elements. Formerly the territory was interpreted as an outer field of human activity, but the main idea of Werlen's work states that the territory (landscape) is constructed by the subjects through action.

On this basis cultural landscapes are not considered to be only a summary of material artifacts, but are also studied on their social meaning and function (Figure).

In a co-operative research project the Leibniz-Institute for Regional Geography in Leipzig [Tzschaschel, Bode, Micheel, 1998; Tzschaschel, Micheel, 2007] together with other research institutes and universities is currently analyzing the subjective constitution of cultural landscape (Kulturlandschaft). Cultural landscapes are regarded as socially defined verbal expressions which characterize the human attitude to their environmental. Approaches of studying elements determining this perception have been developed in recent research on territories, which are in different stages of formation, changing functional status, content and environmental management (including biosphere reservations, significantly changed landscapes as a result of intensive technical activity (i.e. extracting industries, mining), and



Conceptual approaches to cultural landscape research

so-called constructed landscapes, formed in the process of contemporary territorial planning). The research is based on the hypothesis that significant changes do not affect the perception of and attitude towards landscape in everyday life. The survey's results show that (structural) alterations in the appearance which challenge the meanings of the landscape might lead to irritation and disagreement, but not to a different attitude towards traditional values and meanings. Furthermore, the results show that a perceived territory is reflected in a person's mind as an image, contained in each culture. This image is no less important a component of the environment as climate, water resources, the landscape's relief, terrain and vegetation. The human perception of environment is carried out through a system of interdependent signs and symbols, referring to the territory. All this forms the human subjective mental environment, in which we exist.

The results of the study are in accordance with the socio-ecological study in Northern Russian regions held at the Faculty of Geography of Moscow State University [Krasovskaja, 2008; Evseev, Krasovskaya, 1996, 2004; Dushkova, Evseev et.al., 2010; Vorobjevskaja, Sedova, 2008; Kosenkova et.al., 2005]. In particular one of the aims of this study was to assess self-identification of the population with their territory (how local people treat native land – from temporary position or not). Also analyzed was the level of awareness of respondents of ecological problems in their region and the state of local landscapes, knowledge about regional culture and traditions and significant territories (landscapes). The results showed two main trends of perception: The first trend belongs to the newly arrived people, who moved to the region with the beginning of industrial development (1930s), and characterizes from temporary position (the respondents wanted to move to other regions with a more appropriate ecological state after finishing their employment contracts or retirement). This perception can be summarized as "man – conqueror of nature". The second trend belongs to the indigenous (aboriginal) population of the North, who has lived in the territory for many centuries, and has come to the conception "man is a part of nature". The native population has generated images of the environment for centuries, significant places, self-identification with the territory and a feeling of being a part of it (feeling of home). An important fact, worth mentioning is that the ecological conditions do not mean much to the newly arrived people; they perceive mine-workings as an opportunity to earn money but not as an ecological problem, and therefore reinforce technical activity. On the contrary the majority of the native population wants to assert their rights to have an appropriate environment and to discuss projects on regional development.

CONCLUSIONS

At the moment the approaches for geoecological estimation of the territory are very well developed according to the economical aspects of social activity, attention to the research of the objective features of environment-forming landscape ability. However, subjective human perception of the environment quality needs further investigation. The complicated character of all interactions and development of the system "human – environment" supposes new interesting results in further complex work aimed at the human environment perception. The understanding of human motivations determining their behavior during interaction with the environment and knowledge about the system "perception – action" becomes more important for sustainable land use, improving environment quality as well as conditions of living.

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REFERENCES

1. Armand. D.L. (1975) The Science about Landscape. Moscow, Mysl'.

2. Dushkova, D., Evseev, A., Kochurov, B., Lentz, S., Micheel, M. (2010) Perception peculiarities of modern landscapes by people: regional approach. In: Problems of regional ecology. № 6. PP. 6–13.

3. Evseev, A.V., Krasovskaya, T.M. (1996) Ecological-geographical peculiarities of the environment in the North of Russia. Smolensk State Univ. Publ.

4. Federal law of the Russian Federation "About preservation of the environment" (1991) № 7-FZ: it is accepted by the State Duma of 19.02.1991.

5. Golubchikov, Yu.N. (2003) Human geography. M., Editorial URSS. 296 p.

6. Hasse, J. (1999) Bildstoerung. Windenergie und Landschaftsaesthetik. Oldenburg (=Wahrnehmungsgeographische Studien zur Regionalentwicklung 18).

7. Heinritz, G., Lentz, S., Tzschaschel, S. (2006) Leben in Deutschland – eine Einführung. In: Nationalatlas Bundesrepublik Deutschland, Bd. 12: Leben in Deutschland. München. S. 10–25.

8. Humboldt, A. (1808) Ansichten der Natur. Stuttgart und Tübingen.

9. Isachenko, A.G. (1953) Fundamental problems of the physical geography. Leningrad.

10. Isachenko, G.A. (1988) "Window to Europe". History and landscapes. Sankt-Petersburg State University Publ. 476 p.

11. Juengst, P. (Hrsg.) (1984) Innere und aeußere Landschaften. Zur Symbolbelegung und emotionalen Besetzung von raeumlicher Umwelt. (=Urbs et Regio 34).

12. Kant, I. (1786) Metaphysische Anfangsgründe der Naturwissenschaft.

13. Kemper, F.-J. (2003) Landschaften, Texte, soziale Praktiken – Wege der angelsaechsischen Kulturgeographie. In: Petermanns Geographische Mitteilungen, H. 2, S. 6–15.

14. Kosenkova (Dushkova), D., Zierdt, M., Evseev, A. (2005) Humanoekologische Probleme im Norden Russlands // Norden. Beiträge zur geographischen Nordeuropaforschung. Heft 17. Bremen. S. 19–28.

15. Krasovskaya, T.M. (2000) Cultural landscape conceptions: from professional to vision (world-view) / Kaluckov, V.N., Krasovskaya, T.M. // Bulletin of Moscow State University. Geographical issue (Vestnik MGU, Seria geographicheskaya), № 4, pp.3–6.

16. Krueger, R. (1987) Wie raeumlich ist die Heimat – oder: Findet sich in Raumstrukturen Lebensqualitaet? In: Geographische Zeitschrift 75, H. 3. S. 160–177.

17. Lavrenova, O.A. (1998) Geographical space in the Russian poetry of XVIII–XX centuries (Geocultural aspect). Scientifical editor Yu. A. Vedenin. M.: Heritage Institute. 128 p.

18. Lentz, S. (2001) Zur kulturgeographischen Interpretation aktueller Stadtentwicklungsprozesse in Moskau. In: Analysen zur Kultur und Gesellschaft im oestlichen Europa, Bd. 11: Hoehmann, Hans-Hermann (Hrsg.): Wirtschaft und Kultur im Transformationsprozess. Wirkungen, Interdependenzen, Konflikte, S. 239–255, Bremen.

19. Matthiesen, U., Danielzyk, R., Heiland, S., Tzschaschel, S. (Hrsg.) (2006) Kulturlandschaften als Herausforderung fuer die Raumplanung. Verstaendnisse – Erfahrungen – Perspektiven. Hannover (= Forschungs- und Sitzungsberichte der Akademie fuer Raumforschung und Landesplanung 228.

20. Mitchell, D. (2000): The work of landscape. In: Mitchell, D. (Hrsg.): Cultural Geography. A Critical Introduction. Malden, S. 90–117.

21. Natter, W. u. U. Wardenga (2003): Die „neue" und „alte" Cultural Geography in der angloamerikanischen Geographie. In: Berichte zur deutschen Landeskunde 77, H. 1, S. 71–90.

22. Nevsky, V.N. (2007) Relief perception as a tool for human world-view formation / Relief and men. Editor-in-chief T.M. Skovitina, A.A. Schetnikov. M.: Nauchny mir. pp. 21–27.

23. Nikolaev, V. A. (2005) Landscape science: Esthetic and Design. M.: Aspect Press Publ. 176 p.

24. Nohl, W. (2006): Heimat als symbolischer Aneignungsprozess. Konzeptionelle Ueberlegungen und empirische Untersuchungen. In: Naturschutz und Landschaftsplanung 38, H. 5, S. 140–145.

25. Rejmers, N.F. (1992) Nature and Environment Protection. M.: "Prosweshenie". 319 p.

26. Robertson, I. u. P. Richards (Hrsg.) (2003) Studying Cultural Landscapes. London.

27. Semenov-Tyan-Shansky, V.P. (1926) Region and country. M.–L., GIZ-Publ. 311 p.

28. Tilley, C. (1994) A Phenomenology of Landscape. Places, Paths and Monuments. In: Explorations in Anthropology. Oxford, Providence.

29. Tuan, Yi-Fu (1984) Topophilia. Englewood Cliffs, N.J.

30. Tzschaschel, S., Micheel, M. (2007) Forschungsstand: Kulturlandschaftsforschung. Leibniz-Institut fuer Laenderkunde. Leipzig.

31. Tzschaschel, S., Bode, V., Micheel, M. (1998) Kulturraumpraxis in Sachsen – eine empirische Studie. In: Wollersheim, H.-W., Tzschaschel, S. u. M. Middell (Hrsg.) Region und Identi-

fikation. Leipzig (= Leipziger Studien zur Erforschung von Identifikationsprozessen 1), S. 93–115.

32. Uexküll, J. (1921) Umwelt und Innenwelt der Tiere. B.

33. Vorobyevskaya, E.L., Sedova, N.B. (2008) Rekreation nature use in Chibiny (winter aspect) // Problems of regional ecology. M., № 1. pp.152–157.

34. Werlen, B. (1997) Sozialgeographie alltaeglicher Regionalisierungen. Band 2: Globalisierung, Region und Regionalisierung. Stuttgart (Erdkundliches Wissen 119).

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LONG-TERM ECOSYSTEM CHANGE IN JIAOZHOU BAY AND ITS CATCHMENT: THE DPSIR APPROACH

ABSTRACT. Jiaozhou Bay is a semi-closed embayment, affected by anthropogenic factors around Qingdao, China. This article illustrates the long-term change in the Bay and its catchment using the driver-pressure-state-impact-response (DPSIR) approach. Under the Chinese national macro-socioeconomic policy, rapid development and massive urbanization occurred in Qingdao that has resulted in the serious reduction and quality deterioration of its arable land and the variation in water resources. The production and consumption pattern changed with population growth and an increasing demand for water and food as well as pollutants emissions. The pressure alteration in the Bay and its catchment has created far-reaching impacts on the ecosystem. These changes include: significant deterioration in water quality of the catchment; decreased river runoff into the bay; shift in the nutrient regime of the Bay; decreased tidal prism in the Bay; increased eutrophication in the Bay; fragmentation of natural habitats and loss of biodiversity. Relevant policies aimed to formulate the promotion of the water quality have been done in the system. However, the deterioration trend has not yet been halted or reversed. Hence new management mechanisms are under discussion to improve the ecosystem in this area.

KEY WORDS: catchment; ecosystem; DPSIR; Jiaozhou Bay; long-term change

INTRODUCTION

In an ever-changing world, the global coastal zone stands out as an area undertaking extraordinary changes. These changes are formed by natural processes and phenomena, while human society is a greater driver for them in the coastal zone [Crossland et al., 2005]. Long-term ecosystem changes have occurred around the world in many coastal systems such as the Black Sea [Oguz, 2005], the Chesapeake Bay [Hagy et al., 2004], the North Sea [Clark and Frid, 2001], the Bohai Sea [Ning et al., 2010], and Daya Bay [Wang et al., 2008]. Human development of coastal regions has modified coastlines around the world, by deforestation, cultivation, changes in habitat, urbanization, agricultural impoundment and upstream changes to river flow [Crossland et al., 2005]. Coastal bays are interfaces of strong land–ocean interaction. Their ecological functions are more complicated and vulnerable to human activity and land-source pollution are much important than those of the open ocean [Wang et al., 2008].

The driver-pressure-state-impact-response (DPSIR) framework is adopted by Land-Ocean Interactions in the Coastal Zone (LOICZ) program as the approach to organize insights and research approaches on the dominant forcings and effects on the global coastal zone [Newton and Icely, 2008, Crossland et al., 2005]. DPSIR uses a core set of indicators for environmental

performance and considers human activities as an integral part of the ecosystem [Kitsiou and Karydis, 2011]. It is used in this article to link natural, social and economic sciences with policy responses to analyze ecosystem change in the catchment-coast continuum of Jiaozhou Bay and its catchment. In the following sections, the bay is described and its catchment is delineated. DPSIR is used as the analytical tool to present the ecosystem change in the long term. Integrated coastal area and river basin management (ICARM) is suggested as a management path choice for Jiaozhou Bay and its catchment in order to manage and conserve the bay.

DESCRIPTION OF THE SYSTEM

Jiaozhou Bay is a typical semi-enclosed water body that is connected with the Yellow Sea through a narrow channel (~2.5 km), with a surface area of 390 km^2 and an average depth of 6–7 m. The maximum depth is up to 60~70 m in the eastern part of the Bay [Zhang, 2007a]. The system is located in the warm temperate zone with a clear monsoon climate. The annual precipitation is 340–1243 mm with an average of 635 mm [Liu et al., 2005]. This bay is characterized by semi-diurnal tides with a mean tidal range of 2.7~3.0 m and a maximum of 5.1 m [Zhang, 2007a]. The tidal current at the spring tide can be 2–3 $m \cdot s^{-1}$ at the bay mouth and the residual current is <20 $m \cdot s^{-1}$. The water residence time varies from <5-10 days in the mouth to ~100 days at the head of the Bay [Liu, 2004]. Waves are typically wind-induced and low in energy, with mean wave height 0.1–0.4 m and maximum less than 1.9 m [Yang et al., 2004]. So the water mass movement in the Bay is dominated by tides, especially the semi-diurnal M2 tide, which contributes to around 80~90% of the kinetic and potential energy [Liu et al., 2007b]. The peak flood currents are much stronger but of shorter duration than those of the ebb tide as a result of tidal asymmetry [Yuan et al., 2008]. The different residence time of the water above-mentioned leads to strong spatial gradient in nutrient concentration in the Bay with high and low in the head and mouth, respectively. However, stratification of water column is generally weak due to a strong tidal current [Zhang, 2007a]. More than ten small seasonal streams, the Yanghe, Daguhe, Moshuihe, Baishahe and Licunhe, empty into the bay with various amounts of water and sediment loads. With the economic development and population growth in the catchment area, most of these streams, however, have become channels of industrial and domestic waste discharge.

The watershed delineation is done in the interface of ArcSWAT[1] The DEM for the delineation is downloaded from the CGIAR-CSI website [Jarvis et al., 2008]. According to the attribute table of the delineation result, the whole catchment of Jiaozhou Bay is around 7734.9 km^2. The DG basin accounts for 81.6% of the catchment while the second largest, the MS basin, only 5.9%; most of the catchment is within the boundary of Qingdao and it is 81.8% of the whole catchment (Table 1 and Fig. 1).

Based on historical monitoring data, the main contaminants in Jiaozhou Bay are identified as N, P, organic matter, and oil [Gao et al., 2008]. The main issue in the Bay is the increase of harmful algal blooms (HABs). Both the frequency and scale of HABs events have increased since the 1990s [Xiao et al., 2007]. The main HAB species include *Biddulphia aurita, Eucampia zoodiacus, Mesodinium rubrum, Noctiluca scintillans,* and *Skeletonema ccostatum* [Wang, 2006]. Since the summer of 2007, green algal bloom has begun a new issue concerned in the Bay.

According to the Qingdao Urban Master Plan (2006-2020), the population in Qingdao is set to reach 12 million with the urbanization rate as 77.8% in 2020, which will increase the pressures on the Bay and its catchment and lead to ecosystem change in the long-term perspective.

[1] ArcSWAT can be downloaded at http://swatmodel.tamu.edu/software/arcswat.

Table 1. Catchment of Jiaozhou Bay and its distribution

Basin	Area (km^2)	Region	Area (km^2)
LS	18.5	Jiaonan	331.8
HP	18.8	Jiaozhou	1272.1
LC	138.5	Jimo	1149.6
CD	249.2	Laixi	1548.9
BS	253.3	Pingdu	1381.3
YH	294.9	Districts	643.7
MS	459.7	Qingdao	**6327.4**
DG	**6301.9**	other	1407.5
Total	7734.9	Total	7734.9

Note: DG – the Daguhe Basin, YH – the Yanghe Basin, CD – the Caowenhe—Daoerhe Basin, HP – the Haipohe Basin, LC – the Licunhe Basin, LS – the Loushanhe Basin, BS – the Baishahe Basin, MS – the Moshuihe Basin.

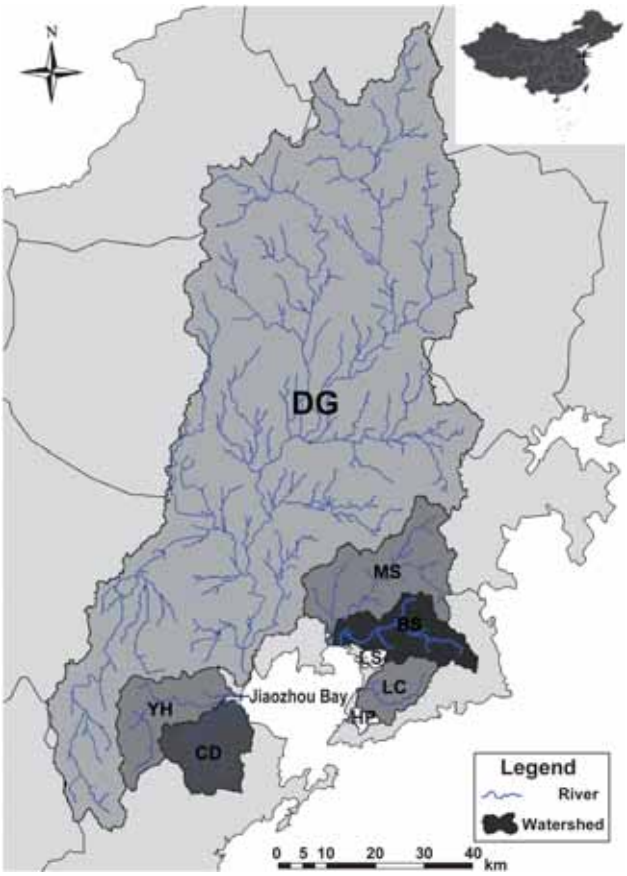

Fig. 1. Jiaozhou Bay and its catchment

DPSIR FOR THE BAY AND ITS CATCHMENT

Since the adoption of reform and openness policy in 1979, economic development has been set as the center of all affairs. However, China has paid its costs for environmental deterioration [Liu and Diamond, 2005].

Generally speaking, statistics is conducted based on the administrative system in China. It is difficult to figure out the specific detail of the socioeconomic values such as the local demography and economy for the DPSIR framework. As 81.8% of the catchment is included in the Qingdao Prefecture, in the following sections, the analysis for the trend under the framework of DPSIR will be mainly based on Qingdao.

Socio-economic drivers

Population

There are several major urban centers within the catchment, especially the downtowns of Laixi, Jimo, Jiaozhou and the six districts of Qingdao. It is newly issued that the total population in Qingdao is 8.7 million in 2010. The registered population in Qingdao Prefecture has been on the rise. However, the rising trend slowed down since the 1990s. The urban population density in Qingdao increases faster and is larger than the overall population density. In 1949, the urban population density was 2.47 times of overall population density. It increased to 2.84 times in 1980, and 2.98 times in 1990 as well as 3.34 times in 2007 (Fig. 2).

Urbanisation

Urbanization relies on a stable supply of natural resources including fresh water, fuel, land, food and all the raw materials

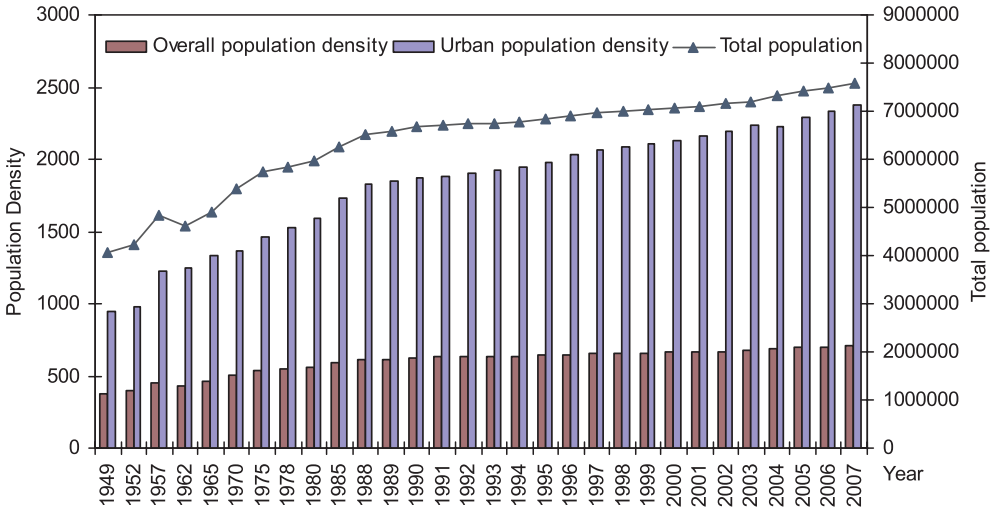

Fig. 2. Total population and population density in Qingdao

[WRI, 1998, UNFPA, 1999, Hardoy et al., 2001]. Along with rapid urbanization and city sprawl, there are definitely drastic increases both in natural resource demands and in the area from which these resources are drawn [O'Meara, 1999]. Urbanization also leads to significant alterations of physical environment far beyond city limits, resulting in habitat loss and accumulation and spread of wastes in the planet.

It is well known that China has been undergoing a rapid and unprecedented process of urbanisation since 1978. It is newly released that the urbanisation rate of China is 49.7% in 2010, increased by 13.6% since 2000. One of the remarkable features for urbanisation in China is migration from the rural to the urban, and migration from the inland to the coastal regions

Qingdao is a coastal city with a more rapid process of urbanisation. On the other hand, its administrative boundary changed for several times since 1949. The current boundary and administrative structure was formed in 1994 with seven districts and five county-level cities. In addition, the definitions of "urban" population in statistic yearbooks are not consistent. It is noted that the Yearbook of Qingdao included the items

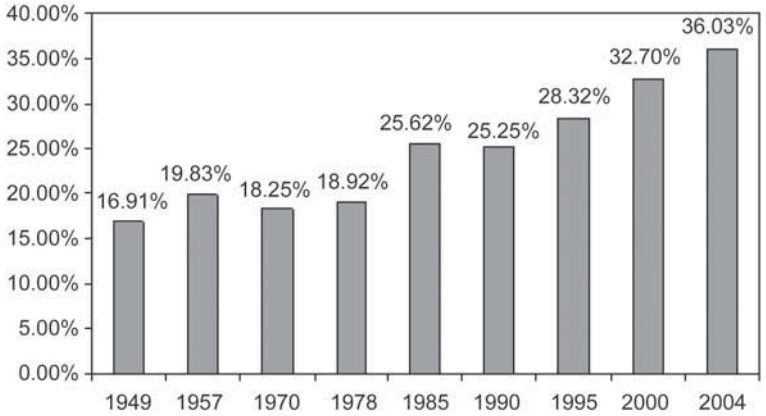

Fig. 3. Urbanization rate of Qingdao in particular years

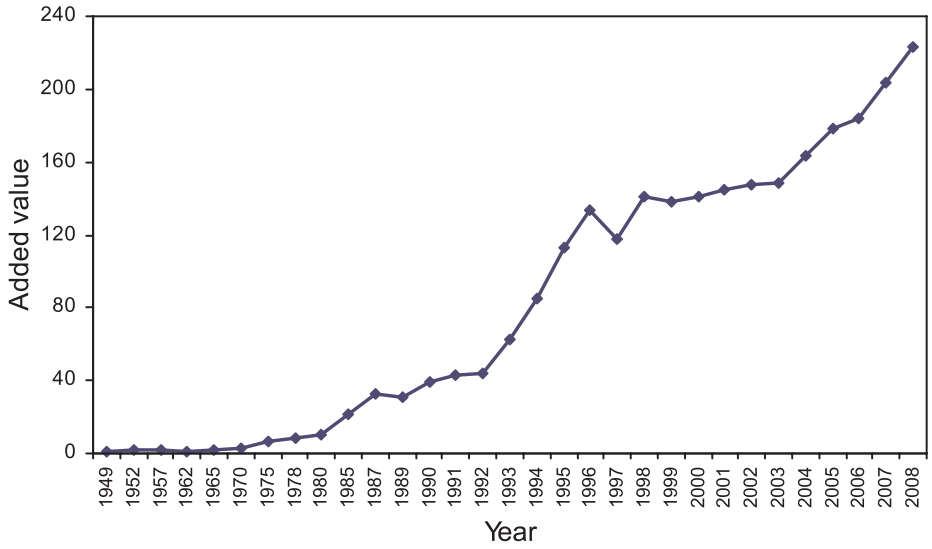

Fig. 4. The added value of primary industry in Qingdao (Unit: 10^4 Yuan)

of urban and rural population before 2005 but they are not listed since 2006. This may be explained that the existing household registration system is under review currently and people's migration is too extensive. All these factors influence the demography.

For the sake of simplicity, the data from the Yearbook of Qingdao before 2006 are used to illustrate the urbanisation trend in the catchment. According to the yearbook, rural population decreased from 1959 to 1961, and it is on the rise in all other years. On the other hand, the urban population increases in all the past years. Several examples of urbanisation rate are illustrated in Fig. 3.

Agriculture

China initiated agricultural reforms in the late 1970s as part of its economic transition program by decentralizing farm production decision to family units. These reforms resulted in remarkable progress in the agricultural sector, which in China is characterized by scarce land, abundant labor and small-scale production with limited but rising mechanization. The overwhelming majority of crop production originates from tiny farms. While a large part of livestock production also comes from small, part-time "backyard" operations, full-time "specialized" household operations and commercial operations have grown rapidly [OECD, 2005]. Since the reforms, Chinese agricultural production has grown, such that today China ranks as the leading global producer of many agricultural commodities. This growth has been achieved largely through substantial increases in productivity, a result of both market-based policy reforms and the adoption of modern agricultural technology and farming practices [U.S. International Trade Commission, 2011].

In the recent years, the proportion of the agricultural sector in the economy of Qingdao is decreasing, although the added value of this sector is increasing except in the 1960s and in 1997. In addition, the added value increased slowly before 1980 and sharply after that year. The added value of this sector in 2008 is 22.34 billion Yuan, which is 21.9 times of that in 1980, 5.7 times in 1990, and 1.6 times in 2000 (Fig. 4).

The total area of arable land for grain is on the trend of decreasing which that for cash crop is increasing. The total production of grain is also on the trend of increasing with the growth of population. The total production of grain increased from 7.23×10^5 t in 1949 to 3.34×10^6 t in 2008. Meanwhile, the

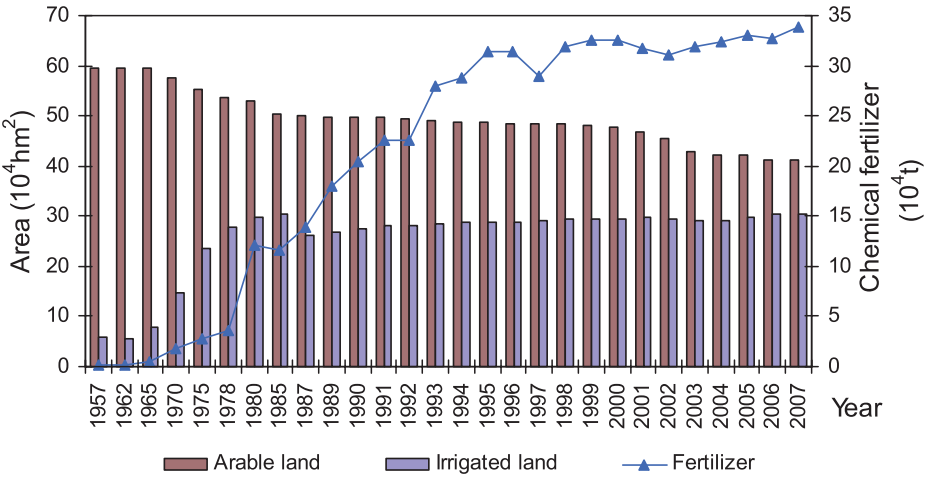

Fig. 5. Arable land, irrigated land and fertilizer application in Qingdao

output per hectare increased from 855 kg in 1949 to 6540 kg in 2008 (Fig. 5).

To increase the input of fertilizer is one of the important ways to increase output of the arable land while it is reducing. The use of fertilizer is on the trend of increasing except 1997 and 2002 when the weather impacted agricultural production to cause the decrease of fertilizer input. The fertilizer use intensity has the similar trend. The use of net fertilizer in 2007 is 3.39×10^5 t, which is 19.26 times of that in 1970, 2.81 times in 1980, and 1.66 times in 1990 (See Fig. 5). On the other hand, the fertilizer use intensity in 2007 is 820.4 kg/ha, which is 26.79 times of that in 1970, 3.61 times in 1980, and two times in 1990. The extensive and heavy use of fertilizer makes great contribution to harvest but it also poses heavy pressure on the environment.

In addition, in order to prevent flooding and provide service of irrigation for the agricultural sector, a lot of reservoirs were built in the catchment. This changed the runoff regimes of the rivers and water cycle in the catchment.

Industry

China has entered the later half of the intermediate industrialization phase[2]. This country has experienced the most intense industrialization of any nation in history, and the consequences, both positive and negative, have been profound. As a 'world factory', it exports products but consumes natural resources and leaves pollutants behind [Liu and Diamond, 2005].

As a coastal city, Qingdao is one of the economic reforming forefronts in China. This region has gone through a zigzagging road of industrialization. In the early 1950s, its industry was mainly textile with a small scale. In 1949, the total industrial output was only 2.16×10^8 yuan with the fixed assets of 4.3×10^8 yuan; while its total industrial output was 8.12×10^{11} yuan with the fixed assets of 4.73×10^{11} yuan and the revenue of 5.34×10^{10} yuan in 2008 (Fig. 6 and Fig. 7). During this period, the ratio between light and heavy industries evolved from 84.61 : 15.39 in 1949 to 42.91 : 57.09 in 2008, which indicates that heavy industry has increasingly grown in the past decades and the industrial structure has significantly changed.

Rapid industrial development and urbanization transfer more and more land away from agricultural production, threatening China's capability to feed itself. During the course of industrialization, the environment has been getting worse by the

[2] From China Daily, http://www.chinadaily.com.cn/business/2007-08/10/content_6021874.htm, accessed on Oct. 7, 2008.

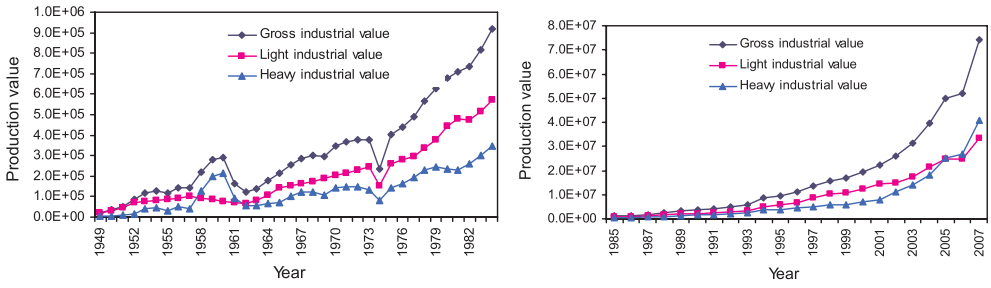

Fig. 6. Production value of industry in Qingdao (10^4 Yuan)

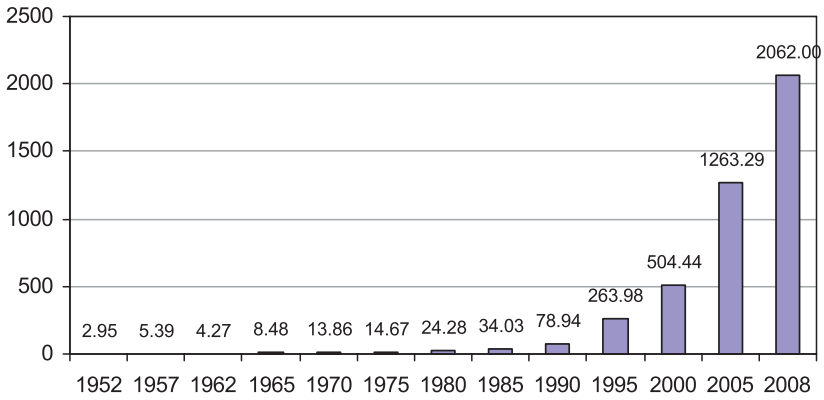

Fig. 7. Gross industrial value of Qingdao

day [Diamond, 2006]. On the other hand, heavy industry relies on consumption of energy and raw material such as oil, raw coal, and iron ore. The negative impacts will be the increase of air and water pollution, to some extent, as well as soil pollution.

Pressures

Land

Industrialization and urbanisation as well as population growth posed pressures on arable land availability. Resources such as land and freshwater are non-tradable goods that are difficult to obtain through international trade. On the other hand, more and more intensive agriculture formed a challenge to land quality.

According to the newly issued census, population in Qingdao accounts for 9.1% of that in Shandong Province, which is 7.15% of the total population in China mainland. On the contrary, the proportion of the arable land is 5.91% for the Province in the country, and 5.37% for the City in this province. This asymmetry poses a big challenge on the grain production in Qingdao and the Province. According to the Yearbook of Qingdao, the urban area in 2007 is 250.7 km^2, which is 9.28, 3.48, 2.66, and 2.10 times of that in 1949, 1980, 1990, and 2000, respectively. The Urban Master Plan of Qingdao (2006-2020) issued in 2009 set the target of urban area in 2020 as 540 km^2, which is increased by 85.2% compared to that in 2002. The urban sprawl also extended to the coast by coastal reclamation, which makes the Bay reduces from c.560 km^2 in 1928 to c. 360 km^2 in 2003.

China's arable land roughly accounts for 7% of the world total, while its usage of chemical fertilizer accounts for around 30% of the world total usage. The ratios of arable land for Shandong in the country, and of Qingdao in the Province are shown in the above, while the ratios of fertilizer usage for the province in the country, and the city in

the province are 9.79% and 6.77%. Taking nitrogen fertilizer as an example, the world average usage per hectare is 60 kg, while this for China as a whole is 205 kg, and 393 kg for Qingdao.

The above percentages indicate that the pressures from land in Qingdao are potentially larger than that of Shandong province and of the country as a whole which is also potentially larger than the world on the average.

Water resources

The natural water endowment in the catchment is relatively worse. Water shortage is relatively serious in Qingdao with a per capita share of 312m^3 per annum, which is only 12% of the national annual average share and 3% of the world share per capita. Meanwhile, the seasonal and annual variation in water resources is remarkable with uneven geo-distribution.

The water consumption in the seven districts of Qingdao from 1995 to 2005 increased from 8.32×10^7 t to 1.37×10^8 t with the increase of water use per capita from 104 L to 142 L, while the population in the districts grew from 2.18 million to 2.65 million (Fig. 8). It is clear that the increase rate of water use is larger than that of population growth.

Water sources for domestic use have been developed with the growth of Qingdao. Groundwater from the Haipo Aquifer was first extracted for municipal water use in Qingdao around 1900 with the daily supply of 400 m^3. Other groundwater supply sites were established in 1908, 1919, and 1958 in the coastal aquifers. But these sites have all been abandoned due to groundwater pollution and sand over-extraction from the river beds. The water from the Daguhe was supplied as municipal water use since 1968. However, rigid water demand growth challenged the water supply network. Hence water transport project from the Yellow River to Qingdao was proposed in 1982 and the first supply from this project occurred in 1989. In the 21st century, the reclaimed water from wastewater treatment plants was supplied for industrial use. Meanwhile, the desalination plant located in the west coast of the Bay will be completed at the end of 2010.

Generally speaking, the increase of water consumption implies the increase of sewage. The domestic sewage rose from 3.49×10^7 t to 2.35×10^8 t with an average of 1.08×10^8 t from 1990 to 2008. During the same period, the industrial sewage emission didn't vary too much with an average of 9.38×10^7 t and the largest volume of 1.07×10^8 t in 1991. Hence, the total sewage volume

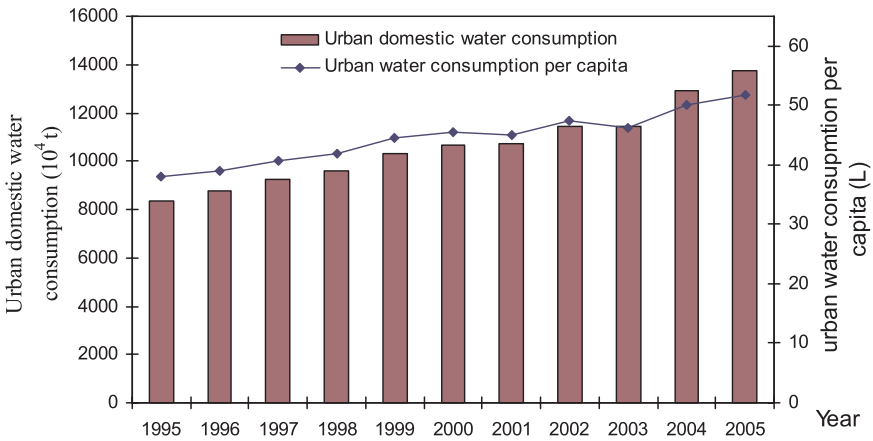

Fig. 8. Urban domestic water consumption and water consumption per capita

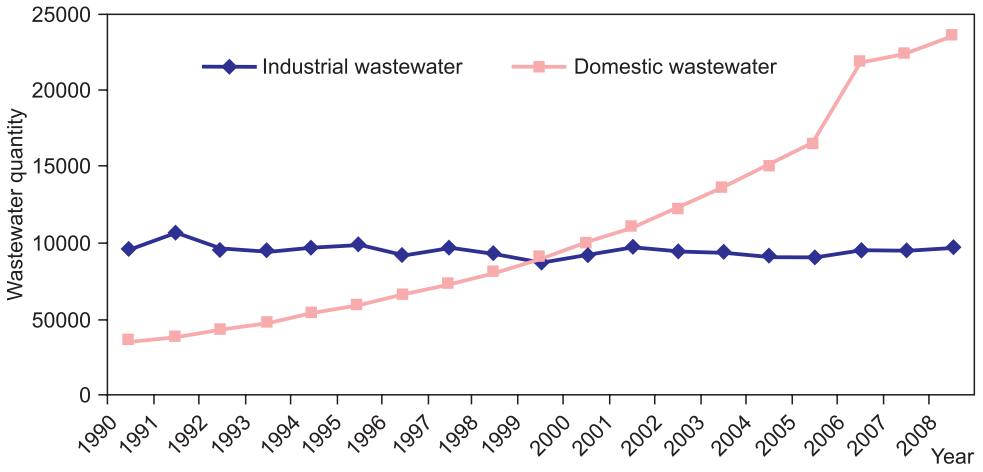

Fig. 9. Domestic wastewater and industrial wastewater in Qingdao since 1990 (10^4 t)

correlates with that of the domestic sewage ($R^2 = 0.996$) (Fig. 9).

As shown in the above, the fertilizer usage in Qingdao is on the rise either in terms of the total quantity or usage per hectare, although the available arable land is on the decrease. However, not all the fertilizer is taken up by the crops. Only 30%~40% will be used by crops in the land, and the rest will be remained in the earth, water and air. Most of the fertilizers will dissolve in the surface water through precipitation, runoff, eluviation and permeation, which ultimately causes water pollution. Non-point source discharges, especially agricultural runoff, are the main causes of water pollution. Agricultural wastewater in Qingdao, including agricultural runoff, animal wastewater, agricultural product processing wastewater and so on, begun to increase from 1990 and reach its peak as 6.30×10^8 t in 1996, and then the discharge of agricultural wastewater started on the track of decreasing. The average discharge of this wastewater from 1990 to 2007 is 5.91×10^8 t, which is 5.9 and 6.3 times as much as municipal wastewater and industrial wastewater discharges, respectively (Fig. 10).

Most direct discharge companies are located in the west coast of the Bay and some in

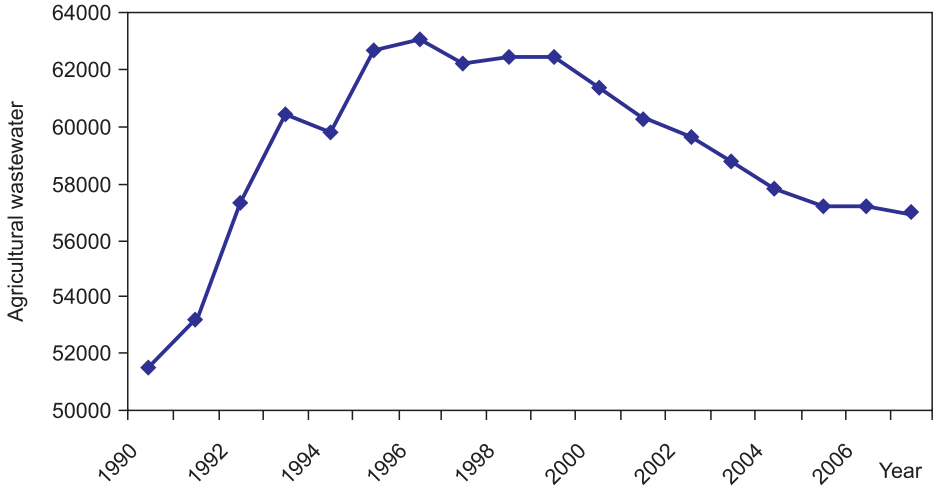

Fig. 10. Agricultural wastewater in Qingdao since 1990 (10^4 t)

the east. These companies discharge about 1.8×10^7 t wastewater into the Bay with 2590 t COD and 95 t ammonia nitrogen [Zhang, 2007b]. 71.51% of pollutants are transported into Jiaozhou Bay by rivers draining into the Bay [Zhang, 2007b]. The Daguhe, Moshuihe, and Licunhe are the three largest sources according the statistics in the year of 2007 [Li et al., 2009].

States and impacts

LULC changes

According to land-use-land-cover (LULC) studies for Qingdao, LULC changes in this area are distinctive. For instance, the arable land reduced by 63787 hm^2, the grassland, water body by 35146 hm^2 and 5641 hm^2, from 1995 to 2005. On the contrary, urban area increased by 65636 hm^2, and forest by 31229 hm^2.

Variation in water resources

Due to damming and increased water use in the catchment, river runoff into the Bay is in the trend of decreasing. Take Nancun Hydrological Station (NHS) in the Dagu watershed as an example, river flow is plotted as shown in Fig 11. This figure indicates that the runoff at NHS represented the decreasing trend since the late 1960s and further reduced in the early 1980s. There was even no runoff in several years after 1981. The trend of runoff variation is in accordance with that of precipitation variation before the 1960s, and the annual peaks of runoff and rainfall were all in the same years. The runoff and rainfall data at NHS from 1951 to 2000 are both divided by every decade into five groups and one-way ANOVA is used to compare the means of each decade for the two types (Fig. 12). It shows that there are no significant differences between the groups of rainfall data ($p > 0.05$), however, the runoff means are on the contrary ($p < 0.05$). The means since the 1980s are one order of magnitude less than those before that decade; the mean in the 1950s is 23.5 $m^3 \cdot s^{-1}$ and that in the 1980s 2.6 $m^3 \cdot s^{-1}$. According to the same statistical method, there are significant differences among the decadal means of runoff from 1973 to 1998 at Zhangjiayuan Hydrological Station in the upstream of the Dagu watershed; and so are there at the Lanxitou Hydrological Station in the Wugu, a tributary river of the Daguhe.

Liu et al [2007] describes the groundwater variations and submarine groundwater discharge in the coastal aquifers of the Bay due to human extraction [Liu et al., 2007a]. Due to groundwater abstraction in Dagu Aquifer and Baisha Aquifer, seawater intrusion happened from 1981 to 1996, and 1976 to 1990, respectively. From 1981 to 1999,

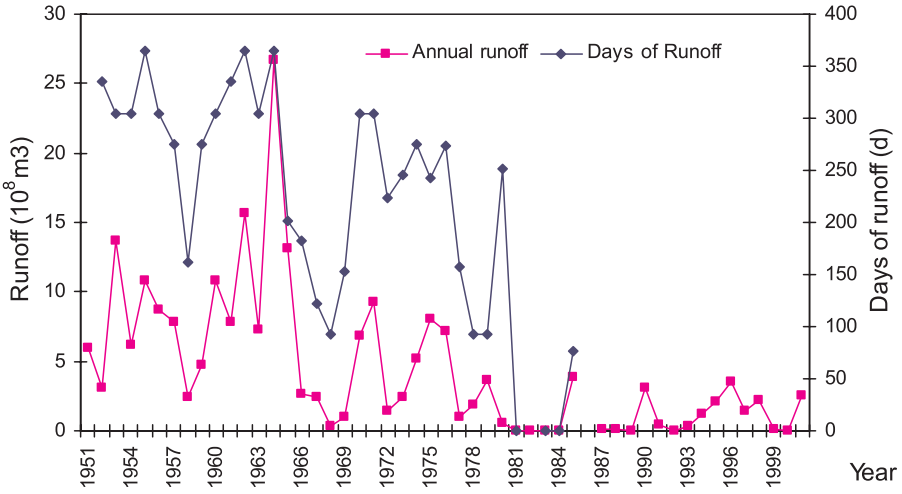

Fig. 11. Annual runoff and days of runoff at Nancun Hydrostation

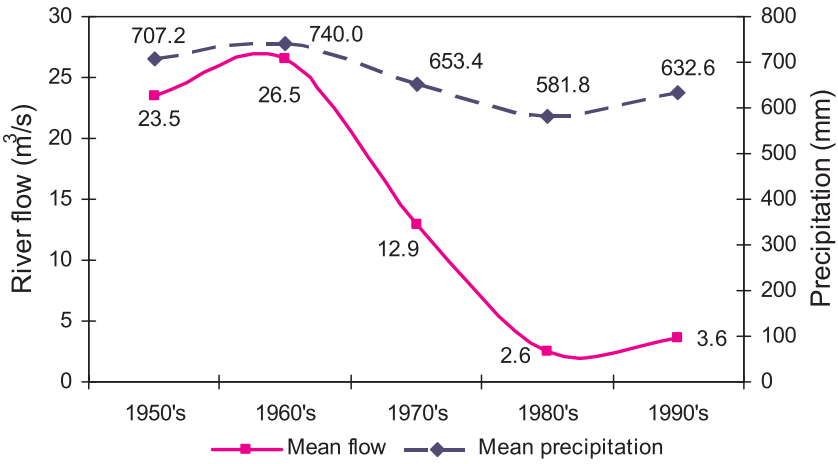

Fig. 12. Inter-decadal variation of river flow and precipitation at Nancun Hydrostation

a depression was formed near the coast of the Dagu Aquifer due to excessive groundwater abstraction, and seawater intrusion occurred. Therefore, no groundwater could be discharged into the Bay in 1981–1999. The construction of a low permeability subsurface dam in 1998 greatly constrained the groundwater discharge from the aquifer to the sea, although the groundwater level has been rising since 1999. Groundwater regimes of the catchment have experienced great changes over the last several decades and therefore it changed the groundwater discharge conditions.

Water quality of the catchment

In the 1960s and 1970s, water quality in the Daguhe was high with [Cl^-] as 18 ~ 40 mg/L, [HCO_3^-] as 94 ~ 211 mg/L, and total dissolved solids as 0.1 ~ 0.4 mg/L; In the late 1980s this river was polluted by industrial wastewater, municipal wastewater, pesticides, chemical fertilizers, and animal and human waste [Ye, 2006]. The average concentration of NO_3^-, NO_2^-, and NH_4^+ in the section ~30 km to the Estuary (referred to as Section I), the lower stream of this river, was 1.98 mg/L, 0.12 mg/L, and 1.02 mg/L, respectively, from 1982 to 1988; while the water quality was much worse with [NO_3^-] as 1.63 mg/L, [NO_2^-] as 0.85 mg/L, and [NH_4^+] as 5.36 mg/L in the section ~18 km to the Estuary (referred to as Section II) (Environmental Protection Bureau of Qingdao, 1990). In the late 1990s, there was no improvement in both sections, and even worse in Section II, with [NO_3^-] as 4.11 mg/L, [NO_2^-] as 0.14 mg/L, and [NH_4^+] as 0.46 mg/L in Section I and [NO_3^-] as 3.32 mg/L, [NO_2^-] as 0.94 mg/L, and [NH_4^+] as 7.16 mg/L in Section II which might be impacted by seawater incursion (Ye, 2006). The main contaminants in all the sections of the Daguhe within Qingdao were COD, NH_4^+, and SS (suspended sediments) from 2000 to 2005. The water quality in the upstream was stable and high while that in the midstream and lower stream was in the trend of worsening, and the quality in Section II was the worst [Meng et al., 2008].

The Moshui River is one of the heavily polluted surface waters in Qingdao [Wang et al., 2009]. Part of this river from its midstream changed into a wastewater drain since 1997 and [NO_3^-] was as high as 9.47 mg/L, [NO_2^-] as 0.69 mg/L, and [NH_4^+] as 15.66 mg/L in the section ~7.5 km to the estuary [Ye, 2006]. The pollution was even worse in the last 10 years as industrialization developed in its catchment and wastewater was drained into the river without any treatment [Wang et al., 2009].

After the 1980s, water quality of the Baisha River was threatened by pesticides, chemical fertilizers, industrial and municipal

wastewater, and animal and human waste. From 1997 to 2001, the average [NO_3^-] was as high as 41.40 mg/L, [NO_2^-] as 0.61 mg/L, and [NH_4^+] as 0.32 mg/L in the section ~3km to the estuary. There is still lack of wastewater treatment facilities in the catchment [Ye, 2006].

There are no industrial and municipal wastewater source points in the Yanghe catchment. The main threats to water quality are from agricultural runoff, animal and human waste in the rural areas [Wang et al., 2009].

From 2001 to 2007, water quality in all seven estuaries including the Daguhe Yanghe, Licunhe, Moshuihe, Haipohe, Loushanhe, Banqiaofanghe were polluted, and other five except the Daguhe and Yanghe were heavily contaminated [Wang, 2009].

Nutrient regime in the Bay

Nutrient survey in Jiaozhou Bay began in the 1960s. From the 1960s to the 1990s, it is reported that nutrient concentrations have increased 4.3 times for NO_3–N, 4.1 times for NH_4–N, 3.9 times for DIN and 1.4 times for PO_4–P [Shen, 2001]. DIN concentration was less than 0.20 mg/L from the 1960s to the 1990s although it was on the rise. At the beginning of the 21st century, DIN concentration continued to increase, with the average as 0.42 mg/L which is 13.7 times as much as that in the 1960s; and DIP concentration increased, too, with the average as 0.019 and 4.4 times as much as that in the 1960s [Shen, 2001].

The atomic ratio of DIN : PO_4–P increased rapidly from 15.9 ± 6.3 for the 1960s, to 37.8 ± 22.9 for the 1990s. SiO_3–Si concentration has remained at a low level from the 1980s to the 1990s. The high ratio of DIN : PO_4–P and low ratios of SiO_3–Si : PO_4–P (7.6 ± 8.9) and SiO_3–Si : DIN (0.19 ± 0.15) showed the nutrient structure of Jiaozhou Bay has changed from more balanced to unbalanced during the last several decades. The possibility that DIN and/or PO_4–P as limiting factors of Jiaozhou Bay phytoplankton has been lessened or eliminated, and that of SiO_3–Si limiting has been increased.

Tidal prism and surface area of the Bay

The overwhelming influence of human activities, especially land reclamation, is the main cause of the significant changes in hydrodynamic conditions and water exchange in Jiaozhou Bay [Shi et al., 2011]. The surface area of the Bay has reduced about 200 km^2 with a direct effect of tidal prism deceasing (Table 2).

The human-induced changes of the coastline position-configuration and nearshore bathymetry have resulted in substantial changes in the residual current patterns, especially in Qianwan Bay, Haixi Bay, and northeastern Jiaozhou Bay.

The overall tidal prim of Jiaozhou Bay has been reduced by 26% as compared to that in 1928. This is considerably less than the 35% reduction obtained by other studies (Shi et al., 2011). The decreasing water-exchange

Table 2. Changes of surface area and tidal prism in Jiaozhou Bay

Year	Surface Area (km^2)	Tidal Prism (10^8 m^3)
1915–1932	560 [a]	n.a.
1935	559 [a]	12.667 [c]
1963	423 [a]	10.065 [c]
1980	n.a.	9.626 [c]
1985	374.4 [a]	n.a.
1988	393.9 [b]	9.48 [c]
1992	n.a.	9.593 [c]
1997	371.4 [b]	9.22 [b]
2002	363.4 [b]	9.08 [b]
2004	362.4 [b]	n.a.
2005	358.9 [b]	9.02 [b]

Note: the letters a, b, and c in the table indicate the references: Jia [2006], Ma [2006], and Zhang [2007b].

ability corresponds to an increasing average residence time (ART) over the past several decades, particularly after the 1980s. In addition, the influences of the return flow of the bay water from the open sea back into the estuary were quantified by determining the return flow factor for each year. An existing tidal prism model was revised by introducing a mixing factor κ, and a simplified formula was developed for Jiaozhou Bay. The revised tidal prism model suggests continued deterioration in water quality and exchange ability of Jiaozhou Bay in the near future.

Dredging is carried out continuously within the Bay to build new port and industrial installations and maintain shipping channels.

Habitats deterioration and biodiversity loss

Due to human activities, large areas of natural wetlands around Jiaozhou Bay have been transformed into sea salt fields and shrimp ponds. This makes the wetland landscape pattern changed significantly, and coastal landscape pattern becomes simple. Due to wetland loss and increased pollution, biodiversity deterioration in the intertidal mudflat is remarkable.

In the 1960s, eastern coastal intertidal zone was typical with healthy environment and rich biodiversity. The number of species was then over 170, while this number began to reduce in the 1970s and it was about 17 in the 1980s. There was even no species collected in some sections of this zone [Zhao, 2002]. In Cangkou intertidal zone, the number of species was about 34~141 in the 1930s to the 1960s; this number reduced to 17~30 in the 1970s to the 1980s; while this habitat was totally lost due to land reclamation in the 1990s [Zhang, 2009]. The composition and number of species has changed in the intertidal zone of the Dagu Estuary in the last several decades: the number of species was over 20 in the 1980s, reduced to about 10 in the 1990s, and several in the 2000s (Fig. 13). The 1980s' dominant species *Mactra quadrangularis* has been replaced by

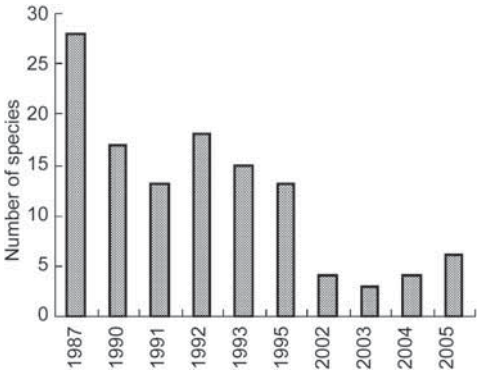

Fig. 13. Change of species numbers in the intertidal zone of the Daguhe estuary (revised from [Wang et al., 2007])

Sinonovacula Constricta [Wang et al., 2007]. Fish stock of the Bay was about 7400 t and that of crustaceans and cephalopods around 1000 t in the 1980s with the maximum sustainable yield as 2300 t. While the fishery survey in 2003 indicates that fish stock is 490 t and that of crustaceans and cephalopods around 374 t with significant biodiversity loss [Zhang, 2009].

Eutrophication in the Bay

At present, Jiaozhou Bay is mainly polluted by nitrogen and phosphorus from the land-based sources, which leads to eutrophication, frequent occurrence of harmful algal blooms and thus ecosystem deterioration. There were 12 HABs occurred in the Bay from 1990 to 2007, which brought heavy ecological, social and economic losses [Zhang, 2009]. The HABs areas are mainly distributed in the east and north of the Bay [Ge, 2003].

Qian et al [2009] assess eutrophication development in the Bat since the 1980s[3] [Qian et al., 2009]. It shows that the eutrophic degree and extent gradually increase in the Bay (Fig. 14). From the 1980s to the 1990s, E was less than 1 while it increased gradually, reached to 1 in the middle 1990s, and became

[3] The assessment equation is the same as Equation 2 (P. 903) in Xiao et al (2007) but they uses E to replace N. If E I 1, the system is regarded as eutrophic. The larger the E value, the more eutrophic.

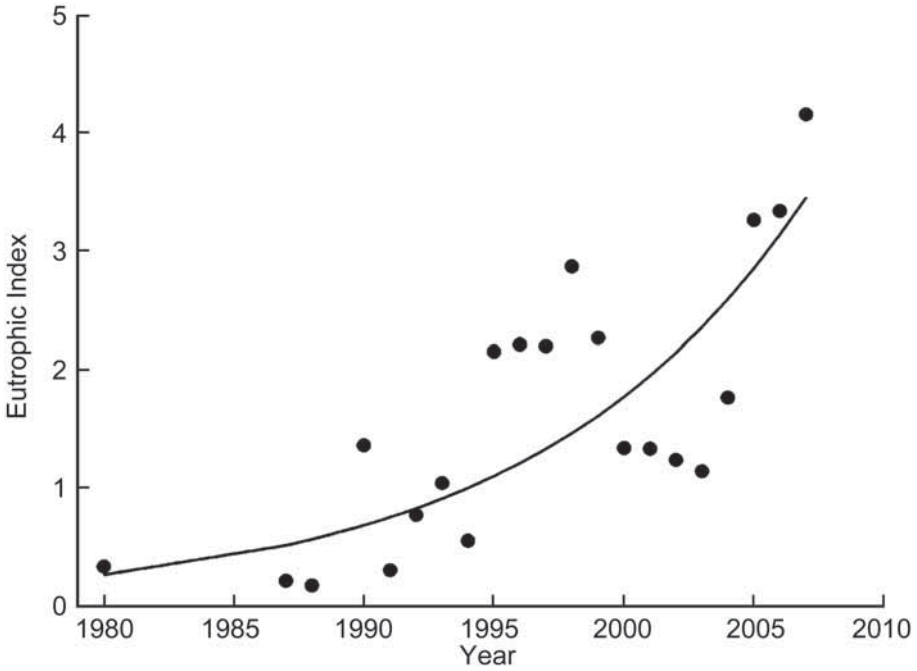

Fig. 14. Change of eutrophic index of Jiaozhou Bay since 1980 (adopted from Qian et al, 2009)

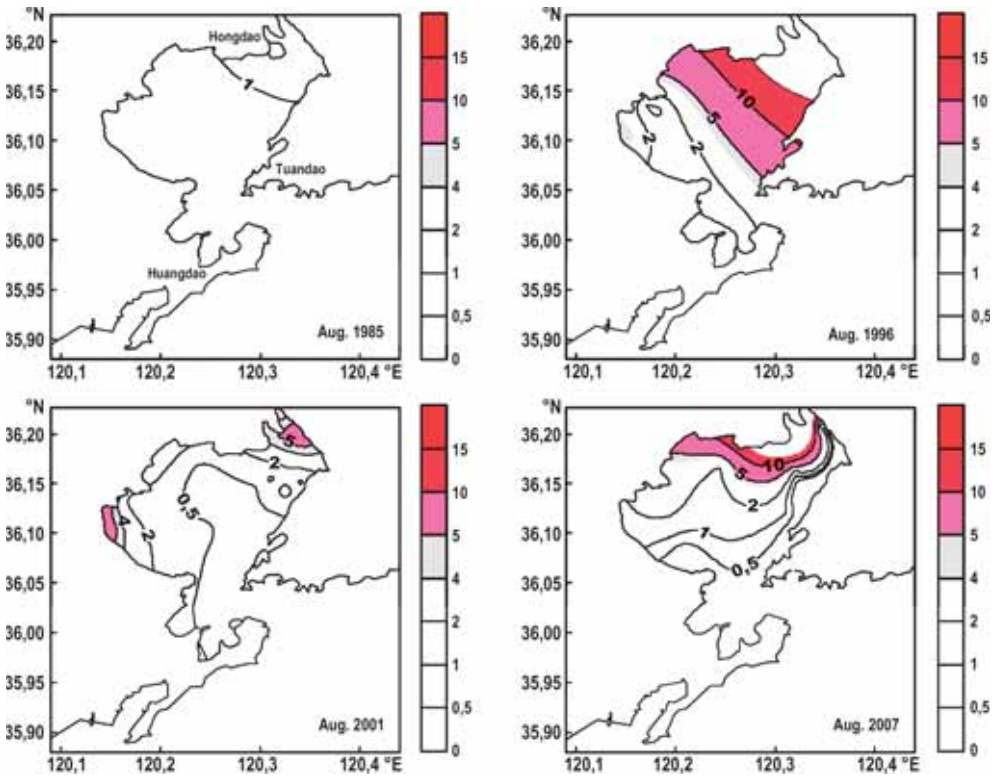

Fig. 15. Distribution of eutrophic waters of Jiaozhou Bay in different years (adopted from Qian et al, 2009)

larger than 2 in the late 1990s and 3 in 2005, and it even surpassed 4 in 2007.

Qian et al [2009] produce graphic to describe the distribution of eutrophic waters in the Bay (Fig. 15) [Qian et al., 2009]. It is clear that the northeast part of the Bay kept eutrophic in the last several decades. The Moshui River runoff is the main contributor to this effect. In the 21st century, the northwest part became eutrophic, too. This can be attributed to increased pollution from the Daguhe runoff.

Other changes and impacts

Other ecological factors in Jiaozhou Bay also changed in the last several decades. The COD in the Bay has gradually increased since the 1990s. Especially, the surface COD in 1998 is larger by 44.7% than that in 1991. Dissolved oxygen in the Bay was in the trend of decreasing [Zhao, 2002]. Surface temperature of the Bay also increased by 0.75 from the 1960s to the 1990s.

Phytoplankton is the producer in the food web of the ocean. The phytoplankton community of Jiaozhou Bay is composed mainly of diatoms and secondly of dinoflagellates[4]. The changes in nutrient structure of the Bay may have led to the decrease of large diatoms and a shift of phytoplankton species composition. It is likely that there is a trend from large diatoms to smaller cells in Jiaozhou Bay. The number of dominant species has also reduced, which indicates the biodiversity loss.

Policy responses

Environmental protection as a national policy

The first national conference of environmental protection was held in 1973 and since then there have been six national conferences of environmental protection held in China. The legislation and national policy for environmental protection has come into being. The law of marine environmental protection, laws of water pollution, air pollution, and law of environmental impact assessment as well as other laws of natural resources have been implemented during these decades.

Measures to protect Jiaozhou Bay

The local people's congress of Qingdao passed a proposal to protect Jiaozhou Bay in 2005 and a new development strategy, "Protecting the Bay, Developing around the Bay", was issued in November 2007. It is top priority to prevent the Bay and its catchment from pollution and reduce contaminants from the land-based sources. The local legislature has taken measures to release two pieces of new regulations, i.e. *Marine Environmental Protection Regulation of Qingdao and River Channel Management Regulation of Qingdao* in 2009. Marine Functional Zoning for Jiaozhou Bay and its adjacent waters and Planning for Wetland of Jiaozhou Bay have been issued. Wastewater treatment facilities are being improved in the catchment. Since July 2007, the waste discharge permit scheme came into force in Qingdao. All the major basins around the Bay have been under regulation. In 2009, wastewater pipeline was up to 265 km and the total investment is more than that in the last ten years. So the point sources are under effective control.

POLICY ANALYSIS AND FUTURE OUTLOOK

Tidal rivers have a strong influence on their adjacent estuary and the surrounding coastal area. During the last 15 years it became more and more obvious that coastal zones in the vicinity of large rivers cannot be managed independently from the rivers and their catchments. The concept of an ICARM is reflected in the UNEP-ICARM approach, in the European Water Framework Directive and partly in LOICZ. All these are focused on water-related topics. The spatial integration of river basin and coastal waters does not always reflect the interaction between terrestrial and aquatic systems well. Therefore, it is not a replacement, but a

[4] According to Wang et al. [2006], 313 species including 224 diatoms and 69 dinoflagellates have been identified in Jiaozhou Bay since the 1930s.

supplement to traditional Integrated Coastal Zone Management (ICZM). Objectives are to raise awareness as well as to promote and to ensure sustainable integrated coastal water – river management.

Neither integrated coastal zone management nor integrated river basin management has been established for Jiaozhou Bay and its catchment. The policies and measures taken to alleviate, prevent and control pollution in the Bay and its catchment are thus not integrated and coordinated among different departments. Rivers in the catchment are divided into sections managed by different local governments, which is difficult to solve the problems between the upstream and the downstream. Coastal management is also conducted by local marine authority, fisheries department, authority of environmental protection and so on. It is difficult to share data and information and conduct joint enforcement among different departments. This sector management mechanism cannot solve the pollution and ecosystem deterioration effectively and efficiently.

As human activities around the Bay and in its catchment are increasing and intensifying, the pressure on the bay and its catchment will continue and even become larger. It is necessary to consider managing the bay and its catchment in an integrated approach. Hence ICARM should be a proper path choice for managing and conserving the bay and its catchment.

CONCLUSIONS

An analytical tool, DPSIR, is used in this article to present the causes and effects in the ecosystem change of Jiaozhou Bay and its catchment. Drivers include national and local policies, population growth, economic development, and urbanization. Pressures represent by two aspects, i.e., land and water resources, given by the drivers. State and impacts show the state change of Jiaozhou Bay and its catchment and their impacts on the ecosystem. Response examines the policy reactions and measures taken to alleviate the trend of ecosystem changes and their impacts.

Under the Chinese national macro-socioeconomic policy, rapid development and massive urbanization occurred in Qingdao that has resulted in the serious reduction and quality deterioration of its arable land and the variation in water resources. The production and consumption pattern changed with population growth with an increasing rigid demand for water and food as well as pollutants emissions. The pressure alteration in the Bay and its catchment has created far-reaching changes and had impacts on the ecosystem. These changes include: significant deterioration in water quality of the catchment; decreased river runoff into the bay; shift in the nutrient regime of the Bay; decreased surface area and tidal prism of the Bay; increased eutrophication in the Bay; fragmentation of natural habitats and loss of biodiversity. Relevant policies aimed at the promotion of the water quality in the system have been formulated. However, the deterioration trend has not yet been halted or reversed. This is because the policies and measures, if not all, are based on sector management approach and ignore the interactions between the bay and its catchment. It is suggested the catchment-coast continuum concept should be used as the basic principle for policy design and ICARM can be one of the path choices. ■

REFERENCES

1. Clark, R.A. & Frid, C.L. (2001) Long-term changes in the North Sea ecosystem. Environmental Reviews, 9, 131–187.

2. Crossland, C.J., Kremer, H.H., Lindeboom, H.J., Crossland, J.I.M. & Le Tissier, M.D.A. (Eds.) (2005) Coastal Fluxes in the Anthropocene, Berlin, Springer.

3. Diamond, J. (2006) Collapse: How Societies Choose to Fail or Succeed, Penguin Books Ltd.

4. Environmental Protection Bureau of Qingdao (1990) Assessment of Water Pollution in Qingdao. Qingdao.

5. Gao, Z., Yang, D., Qin, J., Xiang, L. & Zhang, K. (2008) The land-sourced pollution in the Jiaozhou Bay. Chinese Journal of Oceanology and Limnology, 26, 229–232.

6. Ge, M. (2003) Development of a dynamic model for dissolved inorganic nitrogen and phosphate cycles and budgets in Jiaozhou Bay and applications. Department of Marine Chemistry. Qingdao, Ocean University of China.

7. Hagy, J., Boynton, W., Keefe, C. & Wood, K. (2004) Hypoxia in Chesapeake Bay, 1950–2001: Long-term change in relation to nutrient loading and river flow. Estuaries and Coasts, 27, 634–658.

8. Hardoy, J.E., Mitlin, D. & Satterthwaite, D. (2001) Environmental Problems in an Urbanizing World: Finding Solutions for Cities in Africa, Asia and Latin America, London, Earthscan Publications.

9. Jarvis, A., Reuter, H.I., Nelson, A. & Guevara, E. (2008) Hole-filled seamless SRTM data V4. International Centre for Tropical Agriculture (CIAT).

10. Kitsiou, D. & Karydis, M. (2011) Coastal marine eutrophication assessment: A review on data analysis. Environment International, 37, 778–801.

11. Li, L., Liang, S., Shi, X. & Wang, X. (2009) Contaminative Conditions Analysis of Main Rivers Flowing into Jiaozhou Bay in 2007. Environmental Science & Management, 34, 23–28.

12. Liu, G., Wang, S., Zhu, X., Liu, S. & Zhang, J. (2007a) Groundwater and Nutrient Discharge into Jiaozhou Bay, North China. Water, Air, & Soil Pollution: Focus, 7, 593–605.

13. L, J. & Diamond, J. (2005) China's environment in a globalizing world. Nature, 435, 1179–1186.

14. Liu, S., Zhang, J., Chen, H. & Zhang, G. (2005) Factors influencing nutrient dynamics in the eutrophic Jiaozhou Bay, North China. Progress In Oceanography, 66, 66–85.

15. Liu, Z. (2004) Research on modeling water exchange and nutrient budget in Jiaozhou Bay. Department of Oceanography. Qingdao, Ocean University of China.

16. Liu, Z., Wei, H., Bai, J., Zhang, J., Liu, D. & Liu, S. (2007b) Nutrients Seasonal Variation and Budget in Jiaozhou Bay, China: A 3-Dimensional Physical–Biological Coupled Model Study. Water, Air, & Soil Pollution: Focus, 7, 607–623.

17. Meng, C., Wang, C. & Dong, S. (2008) Analysis on surface water quality changes in Qingdao Reach of Daguhe River. Journal of Water Resources & Water Engineering, 19, 73–76.

18. Newton, A. & Icely, J. (2008) Land Ocean Interactions in the Coastal Zone,LOICZ:Lessons from Banda Aceh, Atlantis, and Canute. Estuarine, Coastal and Shelf Science, 77, 181–184.

19. Ning, X., Lin, C., Su, J., Liu, C., Hao, Q., Le, F. & Tang, Q. (2010) Long-term environmental changes and the responses of the ecosystems in the Bohai Sea during 1960-1996. Deep Sea Research Part II: Topical Studies in Oceanography, 57, 1079–1091.

20. OECD (2005) Agricultural Policy Reform in China. Paris, OECD.

21. Oguz, T. (2005) Long-term impacts of anthropogenic forcing on the Black Sea ecosystem. Oceanography, 18, 112–121.

22. O'Meara, M. (1999) Reinventing Cities for People and the Planet. Washington, DC, Worldwatch Institute.

23. Qian, G., Han, H., Liu, J., Liang, S., Shi, X. & Wang, X. (2009) Spatiotemporal Change s of Main Chemical Pollutant s for the Last Thirty Years in the Jiaozhou Bay. Periodical of Ocean University of China, 39, 781–788.

24. Shen, Z. L. (2001) Historical Changes in Nutrient Structure and its Influences on Phytoplankton Composition in Jiaozhou Bay. Estuarine, Coastal and Shelf Science, 52, 211–224.

25. Shi, J., Li, G. & Wang, P. (2011) Anthropogenic Influences on the Tidal Prism and Water Exchanges in Jiaozhou Bay, Qingdao, China. Journal of Coastal Research, 27, 57–72.

26. U.S. International Trade Commission (2011) China's Agricultural Trade: Competitive Conditions and Effects on U.S. Exports. Washington, DC.

27. UNFPA (1999) Six Billion: A Time for Choices, the State of World Population, New York, United Nations Population Fund.

28. Wang, B. (2006) Eutrophication Status and Its Ecological Effects in the Changjiang Estuary and Adjacent Coastal Waters. College of Chemistry and Chemical Engineering. Qingdao, Ocean University of China.

29. Wang, C. (2009) Study the pattern for integrated coastal zone management based on ecosystem approach: a case study of Jiaozhou Bay. Department of Environmental Science. Qingdao, Ocean University of China.

30. Wang, J., Tian, L. & Han, Z. (2009) Ecological Treatment of River Channels around Jiaozhou Bay, Qingdao, Qingdao Publishing House.

31. Wang, L., Cui, W., Liu, F., Cui, Y. & Ma, Y. (2007) Study on the Status of Eco-environment in Daguhe Estuary of Qingdao. Environmental Monitoring in China, 23, 77–80.

32. Wang, X., Li, K. & Shi, X. (2006) Marine environmental capacity of pollutants in Jiaozhou Bay, Beijing, Science Press.

33. Wang, Y.-S., Lou, Z.-P., SUN, C.-C. & SUN, S. (2008) Ecological environment changes in Daya Bay, China, from 1982 to 2004. Marine Pollution Bulletin, 56, 1871–1879.

34. Wri (1998) World Resources 1998-99, Oxford University Press.

35. Xiao, Y., Ferreira, J., Bricker, S., Nunes, J., Zhu, M. & Zhang, X. (2007) Trophic Assessment in Chinese coastal systems-review of methods and application to the Changjiang (Yangtze) Estuary and Jiaozhou Bay. Estuaries and Coasts, 30, 901–918.

36. Yang, S., Meng, Y., Zhang, J., Xue, Y., Chen, H., Wei, H., Liu, Z., Wu, R., Wang, L., Yang, H., Wang, L. & Zhang, W. (2004) Suspended particulate matter in Jiaozhou Bay: Properties and variations in response to hydrodynamics and pollution. Chinese Science Bulletin, 49, 91–97.

37. Ye, Y. (2006) Groundwater hydrogeochemical characteristics and nutrients discharge into Jiaozhou Bay from ambient areas. Department of Environmental Engineering. Qingdao, Ocean University of China.

38. Yuan, Y., Wei, H., Zhao, L. & Jiang, W. (2008) Observations of sediment resuspension and settling off the mouth of Jiaozhou Bay, Yellow Sea. Continental Shelf Research, 28, 2630–2643.

39. Zhang, J. (2007a) Watersheds Nutrient Loss and Eutrophication of the Marine Recipients: A Case Study of the Jiaozhou Bay, China. Water, Air, & Soil Pollution: Focus, 7, 583–592.

40. Zhang, J. (2009) Coastal Ecosystem Security and Empirical Research of Jiaozhou Bay. Department of Environmental Science. Qingdao, Ocean University of China.

41. Zhang, Y. (2007b) Research on total amount control method and application in Coastal Bays. College of Environmental Science and Engineering. Qingdao, Ocean University of China.

42. Zhao, S. (2002) Long-term Changes of Main Ecological Factors of the Jiaozhou Bay Ecosystem. Department of Marine Biology. Qingdao, Institute of Oceanology, Chinese Academy of Sciences.

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ECOLOGICAL RISKS RELATED TO ACCIDENTS AT PULP AND PAPER PLANTS: THE CASE OF THE MANTUROVO PULP AND PAPER PLANT PROJECT

ABSTRACT. The paper presents approaches to quantitative and spatial assessment of emergency environmental risks at new sites of pulp and paper production using mathematical statistics, probability theory, and cartographic modeling. Damage assessment is based on the type and sphere (atmosphere, soil, and underground and surface waters) of impact. Although damage assessment considers governmentally approved methodology, the formula suggested for the assessment contains some suitable improvements. In addition, a brief characterization of technological process at pulp and paper plants provides objective substantiation of possible accident scenarios. Conclusions discuss economic and social benefits of pulp and paper plants versus their ecological disadvantages.

KEY WORDS: environmental risks, pulp and paper industry

INTRODUCTION

Recently, increasing attention is paid to issues related to the ascending impact of different hazardous industrial facilities and transport, as a rule, characterized by "technological risk" or "threat of an emergency or emergency situation". Risk is an expected assessment of an adverse event's probability; this indicator includes the possibility of adverse consequences of any act or course of events, which is measured by the probability of such effects or likely magnitude of losses. There is a need to consider ecological (environmental) conditions and the natural potential of the territory in the integrated index of technological risk for the most comprehensive description of economic structures' dangers. Not all approaches to risk assessment meet the objectives of ensuring complex security because of significant complexity of technological and natural process and uncertainty of emergency scenarios, which is influenced by numerous factors.

It is necessary to consider environmental risks, i.e., anthropogenic hazards for the environment. Such assessments are especially important at the stage of new industrial facilities planning, so one can choose the best location for construction that meets not only the resource requirements, but is also resistant to anthropogenic pollution.

The goal of this work was to define methodological approaches to ecological risk assessment for hazards associated with emergency release of liquid contaminants using Manturovo Pulp and Paper Plant (P&PP) (Kostroma region) as a case study. The P&PP was designed to be the largest in the European part of Russia with a capacity of 800 000 tons of pulp and 500 000 tons of paper per year.

To implement a comprehensive assessment of ecological risk, the following problems have to be solved:

- provide characteristics to pulp and paper industry as a source of environmental risk;

- assess the likelihood and consequences of emergencies at industrial facilities (to assess emergency risks);

- identify the areas of negative impact and zones most vulnerable to pollution.

METHODOLOGY

Prior to discussing methods of risk assessment, it is necessary to give the definition to the term "risk". "Risk is a measure of hazard, which is characterized by probability and amount of damage". From a mathematical point of view, risk is a mathematical expectance of damages for a considerate period and a product of emergency probability and damage [Akimov et al, 2001]:

$M(D) = Q\tau \cdot D$, where D is damage caused by disaster; $Q\tau$ is probability of its occurrence per year.

The probabilistic method is the most appropriate for risk of emergency situations assessment as it is completely transparent, objective, and is based on statistics of events that have taken place. This method is based on the use of mathematical models to determine the probabilities and consequences. Probability models vary in the level of detail, depending on the available data. The simplest model is based on the representation of the flow of emergencies as a Poisson stream of random events (in the theory of random processes, describes the amount of random events occurring with constant intensity). In this case, probability of occurrence per year is estimated by the formula:

$Q\tau = 1 - \exp(-\lambda\tau)$, where λ is intensity of emergency ($year^{-1}$). Intensity of emergency is determined by date on long-term observations, using the formula:

$\lambda = d/\Delta t$, where d is the number of emergencies over the observation period Δt. For very rare emergencies $Q\tau = \lambda\tau$.

For a more complete emergency risk assessment, one can use the formula:

$M(D) = \Sigma Q(\tau) \cdot D$, where D is the consequences of i-type emergency; $Q(\tau)$ is probability of i-type emergency over a period of time τ.

Damage in financial terms, in general, is estimated by the formula for each component of the geosystem:

$D = V \cdot H \cdot Kc$, where V is the volume (mass) of pollutants emitted (released) into the environment (defined as maximum possible); N is the National Standard Fee for release of 1 ton of pollutant [Russian Federation Government Resolution № 344 dated June 12, 2003]; Kc is a coefficient describing the ratio between pollutant concentrations and the maximum permissible concentrations (MPC) [SanR&N № 4630-88].

The method mentioned above is simple and allows avoiding complicated for prediction out-of-date coefficients that are used in official methodologies. In addition, there is a conversion factor, which depends on the ratio between after emergency pollutant concentrations and the MPC; the excess over the MPC is one of the main characteristics of the emergency hazard rate. To calculate after emergency concentrations of substances in the geosystem components, different techniques are used depending on the type of impact.

Accidents at pulp and paper plants are usually connected with liquid pollutant release. To assess damage, one can use the application of the official methodology, i.e., Recommendation to Action – RA 03-626-03 "Method for determining the size of harm that can be caused to the life or health of individuals, property of enterprises in a case of accidents at hydrotechnical structures". During emergency releases, three geosystem components are affected: soil and surface and underground waters (for simplicity, we will not consider the processes of pollutants entering the atmosphere through evaporation from the surface of water or soil). For each component of the environment, the concentration of pollutants is determined

considering their background content. To estimate the parameters of pollution of soil and underground and surface waters with harmful substances, the following assumptions are recommended: the liquid phase infiltration in the area of impact through the soil is free, without damming from underground water; the water remaining in the soil-plant bed and in the natural hollows and depressions is not considered; and differentiation between pollution in the mass of soil, surface, and underground waters is not considered.

In determining the extent of soil contamination, it was assumed that the entire mass of pollutants filtered from the liquid remains in the soil layer and is spread evenly over the depth of the layer and the area of impact. In determining the extent of groundwater contamination, it has been suggested that the entire mass of pollutants filtered from the surface of the impact zone or from liquid storage gets into groundwater and is spread evenly in the groundwater flow over the area of impact. The calculation does not take into account retention of some harmful substances by the soil. In determining the parameters of contamination of surface water, it was assumed that the entire mass of harmful substances contained in the leaked or filtered liquid from the storage for water spreads evenly throughout the section.

Calculation of parameters of soil contamination. The volume of filtered liquid from the surface into the soil mass V_f (m^3) is defined as:

$V_f = K_f J F_f T_f$, where K_f is the filtration coefficient of the soil layer (m/day) determined based on the grain composition of the soil; J is the gradient of the infiltration flow; S_f is the filtration area (m^3)(equal to the area of impact); V_f should not exceed the total volume of fluid leaked from the storage.

Then, for each pollutant contained in the liquid waste, the concentration of harmful substances in the soil C_{si} (g/m^3) for the area of F_f is calculated:

$C_{si} = (C_i V_f / S_f Ms\ \rho s_d) + C_{sbi}$, where C_{si} is the concentration of *i*-pollutant in the liquid waste (mg/liter or g/m^3); Ms is the depth of the soil layer (m); ρ_{sd} is the density of the dry soil layer, (t/m^3); C_{sbi} is the background concentration of the *i*-substance in the soil (g/m^3).

Parameters Ms and ρ_{sd} are determined from surveys.

In the absence of specific input data, the following values are recommended for approximate estimates:

$$Ms = 0.5 - 1.0 \text{ m};$$

$$\rho_{sd} = 1.4 - 1.6 \text{ g/cm}^3.$$

Calculation of parameters of groundwater contamination. For each i-pollutant contained in the liquid waste, the concentration in groundwater C_{gwi} (g/m^3) for the impact zone is calculated as:

$C_{gwi} = (V_f C_i + S_f m_{gw} n_g C_{gwbi})/(V_f + S_f m_{gw} n_g)$, where C_{gwbi} is the background concentration of *i*-compound in groundwater; m_{gw} is the capacity of groundwater flow (m); and n_g is soil porosity.

Parameters are determined from survey.

Calculation of parameters of surface water contamination. In the case of a flowing water body (river), the concentration C_{wi} (g/m^3) will be:

$C_{wi} = (Q_{max} C_i + Q_w C_{wbi})/(Q_{max} + Q_w)$, where Q_{max} is the maximum flow rate from the storage (m^3/sec) and Q_w is the flow rate of the water body (m^3/sec).

In the case of Manturovo P&PP, we are dealing with a river, so the scenario with a closed water body will not be considered (this scenario may be found in the full version of RA 03-626-03). The resulting concentrations in the soil, groundwater, and surface water were compared with the MPC. Depending

Table 1. Values of the conversion factor *Kc*

Ratio between the final concentrations and the MPC	Pollution degree	Coefficient (*Kc*)
<2	Allowable	1
2–8	Low	1.2
8–16	Medium	1.4
16–32	High	1.6
>32	Very high	2.0

on the ratio between the final concentrations and the MPC, the conversion coefficient (*Kc*) has the following values (Table 1).

Spatial representation of environmental risks. The area of contaminated soil and underground water is calculated based on a simple model, where the zone is presented as a complex prism of a known volume (the volume of fluid that was released) and height (the minimal liquid layer). Thus, the area is equal to the quotient of the volume and the height.

In the case of an open hydrological object (river), the extent of affected area depends on many factors: the characteristics of the river (flow speed – V, the average depth at the site – h, and the water flow in the river – Q_1); the characteristics of runoff (harmful component, water flow – Q_2, the concentration of harmful component – C_i in wastewaters, and the background concentration – C_{bi}). The concentration of harmful components in the water at the place of the next intake is calculated by the formula:

$$C_{i1} = (C_i - C_{bi})/K,$$

where K is the dilution coefficient multiplicity;

$K = (\gamma Q_1 + Q_2)/Q_2$, where γ is the degree of wastewater completeness in the pond;

$$\gamma = (1 - \beta)/(Q_1 + Q_2)^{\beta},$$

$\beta = \exp(-\alpha L^{1/3})$, where L is the distance to the water intake; α is the coefficient taking into account hydrological factors of mixing;

$\alpha = \varepsilon(Lf/Ls)-(D/Q_2)^{1/2}$, where Lf/Ls is the coefficient of sinuosity of the river (for plain rivers on a short-range equals to 1); ε is the coefficient depending on the place of runoff release into the river; it equals to 1, if the release was at shore; D is the coefficient of turbulent diffusion; for plain rivers is determined by the formula:

$$D = hV/200.$$

PULP AND PAPER INDUSTRY AS A SOURCE OF ENVIRONMENTAL RISK

Current studies of pulp and paper industry (PPI) have a great potential due to the fact that this branch of national economy may soon become Russia's branch of specialization by virtue of rich resource potential [Kuzminov, 2009]. The main raw material for the Russian pulp and paper industry is wood. This is due to the rich forest resources and poorly established system of waste paper recycling. The most valuable type of wood is coniferous; its reserves in Russia are significantly higher than in other countries. Coniferous plant fibers are longer, allowing to produce higher quality types of paper and pulp, characterized, above all, by high solidity. But the use of birch and aspen has a great potential also. Modern technologies allow receiving products of considerably high quality out of deciduous wood.

Production of pulp and paper products includes the processes of chemical and mechanical wood processing, as well as secondary processes related to full or partial recovery of waste. The process of chemical treatment of wood is the dominant process that causes great harm to the environment [Kasparov, 1979].

The mass fraction of cellulose in wood varies from 32 to 56%. In softwood, the percentage of cellulose is usually 46–54%; in hardwood, it is 41–45%. In addition to cellulose, wood contains large amounts of hemicellulose

(20–35%) and lignin (18–28%). The main purpose of cellulose cooking is freeing wood from fibers, so its other name is delignification. Based on the chemical composition of the reactants in the process of cellulose cooking, one can define alkaline and acidic methods of cooking. Alkaline methods are the sulfate type of cooking dominant, at the present time, in Russia and the world. The main reagents used in the alkaline methods are sodium hydroxide and sodium sulfide. This method allows processing both hardwood and softwood and can operate with highly resinous wood.

Pulp is cooked with cooking liquor (sulphate, or white alkali liquor) containing sodium hydroxide, sodium sulfide, a small amount of carbonate and sodium sulphate. Sodium hydroxide and sodium sulfide are the active part of white liquor. Their total concentration, in terms of Na_2O, ranges from 70 to 120 g per liter.

A pulp mill digester processes about 450–500 tons of pulp per day. The upper zone of the digester is for brewing, the middle part is for cooking, and in the lower part, the pulp is washed with weak alkaline. The pulp mass with concentration of 14–16% and cooled to 80–85°C is continuously unloaded into the blow tank. Cooking processes take about 4.5 hours.

At the end, the cooking liquor (7–10 m^3 per a ton of pulp) becomes almost black, so it is called black alkali liquor. It collects most of the wood lignin in the form of alkali lignin and hemicelluloses portion, which, in alkaline medium, becomes hydrolyzed and oxidized to a form of oxy acids. Black alkali liquor is processed into green alkali liquor which is treated with slaked lime to convert sodium carbonate to sodium hydroxide to gain white alkali liquor, which is, again, used for pulping.

Bleached pulp is obtained by treatment with chlorine, chlorine-containing substances, or hydrogen peroxide (the cleanest way, without a danger of dioxin production). The composition of raw materials for paper production may include various combinations of cellulose, wood pulp, waste paper, adhesives (to give water-repellency), alumina (for glue fixing), kaolin or chalk (for improved printability and smoothness), dyes, etc. After mixing, the resulting composite mass is sent to a paper machine, after which the rolls of paper are transported for sale or fed to the cutting machine and the packing station.

In the process of processing wood, various wastewater products are formed. They contain acids, alcohols, ethers, aldehydes, ketones, resinous substances, metal salts, etc. The share of recycled water at wood chemical plants is up to 90% of the total runoff.

Key environmental risks associated with accidents involve damage of pulp vessels containing hazardous substances, their emissions to the environment, and the subsequent formation of chemically hazardous and explosive clouds and mixtures. The layout of storage tanks and industrial chemically hazardous substances is performed based on the measures of industrial safety: tanks are mounted on pallets; for chemical emergencies, back-up tanks and reservoirs are provided. At the P&PP, there are facilities that use and store substances in quantities exceeding the quantities specified in Annex 2 to the "Federal Law № 116-FL": oxidizing substances (acids, hydrogen peroxide) – more than 210 tons/day (limit of 200 tons), toxic substances – more than 500 tons/day (the maximum amount 200 tons).

RESULTS

Based on the chemical processes, we consider four scenarios of accidents at the P&PP with consequences for the environment: release of (I) white alkali liquor, of (II) black alkali liquor, and of (II) green alkali liquor, and (IV) the failure of the waste water treatment facilities. Since the industrial site of the Manturovo P&PP is located at the distance of 1.5 kilometers from the Unzha riverbed (Fig. 1), the direct impact, for the first three scenarios, will be to the soil and groundwater with the area of impact of less than 1 km^2 (within the industrial site). In the case of the fourth scenario, as the calculations show, the maximum area of

Fig. 1. Unzha river near Medvedevo village – about 50 km downstream from Manturovo (photo by Gunko M.)

damage for the majority of pollutants is even smaller (about 800 m^2), but they go straight into the river as the wastewater treatment plant is located on its banks.

Based on expert evaluation and statistical data on accidents at pulp and paper plants, the most likely accident at the P&PP is a local-level emergency when the boundaries of the zones of impact of damaging factors are within the limits of the industrial site; the likelihood of the emergency is 10^{-4}–10^{-6} cases per year. This puts the P&PP territory, as well as surrounding areas, in the zone of acceptable risk, in accordance with Annex "D" of the "Set of Rules № SR 11-113-2002".

Table 2 presents volumes, areas, and fees obtained considering four scenarios proposed abov e.

Thus the risk of accidents with the environmental impact (the mathematical expectation of damage per year) is:

1. White alkali liquor – 7 700 rubles per year;
2. Black alkali liquor – 3 400 rubles per year;
3. Green alkali liquor – 19 100 rubles per year;
4. Failure of wastewater treatment facilities – 8400 rubles per year.

Table 2. Emergency scenarios

	I	II	III	IV
Sphere of impact	Soil, groundwater	Soil, groundwater	Soil, groundwater	Surface water
Volume of released pollutants (m^3)	1944	3888	2916	148 531
Area of impact (m^2)	277 714	555 428	416 571	?
Damage (rub)	77.6 mln	34 mln	191 mln	84 mln

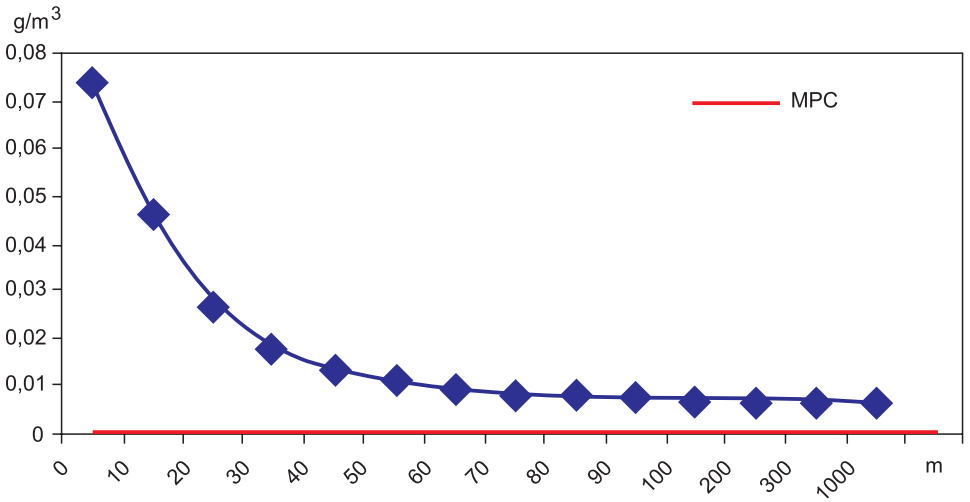

Fig. 2. Distribution function of phenols' concentrations downstream the point of discharge

Based on a series of calculations, the concentrations of pollutants in the Unzha River (the fourth scenario) exceed the MPC (Fig. 2). After 80-meter mark past the point of discharge, only phenol concentration exceeds the MPC; after the mark of 300 m, is stays around the same value of 0.070 g/m^3 without undergoing significant changes up to 1000 m.

This suggests that the increase will be observed at a significant distance from the discharge point; the accuracy of the methodology proposed above does not allow us to estimate the specific distance where phenol concentration falls below the MPC.

CONCLUSIONS

The method presented herein allows integrating fragmented information about dangers of individual enterprises in a system whose components are natural and industrial factors, various combinations of which have different effects on the formation of regional hazards in general.

This method allows taking into the account natural and socio-economic risk-factors and their influence on each other.

Clearly, any industry is harmful to the environment, but the damage must be weighed against the socio-economic benefits for the territory and its population. For a depressive peripheral area of a peripheral federal region (such as Manturovo in the Kostromskaya region), new industrial activities are very beneficial for the employment and financial stability of the population. Successful implementation of a project with the creation of new transportation, housing, and social infrastructure improves the attractiveness of the region for new projects. The question arises on the type of industry and the natural capacity of the environment sufficient for the implementation of new projects.

As we have found out in the study, the risks of accidents are of a low probability and impact a relatively small area, so the P&PP might not be as significant treat to the environment, especially if modern "green" technologies are used. One of the main problems of the status of the territory is primarily related to environmental alarmism. According to the popular public opinion, the area adjacent to the industrial enterprise will be considered "deadly" and "heavily polluted". While in the EU, for example, people live close to waste incineration plants and the industrial area in Singapore near Jurong, where one of the largest sites of oil processing world is situated, is organized into a national park. It is not that governments, scientists, and people do not realize the danger of anthropogenic impacts, but the fact that

the production uses "green" technologies make these facilities acceptable. According to numerous reviews, living near the sites mentioned above does not present hazard to human health and the environment. Thus, the real danger in the light of modern safety devices (water treatment plants, filters, etc.) is greatly exaggerated.

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REFERENCES

1. Akimov, V.A., Potapov B.V., and Radaev N.N. (2001) Methods of comparative risk assessment for regions of the Russian Federation. Environment and Industry of Russia, February, pp. 25–32.

2. Akimov V.A., Lesnikh V.N., and Radaev N.N. (2004) Fundamentals of risk analysis and management in natural and technological spheres. Moscow: Delovoy Ekspress, p. 380.

3. Kasparov, G.B. (1979) Economy, organization, and planning in pulp and paper production. Forest products industry, № 4, pp. 41–58.

4. Kuzminov, I.F. (2010) Kostroma region outskirts: socio-economic consequences of forest governance transformation. Northern village: traditions and innovations. Moscow: GU-VSHE, p. 260.

5. Recommendation to action № RA 03-626-03 dated March 15, 2003 "Method for determining the size of harm that can be caused to the life or health of individuals, property of enterprises in case of accidents at hydrotechnical structures".

6. Russian Federation Government Resolution № 344 dated June 12, 2003 "About fees for air pollution from stationary and mobile sources, discharges of pollutants into surface and ground water bodies, industrial and consumer waste burial".

7. SanR&N № 4630-88 dated July 4, 1988 "Sanitary rules and norms of surface water protection from pollution".

8. Set of Rules № SR-11-113-2002 dated July 23, 2002 "Order on engineering measures of civil defense and emergency prevention when preparing a petition of intent and substantiation for investment in construction of enterprises, buildings, and facilities".

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GEOGRAPHICAL PRINCIPLES OF THE REGIONAL NATURAL AND MANMADE DISASTER SECURITY MANAGEMENT IN UKRAINE

ABSTRACT. A concept of zoning that addresses Natural and Man-made Disaster Security (NMDS) is proposed. NMDS's features and factors used in regional divisions are discussed. The system of factors and the level of their influence are described. The nature, principles, criteria, and indicators for appropriate zoning are determined. Ukraine's territory is described from the standpoint of NMDS considering spatial differences and the level of population security, economic facilities, and natural ecosystems in respect to negative impacts of natural and technogenic character. Features and dynamics of NMDS of Ukraine from the regional division perspective and natural and technogenic hazards to the regions are shown. Prospects of social geography theory and methodology in the development of the foundations of NMDS are provided. A socio-geographical mechanism of NMDS for the regions is presented. Goals and key directions of its implementation are defined. A system of methods and implementation measures of socio-geographical mechanism of NMDS is proposed. The organizational and management structure of NMDS of Ukraine at different hierarchical territorial levels, particularly at the regional level, is identified. The system of organization and management of environmental monitoring and detection of human, financial, and material reserves is necessary in prevention and minimization of negative impacts of natural and manmade disasters.

KEY WORDS: natural and manmade disaster security, potentially dangerous areas, emergency situations, socio-geographical mechanism, zoning for natural and manmade disaster security.

INTRODUCTION

Territorial organization of ecological security and organizational and management structure of Natural and Man-made Disaster Security (NMDS) at different territorial levels of hierarchy in Ukraine have not been well studied yet, in particular, in terms of natural and manmade risks at the regional level. However, it is within specific regions that natural and manmade hazards can be identified and concretized most completely, the most effective territorial reserves needed for emergency situations can be pulled, and the establishment of a full range of activities aimed at risk reduction is possible.

In Ukraine, there are significant differences in manifestations of natural hazards that have a significant impact on natural and technogenic security areas. To date, the nature of technogenic security at different hierarchical levels has a sectoral basis, according to which, the bulk of resources and power is concentrated with the Ministry of Emergency Situations of Ukraine; its territorial departments supervise, control, and gather information on the status and security. Thus, a considerable flow of operational information and a holistic vision of the territory are lost; in case of natural and manmade hazards, it is only possible to characterize a certain part of emergency situations' development and balance, making situations not always predictable and controllable. In this regard, the socio-geographical approach in solving problems of the regional natural and technogenic security may be used to integrally achieve strategic and tactical objectives of NMDS, linking them with economic and social objectives of the regional development.

At the present time, only isolated issues of NMDS are solved at the regional level. However, it is impossible to completely address the problem, for example, of overcoming disastrous floods without identifying their relationships with other natural hazards, anthropogenic impact on nature, and hazards that manmade objects carry. Another negative consideration is that, in the regional division at which level the state is implementing the regional security policy, only the Autonomous Republic of Crimea and administrative oblasts of the country are considered. This ignores the real risks of emergencies' spatial features and similarities of sets and levels of danger in adjacent oblasts.

RESEARCH METHODS

Approaches of scientific support for NMDS

Theoretical and methodological foundations for zoning using ecological characteristic have not been sufficiently developed as a result of many reasons, including objective, especially considering the large quantity of region-specific factors and interaction between various features of hazard sources: natural and manmade. It is possible to say that this type of zoning is a separate branch among other sectoral zoning types, because it considers factors of production, infrastructure facilities, and resettlement of population, which brings it close to the socio-geographical division; however, it also considers natural phenomena, features of geological structure, climatic conditions, etc., suggesting a similarity to the physical-geographical zoning. In addition, during the zoning procedure, hazardous substances spreading in ecosystems (due to emissions, effluents, solid waste accumulation) should also be considered, i.e., the level of pollution must be taken into account too. While there are studies devoted to NMDS (e.g., monographs by Danylyshyn et al. [2004]; Doroguntsov et al. [1998, 2002]; Rose [2004]; etc.), approaches to zoning that utilize ecological features have not been sufficiently developed. Some theoretical principles and suggestions for zoning are presented in works of M. Kolosovskiy [1958], A. Melnychuk [2005], and A. Dovgan [2003]. There have been no synthesis efforts of the preliminary results in this scientific direction and the integrated scientific concept of zoning in terms of NMDS has not been developed. The goal of this research effort is to address these areas.

Risk is an important factor in many public policy decisions, insurance policies, and regulatory actions [Kellenberg, 2008]. Experts have emphasized the need for a systematic approach to security management [Santos-Reyes and Beard, 2008]. The NMDS provision is described as a part of organizational and economic mechanism [Danylyshyn et al., 2008]. The proper mechanism of NMDS is understood as a set of measures, methods, instruments, and tools to influence the functioning of economic entities, the vital activity of population, natural complexes, and other areas of importance. The human-geographical approach requires a broader

understanding of the NMDS mechanism as a concept. It is based on the regional system approach that considers a complex open system within which deterministic subsystems (technical objects) and self-developing systems (landscapes) are combined. Studies conducted to date show relationship between the income per capita and measures of managing risk from natural disaster [Tansel, 1995]. Isolation of regions as integral formations is influenced by human management and by self-organization [Dovgan, 2003].

Zoning, in terms of NMDS, is the division of the territory into separate parts that are different from each other in the character of natural and technogenic hazards. The characteristics of such units are: (1) the nature of risk (prevalence of natural or manmade hazards) and (2) the level of danger. The level of risk can be evaluated in absolute terms (the level of individual death risk) or relative – different integral security parameters that allow comparing different territorial units in terms of security. The areas of specific natural and manmade security level have characteristics of integral socio-geographical divisions. This includes the presence of the core, i.e., a city with the large population and industries and concentrated infrastructure facilities. The role of the core is dual: on the one hand, it concentrates a large number of hazards; on the other hand, it has concentrated population, for which it is necessary to create a safe environment. Therefore, in zoning divisions, in general, cities are the object of a detailed investigation and of the influence of the authorities and local governments in reducing risk. Socio-geographical location, natural conditions, and resources are described here in terms of addressing emergency situations that may worsen the living conditions of the population. For the given natural area, a set of natural hazards, climate conditions, and landscape features must be sufficiently similar. The definition of the nature of hazard in the area requires consideration of such features as economic specialization (to identify specific types of hazard sources: chemical, fire, explosives, radiation, hydrodynamic, etc.) and the homogeneity of climatic conditions (detection of specific types of natural hazards).

Objectivity of this type of zoning follows from the fact that the research subject, as in other areas of socio-geographic research, is a set of elements of living and inanimate nature and humans that interact with each other; this interaction provides the existence and functioning of geographical systems [Mezentsev, 2005]. In respect to NMDS and addressing hazards that are present in the technosphere, society, and environment, the procedure of regional division includes not only spatial differences and relations within socio-geographic systems, but, above all, the security level of population, economic facilities, and natural ecosystems. The fact, that regional differences in the levels of security have traditionally not been taken into account during integrated zoning, explains the intensification of natural and manmade hazards in the past decade, which is supported by statistics [National Report, 2007]. In this regard, this type of zoning can not be regarded only as a sectoral zoning, and, to a certain extent, it is the integral zoning because it includes all available information [Mezentsev, 2005], e.g., data on elements of inanimate nature, on the state of living nature, on the affected natural elements, on production activities, human beings, etc.

Like other types of zoning, the natural hazard zoning has scientific, educational, and practical value. Thus, the study of regional division allows a more detailed analysis of the security; it also allows reaching the appropriate level of regionalization for individual high-risk (potentially dangerous) regions. The delineation of these regions in integrated zoning would improve administrative and territorial division of the country. The practical significance of this approach is that the results and research of zoning and of individual regions provide the basis for management decisions to enhance NMDS in the regional context.

Algorithm, principles, criteria, and indicators of zoning

The first step should include assessment of factors that influence zoning. Factors affect the identification of the regions in different ways. These factors provided the basis for formulation of principles and criteria and they represent indicators in defining zoning in terms of NMDS. Under the principles of zoning, we consider the statements and the rules of the territorial division formulated earlier [Ishchuk, 2008]. In our study, we followed the principles listed below:

1. Accordance with the administrative division of the state, which determines that the administrative boundaries, that already exist, be used in zoning. This would allow efficiently improving security and security measures based on the current Unified State System of Response and Prevention of Emergencies [Cabinet of Ministers of Ukraine, 1998].

2. Potential value of individual regions, which considers hazards that have the established and objective basis for the existence and that impact the livelihoods of the population. Their mitigation should be included into long-term plans and programs of the regional development.

3. Consideration of interrelations between natural and manmade hazards (synergistic effects). Although the mechanisms of natural and manmade hazards are different, there is interaction between them. Often, large damage caused by an emergency situation of the natural character is linked with a poor reliability of technical systems, such as construction of residential buildings and major infrastructure facilities in flood areas without existence of dams. Also, natural disasters often trigger large-scale manmade disasters, for example: droughts are the factor of fires and explosions at potentially dangerous objects.

Furthermore, during the implementation of zoning, it is desirable to adhere to such requirements as continuity, uniqueness, and single scale use, sometimes known as zoning requirements. They are the key to the appropriate general zoning division grid [Mezentsev, 2005]. Definition of criteria and zoning indicators is difficult for the traditional types of zoning and for the new one; it is a key question, the answer to which affects substantially the final result, i.e., the configuration of the regions. One of the main criteria may be the presence, in the area, of some prevailing environmental problem caused by disharmony in interaction and mutual influence of natural elements, anthropogenic systems, and human behavior. The examples of this problem are the Chernobyl nuclear power plant in Polissia and flood forecasting and prevention in the Carpathian region. We define quantitative criteria as the integral calculated coefficients that reflect the level of natural and man-made threats and the level of individual death risk.

The system of indicators that reflects the level of NMDS in general has been developed. The first group of indicators that estimate the level of both natural and manmade hazards is as follows:

– size of potentially damaged area, km^2;

– ratio of the area of the likely damage to the total regional area,%;

– population of the area of possible damage, thousand of people.;

– percent of population living in the area of possible hazard relative to the total population of the area, %.

For manmade hazards, the following indicators are also included:

– number of potentially hazardous objects and vehicles;

– distribution of potentially hazardous objects by degree of danger, %;

– quantity of hazardous substances on potentially hazardous objects, ton;

– distribution of hazardous substances in terms of toxicity, %.

The delineation of the regions should also consider indicators of industrial activity (industrial production by sector, area specialization index), social development (frequency of major diseases), and pollution (amount of mineral extraction, emissions, discharges, accumulation of solid wastes).

Cluster analysis applied to the socio-geographical zoning proved to be very helpful [Popovkin et al., 1994]. To justify the

Ranking of the administrative regions (oblasts) of Ukraine by the level of NMDS

№	Regions	Integral rank by manmade hazards	Integral rank by natural hazards	Emergency character criterion	Generalized emergency character criterion
1	Donetska oblast	55	28	1.96	2.17
2	Luganska oblast	88	37	2.38	
3	Dnipropetrovska oblast	68	41	1.66	1.57
4	Zaporizska oblast	100	58.5	1.71	
5	Kirovogradska oblast	75	66	1.14	
6	Cherkaska oblast	107	60	1.78	
7	Khmelnytska oblast	68.5	70	0.98	0.80
8	Vinnytska oblast	71	75.5	0.94	
9	Ternopilska oblast	44	54	0.81	
10	Chernivetska oblast	42	87	0.48	0.72
11	Lvivska oblast	59	74	0.80	
12	Zakarpatska oblast	38.5	83	0.46	
13	Ivano-Frankivska oblast	51.5	76	0.68	
14	Volynska oblast	63	68	0.93	
15	Rivnenska oblast	80	59	1.36	
16	Zhitomirska oblast	48	70	0.69	0.78
17	Kyivska oblast	45	69.5	0.65	
18	Chernigivska oblast	56	105	0.53	
19	Sumska oblast	51	78.5	0.65	
20	Poltavska oblast	58.5	63.5	0.92	1.07
21	Kharkivska oblast	61	50.5	1.21	
22	Mykolayivska oblast	81	73	1.11	1.03
23	Khersonska oblast	66.5	74	0.90	
24	Autonomous Republic of Crimea	58	54	1.07	
25	Odeska oblast	87	50	1.74	1.74

division of the country in terms of NMDS, we performed cluster analysis of administrative regions (oblasts and the Autonomous Republic of Crimea (ARC)). The ranking method allowed us, first, to identify the nature of the hazard and the prevalence of certain hazards in specific groups, and, second, to group oblasts and the ARC into groups that formed the basis for the divisions. Ranking allowed delineating the boundaries precisely, which was not possible by the cluster analysis alone. The nature of risk was determined by the appropriate criterion, calculated as the ratio of the ranks in a natural hazard to the relevant indicator of a manmade hazard. To determine ranking, the integrated hazard criterion was used [Danylyshyn et al., 2008], which was supplemented by calculated relative indicators of the number of situations of natural and manmade character.

The generalized nature of the risk criterion indicates the ratio between natural and manmade hazards in the territory. The proximity of the criterion's values and consideration of the principle of administrative division allowed uniting the oblasts into the districts (see Table).

Human-geographical mechanism of NMDS

Selecting regions within Ukraine is the main consideration in optimization of the regional policy and the prerequisite of effective human-geographical mechanism of NMDS. Using the theory and methodology of social geography in the development of the foundations of NMDS involves primarily understanding its characteristics as a complex of human-geographical parameters. NMDS's status is determined by the level of balance of human-geographical complex, rational allocation of enterprises, engineering structures, and transportation facilities that are potentially dangerous. Human-geographical arrangement should include actions, methods, and means of influence based on the use of space resources of regional development and provide risk reduction by improving the regional territorial structure and by establishing the necessary connections and relations in the system of the regional NMDS.

The human-geographical mechanism of the regional NMDS includes scientifically based activities of the government aimed at reduction of natural and manmade hazards for the public, commercial facilities, and the region in general to acceptable levels by improving measures to prevent and minimize the consequences of natural and manmade disasters. An effective organizational and economic mechanism of NMDS regulation may still have some shortcomings and may need improvement, including the implementation of human-geographical activities.

RESULTS

Activities to ensure NMDS at different hierarchical levels

At the global level, it is important to ensure the country's participation in the world-scale international activities aimed at studying natural and technogenic risks, forecasting, prevention, and minimization of the consequences of emergencies. The most successful, in this regard, is the participation of governmental delegations in the global-level international forums where negative consequences of anthropogenic impact on global environment are discussed and steps to resolve the most urgent environmental problems are determined (Rio de Janeiro (1992), Johannesburg (2002), and Copenhagen (2009)), and, the clearly established and mutually beneficial cooperation between Ukraine and NATO in the field of NMDS.

Our country participates actively in international exercises, forums, and meetings of experts from NATO. At the initiative and with support projects of this organization, the global information preparedness and response system to emergency situations have been created. Ukrainian experts participated in training courses in the states – the Alliance members. Another solution to security

problems is associated with the system of intergovernmental regional arrangements. For our country, the most important is the interaction within the CIS (the Interstate Council on Emergency Situations of Natural and Manmade Character) and the GUAM (Organization of Black Sea Economic Cooperation). Coordination of security legislation and assistance facilitates overcoming the powerful impacts of emergencies and promotes coordinated measures to enhance NMDS of the population.

Globalization of the scale and consequences of emergency situations and their increased cross-border impacts are forcing our country to be included in a wide range of international cooperation activities in this field. Ukraine has a number of bilateral intergovernmental agreements in preventing the emergency situations and minimizing their effects: with the Russian Federation, Armenia, Kazakhstan, Slovakia, Greece, and Belarus. Ukraine is a participant of international conventions on nuclear security, which is the key element to the global nuclear security. It has governmental bilateral agreements in radiation security with Austria, Poland, Germany, Norway, and Finland. Our country is also a member of the International Civil Defense Organization. Ukraine participates in UN activities and exercises aimed at improving NMDS.

The bodies that determine the impact on NMDS in Ukraine are: the National Security and Defense Council of Ukraine, the Cabinet of Ministers of Ukraine, the Supreme Council of Ukraine, the Ministry of Emergencies, chief departments of the Ministry of ARC, oblasts, Kyiv and Sevastopol, their districts, city departments (sectors), local administrations, local authorities, civil defense services, fire-rescue and emergency rescue units, and economical entities that own objects with increased risk [Danylyshyn, et al., 2008].

A substantial risk decrease in the regions of Ukraine should be provided with a clear realization of regional policy in the sphere of security through the development and implementation of comprehensive public regional programs. They are implemented through effective management of NMDS. The system of control over NMDS in Ukraine requires substantial reorganization, automation, and geographical reorientation.

Management of the most significant public natural and manmade risks can be achieved at the level of regional divisions selected in this work. According to earlier studies [Kononenko, 2007], factors of division can be grouped into three categories: human, natural, and organizational and management. According to the calculations, the main impact on the state of NMDS, among human activities, is provided by the level of development of industry. The significant concentration of industrial capacity in certain regions, uneven development of industrial infrastructure, specialization of the industrialized regions of Ukraine associated with high level of potential emergency situations (coal mining, power, chemicals and petrochemicals, etc.) form a significant territorial differentiation of distribution of anthropogenic emergency situations. Natural hazards include landslides, floods, flooding, and seismic instability. Natural hazards, e.g., dangerous geological, hydrological, meteorological phenomena, may be of a greater importance to the western regions of the country. Among the organizational and management factors that impact the security of the population, organizational, productive, engineering, control, and legal and financial resources can be identified. The influence of these factors is significant, especially considering the fact that the system of natural and technogenic security in the regions has not been yet fully implemented. Factor analysis [Kononenko, 2007] identified two groups of factors that provide the greatest effect, i.e., of the anthropogenic and of the natural character: the influence of anthropogenic and natural factors on the regional ecological security is 52% and 11%, respectively.

Cluster analysis of selected groups showed, first, similarities in the manifestation of threats in Polissia oblasts (Chernihiv, Zhytomyr, Rivne, Volyn, Kiev, and Sumy regions); second, the formation of the group of oblasts in the western region, which includes Chernivtsi, Ivano-Frankivsk, Ternopil, Lviv, and, also, the Khmelnytsky and the Vinnytsia oblasts; third, closeness of NMDS indices of Poltava and Kharkov oblasts; and, fourth, the isolation of southern and eastern oblasts, with, among the southern regions, Odesa, Mykolaiv, and AR of Crimea have common characteristics. The following oblasts can be isolated individually: Kherson, Dnipropetrovsk, Donetsk, Kirovohrad, Cherkassy, and Transcarpathia.

In terms of natural and manmade hazards, the following divisions in Ukraine were identified based on a particular structure of regional human-geographical complexes, on areas of influence of existing facilities and sources of increased danger, on security features of the prevailing regional industrial complexes, on the prevalence of some types of natural and manmade risks, on cluster analysis, and on collected statistics:

I. West: high risk of floods, geological, and manmade emergency situations related to meteorological hazards and forest fires;

II. North: frequent floods and manmade high risk related to forest fires, floods, spread of infectious diseases, accidents at hydrodynamic facilities;

III. Central-Western: geological and manmade risks and frequent meteorological emergency situations;

IV. Central: radiation, chemical, explosion, fire, flood, and landslide risks and high risk of emergencies at facilities of the hydrodynamic and energy complex;

V. Northeast: floods, chemical, explosions, fire danger, and risk of emergencies of meteorological character;

VI. East: explosion, fire, chemical, and geological risk and high risk of emergencies of meteorological character;

VII. South: geological and manmade risk and high risk of meteorological emergencies associated with floods;

VIII. Southwest: geological, explosion, and fire risk and high risk of emergencies at municipal facilities; risk associated with production.

The socio-geographical aspects of differences in internal security within certain groups of oblasts have been researched and identified; analysis of natural and man-made disasters has been performed (Fig. 1).

The human-geographical mechanism of the regional NMDS

The human-geographical mechanism of the regional NMDS (Fig. 2) outlines the procedure and the content of the governmental policy aimed at achieving the strategic goal of NMDS management [Oliynyk et al., 2010].

We consider the effectiveness of territorial organization of the regional NMDS as defined by: the allocation of its centers of different hierarchical levels (inter-district, district, and local levels) and of high risk objects outside the settlements; the areas of high risk due to a psossible negative impact on the public caused by natural and manmade hazards; the level of infrastructure development (networks of human, financial, technical, and material resources stocks; the system of civil alert in case of emergencies, etc.); and the efficiency of NMDS management.

Under the natural and industrial security centers, we propose to consider the population centers, whose components form the territorial structure of specific combinations of natural and manmade hazards to human life, the system of forces and means of emergency situations prevention and of minimization of their effects, and risk emergency management.

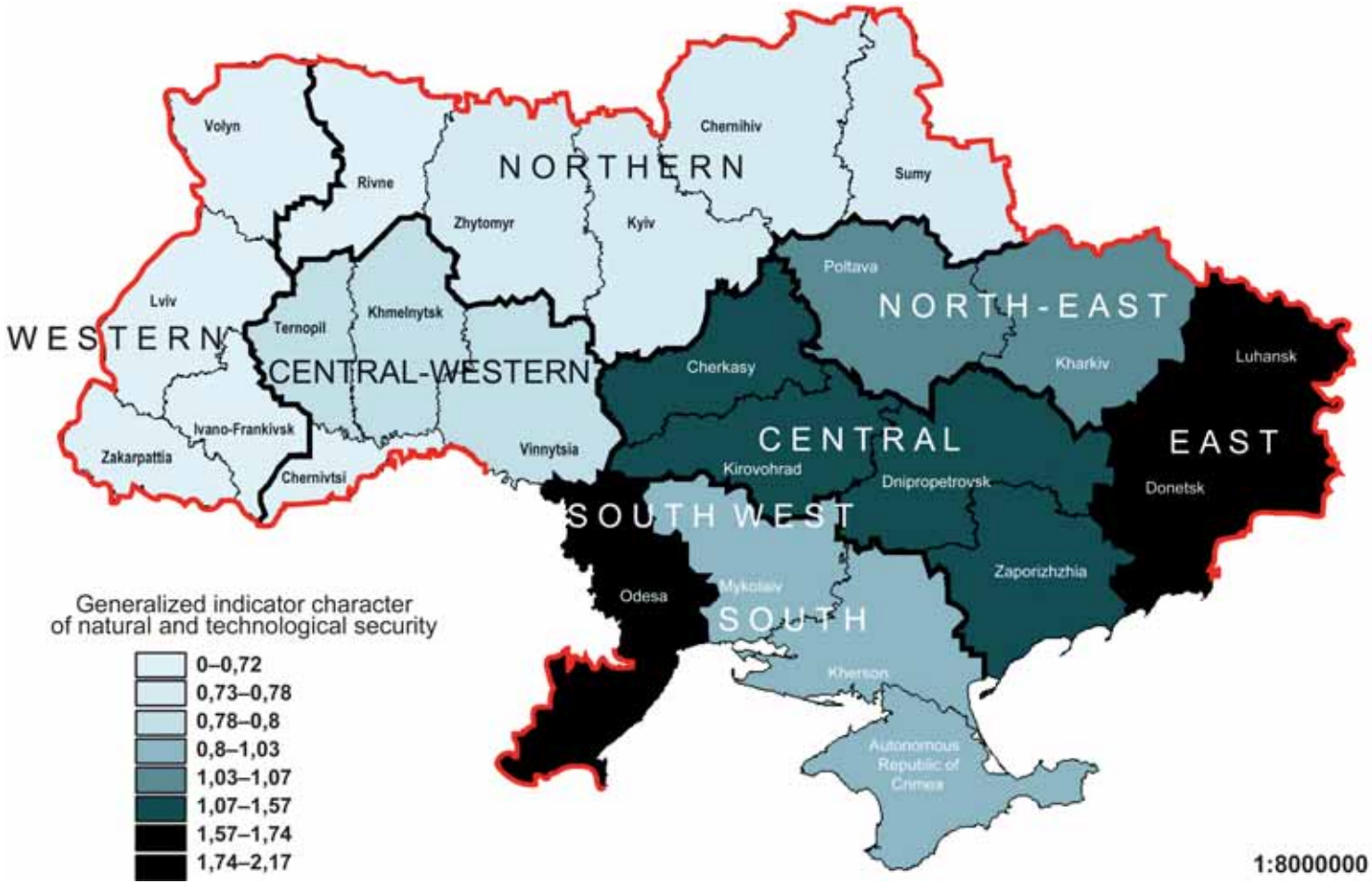

Fig. 1. Divisions based on the level of NMDS

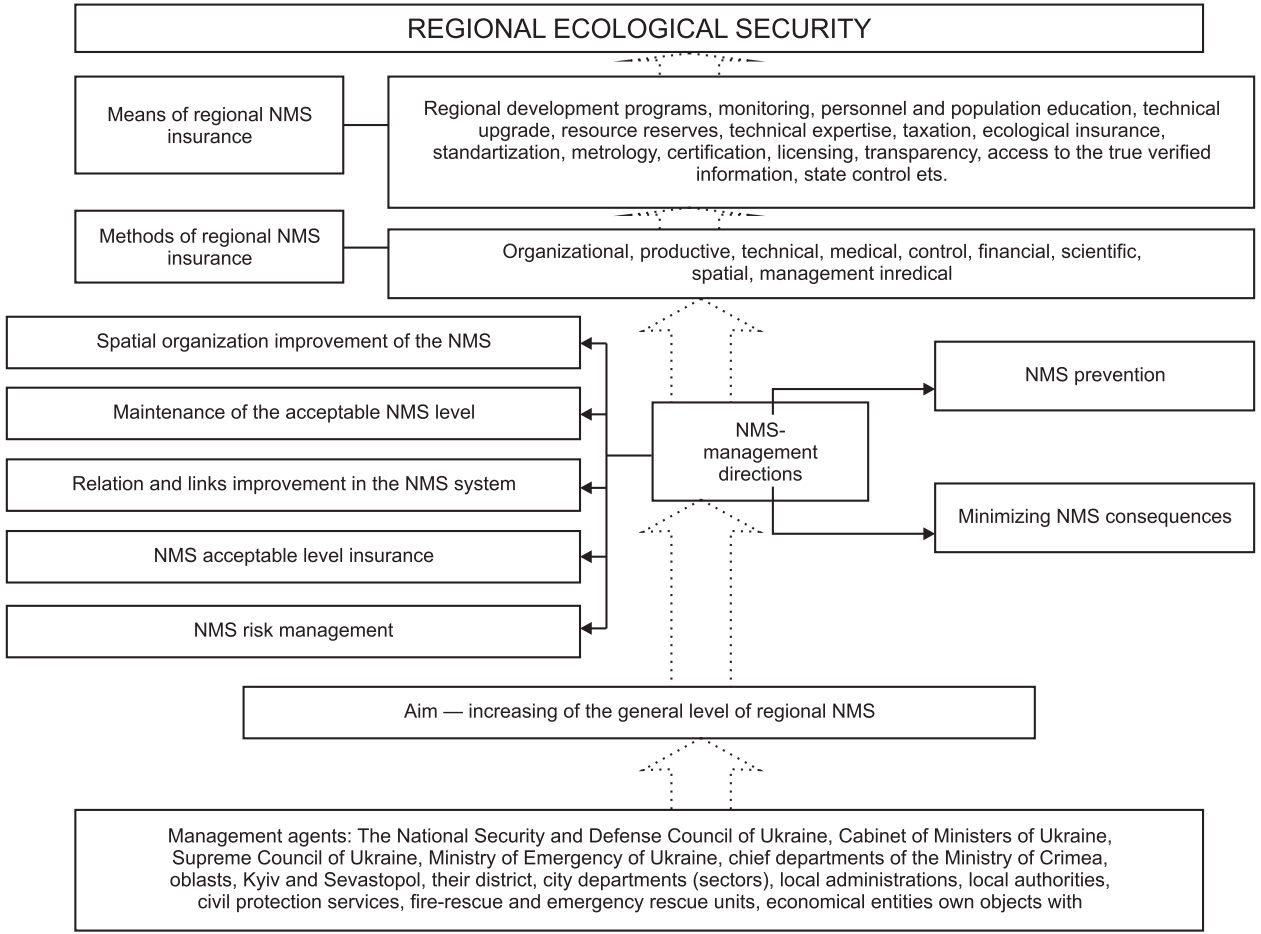

Fig. 2. The human-geographical mechanism of the regional NMDS

The improvement of the territorial organization of NMDS is associated with reducing natural and manmade territorial risks through the elimination of high-risk objects that do not play an essential role for the regional development, through the optimization of placement of the objects whose elimination is not possible, through increasing emergency-prevention activity and a level of population readiness, and through the appropriate authorities preparedness in emergency situations; it can be achieved by development of appropriate infrastructure and optimization of management of NMDS.

Optimal spatial relations in NMDS systems depend on the complexity of their functional structures. The most important components are environmental, industrial, infrastructural, and management relations. Uncontrolled anthropogenic pressure (associated primarily with economic activity) dramatically increases the risk of natural disasters and the number of people who live or work in the areas of possible hazardous situations. Close interrelation of natural and manmade risks creates high potential for disasters or accidents within compact areas. It is especially dangerous because of a possible combination of effects of several types of emergencies. Thus, elimination or minimization of negative consequences is a complex and difficult task. Spatial manmade relations are caused by dangerous areas growing as a result of hazardous substances movement and proliferation of dangerous technologies that should fall under the system of strict control and management. It defines the role of infrastructure bonds. Various sources of natural threats, high risk objects, services of preventing emergencies and minimizing their consequences, and appropriate management structures are considered and included, via appropriate infrastructure, into a unified integral territorial system of NMDS.

Risk management of natural and manmade disasters, as the area of government regulation, involves a complex of measures aimed at maintaining risk (for certain high risk objects, industries, regions, etc.) at the lowest possible level. Risk management process is cyclic and includes the following mandatory steps: monitoring NMDS and risk identification, risk assessment, selection of methods and means of risk management, their implementation, and evaluation of the application effectiveness. The principal methods of reducing risks are risk elimination, localization, redistribution, control, insurance, and absorption. Each of these methods involves the use of a set of measures depending on the initial level of risk, availability of resources, and economic and social feasibility of dangerous economic activities [Kononenko and Melnychuk, 2006].

At the regional level, the goal, direction, and implementation of methods to ensure NMDS define the following measures:

- development of the action system and, if necessary, of the state regional program, for the implementation of a range of preventive measures aimed at reducing risk of emergency situations and minimizing their consequences;
- monitoring in addressing natural and manmade hazards;
- training for response of population and the personnel of high-risk objects in emergency situations;
- effective manmade interaction of high-risk objects;
- required reserves of human, financial, and material resources; necessary supplies of medicines, equipment, and personal protection;
- technical expertise in the area of population and territorial security at the design stage of high-risk objects, technical processes improvement, and standard technology and production equipment upgrading;
- introduction of the effective taxation systems, environmental insurance, standardization, metrology, certification,

licensing, and representation in the sphere of NMDS.

– provision of the population with objective information about natural and industrial hazards in the region, their severity, the ways to overcome them through the establishment and maintenance of regional geographic information systems and through the creation of modern back-up notification systems for emergencies;

– verification of these measures, and managing risk of natural and manmade emergencies at an acceptable level.

Effective management of NMDS is based on pasportization (i.e., classification) of regional risks. The passports of the country divisions, defined based on the level of natural and industrial hazards, must include geographic features and identified sources of high risk. They should be coded and classified according to types. The types of serious hazards and emergencies associated with them should be defined. Potential chain emergencies, their probability, acuity, and the most serious negative consequences that may arise in response to natural and manmade disasters must be defined. Existing governmental bodies; services; material, financial, and human reserves available to prevent and minimize negative consequences of emergency situations; and their main characteristics and parameters should be taken into account. All emergency situations that occurred in the past and their main features and options for response must be described [Oliynyk et al., 2009].

Only a comprehensive system of state measures based on principles of priorities for human security can significantly improve the condition of NMDS in Ukraine. Warning of the natural emergency situations will be more efficient through the development and implementation of the new equipment and technologies for monitoring natural hazards, through modernization, and through adequate funding of the relevant services. There should be broad awareness of structure and acuity of the most significant hazards in the country and its regions and of response means.

Strengthening the supervisory functions of the state, especially at the regional and local levels of security, is the main precondition for reducing risks of manmade emergency situations.

Effective, comprehensive, and specific activity to manage natural and manmade security can be effectively provided at the level of divisions defined by the level of natural and industrial hazards.

CONCLUSIONS

The results presented in this paper form the part of theoretical and methodological foundations of regional studies of NMDS from the standpoint of human geography. The paper also discusses the development and implementation of the socio-geographical mechanism.

By NMDS zoning, we understand the division of the territory into separate parts that are different from each other by specific combinations of natural and manmade hazards. Their primary characteristics are the origin and level of hazard. The principles of NMDS zoning were identified. They include compliance with the state administrative-territorial system and potential features of divisions that take into account the balance between natural and manmade hazards (synergistic effects). Quantitative zoning criteria are used in the integral calculation indicators reflecting the level of natural and manmade hazards and the level of the individual death risk.

Centers for prevention of natural and manmade hazards in each region would be able to reduce significantly risk of natural and technogenic emergency situations. The centers should provide analysis of factors, distinguish sources and high risk objects, perform risk certification and monitoring, created resources of material, financial, and human reserves, and interact effectively with business community and public organizations. ■

REFERENCES

1. Cabinet of Ministers of Ukraine (1998). On the unified state system of prevention and response to emergency situations of manmade and natural character. August 3, № 1198 (in Ukrainian).
2. Danylyshyn, B., Kovtun, V., and Stepanenko, A. (2004): Scientific basis of natural and industrial (environmental) security forecasting. Lex House, Kyiv (in Ukrainian).
3. Danylyshyn, B., Stepanenko, A., and Ralchuk, A. (2008): Security Strategy of the regions of Ukraine and its guarantee. Vol.1 Natural and manmade (environmental) security. Naukova Dumka. Kyiv (in Ukrainian).
4. Dorohuntsov, S. and Ralchuk, A. (2002): Managing manmade environmental security in the context of sustainable development paradigm: the concept of system-dynamic solution. Naukova Dumka, Kyiv (in Ukrainian).
5. Dorohuntsov, S., Stepanenko, A., and Kovtun V. (1998): Economic, legal and environmental principles of potentially hazardous enterprises privatization. Logos. Kyiv (in Ukrainian).
6. Dovgan, A. (2003): "Natural and ecological security of Ukrainian population and regions," Geography and modernity, 9: 114–123 (in Ukrainian).
7. Ishchuk, S. (2008): "Scientific basis of socio-economic zoning," Economic and Social Geography, 58: 26–31(in Ukrainian).
8. Kellenberg, D. K. and Mobarak A. M. (2008): "Does rising income increase or decrease damage risk from natural disasters?" Journal of Urban Economics, 63 (3): 788–802.
9. Kirchsteiger, Ch. (1999): "Trends in accidents, disasters, and risk sources in Europe Original Research Article," Prevention in the Process Industries, 12 (1): 7–17.
10. Kolosovsky, N. (1969): Theory of Economic Regionalization. Mysl. Moscow (in Russian).
11. Kononenko, O. (2007): "Factors that determine the state of regional ecological security in Ukraine," Economic and social geography, 57: 196-201 (in Ukrainian).
12. Kononenko, O. and Melnychuk, A. (2006): "State regional environmental policy in Ukraine and areas for improvement," Economic and Social Geography, 56: 134–142 (in Ukrainian).
13. Melnychuk, A. (2005): "Natural and man-made security evaluation of the Ukrainian population in terms of areas allocated by the level of natural and manmade hazards," Geography and modernity, 13: 121–129 (in Ukrainian).
14. Mezentsev, K. (2005): Human-geographical forecasting for regional development. Publishing center "Kyiv University," Kyiv (in Ukrainian).
15. National Report on the Manmade and Natural Security of Ukraine in 2007 (in Ukrainian).
16. Oliynyk, Ya., Kononenko O., and Melnychuk A. (2009): "Improving management of natural and manmade security at the regional level," Regional issues in Ukraine: geographical analysis and search for solutions, 360–364 (in Ukrainian).
17. Oliynyk, Ya., Kononenko, O., and Melnychuk, A. (2010): "Human-geographical mechanism of natural and manmade regional security," Economic and Social Geography, 61: 3-12 (in Ukrainian).
18. Popovkin, V., Kalytenko, A., Rozynka, V., and Syrotych, M. (1994): Preliminary design of economic zoning of Ukraine. NISS. Kyiv (in Ukrainian).
19. Rose, A. (2007): "Economic resilience to natural and manmade disasters: Multidisciplinary origins and contextual dimensions," Environmental Hazards, 7 (4): 383–398.

20. Santos-Reyes J. and Beard A. (2008): "A systemic approach to managing safety," Process Industries, 21 (1): 15–28.

21. Scientific report of Ukraine / United Nations Conference on "Environment and Development" (Brazil 92), 1992. Time, Kyiv.

22. Tansel, B. (1995): "Natural and manmade disasters: accepting and managing risks," Safety Science, 20 (1): 91–99.

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CRITERIA OF THE ECOSYSTEM STABILITY IN THE NORTHERN REGION OF THE CASPIAN SEA

ABSTRACT. The aim of the work is to determine the criteria of the marine shallow-water ecosystem stability using the Northern region of the Caspian Sea as a case study. For each 260 reference points, we received data on 76 parameters, including physical-geographical, hydrochemical, and hydrobiological characteristics that have been analyzed by the method of principle components. The analyzes of these data allowed us to reveal and evaluate principal geoecological factors that influence the distribution of *Acipenseridae* in the Caspian Sea as a top level of the ecosystem's trophic chain. The main geoecological factors and the factor of anthropogenic load of the Caspian Sea ecosystems' stability have been determined.

KEY WORDS: The North Caspian Sea, criteria of the aquatic ecosystem stability, sub-aquatic natural complex, anthropogenic load, landscape forming factors, factor analyses, sturgeon population.

INTRODUCTION

One of the criteria for the stable state of the Caspian Sea ecosystem is the wellbeing of long-lived sturgeon fishes (*Acipenser population*) as species that reside at the upper trophic level of the aquatic ecosystem. Its population is presently subjected to a heavy anthropogenic impact. Of a special significance for their spawning, fattening, and winter stay, are the underwater natural complexes of the northern Caspian Sea aquatic environment, where each of the water areas is important for normal functioning of this population. Therefore, in order to preserve the most productive northern region of the Caspian Sea, it is necessary to carry out zoning of its underwater natural complexes and of their landscape-forming factors and to determine the quantitative significance of each factor. In the natural conditions, it is difficult to separate factors that impact sturgeon fishes one from another and it is even more difficult to estimate quantitatively the role of each of these factors. In this study, an attempt is made to fill in this gap.

The objective of this study is to determine the main factors that characterize the basic features and influence the stable functioning of the Caspian Sea ecosystem, according to the degree of their significance. To achieve this objective, the following tasks were solved:

1) Creation of a data base of a number of basic geoecological characteristics of the underwater landscapes in the northern part of the Caspian Sea collected in filed studies and from literature sources and their subsequent statistical processing;

2) Subsequent mapping of water areas with similar natural conditions and classification and complex zoning of the region under study;

3) Selection of basic parameters that characterize integrally the state of each underwater landscape component using results of pairwise correlation analysis;

4) Definition of basic factors as criteria determining the conditions of stable existence of sturgeon fishes applying the method of main components to the region as a whole and to its large underwater natural complexes represented by physical-geographical areas and sub-areas.

THE STUDY OBJECT AND RESEARCH METHODOLOGY

To study the region, which is bordered from the north, east, and west by the coasts, and from the south – by a boundary running along the straight line from the cape Burun to the cape Segendi, the data on different parameters of the state of sea environment were analyzed. These data were obtained by on-ship observations carried out on standard cross-sections in 1960–2000. Overall, thousands of marine stations were installed over this region, where tens of thousands observations were carried out. The data of the entire historical line of observations in a 0-m horizon and in the near-bottom layer for the warmest (August) and the coldest (February) months were interpolated to the nodes of a regular grid with a step of 25×25 km using GIS-technologies. Thus, for all the observed and calculated oceanographic parameters of the study sea environment, three-dimensional data matrixes were formed, which became the basis for the analysis of the environmental state of the bottom natural complexes (BNC). These parameters included geologic-geomorphological (depth, relief type), lithological (granulometrical composition and type of bottom sediments); hydrodynamical (wave height); climatic (total and absorbed solar radiation, balance of radiation); hydrological (average multi-year winter (February) and summer (August) temperatures of surface and near-bottom water, ice distribution); biological (distribution of five species of sturgeon fishes; total biomass of phytoplankton, zooplankton, and zoobenthos; biomass of dominant species of phytoplankton, zooplankton, and zoobenthos; as well as a number of forage types for zoobenthos sturgeon species (*Abra, Nereis* and others)); hydrochemical (salinity, distribution of Cl, SO_4, HCO_3, Ca, Mg, NO_2, NH_4, PO_4, Si, O_2, Ph in water and bottom sediments, alkalinity); and anthropogenic pollution (concentrations of oil hydrocarbons (HC), phenols, synthetic surface-active substances (SSAS)). The coast landscapes were also taken into account [Landscape Map of the USSR, 1987] (Fig. 1). As a result, data sets for 54 parameters were obtained for each reference point (totally, 260 points). Thus, the analyzed variables represent the integral characteristics of the landscape-forming and geoecological factors, covering the entire complex of components of the coastal zone landscapes.

In order to distinguish and to map water areas with similar natural conditions, the landscape zoning of the sea-bottom natural complexes was carried out. The basic types of the bottom natural complexes were determined, which are typical to the water area under investigation and refer to three sub-areas of the Caspian Sea: (1) the Northern-Caspian shallow-water, (2) the Northern-Caspian deeper-water, and (3) the northern part of the Central Caspian sub-area (Fig. 2). For quantitative substantiation of structural changes in the interconnections between the components of the sub-areas that fulfill different functions in the sea ecosystem, the initial matrix of variables characterizing the entire study region was appropriately subdivided. As a result, four matrixes of variables were compiled: the first – characterizing the entire water region under study and incorporating the data of all observation points, included 54 columns and 211 lines; the second – for the Northern-Caspian shallow-water sub-area, with a size of 54×69; the third – for the Northern-Caspian deeper-water sub-area with a size of 54×77; the fourth – for the Northern part of the Middle Caspian area with a size of 54×65, involving data of the observation points lying in the central part of the sea (area including the Mangyshlak rapids and south of it).

The initial matrix for the entire study region was treated using the method of

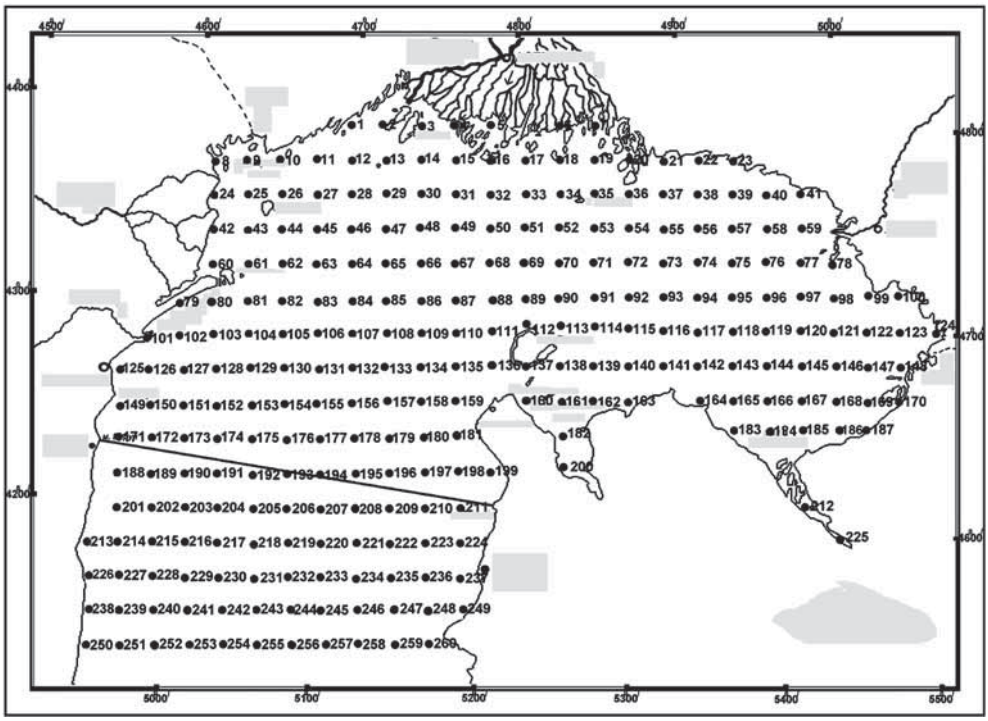

Fig. 1. The map of the observation points' locations

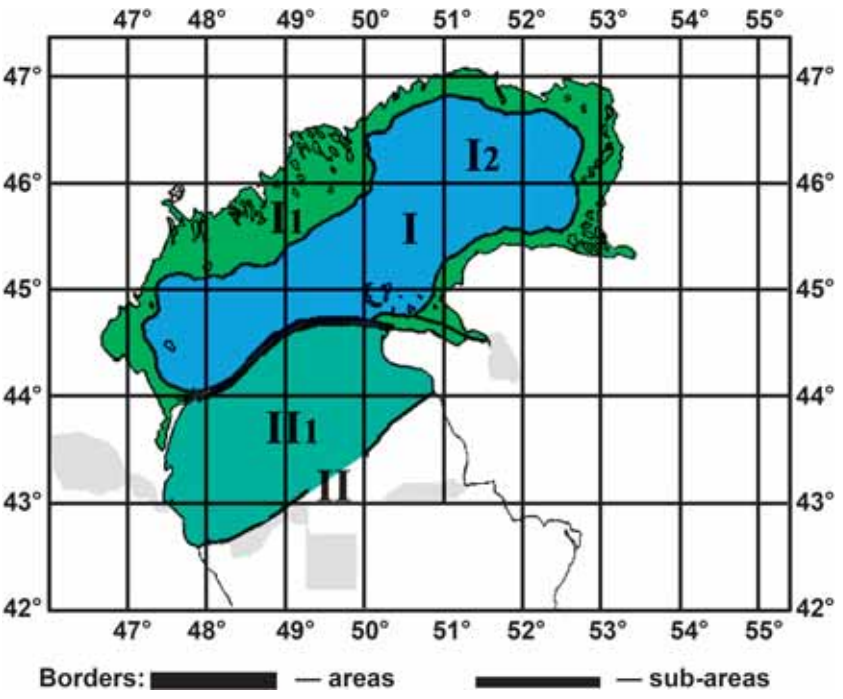

Fig. 2. The map of basic natural complexes

pair correlation analysis. Into consideration there were taken the strong correlating links ($r \geqslant 0.7$) that characterize the interaction between the components of the underwater natural complexes. The matrix diagonal consists of sufficiently high correlation coefficients (r) and more than half of the matrix has coefficients $r > 0.3$; hence, the variables selected for the analysis are sufficiently representative.

The number of different factors influencing an open ecosystem is great; therefore, it is necessary, during the investigations, to identify those indices and factors that determine the ecosystem's stable functioning. For this purpose, it is necessary to select such integral indices that determine qualitatively the integral state of any component in the ecosystem according to some certain function [Pegov, 1992]. Such approach allows obtaining the most general pattern of an integral parameter. In accordance with the above-said, we have selected the integral indices characterizing each of the basic components of the underwater landscape and connected with other indices by strong correlation links. Here, no strong correlation links were revealed between the density of sturgeon distribution over the water area and other indices; the links were established only at the level of mean coefficients ($r \geqslant 0.31$–0.5).

In order to determine the significance of the influence of different parameters on the density of sturgeon distribution, the entire collection of data was processed using the factor analysis with the aid of the method of main components. The method was aimed at defining the regular features governing the phenomenon under study (namely, the density of sturgeon distribution over the water area), i.e., those basic factors that determine the behavior of a large number of various characteristics of this phenomenon [Braverman and Muchnik, 1983]. This helped to distinguish, among the measured variables, a small number of hidden factors characterizing basic features of sturgeon fishes distribution. For solution of this task and using the results of correlation analysis, there was selected a row of parameters for 211 observation points (because, in this case, the entire data row was required) and a row of variables that describe quantitatively the basic features of natural complexes in the study region.

Basic factors for the entire region were defined from the analysis of the initial matrix with a size of 14×211 (i.e., consisting of 211 lines or points of observation, and 14 variables (columns), which quantitatively described 14 features of different BNC components). Then, for substantiation of the influence of abiotic factors on the sturgeon existence, the obtained basic variables characterizing the ecosystem's integral state were processed by the method of main components, where the dependent variable "C" is the catch of sturgeon fishes. The variables measured were as follows:

X1 – average multi-year temperature of the sea surface for February (°C) – characterizes hydrological and thermal regime of the Caspian Sea;

X2 – boundaries of ice distribution (coded in estimated numbers) – this variable characterizes natural climatic, and hydrological conditions of the North Caspian area in winter period;

X3 – NO_2-distribution on the sea surface (mkg NO_2/l) – characterizes hydrochemical conditions;

X4 – O_2-distribution (mg/l) on the sea surface – characterizes hydrochemical conditions;

X5 – average annual distribution of salinity ($^0/_{00}$) in surface waters – characterizes hydrochemical regime in the sea;

X6 – radiation balance per year (MJ/m^2) – determines the difference between incoming and outgoing solar energy and characterizes climatic conditions;

X7 – depth (m) – serves as a characteristics of the sea-bottom relief;

X8 – distance from the Volga-Caspian main channel (in km) – characterizes a degree to which the Volga River runoff influences pollution of the sea area;

X9 – distribution of the total biomass of the zooplankton (g/m^2) in the Caspian Sea – characterizes the sea biological complexes;

X10 – distribution of the total biomass of the phytoplankton (mg/m^3) in the Caspian Sea – characterizes biological complexes of the sea and determines its productivity;

X11 – distribution of biomass of the zoobenthos (g/m^2) – characterizes conditions for forming forage resources of sturgeon fishes;

X12 – average annual distribution of phenols (mg/l) in the water – characterizes a degree of pollution of the water area (as one of basic components of water pollution);

X13 – average annual distribution of oil hydrocarbons (OH) (mg/l) in the water – characterizes a degree of pollution of the water area (as one of basic components of water pollution);

X14 – distribution of five species of sturgeon fishes (*Acipenser gueldenstaedtii Brandt; Acipenser nudiventris Lovetsky; Acipenser persicus Borodin; Acipenser stellatus Pallas; Huso huso Linnaeus*) in the North Caspian Sea area (coded in estimated numbers).

Thus, the defined variables make it possible to cover the entire complex of components composing the sea-BNC.

Tables 1–4 present the matrix of pair linear correlation coefficients of the selected parameters. Table 1 presents the matrix of the pair correlation links between the integral variables for the entire studied region. Table 2 presents the matrix of the pair correlation

Table 1. The matrix of the pair correlation links between the integral variables for the entire studied region

Variables	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1													
X2	–0.77	1												
X3	–0.2	0.41	1											
X4	0.3	0.02	0.38	1										
X5	0.61	–0.78	–0.58	–0.3	1									
X6	0.35	–0.55	–0.38	–0.4	0.61	1								
X7	0.75	–0.75	–0.46	–0.05	0.79	0.46	1							
X8	–0.01	0.05	–0.16	0.05	–0.03	–0.16	–0.03	1						
X9	0.51	–0.41	0.01	0.3	0.31	0.21	0.43	–0.16	1					
X10	–0.32	0.36	0.31	0.21	–0.47	–0.41	–0.32	–0.12	–0.1	1				
X11	0.31	–0.5	–0.36	–0.24	0.62	0.53	0.37	–0.08	0.07	–0.5	1			
X12	–0.43	0.55	0.01	0.16	–0.55	–0.55	–0.42	0.42	–0.4	0.24	–0.42	1		
X13	0.25	–0.26	0.08	0.04	0.23	0.31	0.12	–0.2	0.3	–0.04	0.17	–0.65	1	
X14	–0.1	0.17	0.18	0.21	–0.13	–0.16	–0.15	–0.13	0.21	0.12	–0.17	–0.03	0.12	1

Table 2. The matrix of the pair correlation links between the integral variables for the Northern-Caspian shallow-water sub-area

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
X1	1													
X2	–0.71	1												
X3	–0.23	0.5	1											
X4	0.15	0.16	0.37	1										
X5	0.37	–0.65	–0.54	–0.41	1									
X6	0.31	–0.69	–0.42	–0.54	0.6	1								
X7	0.45	–0.54	–0.54	–0.22	0.65	0.46	1							
X8	0.02	–0.03	–0.24	0.05	0.1	–0.19	0.03	1						
X9	0.08	0.05	0.12	0.1	–0.18	0.09	–0.001	–0.22	1					
X10	–0.31	0.5	0.43	0.06	–0.37	–0.18	–0.04	–0.44	0.2	1				
X11	0.35	–0.66	–0.3	–0.11	0.67	0.67	0.44	–0.02	–0.1	–0.26	1			
X12	–0.35	0.34	–0.21	0.32	–0.3	–0.55	–0.14	0.46	–0.21	–0.09	–0.36	1		
X13	0.32	–0.3	0.09	–0.37	0.3	0.38	0.07	–0.21	–0.03	–0.05	0.33	–0.83	1	
X14	–0.21	0.3	0.24	–0.11	–0.06	–0.04	–0.12	–0.18	0.42	0.08	–0.3	–0.08	–0.14	1

Table 3. The matrix of the pair correlation links between the integral variables for the Northern-Caspian deeper-water sub-area

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
X1	1													
X2	-0.33	1												
X3	0.18	0.24	1											
X4	0.2	0.35	0.43	1										
X5	0.23	–0.82	–0.4	–0.58	1									
X6	0.05	–0.3	–0.19	–0.51	0.53	1								
X7	0.12	–0.64	–0.22	–0.08	0.55	0.11	1							
X8	-0.1	0.41	–0.42	0.18	–0.4	–0.3	–0.38	1						
X9	0.07	–0.21	0.36	0.2	0.08	–0.02	0.2	–0.5	1					
X10	0.05	0.02	–0.17	0.37	–0.21	–0.39	–0.02	0.3	0.11	1				
X11	0.15	–0.35	–0.26	–0.48	0.6	0.43	0.13	–0.3	–0.1	-0.52	1			
X12	–0.21	0.51	–0.18	0.32	–0.64	–0.45	–0.4	0.79	–0.42	0.25	-0.36	1		
X13	0.22	–0.2	0.3	0.13	0.24	0.22	0.14	–0.35	0.43	0.03	0.03	-0.55	1	
X14	0.02	0.1	0.38	0.44	–0.18	–0.23	0.25	–0.30	0.43	0.16	-0.23	-0.05	0.17	1

Table 4. The matrix of the pair coefficient correlations between the integral variables for the Northern part of the Middle Caspian area

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
X1	1													
X2	–0.82	1												
X3	–0.52	0.58	1											
X4	–0.04	0.21	0.45	1										
X5	0.35	–0.33	–0.5	–0.53	1									
X6	0.52	–0.64	–0.57	–0.57	0.61	1								
X7	0.7	–0.59	–0.55	–0.4	0.73	0.7	1							
X8	0.8	–0.72	–0.49	–0.24	0.31	0.44	0.55	1						
X9	0.7	–0.72	–0.46	–0.07	0.33	0.63	0.62	0.4	1					
X10	–0.76	0.6	0.39	0.01	–0.3	–0.2	–0.44	–0.62	–0.38	1				
X11	–0.07	–0.03	–0.06	–0.06	–0.05	0.16	–0.04	–0.3	0.21	0.21	1			
X12	0.6	–0.55	–0.38	–0.24	0.13	0.32	0.23	0.6	0.42	–0.5	0.006	1		
X13	–0.16	0.24	0.42	0.6	–0.3	–0.35	–0.24	–0.3	–0.11	0.18	0.13	–0.38	1	
X14	–0.23	0.3	0.55	0.45	–0.3	–0.3	–0.25	–0.2	–0.23	0.36	0.03	–0.20	0.46	1

links between the integral variables for the Northern-Caspian shallow-water sub-area. Table 3 presents the matrix of the pair correlation links between the integral variables for the Northern-Caspian deeper-water sub-area. Table 4 presents the matrix of the pair coefficient correlations between the integral variables for the Northern part of the Middle Caspian area

Over half of the matrix has values $r > 0.3$. Hence, the data selected for the analysis are representative. The use of the method of main components for the analysis of the correlation matrix allows distinguishing basic factors that influence the distribution of sturgeon fishes in each selected area and estimating their significance.

Table 5 presents the basic components in the factor analysis. The columns in the Table characterize the obtained general factors for the selected areas. Their contribution to the total dispersion is different and is determined by their own numbers and their contribution (in %) to the total sturgeon dispersion. Also, the total contribution of the defined factors to the total dispersion is shown. From Table 5, we can see that the first three factors defined for each area under consideration determine, for the entire region, 67.9% of sturgeon dispersion. For the Northern-Caspian shallow-water sub-area, it is 66.4%. For the Northern-Caspian deeper-water sub-area, it is 66.6%. For the Northern part of the Middle Caspian area, it is 72.0%. Thus, the major part of the parameters' variability falls on these three factors. Therefore, in further analysis, we used only three general factors, as the rest of the factors provide a small contribution to the total dispersion.

In the first group of columns in Tables 6–9, the loads of 13 parameters on three general factors obtained by the method of main components are included. In the second group, the final factor loads were obtained through three rotations. Table 6 presents the factor matrix for the data analysis of the entire studied region. Table 7 presents the

Table 5. Main components for the factor analysis

		1	2	3	4	5	6	7	8	9	10	11	12	13
Studied region	Eigen values	5.160	2.013	1.651	0.881	0.739	0.589	0.492	0.429	0.371	0.265	0.182	0.131	0.097
	Variation percentage	39.7	15.5	12.7	6.7	5.6	4.5	3.7	3.3	2.8	2.1	1.4	1.0	0.7
	Total percentage	39.7	55.2	67.9	74.6	80.3	84.8	88.6	91.9	94.8	96.8	98.2	99.2	100.0
Northern-Caspian shallow-water sub-area	Eigen values	4.788	2.430	1.411	1.212	0.864	0.687	0.584	0.335	0.269	0.179	0.102	0.093	0.044
	Variation percentage	36.8	18.7	10.9	9.3	6.6	5.3	4.5	2.6	2.1	1.4	0.8	0.7	0.3
	Total percentage	36.8	55.5	66.4	75.7	82.3	87.6	92.1	94.7	96.8	98.2	99.0	99.7	100.0
Northern-Caspian deeper-water sub-area	Eigen values	4.447	2.569	1.649	1.077	0.887	0.563	0.515	0.433	0.338	0.223	0.149	0.089	0.061
	Variation percentage	34.2	19.7	12.7	8.3	6.8	4.3	4.0	3.3	2.6	1.8	1.1	0.7	0.5
	Total percentage	34.2	53.9	66.6	74.9	81.7	86.0	90.0	93.3	95.9	97.7	98.8	99.5	100.0
Northern part of the Middle Caspian area	Eigen values	6.049	1.907	1.410	1.102	0.540	0.479	0.439	0.330	0.251	0.190	0.148	0.111	0.043
	Variation percentage	46.5	14.6	10.8	8.48	4.1	3.6	3.3	2.5	1.9	1.4	1.1	0.8	0.3
	Total percentage	46.5	61.1	72.0	80.5	84.7	88.4	91.7	94.3	96.2	97.7	98.8	99.7	100.0

Table 6. The factor matrix for data analysis of the entire studied region

Variables	Factor 1		Factor 2		Factor 3	
	Before rotation	After rotation	Before rotation	After rotation	Before rotation	After rotation
X1	0.706	0.293	0.280	0.854	0.489	0.036
X2	–0.867	–0.581	–0.078	–0.672	–0.236	–0.158
X3	–0.505	–0.744	0.609	–0.065	–0.157	0.306
X4	–0.206	–0.632	0.625	–0.577	0.559	–0.115
X5	0.911	0.799	–0.172	0.442	0.047	0.166
X6	0.734	0.718	–0.163	0.087	–0.353	0.408
X7	0.809	0.566	0.014	0.657	0.312	0.045
X8	–0.135	0.072	–0.416	0.074	0.556	–0.700
X9	0.460	–0.045	0.571	0.695	0.232	0.312
X10	–0.540	–0.616	0.341	–0.170	–0.077	0.08
X11	0.663	0.704	–0.259	0.088	–0.216	0.227
X12	–0.698	–0.351	–0.409	–0.289	0.465	–0.814
X13	0.382	0.037	0.508	0.209	0.401	0.721

Table 7. The factor matrix for data analysis for the Northern-Caspian shallow-water sub-area

Variables	Factor 1		Factor 2		Factor 3	
	Before rotation	After rotation	Before rotation	After rotation	Before rotation	After rotation
X1	0.605	0.489	0.002	0.293	0.657	–0.055
X2	–0.877	–0.785	–0.133	–0.309	–0.291	0.202
X3	–0.574	–0.768	–0.560	0.297	0.242	0.263
X4	–0.440	–0.377	0.152	–0.310	0.793	0.061
X5	0.841	0.808	0.191	0.221	–0.163	–0.241
X6	0.833	0.749	–0.214	0.444	–0.189	0.105
X7	0.674	0.834	0.181	–0.089	0.018	0.147
X8	–0.013	0.044	0.723	–0.358	0.009	–0.696
X9	–0.066	0.044	–0.372	–0.039	0.326	0.671
X10	–0.416	–0.309	–0.544	–0.045	–0.152	0.745
X11	0.764	0.653	–0.011	0.367	0.103	–0.119
X12	–0.513	–0.170	0.798	–0.909	–0.046	–0.293
X13	0.497	0.093	–0.604	0.917	–0.052	–0.054

Table 8. The factor matrix for data analysis of the Northern-Caspian deeper-water sub-area

Variables	Factor 1		Factor 2		Factor 3	
	Before rotation	After rotation	Before rotation	Before rotation	Before rotation	After rotation
X1	0.248	–0.008	–0.283	0.102	–0.244	0.141
X2	–0.767	0.189	–0.024	–0.206	0.488	–0.840
X3	–0.121	0.108	–0.0773	0.665	0.469	–0.592
X4	–0.550	0.704	–0.610	0.171	–0.200	–0.360
X5	0.896	–0.517	0.242	0.133	–0.248	0.789
X6	0.622	–0.706	0.266	0.113	0.313	0.213
X7	0.570	0.039	–0.073	0.246	–0.528	0.765
X8	–0.690	0.332	0.476	–0.809	–0.244	–0.203
X9	0.278	0.229	–0.708	0.774	–0.058	0.129
X10	–0.387	0.795	–0.210	–0.122	–0.708	0.248
X11	0.632	–0.777	0.389	–0.050	0.268	0.237
X12	–0.839	0.428	0.349	–0.716	–0.127	–0.387
X13	0.395	–0.009	–0.579	0.650	0.020	0.110

Table 9. The factor matrix for data analysis for the Northern part of the Middle Caspian area

Variables	Factor 1		Factor 2		Factor 3	
	Before rotation	After rotation	Before rotation	Before rotation	Before rotation	After rotation
X1	0.863	0.918	0.440	0.322	0.085	0.045
X2	–0.861	–0.821	–0.241	–0.337	–0.139	0.123
X3	–0.742	–0.437	0.227	–0.475	0.014	0.422
X4	–0.459	0.089	0.750	–0.488	0.239	0.774
X5	0.620	0.093	–0.456	0.868	0.013	–0.198
X6	0.773	0.329	–0.392	0.711	0.253	–0.322
X7	0.806	0.421	–0.171	0.828	0.146	–0.057
X8	0.783	0.785	0.306	0.238	–0.288	–0.213
X9	0.732	0.653	0.162	0.428	0.486	0.090
X10	–0.659	–0.790	–0.484	–0.133	0.216	0.002
X11	–0.034	–0.103	–0.239	–0.001	0.749	0.018
X12	0.623	0.732	0.242	–0.148	–0.204	–0.462
X13	–0.441	–0.155	0.423	–0.096	0.519	0.862

factor matrix for the data analysis for the Northern-Caspian shallow-water sub-area. Table 8 presents the factor matrix for the data analysis of the Northern-Caspian deeper-water sub-area. Table 9 shows the factor matrix for the data analysis for the Northern part of the Middle Caspian area. The rotations were made in order to estimate more completely the loads of particular variables on the main components and implemented by means of replacing diagonal elements of the correlation matrix by corresponding estimates of communion. Rotation of the factorial matrix is necessary to determine more precisely and clearly a contribution of each variable to any of the factors. This was the final purpose of the factorial analysis by the method of main components. Indeed, it is seen from the analysis of Tables 6–9 that all the significant variables (1–13) are divided into groups according to their loads on the three distinguished general factors; each group contributes considerably to one or another factor and carries a certain meaning.

ANALYSIS OF THE FACTORIAL MATRIX OBTAINED FOR THE ENTIRE STUDY REGION

Factor 1 has the highest share of the total dispersion in the factorial matrix: it determines 39.7% of the variables (Table 5). The largest loads (Tables 6 and 10) on the factor come from the variables X3, X4, X5, X6, X10, and X11. Taking into account the combination

Table 10. The general table of the landscape-forming and geo-ecological factors of stability in the studied region ecosystem

The entire studied Caspian Sea region		
Factor 1	**Factor 2**	**Factor 3**
X3, X4, X5, X6, X10, X11	X1, X2, X7, X9	X8, X12, X13
Hydroecological factor of the food resources forming	Wintering – post-wintering factor	Factor of anthropogenic load
Northern-Caspian shallow-water sub-area		
Factor 1	**Factor 2**	**Factor 3**
X2, X3, X5, X6, X7, X11	X12, X13	X8, X9, X10
Hydroecological factor of the food resources forming in winter	Factor of anthropogenic load	Feeding conditions for growth of the young generation
Northern-Caspian deeper-water sub-area		
Factor 1	**Factor 2**	**Factor 3**
X4, X6, X10, X11	X3, X8, X9, X12, X13	X2, X5, X7
Hydroecological factor of the food resources forming	Factor of anthropogenic load on zooplancton	Wintering factor
Northern part of the Middle Caspian area		
Factor 1	**Factor 2**	**Factor 3**
X1, X2, X8, X9, X10, X12	X5, X6, X7	X4. X13
Factor of anthropogenic load during wintering – post-wintering period	Hydroecological factor	Factor of hydrocarbon pollution

of the parameters enclosed into the given factor, it can be assumed that it characterizes the influence of forage resources in the sea on the sturgeon fishes distribution. We define it as the **"Geoecological factor of food resources formation".**

The Caspian Sea is located at relatively low latitudes, which provides an intensive inflow of solar radiation; the annual radiation balance is positive [Caspian Sea.... 1986]. For the entire sea area, the radiation balance is positive from March to October and reaches maximum values in June and July. Intensive warming of the North Caspian water promotes development of the phytoplankton, which typical feature is the increase of biomass with a temperature rise [Project "Seas".... 1996]. At the same time, penetration of dissolved organic substances to the sea, among which is nitrogen – the most important for feeding plankters, also influence the development of phytoplankton and, via it, of all other units in the trophic chain. As the Caspian Sea benthos predominantly contains phytophagous animals – eaters of plankton and benthos algae, as well as detritus [Kasymov and Askerov, 2001], the biomass of benthos depends directly on the biomass of phytoplankton.

Mass development of the major fresh-water and autochthonous complexes of the bottom fauna is observed in the coastal desalted areas of the North Caspian Sea at depths of below 6 m [Caspian Sea..., 1989; Kushnarenko, 2003], whereas beyond the 100-m isobath, where food, oxygen, and heat are limited, the amount of benthos is low (fractions of a gram per 1 m^3) [Project "Seas"..., 1996]. These areas with scanty bottom population are not worth as fattening sea places for benthos-eating fishes, though they occupy over 60% of the entire Central and South Caspian Sea area.

Salinity of the North Caspian Sea is not the only important physical-chemical characteristics of its waters, but it, to a great extent, determines its biological productivity. It has been established that the main factors determining the North Caspian salinity formation [Caspian Sea...,1986; Pakhomova and Zatuchnaya, 1966] include river runoff, wind regime, water dynamics (water currents, rises and falls of waves), and water exchange with the central part of the sea. About 80% of freshwaters of the river runoff belong to the North Caspian Sea [Project "Seas"..., 1996]. Conditions for fattening of young and adult fishes in the sea are formed under the influence of biogenic runoff and salinity. Besides, as a rule, the volume and the character of the river runoff determine scales and effectiveness of spawning of fishes in river deltas and channels. Such fishes include the most valuable marketable sturgeon and catadromous fishes.

Distribution of salinity in shallow waters determines the predominance of development of specific communities of plankton and benthos, i.e., of the food base for fishes. The North Caspian Sea salinity regime appeared to be favorable for bottom organisms of the Mediterranean complex [Biological productivity..., 1974]. Some of the organisms (*nereis, abra, cerastoderma,* crab) are the main feeding objects of adult sturgeon and salmon. It has been shown in the studies of the adaptation process of young sturgeon fishes to salt water, that they are able to survive in water with increased salinity after gradual, step-by-step transition to this environment [Biological grounds..., 1979].

Oxygen content in water is determined by intensity of physical processes (gas exchange between sea and atmosphere, transfer by water masses) that occur in it, as well as by its formation, during photosynthesis, and consumption of it, during biochemical processes. Oxygen deficit may cause changes in physiologic-biochemical processes in the organism of fishes, their behavior, and deteriorate migration abilities of weakened species. There were cases [Ecological factors..., 1993] when the deficit of oxygen emerged so quickly that fishes were late to leave the famishing zone and died. It is also known that the deficit of oxygen in winter

causes, besides the death of fishes, their mass escape to adjacent areas. Formation of areas with oxygen deficit negatively influences development of zoobenthos and the basic feeding objects of fishes – benthophages [Katunin, et. al., 2005].

Thus, this factor has the greatest importance, as they, to a considerable degree, determine both the conditions for forming food resources for sturgeon fishes and the conditions of their natural habitat.

Factor 2 has the second (by magnitude) significance. According to it, 15.5% of the total dispersion is determined (Table 5). After rotation, the high values (>0.7) of variables X1, X2, X7, and X9 (Tables 6 and 10) were revealed, which allows us to define it as the **"Wintering – post-wintering factor".** The factor includes the values of winter temperature, depth differences (availability of winter-staying holes), ice extent, and the amount of zooplankton, i.e., the most important conditions for surviving of sturgeon fishes in winter period.

The northern part of the sea freezes up every year; a considerable sea area is covered by fixed ice – fast ice that composes there the major part of the ice cover [Caspian Sea..., 1986]. Even during very mild winters, the northern and the north-eastern shores of the Caspian Sea are blocked by fast and drift ice. Formation of the constant ice cover may cause oxygen deficit in winter-stay holes, which leads to oxygen hunger of sturgeon fishes and their mass death.

With water cooling in the northern part of sea in autumn, the sturgeon fishes migrate to the south. In spring, with warming of water and development of forage, they return from wintering places to the more shallow-water northern part for fattening. The Russian sturgeons that stay for wintering in the northern part of the sea are characterized by seasonal distribution along depths., i.e., a decrease of the habitat depth from winter to summer and visa versa. They do not form steady winter accumulations and pass from one hole to another during winter. Beluga, Persian sturgeon, and acanthi, in winter, leave the northern part of the Caspian Sea [Kasymov and Askerov, 2001] and meet mainly in its central and southern parts.

A considerable part of the sea plankton consists of meroplankton or temporary plankton. The major parts of the benthos animals in their larval stage [Odum, 1975] have plankton forms that, before settling down onto the bottom, are enclosed into the plankton during different periods of time. Availability of zooplankton in the given factor allows us to define it as "**post-wintering**", as in spring, the plankton consists mainly of representatives of zoobenthos being in the early ontogenesis stage and, hence, representing feeding products for ichthyofauna in subsequent fattening periods. Seasonal changes of the zooplankton in the northern part of the Caspian Sea depend mainly on two factors – temperature and salinity [Kasymov and Askerov, 2001]. Plankton develops weakly in winter under the ice, but in spring, with warming of water, its biomass begins growing actively.

The **"Wintering – post-wintering factor"** determines seasonal migrations of sturgeon fishes across the sea, as well as the conditions for forming the forage base for the subsequent fattening period.

Factor 3 is the third by its significance. Its contribution to the total dispersion in the factorial matrix is 12.7% (Table 5). Maximum loads of variables (r>0.7) X8, X12, and X13 (Tables 6 and 10) on the given factor indicate that it can be characterized as the **"Factor of anthropogenic loading".** It is not an accident that this factor includes, together with the variables characterizing distribution of oil and phenols across the water area, also the variable that determines the influence of the runoff from the Volga River. Investigations of 1975–1999 [Katunin, et. al., 2000] show that the interannual dynamics of oil hydrocarbons in the Volga River and North Caspian Sea is synchronized. Increase or decrease in oil hydrocarbon concentrations

in the Volga water in each particular year is accompanied by a simultaneous change in the content of this compounds in the North Caspian Sea. The same happens with contamination by phenols that are one of the most widely spread contaminants penetrating to surface waters with wastes from the plants of oil-refinery, shale-processing, timber, chemical, coke-chemical, and aniline-dye industries. All the largest channels of the Volga River and its main channel flow into the western sector of the North Caspian Sea [Biological productivity...,1974; Mouth area..., 1998] from where the majority of contaminants penetrates. At the same time, the eastern coast of the North Caspian Sea is located in a more advantageous position, i.e., unlike the western coast, it actually does not have a developed river network and is less populated [Geoecology..., 2001]. An important role in transfer and transformation of contaminants belongs to the along-coastal current directed mainly from north to south; a part of contaminants come by transit with the river flow into the sea due to this process [Makarova and Kurapov, 2002].

Such components of biocenoses as nekton, plankton, and benthos [Ivanov and Sokolsky, 2000] possess a high accumulating ability relative to micro-admistures of the environment and are very sensitive to the action of toxicants in the sea (for example, HC, SSAS, phenols, heavy metals) that can concentrate with transition from one level of the trophic chain to another, usually influencing more heavily those organisms that are located at the chain end than those being at the beginning of the chain, i.e., producers with a short-lived cycle [Nelson-Smith, 1977]. Sturgeons are long-living fishes, therefore, the consequences of oil intoxication under long systematic action of small doses may be manifested in several generations [Ivanov and Sokolsky, 2000].

The investigations (1993–1999) [Geraskin, et. al., 2005] of physiological state of the Russian sturgeon, salmon, and beluga, fished up in the sea showed that oil pollution in increased concentrations is received by sturgeons in the natural conditions as a stress-factor and, in combination with other toxicants, leads to an increase of impacts on fishes. Consequences of chronic poisoning by small doses of toxicants, which do not cause the effect of escaping, are even more dangerous. In areas affected by these toxicants [Ecological factors..., 1993], there is a sharp increase in abnormally altered fishes, pathological changes of liver, a decrease in number of feeding fishes due to disturbance in their coordination of food-procuring behavior, removal to spawn, and a partial loss of orientating ability during migration.

Pollution of water basins causes ever-growing forced migrations of fishes from areas with unfavorable conditions, having a character of escape and affecting directly or indirectly the stability of a habitat of the population (local stock), structure of the population, and the process of reproduction [Ecological factors..., 1993]. At the same time, even in the centers of volley-type disposals of toxic waters, a part of species appears to be able to sensor a threat and to try to escape from the polluted zone, which is quite feasible, as oil pollution [Khoroshko and Emirova, 2002] has generally a mosaic character. Possibly, just the ability to sensor the zone of pollution and leave it in proper time determines a relatively low impact of the "Factor of anthropogenic loading" on the sturgeon fishes distribution.

ANALYSIS OF THE FACTORIAL MATRIX OBTAINED FOR THE NORTHERN-CASPIAN SHALLOW-WATER SUB-AREA (SHALLOW-WATER ZONE)

Factor 1. After rotation, the high final loads on the given factor (Tables 7 and 10) have variables X2, X3, X5, X6, X7, and X11. Taking into account the meaning of the variables that are included in this factor, it can be considered as similar (with slight changes) to the **"Factor of forming food resources"** determined for the entire study region; it can be characterized as the **"Geoecological factor of forming food resources in winter time",** as this factor of the Northern-Caspian shallow-water sub-area is summed with the

variables characterizing the conditions for existence of sturgeon population in winter period (variables X2 and X7), which are especially complicated in shallow-water areas because of ice situation, and does not include the variables characterizing the distribution of oxygen and the total phytoplankton biomass, as in the coastal zone there is usually no oxygen deficit and phytoplankton does not serve as food for adult sturgeon fishes. This factor is also the first in defining general factors for the entire study region, but, in this case, its contribution to the total dispersion of the variables decreases to 36.8%.

Factor 2 has the second (by significance) load in the factorial matrix: it determines 18.7% of the total dispersion (Table 5). The highest load ($r > 0.7$) on the factor comes from variables X12 and X13 (Tables 7 and 10), which allows us to define it as the **"Factor of anthropogenic loading"**, actually identical to **Factor 3** for the entire region. The factor includes the variables characterizing pollution of the study area by phenols and oil, but does not include variable X8 that characterizes the degree of influence of the Volga River runoff, because, in this case, only the coastal areas are considered, to where pollutants are penetrating from populated settlements, with wastewaters from fields, etc. At the same time, its contribution to the total dispersion of variables is higher than that of the **"Factor of anthropogenic loading"** for the entire region and increases to 18.7%. As the seawater areas receive the major impacts of anthropogenic pollution which amounts to 90 % and is deposited in the coastal zone, the significance of this factor has increased compared with the entire sea area and has shifted to the second place.

Factor 3 has a 10.9%-contribution to the total dispersion in the factorial matrix (Table V). The high contribution of variables X8, X9, and X10 (Tables 7 and 10) to this factor makes it possible to characterize it as a factor determining conditions for fattening of young sturgeon fishes after they swim down to the sea, i.e. , the **"Factor of feeding conditions for fattening of young fishes**".

Analyzing the variables enclosed into this factor – a distance from the Volga-Caspian main channel, distribution of biomass of zooplankton, and phytoplankton – it can be concluded that the factor indicates the importance of the high-productive shallow-water areas of the North Caspian Sea and, first of all, of the mouth area of the Volga River for fattening of young sturgeon fishes during their swimming down to the sea. The factor's variables clearly show that the hydrogeological conditions of the rivers flowing into the sea and biogenic substances penetrating with the river flows determine conditions for forming the phytoplankton's biomass in the sea shallow-water areas, which, at early stages of sturgeon evolution, are the main objects of feeding and zooplankton.

ANALYSIS OF THE FACTORIAL MATRIX OBTAINED FOR THE NORTHERN-CASPIAN DEEPER-WATER SUB-AREA

Factor 1 has the largest importance of the total dispersion in the factorial matrix and amounts to 34.2% of the variables' dispersion (Table 5). After rotation, the high final loading (Tables 8, 10) on the factor is given by variables X4, X6, X10, and X11. The enclosed variables actually coincide with the same variables of **Factor 1** for the entire region, excluding variables X3 and X5, characterizing the sea hydrochemical regime as, due to circulating features of water currents in the central part of the North Caspian Sea, the hydrochemical parameters determined by the Volga River runoff are sufficiently stable. Despite the fact that the contribution of this factor to the total dispersion for the North Caspian-deeper sub-area is somewhat lower than that of the first factor for the entire study region (39.7%), it can be also defined, by the meaning of the variables enclosed into it, as the **"Geoecological factor of forming food resources"** for the North Caspian- deeper sub-area. Owing to this factor, there is a potential to estimate the role of hydrochemical, natural-climatic, biotic, and food resources in distribution of sturgeon fishes across the northern part of the sea area.

By significance, **Factor 2** occupies the second place. Its contribution to the total dispersion amounts to 19.7% (Table 5). After rotation, there were revealed the high values of variables X3, X8, X9, X12, and X13 (Tables 8 and 10), which enables defining this factor as the **"Factor of anthropogenic loading on zooplankton"**, which actually coincides with **Factor 3** for the entire region. They show the determinant influence of the Volga River runoff upon penetration and distribution of pollutants across the northern part of the Caspian Sea, which, in turn, controls the zooplankton's biomass – the basic food resources for fattening of young sturgeon fishes.

Factor 3 (by significance) has a contribution to the total dispersion in the factorial matrix equal to 12.7% (Table 5). The highest loading comes from variables X2, X5, and X7 (Tables 8 and 10), which allow defining it as the **"Wintering factor**". It has a number of significant differences from the **"Wintering – post-wintering factor"** for the entire region. The **"Wintering – post-wintering factor"** is the second, by significance, for the entire region (its contribution is 15.5%) and determines both seasonal migrations of sturgeon fishes across the sea area and conditions of forming a forage base for the subsequent fattening period. The **"Wintering factor"**, for the Northern-Caspian deeper-water sub-area, allows one to estimate the importance of the habitat's sea state, depth differences (availability of wintering holes), and ice distribution for the distribution of sturgeon fishes in winter period, but it does not determine conditions of forming the forage base for fishes. Possibly, this is connected with the fact that, in winter period, the major sturgeon fishes migrate to deeper layers of the Central Caspian Sea.

ANALYSIS OF THE FACTORIAL MATRIX OBTAINED FOR THE NORTHERN PART OF THE NORTHERN PART OF THE MIDDLE CASPIAN AREA

Factor 1 is the most important for the Northern part of the Middle Caspian area, as its contribution to the total dispersion amounts to 46.5% (Table 5). A significant load on the factor comes from variables X1, X2, X8, X9, X10, and X12 (Tables 9 and 10), so it can be characterized as the **"Factor of anthropogenic impact in wintering – post-wintering period"**. Unlike the analogous **"Wintering – post-wintering factor**" for the entire study region, it includes not only actually all the variables (except X7), but, additionally, a number of new variables – X8, X10, and X12, pointing to the importance of anthropogenic impacts in winter period on the given sub-area subjected, in this period, to eutrophication. The importance to be protected from anthropogenic impacts in the wintering – post-wintering period for the Central Caspian Sea is doubtless, as, in winter, the sturgeon fishes migrate just to this region and just the Central Caspian is subjected to eutrophication, which intensifies and accelerates due to anthropogenic pollution.

Factor 2 is the second by significance; it determines 14.6% of the total dispersion (Table 5). After rotation, the values of variables X3, X5, X6, and X7 are high (Tables 9 and 10), which enables its determination as the **"Geoecological"**. This factor corresponds partially to **Factor 1** for the entire study water area and indicates a threat of methane at large depths, which creates a hazard for existence of sturgeon population wintering in this region.

The contribution of **Factor 3** to the total dispersion in the factorial matrix amounts to 10.8% (Table 5). Due to the maximum values of variable X4 and X13 (Tables 9 and 10) it can be defined as a factor of anthropogenic loading manifesting itself especially vividly in this area in the form of the **"Hydrocarbon contamination". Unlike Factor 3** for the entire region, the given factor for the central sea part did not include the variables characterizing the influence of the Volga River runoff and distribution of phenol contamination across the water area, but did include variable X4, characterizing oxygen distribution over the sea surface. It is possible that, for the central sea part, the river runoff does not already play such an

important role in the distribution of pollutants across the water area and that oil pollution increases due to active development of sea deposits in this part of the sea. Presence of variable X4 in the factor is not occasional; the existence of the oil film on the water surface promotes formation of zones of hypoxia due to a decrease in intensity of aeration processes, which obstructs breathing of fishes and forces adult fishes to leave the polluted areas and can lead to increase in depths [Sapozhnikov and Belov, 2005]. This factor helps estimating the role played by the distribution and geography of hypoxia zones in the distribution of sturgeons over the sea area. Additional input of organic substances during water pollution by oil products deteriorates gas regime in the sea.

CONCLUSIONS

1. The analysis of the obtained data enabled distinguishing three basic factors, including the study parameters and the total dispersion, loading of which amounts to 67.9%. Thus, there are three significant characteristics that, in combination, considerably determine the existence of sturgeon fishes in the northern part of the Caspian Sea. The established factors are closely interconnected with each other, but they are not equal in magnitude: the largest, among them, is the **"Factor of forming food resources"**, which has the basic load in the factorial matrix. The **"Wintering – post-wintering factor"** is the intermediate by significance and it is the linking factor between the first and the third, i.e., the **"Factor of anthropogenic loading"**.

The conditions of wintering of species staying in wintering holes of the North Caspian Sea are important factors for existence of sturgeon fishes. These conditions are determined by distribution of the ice cover, whose area varies year to year and depends on a number of factors, in particular, on temperature and depth of water. In turn, the same factors determine also the conditions of forming the zooplancton's biomass in spring as an initial evolution stage of the majority of species of zoobenthos. The **"Factor of anthropogenic loading"** carries the lowest loading in the factorial matrix as compared with the previous factors. Combination of the variables enclosed into the factor shows that the input and the distribution of pollutants across the water area in the northern part of the sea depend mainly on the Volga River runoff.

2. To a greater extent, the distribution of sturgeon fishes depends on formation of a forage base for the species, i.e., the biomass distribution of the bottom fauna across the northern part of the sea area. This is illustrated by the first factor, namely, by sufficient amounts of biogenic elements and incoming solar energy, which determine intensive development of the phytoplankton as the basic food of the zooplankton. The zooplankton serves, in turn, as the basic food of the zoobenthos that is a component in the ration of many fish species – benthophages; sturgeon fishes of the Caspian Sea are feeding at different stages of ontogenesis both by zooplankton, zoobenthos, and fishes.

3. The leading factor in winter for the Northern-Caspian shallow-water sub-area, especially in its north-eastern and eastern parts with severe icing regime, is the factor of forming of forage resources. The next, by significance, is the factor of anthropogenic loading that, in this case, does not include the variable characterizing the distance from the Volga River mouth, which is the main supplier of polluting substances to the region. Many water zones of the this sub-area lie beyond the influence zone of the Volga River and are subjected to anthropogenic pollution coming with discharges from local rivers, coastal settlements, industrial and agricultural enterprises, runoff from fields, etc. The third significant factor of stability of this ecosystem is the factor of feeding conditions for fattening of young sturgeon fishes for which the Northern-Caspian shallow-water sub-area is a natural habitat.

4. Analysis of the factorial matrix obtained for the Northern-Caspian deeper-water sub-area showed a predominant influence of the **"Geoecological"** factor of forming

food resources. However, due to circulating features of water currents in the central part of the North Caspian sub-area, the hydrochemical parameters, determined by the Volga River runoff, are sufficiently stable and, thus, are not presented in this factor. The second is the **"Factor of anthropogenic loading on zooplankton"**. Actually coinciding with **Factor 3** for the entire study region, it shows a determinant influence of the Volga River runoff on the input and distribution of pollutants across the northern part of the Caspian Sea water area, which, in turn, determine the zooplankton's biomass – the basic food resources for the fattening of young sturgeon fishes. The third (by significance) **"Wintering factor"** has a number of essential differences from the **"Wintering – post-wintering factor"** for the entire study region. It enables estimation of the influence of the sea state in the habitat (availability of wintering holes) and ice distribution on sturgeon distribution in winter period. However, the factor does not determine the conditions of forming the food base of sturgeon fishes. Possibly, this is connected with the fact that, in winter period, the majority of sturgeon fishes migrate to deeper areas of the Central Caspian Sea.

5. In the Northern part of the Middle Caspian area, **Factor 1** can be characterized as the **"Factor of anthropogenic impact in wintering – post-wintering period"**. The importance of being protected against anthropogenic impacts this time of the year for the Northern part of the Middle Caspian area is doubtless, as, in winter, sturgeon fishes migrate just to this area and just the Northern part of the Middle Caspian area that suffer eutrophication at depth which intensifies and accelerates due to anthropogenic pollution. The second significant factor is defined as the **"Geoecological"** and it indicates a threat of generating methane on the bottom, which creates a hazard for existence of sturgeon population wintering in this region. The third is the factor of anthropogenic loading manifesting itself in this area in the form of the **"Hydrocarbon contamination"**, as, in this case, this factor did not include the variables characterizing the influence of the Volga River runoff and distribution of phenol contamination across the water area, but did include a significant contribution of variable X4, characterizing oxygen distribution over the sea surface. Oil pollution in the given area increases due to active development of sea deposits in the shelf zone. The widely spread oil film on the water surface causes the formation of hypoxia zones due to a decrease in intensity of aeration processes, which obstructs breathing of fishes and forces adult fishes to leave the polluted areas and can lead to their depths [Sapozhnikov and Belov, 2005].

6. The landscape zoning of the region carried out in this study made it possible to analyze the geoecological situation in the sea and to reveal the factors of stable existence of different sub-areas both in the northern part of the Caspian Sea and its ecosystems as a whole. As the natural geoecological factor of forming forage resources is the main criterion determining stability of the ecosystem state in the northern part of the Caspian Sea, the processes of dynamics or changes in natural conditions of the region (including climatic fluctuations) lead to the most considerable changes in its ecosystem. Thus, for predicting possible changes in the composition and stability of the water ecosystems in the Caspian Sea, it is necessary to use an integrated approach that considers both the growing anthropogenic impact and possible climatic changes.

Shift of the significance of the factor of anthropogenic loading to the second place for each sub-area from the third place for the entire region indicates that an ecosystem of a larger size and having a more diverse set of natural complexes possesses buffer ability to "compensate" for the areas that disappear under the impact of increasing anthropogenic loading, thus, giving mobile representatives of the ecosystem a chance to exist in other equatorial natural complexes that are, initially, are less suitable for them. From the standpoint of landscape science, this tendency confirms, obviously, a biological phenomenon discovered, in the early 1970s,

by Professor L.S. Berdichevsky: during a strong anthropogenic impact the *"fish spawning occurs often in places not typical to the given species.... becoming matched are the dates and places of spawning of different fish species, including commercial and non-commercial species".*

For the Central Caspian Sea, the shift of the factor of anthropogenic loading to the first place means, obviously, that the ecosystem's buffer capacity is exhausted due to the active development of this area by oil-producing companies. ■

REFERENCES

1. Biological grounds of sturgeon breeding in the water bodies of the USSR. (1979). Moscow: Publ. House "Nauka". 222 p. (In Russian)

2. Biological productivity of the Caspian Sea. (1974). Moscow: Publ. House "Nauka". 245 p. (In Russian)

3. Braverman, E.M., Muchnik, I.B. (1983). Structural methods of empirical data processing. Moscow: Publ. House "Nauka". 464 p. (In Russian)

4. Caspian Sea: Hydrology and hydrochemistry. (1986). Moscow: Publ. House "Nauka". 261 p. (In Russian)

5. Caspian Sea: Ichthyofauna and marketable resources. (1989). Moscow: Publ. House "Nauka". 236 p. (In Russian)

6. Ecological factors of spatial distribution and movement of hydrobionts. (1993). St.-Peterburg: "Hydrometeoizdat". 335 p. (In Russian)

7. Geoecology of shelf and coasts of Russia. (2001). Edited by N.A. Aibulatov. Moscow: Publ. House "Noosphera". 428 p. (In Russian)

8. Geraskin, P.P., Metallov, G.F., Aksenov V.P., et.al. (2005). Oil pollution of the Caspian Sea as a factor of impact on the physiological state of sturgeons. Proceedings of the 1st Int. Scien.-Prac. Conference "Problems of preserving the Caspian Sea ecosystem in the conditions of oil and gas deposits development". Astrakhan: Publ. House "KaspNIRH". pp. 54–60. (In Russian)

9. Ivanov, V.P., Sokolsky, A.F. (2000). Scientific fundamentals of protection of biological resources in the Caspian Sea against oil pollution. Astrakhan: Publ. House "KaspNIRH". 181 p. (In Russian)

10. Kasymov, A.G., Askerov, F.S. (2001). Biological diversity: oil and biological resources of the Caspian Sea. Baku: Publ. House "Print Studio". 325 p. (In Russian).

11. Katunin, D.A., Khripunov I.A., Egorov, S.N., et. al. (2005). Multi-year dynamics of forming the zones of hypoxy in the North Caspian Sea. in areas of oil and gas deposits. Proceedings of the 1st Scientific-Practical Conference "Problems of preserving the Caspian Sea ecosystem

in conditions of development of oil and gas deposits". Astrakhan: Publ. House "KaspNIRH". pp. 98–101. (In Russian)

12. Khoroshko, V.I., Emirova, R.I. (2002). Monitoring of toxicant contents in the tissue of hydrobione. Fishing investigations in the Caspian Sea. Astrakhan: Publ. House "KaspNIRH". pp. 71–77. (In Russian)

13. Kushnarenko, A.I. (2003). Ecologic-ethological principles of quantitative account of fishes in the North Caspian region. Astrakhan: Publ. House "KaspNIRH". 180 p. (In Russian).

14. Landscape Map of the USSR. Scale 1: 2500000. (1987) Moscow. (In Russian)

16. Makarova, E.N., Kurapov, A.A., (2002). Influence of the Volga River runoff on the water state in the North Caspian Sea areas set aside for oil extraction. The current problems of the Caspian Sea: Proceedings of Int. Conference devoted to the 105th Anniversary of KaspNIRH. Astrakhan: Publ. House "KaspNIRH". pp. 202–204. (In Russian)

16. Mouth area of the Volga River: hydrologic-morphological processes, regime of contaminants and influence of the Caspian Sea level variations. (1998). Moscow: "GEOS". 280 p. (In Russian).

17. Nelson-Smith, A. (1977). Oil and ecology of the sea. Moscow: "Progress". 302 p. (In Russian)

18. Odum, Yu. (1975). Principles of ecology. Moscow: Publ. House "Mir". pp. 435–436. (In Russian)

19. Pakhomova, A.S. , Zatuchnaya B.M. (1966). Hydrochemistry of the Caspian Sea. Leningrad: "Hydrometeorological Publ. House". 243 p (In Russian)

20. Pegov, S.A. (1992). Natural resources use: prediction and management. Theory and methods of geographical prediction: potential and ways. Moscow: "Nauka". pp. 111–117. (In Russian)

21. Project "Seas". Hydrometeorology and hydrochemistry of seas. (1996). Issue 2. Hydrochemical conditions and oceanological principles of formation of biological productivity. Edited by Terzieva, F.S., Maksimovskaya, M.P., Yablonskaya, E.A. Vol. 6. Caspian Sea. St.-Peterburg: "Hydrometeoizdat". 322 p. (In Russian)

22. Sapozhnikov, V.V., Belov, A.A. (2005). Causes of changes in the Caspian Sea ecosystem and its current state. Proceedings of the 1st Scientific-Practical Conference "Problems of preserving the Caspian Sea ecosystem in conditions of development of oil and gas deposits". Astrakhan: Publ.House "KaspNIRH". pp. 181–187. (In Russian)

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UN LIEU, UN TOPONYME, UN HÉRITAGE CULTUREL: L'HISTOIRE LÉGENDAIRE DE LA FONDATION DE CARTHAGE-BYRSA

A PLACE, A PLACE NAME, A CULTURAL HERITAGE: THE LEGENDARY HISTORY OF THE FOUNDING OF CARTHAGE-BYRSA

ABSTRACT. The strategic location of Tunisia and its rich farmlands attracted many waves of settlers whose presence has contributed to an ethnic and cultural mix of peoples. Berbers, Numidians, Phoenicians Carthaginians, Romans, Byzantines, Normans, Arabs, Spaniards, Sicilians, Maltese, Turkish and French were all involved in this small territory. This has led to geographical names in Tunisia to be a mixture of different languages and undergo several linguistic changes. Those toponyms in addition to the historical depth of Tunisia they recall, they witness the age and memory of the country and constitute a cultural heritage passed on from one generation to another through the ages. The toponym Carthage/ Byrsa is an example. Its origin is the subject of several interpretations, the most common is that related to the legendary history of the founding of the city Carthage-Byrsa by the Phoenician princess Elyssa.

KEY WORDS: Tunisia, toponym, cultural heritage, Carthage-Byrsa, Elyssa, legendary history, ethnic and cultural mix of people, a mixture of languages.

INTRODUCTION

Les noms des lieux ne servent pas seulement de points de référence spatiale pour désigner, situer ou décrire un lieu dans l'espace, ils sont souvent porteurs de message et servent de clé de renseignements sur l'histoire d'un pays à travers le temps ainsi que sur les valeurs civilisationnelles des peuples qui l'ont nommés. C'est ce qui fait d'eux un héritage culturel qui devrait être préservé par tous les moyens.

Cet article traite de l'origine du toponyme Byrsa plutôt connu comme la colline de Byrsa, le centre de la ville punique Carthage, une colline surplombant ce qui est aujourd'hui connu comme le Golfe de Tunis et dont le nom est souvent associé à Carthage (Carthage -Byrsa). Cette région, actuellement une élégante zone résidentielle, offre de merveilleux vestiges et traces des civilisations anciennes.

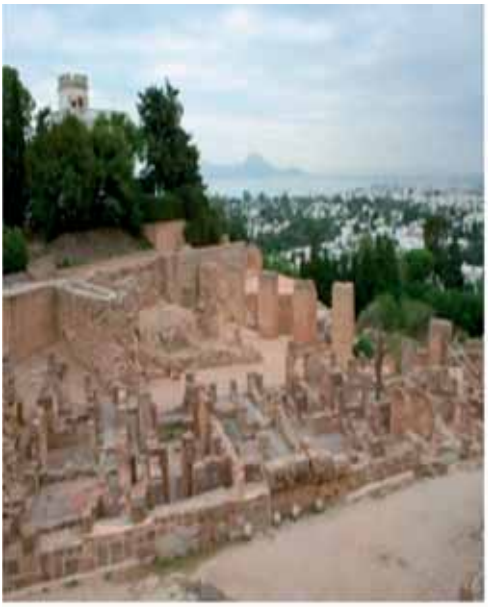
En effet, le toponyme de Byrsa est étroitement lié à l'histoire de la fondation de la ville de Carthage.Selon de nombreuses sources, cette histoire est légendaire car elle raconte la perspicacité et la ruse de la princesse Elissa de Tyr (en Liban) qui est venue sur ces rivages pour fonder une nouvelle ville (Carthage).

Vu les différentes cultures qui se sont succédées (Phénico-Punique, Romaine, Paléochrétienne, Arabe) et en plus de la profondeur historique de la Tunisie qu'ils rappellent, ces toponymes représentent

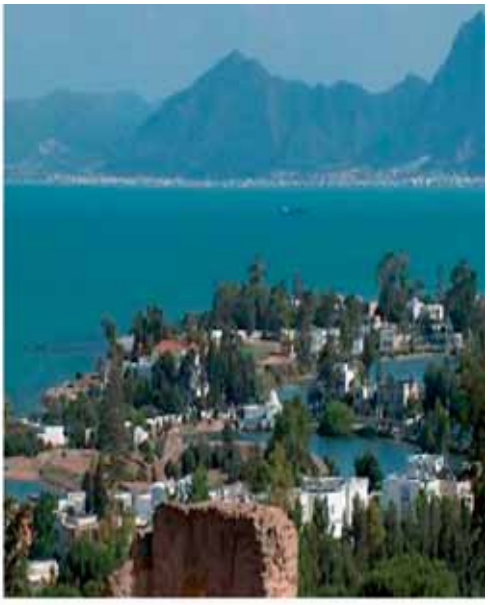
une partie du patrimoine culturel national et servent de témoin pour l'héritage durable qui doit être préservé par tous les moyens, principalement par le biais de la normalisation des noms géographiques. Aujourd'hui, ces toponymes jouent un atout important dans le développement du tourisme dans le pays et particulièrement dans la région de Carthage.

L'HISTOIRE DE CARTHAGE

Carthage, en Arabe: قرطاج; en Latin: Carthage, Carthago ou Karthago; en Punique: Kart-Hadasht est située dans la banlieue nord de Tunis, à 17 km de la capitale, avec une population d'environ 21.000. Carthage a été classée site du patrimoine mondial de l'UNESCO depuis le 26 Octobre 1979.



La partie la mieux réservée du quartier Punique de Cartahge



Le port Punique vu de la colline de Byrsa

Les Thermes d'Antonin

Fondée en 814 avant JC par les Phéniciens (Elissa, princesse de Tyr), Carthage – ou en Punique, Kart-Hadasht – nouvelle ville ou ville brillante- est un vaste site archéologique, situé sur une colline (la colline de Byrsa) dominant le golfe de Tunis et la plaine environnante. Emplacement exceptionnel de mélange, de la diffusion et de l'épanouissement de plusieurs cultures qui se sont succédées (Phénico-Punique, Romaine, Paléochrétienne et Arabe), cette métropole est devenue, grâce à ses ports, une grande puissance maritime dans le bassin méditerranéen, et par conséquent un rival aux Romains qui ont fini par la détruire en 146 avant JC. Elle fût reconstruite un siècle plus tard par les mêmes Romains qui ont fait d'elle l'une des plus grandes villes de l'Empire -la ville de Saint-Augustin- qui a disparu au VIIème siècle, avec l'arrivée des Arabes.

La métropole comprend les vestiges de la présence des époques: Punique, Romaine, Vandale, Paléochrétienne et Arabe. Les principaux éléments connus du site de Carthage sont l'acropole de Byrsa, les ports Puniques, le tophet Punique, les nécropoles Puniques, le musée de Carthage, l'Amphithéâtre Romain, lesThermes d'Antonin, les citernes de Malaga, la réserve archéologique et la cathédrale Saint-Louis construite par les Français dans les années 1890 à l'endroit où le roi français Louis IX est mort en 1270.

D'autres sites importants à Carthage qui nécessitent d'être mentionnés, sont le palais présidentiel, la mosquée Al Abidine, construite en 2003 au cœur du site archéologique de Carthage et le cimetière américain où reposent 2.841 militaires américains qui ont perdu leur vie dans la Seconde Guerre mondiale lors d'activités militaires allant de l'Afrique du Nord au Golfe Persique.

LA LEGENDE DE BYRSA

Dans la Carthage antique, Byrsa était la citadelle fortifiée au-dessus du port. Byrsa était aussi le nom de la colline sur lequel elle reposait.

Selon certaines sources, le nom est dérivé du mot phénicien pour *citadelle*; selon d'autres il est une corruption de *Barsat*, ce qui signifie *forteresse* en phénicien (se référant à la hauteur de la colline: 55 mètres), alors que dans d'autres sources, cela signifie *peau de bœuf*.

La dernière interprétation pour Byrsa (peau de bœuf) pourrait être liée à la légende de la reine Elissa (Dido en Romain ; Deido en Grec et Didon en Latin) dont les détails de la vie sont peu précis et déroutant: la belle Elissa et son frère Pygmalion sont les enfants héritiers du roi Matten de Tyr. Craignant son frère qui avait assassiné son mari dans l'espoir de mettre la main sur son trésor, Elissa a quitté Tyr avec un groupe de fidèles y compris certains sénateurs.

De passage par Chypre, les exilés se sont emparés de certaines personnes, principalement des femmes pour accroître leur nombre.

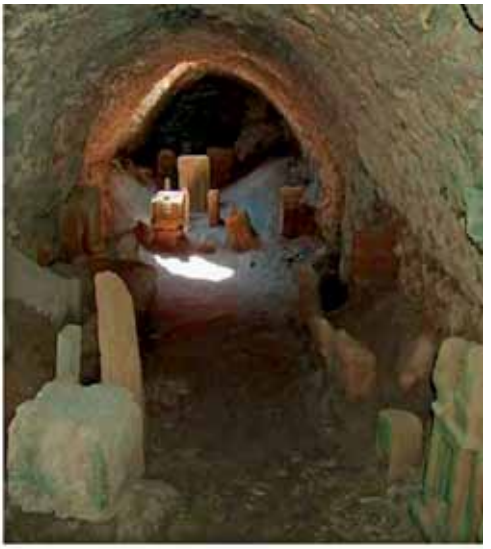
D'après les récits de Virgile et de Justin sur la fondation de Carthage par Didon, lorsque Didon et ses partisans sont arrivés sur la côte de l'Afrique du Nord, ils ont campé à Byrsa. Un chef berbère nommé Hiarbas leur a offert autant de terrain qu'en pourrait couvrir une peau de bœuf. Elissa a fait couper la peau en lanières très minces et les a posées bout à bout sur terre jusqu'à ce qu'elle ait complètement encerclée Byrsa. Cette histoire est considérée comme apocryphe, et a probablement été inventée parce *Byrsa* ressemble au *βυρσα* mot grec signifiant *peau de bœuf*. **(**Cet événement est commémoré dans les mathématiques modernes: Le "problème isopérimétrique" pour encercler une surface maximale dans une limite fixe, est souvent appelé le "Problème de Didon" dans le calcul moderne des variations. (*Il est à noter qu'une conférence internationale sur le problème isopérimétrique de la reine Didon et de ses ramifications mathématiques a eu lieu à Tunis du 21 au 29 mai 2010*).

Beaucoup d'habitants voisins ont rejoint le campement et ensemble, avec certains

habitants de la ville phénicienne voisine, Utique, ont exhorté la construction d'une ville qui fût par la suite Carthage-Byrsa. En creusant les fondations, on trouva dans les premières une tête de bœuf, indiquant un sol fertile mais voué à un perpétuel esclavage. On transporta donc l'emplacement la ville en un autre endroit. Là on trouva une tête de cheval, ce qui signifiait que le peuple serait belliqueux et puissant et l'on décida de bâtir la ville sur cet emplacement de favorable augure.

La fin de cette légende est triste puisque Elyssa se jeta dans le feu. Dans certains récits, on raconte qu'elle a fait cela pour protéger sa ville et rester fidèle à son mari, après que le roi Hiarbas l'a demandé au mariage. Dans d'autres, on raconte que parce qu'elle a été incapable de supporter son abandon par Enée, le fameux héros de Troie, de qui elle est tombée amoureuse lors de son escale sur les rivagesl de l'Afrique du Nord après une tempête, mais qui a du reprendre son

La nécropole romaine de Carthage



Tophet avec lieu de sacrifice pour enfant

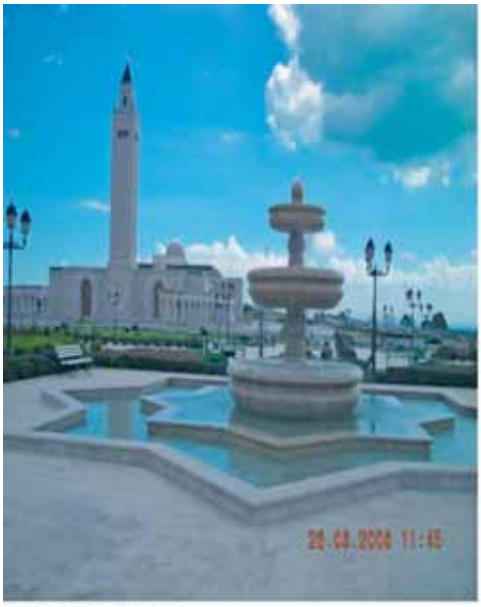
La Cathédrale St Louis

voyage pour fonder une nouvelle ville en Italie, qui est Rome.

De nombreux sites en Tunisie (résidences, hôtels, restaurants, rues...) portent aujourd'hui les noms de Didon, Elissa, Hannibal etc, en hommage à ces héros et leurs civilisations qui on fait de Carthage un lieu qui continuera toujours à nourrir l'imagination universelle grâce à sa renommée historique et littéraire.

LA RENAISSANCE DE BYRSA: L'ENFANT DE BYRSA

Un événement historique important qui a amené le toponyme de Byrsa à l'avant, est la découverte fortuite en 1994 d'une sépulture d'un jeune homme sur le flanc sud de la colline de Byrsa, qui est l'un des sites les plus célèbres de la Carthage antique. Une équipe mixte franco-tunisienne s'est déplacée pour l'excavation. Une étude anthropologique du



La mosquée Al Abidine

Le cimetière Américain

L'enfant de Byrsa

(Avant la reconstruction dermoplastique)

(Après la reconstruction dermoplastique)

squelette a montré que les os ont plus de 2.500 ans, que l'homme est décédé au 6ème siècle avant JC entre l'âge de 19 et 24, qu'il avait un physique très robuste et a été de 1,7 mètre de hauteur, selon la description faite par Jean Paul Morel, directeur de l'équipe archéologique française à Carthage-Byrsa.

L'homme de Byrsa a été rebaptisé *Ariche* – ce qui signifie *l'homme désiré* – à l'initiative du ministre Tunisien de la Culture. Ariche a retrouvé un aspect vivant presque humain très proche de la physionomie d'un Carthaginois du 6ème siècle avant JC, après une reconstruction dermoplastique entreprise à Paris par Elisabeth Daynes, sculpteur spécialisée dans les reconstitutions hyper-réalistes.

Rapatrié le 24 Septembre 2010, Ariche sera en exposition au musée de Carthage à Byrsa jusqu'à fin Mars 2011; après il voyagera au Liban, le pays des Phéniciens qui fondèrent Carthage, pour une exposition à l'Université Américaine de Beyrouth. ■

REFERENCES:

1. Azédine BESCHAOUCH (1993) La légende de Carthage, Gallimard, Paris
2. Hassine FANTAR (2000) Carthage: approche d'une civilisation, CNRS, Paris
3. Musée National de Carthage
4. Bayt El Hikma, Carthage (Académie Tunisienne des Sciences, des Lettres et des Arts)
5. http://fr.wikipedia.org/wiki/Byrsa
6. http://www.sacred-destinations.com/tunisia/carthage
7. http://en.wikipedia.org/wiki/Dido_(Queen_of_Carthage)
8. http://fr.wikipedia.org/wiki/Carthage
9. http://www.superstock.com/stock-photography/Carthage
10. http://www.matunisie.com/forum/index.php?/topic/511-carthage/
11. http://archaeologynewsnetwork.blogspot.com/2010/10/carthage-unveils-man-of-byrsa.html

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A LIFE IN SCIENCE WHICH IS LIFE ITSELF

ON THE 80TH ANNIVERSARY OF ACADEMICIAN V.M. KOTLYAKOV

Science is Life
V.M. Kotlyakov. The Selected Works, Book 6

The epigraph for this article is composed of the words taken from the title of the Book 6 of "The Selected Works" by V.M. Kotlyakov[1] where the hero of the anniversary tells about his life journey and his 50-year-long work in science. For him, of course, science and life are inseparable. His next anniversary has approached now and, today, we can talk about 56 years in science. And what about life of V.M. Kotlyakov, the world-renowned outstanding scientist, academician, the leader of the Russian glaciology, and the symbol of national geography? It is there, among the lines of his books and articles, in numerous interviews to various media, and in personalia written by his friends and colleagues for various publications. No wonder that traditional memoir headings in the book by Academician V.M. Kotlyakov end with the second chapter "At the University" (there is only one preceding chapter – "Childhood and Young Years"). And further on, there are three impressive chapters: "Polar Countries" (about winter expeditions to the Antarctic and research in the Arctic), "The Becoming of the Soviet Glaciology" and "International Glaciological Life" (this chapter is about life, but very special, "glaciological" one). This means that, after graduating from university, he did not have life in our common sense; science has been his life. Thus, this simple philosophy explains the understanding of science as a form of life of an outstanding scientist[2].

And it appears that the hero of the anniversary does not separate one from the other. He does not imagine himself without geography, glaciology, his institute, the Russian Geographical Society (RGS), maps, atlases, books (his own and written by his colleagues), expeditions, congresses, conferences, symposia, national committees, scientific councils, editorial boards of magazines, encyclopedias and serial publications, funding committees, etc. And this is still not enough for him. All the above mentioned should impetuously move around the leader speeding up while approaching a specific date of an event, e.g., an international conference, a meeting of the editorial board of "Proceedings of RAS. Geographical Series", etc. In this respect, the 90th anniversary of the Institute of Geography of RAS has been very remarkable. There, V.M. Kotlyakov has worked for 56 years, 25 of them – as director, and 42 – as head of the Glaciological Division. Generally speaking, the Institute is his home. The row of events designed over a year prior to the Institute's anniversary, was gradually shrinking and fading with the date of the event approaching. However, at the very "point of no return", as soon as the director began convening meetings of the executive committee nearly each week and getting involved in the activities of literally all steering groups, the executive committee has got a second wind: the book "The Institute of Geography and its People" has been prepared for publication, meetings with the Institute's veterans have commenced, a jubilee brochure has been published, and the program has been finalized. And so in all…

Five years after the previous jubilee of V.M. Kotlyakov have raced by. This period encompassed the 90th anniversary of the Institute of Geography, as well as the 165th

[1] Kotlyakov, V.M. The Selected Works. In Six Volumes. Book 6. Science is Life. RAS. Institute of Geography. Moscow. "Nauka". 2003. 574 p.

[2] Agranat, G.A. Geography: The achievements of science, success of a scientist (review). Herald of RAS. Vol. 73, № 2. 2004. pp. 177–180.

anniversary of the Russian Geographical Society (RGS) and other memorable dates. The years have flown so fast that we haven't completely realized the significance of the sequence of the anniversaries in the world of geography, which happen to take place in the early XXI century. And the jubilees of Academician V.M. Kotlyakov are, undoubtedly, prominent among them all.

There is a certain problem associated with the oncoming jubilee. On the previous one (the 75th anniversary), a collection of works in six volumes with the autobiography[3] and a book in the series "Bio-Bibliography of Scientists" by "Nauka Press" had been published. It seems unlikely to expect similar accomplishments now. However, the hero of the anniversary has a lot to "account for" during the last five years:

– Receiving the award of the 2007 Nobel Peace Prize as a member of the Intergovernmental Panel on Climate Change;

– Receiving the award of the Order of Merit for the Fatherland of the IV Degree;

– Publication of the Elsevier's Dictionary of Geography[4] in five languages and of its Russian version[5];

– The 50th anniversary of the Russian Antarctic research (2006); V.M. Kotlyakov received SCAR Pin of Honor; he conducted meetings devoted to research of the sixth continent in Moscow and St Petersburg;

– Participation, as the leader of the Russian delegation, in the International Geographic Congress in Tunisia (2008), the IGU Conference in Israel (2010) and in many other international meetings;

– Publication of the first issue of the "Ice and Snow" magazine ("Nauka" Press) (2010) that continued the series "Proceedings of Glaciological Research " founded by V.M. Kotlyakov in 1961;

– Organization and implementation of the 2007–2008 International Polar Year (IPY) (that could be considered another "brainchild" of our hero of the anniversary) and summarization of its first results[6];

– The 165th anniversary of the RGS; holding the Extraordinary Congress of the RGS (2009) which marked its reform, and the RGS-sponsored conference "The Arctic – Territory of Dialog" (2010); regular contacts with S.K. Shoigu who became President of the RGS and V.V. Putin who became Head of the RGS's Board of Trustees; organization and conduct of the 14th Congress of the RGS (December 2010) where first results of the reform have been summarized and its strategy and perspectives were discussed;

– Publication of two volumes of a monograph on glaciation of the Northern Eurasia in the past, present, and future[7] edited by V.M. Kotlyakov;

– The 90th anniversary of the Institute of Geography of RAS (2008) and publication, by that date, of the book "The Institute of Geography and its People"[8];

– Preparation (editor-in-chief) and publication of the "Atlas of Kuril Islands"[9] in cooperation with the Pacific Institute

[3] Kotlyakov, V.M. The Selected Works. In Six Volumes. Book. 6th. Science is Life. RAS. Institute of Geography. Moscow. "Nauka". 2003. 574 p.

[4] Kotlyakov, V.M., Komarova A.I. Elsevier's Dictionary of Geography. English, Russian, French, Spanish, and German // Elsevier. Amsterdam–Boston–Heidelberg–London–New York–Oxford–Paris–San Diego–San Francisco–Singapore–Sydney–Tokyo, 2007. 1048 p.

[5] Kotlyakov, V.M., Komarova A.I. Geography: Concepts and terms: Dictionary in five languages. Russian, English, French, Spanish, and German // Moscow, Nauka, 2007. 859 p.

[6] Kotlyakov, V.M., Frolov I.E. Russia in the International Polar Year 2007–2008. Preliminary results of studies of the cryosphere // Ice and Snow. 2010. № 1 (109). pp. 127–139;

[7] Kotlyakov, V.M. (Editor in Chief) Glaciation in North and Central Eurasia in the Modern Era // 2006. Moscow. Nauka, 48 p.; Kotlyako, V.M. (Editor in Chief) Glaciation in North Eurasia in the Recent past and the Nearest Future // 2007. Moscow. Nauka, 366 p.

[8] Kotlyakov, V.M. (Editor in Chief). The Institute of Geography and its People: the 90th Anniversary. Moscow. Nauka. 2008. 677 p.

[9] Kotlyakov, V.M. (Head of the Editorial Board) Atlas of the Kuril Islands. Moscow-Vladivostok: "DIK." 2009. 515 p.

of Geography of the Far Eastern Branch of RAS and with the Federal Service of Geodesy and Cartography;

– Development of new programs of the Presidium of RAS and the Division of the Earth's Sciences of RAS for fundamental research; V.M. Kotlyakov is their leader and the ideological inspirer and the team of the Institute of Geography is responsible for their implementation (2006–2010);

– The list of the hero of the anniversary's publications has grown by 100 papers; almost two dozen books were published under his editorship.

There is unlikely a person in the world, and indeed in our country, who has accomplished more from 2006 to 2011. And it is here that we can recall the phrase that opened V.M. Kotlyakov's book "Science is Life"[10]. Using the expression of the consuls of Rome finishing their ruling cycles, he wrote: "I have done what I could; let those who can do better".

The symbol of the national geography. Exceptionally large volume of publications have been written on V.M. Kotlyakov and his work: together with Internet publications this list is at least 190–200 items long. Such publications were particularly numerous during recent years when the Institute of Geography, RAS, the RGS and the whole country celebrated the 70th and the 75th anniversaries of the scholar. All scientific periodicals, i.e. "Herald of RAS"[11], "Proceedings of RAS. Geographical Series"[12], "Geography and Natural Resources"[13], "Proceedings of the RGS", "The Earth and the Universe", etc.), published milestone articles. Since 1978, his biographical profiles have been appearing in the biographical dictionaries and encyclopedias. Information on him, his biography, and his contribution to the national science can be found in the "World Biographical Encyclopedia (1998)", "Great Soviet Encyclopedia (1980, 1983, 1985, 1990)", and "Russian Encyclopedic Dictionary (2001)", as well as in other two dozen reference biographical publications. Journalists interview him with enthusiasm, usually picking for the articles trivial titles associated with cold, snow, or ice, such as "Snow Man", "Ice Conqueror", or attempting, indeed, to link glaciology with "Father Frost" (Where was he born? Where does he live? Where does he govern?) or with "Snow Queen". These are the journalists. But he, himself used the titles of his popular articles to move the readers closer to the subject: "The Atlas of the "Refrigerators" of Our Planet", "Who Needs Last Year's Snow?" etc.

V.M. Kotlyakov is appreciated as an outstanding scientist, a public figure, a long-established scholar, and a very organized person not only in RAS, but also far beyond. I remember how young staff of a central TV channel aspirated about an interview with V.M. Kotlyakov and about their work with him on a broadcast.

When the time came for the anniversaries of his university classmates who, at large, became well-known geographers working, as a rule, at the Institute of Geography of RAS and at the MSU Faculty of Geography, V.M. Kotlyakov himself volunteered to write an article for "Proceedings of RAS. Geographical Series" to congratulate them.

When summarizing everything accomplished by V.M. Kotlyakov during these long years, one can be easily impressed by the volume, thematic breadth, and the depth of his work. It is quite understandable in respect to glaciology as a branch of geographical science: for many decades he remains its standing leader, who has modernized it and broadened its scope and methodology,

[10] Kotlyakov, V.M. The Selected Works. In Six Volumes. Book 6. Science is Life. RAS. Institute of Geography. Moscow. "Nauka". 2003. p. 9

[11] Agranat G.A. Geography: The achievements of science, success of a scientist (review). Herald of RAS. Vol. 73, № 2. 2004. pp. 177–180.

[12] Belonovskaya, E.A., Belyayev, A.V., Velichko, A.A., Diakonov, K.N., Dreyer, N.N., Zinger, E.M., Kasimov, N.S., Krenke, A.N., Lipets, Yu.G., Osokin, N.I., Saltykovskaya, L.V., Tishkov, A.A. Vladimir Mikhailovich Kotlyakov is 75! // Proceedings of RAS. Geographical Series. 2006. № 5. pp. 7–11.

[13] Baklanov, P. Ya, Snytko, V.A., and Chibilev, A.A. "The Collection of Works" of Academician V.M. Kotlyakov [in six books] // Geography and Natural Resources. 2004. № 4. 157 p.

has promoted the most advanced methods of investigations (remote sensing, isotope, paleoclimatic, geochemical etc.), has created a strong unified terminology, and several times has managed to assemble large teams (up to 300 people) for inventory and mapping of the glaciers. There were good grounds for rewarding the creators of "The World Atlas of Snow and Ice Resources"[14] led by V.M. Kotlyakov with the 2001 State Award of the Russian Federation in Science and Technology. He also remains the "Pimen of the national glaciology and a chronographer of the glaciological literature"; he diligently follows everything that is published by glaciologists, summarizes and makes it available to all interested persons.

But this is not yet the entire story. All that creates the modern geographical science now, and all that, in one or another way, excites the minds today, had been suggested and stated by him decades ago in the form of ideas and hypotheses and had been planned in the format of research programs. These include deep drilling of glaciers, isotope analysis of ice core-samples and the reconstruction of the history of the Earth's climate and natural environment during different phases of its evolution. Moreover, these are his views on the modern climate change, its natural and anthropogenic components, and its impact on the nature, economy and population. When he was elected director of the Institute of Geography, he had to wrap up, either willingly or unwillingly, into the multitude of themes and to accept responsibility for finalizing large projects of Academician I.P. Gerasimov, including the atlas "Nature and Resources of the World". It is clear now from the words spoken by the hero of the anniversary himself, that this "is connected primarily with inevitable expansion (and, to some degree, with change) of interests" at acceptance of the position of director of the Institute of Geography of RAS.

[14] The World Atlas of Snow and Ice Resources. Vol.2. Book 1. Ed. By Kotlyakov, V.M., Grosvald, M.G., Davidovich, N.V., et al. RAS. 1997. 264 p

How does he manage to accomplish this, is a big secret. But it is only a secret to those who don't know V.M. Kotlyakov. We feel emboldened to say that we know him well and understand how he does it.

Nulla dies sine linea. Let us take, for example, his publications. For already 55 years, V.M. Kotlyakov has been producing articles, scientific and popular science papers, books, and maps. Their number is over a thousand! Moreover, upon careful examination of the hero of the anniversary's biography, his exceptional commitment becomes clear – at least 20 to 25 scientific and at least two to five popular science works per year. We should also mention his work as the scientific editor of monographs and collections of papers (over a hundred since 1964). In this connection, it is appropriate to note that Academician V.M. Kotlyakov was the editor of most monographs on glaciological issues published in the USSR and in Russia. And what about his famous "brainchild", i.e. "Proceedings of Glaciological Research" (PGR), now titled closer to the subject of studies, i.e. "Ice and Snow"? Since 1961, for already 50 years (!), he has been editor-in-chief of this publication. The mission fits to be included in the "Guinness Records". And still no beaten tracks. Over a hundred issues have been published, but the twinkling eyes of the editor-in-chief tell about his sincere interest in each issue, each paper, and each illustration.

Analyses of themes of V.M. Kotlyakov's publications conducted by the compilers of his bibliography on the 75th anniversary of the scholar showed that, as it should be expected, his scientific interests have broadened. From special problems of snow studies, ice studies, and glaciology (in 1950s–1960s) they gradually expanded, in 1970s–1980s, to encompass mountain geoecology, its new methods, including remote sensing and mapping of glaciers and compilation of glaciers cadastre. And then, since the mid-1980s till nowadays, his scientific interests have embraced general geographical, ecological-geographical, and environmental

problems, paleoglaciology, and climate change. Recent years were marked by the publication of the Elsevier's Dictionary of Geography[15] compiled by V.M. Kotlyakov and A.S. Komarova and of its Russian-language version[16]. In keeping with the best traditions of the national science, he familiarized his colleagues with the entrails of his work on this thousand-page thick reference book[17]. He shared with them his doubts and success in achieving truly "geographical sockdolager", i.e., terminology of 14 geographical disciplines[18]. The experience of analysis of the terminology and supporting reference material proved to be not only successful but also very useful; it vitalized this almost forgotten branch of geographical science capable to unify approaches to problem solving in many geographical sciences. This experience gave a new impulse to the integrity of geography.

In 2000–2004, V.M. Kotlyakov published six volumes of his selected works. It is difficult to remember something even remotely similar in the national geographical science of the XX century. The unprecedented nature of this event is associated with the fact that this publication asserts the right of geography to occupy an important place in the modern life. The scientific deed of the scholar noted by his colleagues[19] and widely recognized by the public, was also in consolidating the leading role of geography in the scientific support of the country's sustainable development and in promotion of greening and humanization of geography itself. In 2005, the Presidium of RAS awarded him with the L.S. Berg Gold Medal for this work.

From the International Geophysical Year to the International Polar Year-3. A five-year period between V.M. Kotlyakov's anniversaries included the 2007–2008 International Polar Year (IPY). But there are only few who remember now that it was after more than 50 years since his participation in the International Geophysical Year (IGY) (1957–1959) and his first winter expeditions to the Severny Island of the Novaya Zemlya (1955) and to the Antarctic (1956–1957) that he came back to the idea of holding the IPY[20]. Recognizing the fact that the Arctic and the Antarctic are the areas of global cooperation and together with his friends and colleagues, he was among the originators of the IPY-3 initiative that emerged as early as in 2003. Far back in the 1950s, the IGY managed to breach the "Iron Curtain"; today, the mission of the IPY is to provide for the cooperation of scientists for prevention of negative and often catastrophic consequences of the modern transformation of the environment and climate. 2007–2008 marked 50 years since the IGY, and 125 and 75 years since IPY-1 and IPY-2, respectively. V.M. Kotlyakov has repeatedly spoken and written on the need to be engaged again in extensive Arctic and Antarctic research using new approaches and methods. The IPY-1 and the IGY coincided with different climatic cycles of the Earth: cooling at the end of the XIX century, warming in the 1920s–1940s (most noticeable in the Arctic), and cooling in the 1950s–1970s. During recent decades of the XX century and the early XXI century, there is a marked warming of the global climate. The most significant changes occur in the Polar Regions and there is high uncertainty associated with forecasted trends of climatic changes there[21].

[15] Kotlyakov, V.M., Komarova, A.I. Elsevier's Dictionary of Geography. English, Russian, French, Spanish, and German // Elsevier. Amsterdam–Boston–Heidelberg–London–New York–Oxford–Paris–San Diego–San Francisco–Singapore–Sydney–Tokyo, 2007. 1048 p.

[16] Kotlyakov, V.M., Komarova, A.I. Geography: Concepts and terms: Dictionary in five languages. Russian, English, French, Spanish, and German // Moscow, Nauka, 2007. 859 p.

[17] Kotlyakov, V.M., and Komarova, A.I. Geography as a multi-disciplinary science (from the experience of compiling a multilingual dictionary of geographical terms) // Proceedings of RAS. Geographical Series. 2004. № 3. pp. 8–17.

[18] Drozdov, A.V., and Tishkov, A.A. Multilingual Elsevier's Dictionary of Geographical Terms and Concepts // Proceedings of RAS. Geographical Series. 2007. № 4. pp. 134–135.

[19] Maksakovsky V.P. Geography in a changing world. On the publication of "The Selected Works of Academician V.M. Kotlyakov" // Geography in School. 2003. № 4. pp.. 3–7; Baklanov, P.Ya, Snytko, V.A., and Chibilev, A.A. "The Collection of Works" of Academician V.M. Kotlyakov [in six books] // Geography and Natural Resources. 2004. № 4. 157 p.

[20] Kotlyakov, V.M., and Sarukhanyan, E.I. The International Polar Year 2007–2008 // Nature. 2007. № 3. pp. 34–40; Kotlyakov, V.M., Sarukhanyan, E.I., and Frolov, I.E. The first steps of the International Polar Year 2007–2008 // Nature. 2010. № 9. pp. 44–55

[21] Kotlyakov, V.M. and Sarukhanyan, E.I. The International Polar Year 2007–2008 // Nature. 2007. № 3. pp. 34–40

Throughout the entire preparation period and in the course of the IPY-3, V.M. Kotlyakov was "in charge" – he participated in selection of international projects (so called "clusters"), coordinated glaciological research in Russia, and leaded the implementation of international projects. Invisible strings of a musical instrument called "polar research" were extending to reach him from all regions of the Arctic and the Antarctic. Skeptics were laughing: "Where can one get money? Where are the experts? Where is youth to work in snow and ice?" But even three years prior to the beginning of the IPY-3, he had secured funding for special programs for fundamental research of the Presidium and the Division of the Earth's Sciences of RAS aimed at the organization and implementation of the IPY in the Russian Arctic and the Antarctic. Annually in October, the city of Sochi, haven't yet cooled from hot summer holidays, became, one may say, a "near polar" city. Under the leadership of Academician V.M. Kotlyakov, special conferences were held there devoted, initially, to the organization and, then, to the summarization of the first results of the IPY. None of other Russian cities (except for Moscow and St. Petersburg) has experienced such a gathering of researchers of snow and ice. And maybe it was the scientific foresight of V.M. Kotlyakov that contributed to the selection of Sochi as the capital of the oncoming Winter Olympic Games.

Honorary President of an oldest scientific-social organization of Russia. The Russian Geographical Society has celebrated its 165th anniversary and V.M. Kotlyakov contributed 55 years of his membership to it. And all these years, it was not just a passive membership, but an active work, first of all, at the Moscow center of the RGS. Since 1980, he was continuously elected Vice-President of the RGS. In 1991, he was elected President of the newly founded Geographical Society of the Russian Federation. Then, after the merger with the RGS at the XI Congress, he was also unanimously elected Honorary President of the RGS. This recognition of V.M. Kotlyakov as a scientist and a leader of the national geographical community proves that it is not limited just to academia or higher education. He has also received awards from the RGS: the F.P. Litke Gold Medal for his "Dictionary of Glaciology" (1984) in 1985, the N.M. Przhevalsky Gold Medal for the monograph "The World of Snow and Ice" (1994) in 1996, and the Big Gold Medal of the RGS in 2005.

And whereas he has been already well-known abroad as a leader of the national glaciologists, it is specifically because of his work at the RGS that his recognition as a geographer-encyclopedist became possible: he has been elected a member and a corresponding member of a number of foreign geographical societies, namely, American (1987), Mexican (1996), Estonian (2000), and Ukrainian (2008).

One can understand the leaders of our country, e.g., Prime Minister V.V. Putin and Minister for Emergency Situations and President of the RGS, S.K. Shoigu, who take interest in the problems of geography and environmental protection in Russia and regularly contact V.M. Kotlyakov and N.S. Kasimov to seek advise and support for various undertakings of the RGS which is undergoing the profound reforms.

It is encouraging to see our hero of the anniversary in presidiums of the important meetings of the RGS next to those, who themselves, at their own initiatives, came to assist this organization recognizing that "without geography we are in the middle of nowhere!" and attempting to give this organization new impetus to development. And despite the words of those who favored more the former waning life at the RGS, especially at its regional branches, our hero of the anniversary is exactly the one who made sure that geographers have their "corporate fortress" that protects the union of academic, higher education, sectoral, and secondary education geography. Recently, in connection with the reforms of the RGS and the activities of its Executive Directorate, one can see the genuine admiration of

young organizers of the RGS events when they look at the symbol of the modern geographical science, i.e., at Honorary President of the RGS! Oh! They will tell a lot about Academician V.M. Kotlyakov, linking him with his geographical ancestors, such as N.M. Przhevalsky, F.P. Litke and L.S. Berg.

"To wander is the miller's joy, to wander!"
The heading of the final section of our essay on the anniversary of V.M. Kotlyakov is from the famous song by F. Schubert "Wandering!" The secret of creative longevity, of infectious interest to science and all new in it and of exceptional diligence and attention to people is in motion. In the 1950s, he found his "guiding star" in science and chose a difficult life and career path. And he departed along it without taking any rest-stops, from one milestone to another. The year 2011, as well as the year 2010, is filled to the rim with works, trips, presentations, papers, and books. He is welcomed in Paris, Geneva, Vienne, Oslo, and Berlin, where the headquarters of international organizations and national committees that he heads are located. He plans his participation in international geographical congresses and conferences a year before, or even earlier. Since the establishment of international scientific committees on the Arctic and the Antarctic, it has become his duty to participate in their meetings. The colleagues-geographers from the CIS countries regard V.M. Kotlyakov as their leader and receive him as a reputable member, an old friend, and an honorary guest at their events. And all this is only abroad and in one year only!

And there are also trips and events in this country. These are just impossible to account and work into the schedule. Regular, actually annual, conferences of glaciologists; visiting sessions of the Scientific Council of RAS on the problems of fundamental geography; repeated meetings of the Scientific Council and the Presidium of the RGS in St. Petersburg … After the successful start in 2010 in Moscow, it was decided that in 2011, the international conference "The Arctic – Territory of Dialog" will be held in Arkhangelsk. V.M. Kotlyakov, as one of the initiators and the organizers of this international meeting, began the preparatory work actually one year prior.

Our hero of the anniversary is in the constant motion – heading the Section on Oceanology, Physics of Atmosphere, and Geography of the Division of the Earth's Sciences of RAS, the Institute of Geography of RAS, several dozens of societies, councils, committees, commissions, and editorial boards; editing several books simultaneously; preparing 20–30 scientific and popular science articles each year; closely supervising the work of his students, graduate students, and candidates for doctoral degrees; and constantly giving interviews to TV programs and other mass media. And this is happiness for him!

However, the purpose of this essay is not to list all numerous duties of V.M. Kotlyakov. The purpose of it, indeed, is to create a portrait of the scholar through the eyes of his colleagues, whom he walks next to, but a little bit faster than anyone else. It is precisely the reason that he has been considered the leader of our science and our geographical community. The portrait is ready, being made with large brushstrokes. Now it remains only to wish Vladimir M. Kotlyakov to stay in motion as long as possible, i.e., to wish him happiness, fascinating journeys, new books, and long life in the name of the Science!

A.A. Tishkov

FRIDTJOF NANSEN
(ON THE 150TH ANNIVERSARY OF HIS BIRTH)

In 2011, two great events, important to the entire educated world, have coincided. These are the 150th birthday anniversary of Fridtjof Nansen (10/10/1861) and the 100th anniversary of Roald Amundsen's expedition reaching the South Pole (14/12/1911). On January 23, 2011 in Tromsø, Norway, the celebration of the Jubilee Year in honor of the two national heroes – polar explorers has been launched. The main celebration was on October 10. Norwegian Foreign Minister Jonas Gahr Store said that the north of the planet is the priority of Norwegian foreign policy, that it is necessary to protect the Arctic nature, and that the extreme north is, in a sense, the territory common to Russia and Norway. Northern unity of the two countries in the early twentieth century has been turned into a reality by the great Fridtjof Nansen (Fig. 1).

Fridtjof Nansen was born in the town near Kristiania to the family of a lawyer. At the age of 23, he graduated in zoology from the University of Kristiania. In 1886, he was awarded the Big Gold Medal of the Royal Academy of Sciences for research in animal parasitology. In 1888, Nansen was awarded a doctoral degree. In 1897, he accepted a professorial position. Prior to that, there were carefully planned expeditions to Greenland and on the "Fram" that received worldwide recognition. In 1906–1908, he was Ambassador of Norway in the UK. In 1913, he took a trip to Siberia and the Far East. At the end of World War I, he became the representative of Norway to the United States and, in 1920–1922, he was the League of Nations' High Commissioner for Refugees. He issued special Nansen passports, saving lives of many people. In 1921, on behalf of the International Red Cross, he set up a committee "Nansen Aid" to save the starving Volga region and arranged to send there 4000 trains with food supplies. Nansen was one of the few international-standard politicians who were loyal to the young Bolshevik Russia and the USSR. In 1922, he was awarded the Nobel Peace Prize. Of theses funds, Nansen paid for equipment for several Machine and Tractor Stations in the RSFSR.

Fig.1. Nansen at 32 years of age

The Greenland expedition. On July 17, 1888, the ship "Jason" approached the east coast of Greenland, near Angmassalik, by 180–20 km and landed the expedition of six men led by Nansen on the floating ice fields. The ice drifted south through storms. Progression on two boats to the largest world's island through a big clearing between ice and icebergs came with a huge risk. On the twelfth day, they reached the shore where they met Eskimos. Nansen has described their life and social order. Upon reaching the fjord Umivik, on August 23, they began sled-ski ascent of the ice sheet. Frost reached –40°C. On September 5, they came to a glacier pass at an altitude of 2720 m; on September 24, they were on its western edge and arrived in Godthab on October 12 where

Fig. 2. "Fram" in the ice-prison

they spent the winter. The steamer "Vidbern" brought them to Kristiania (the former name of Oslo) on May 30, 1889. Six heroes were honored by the entire nation. Information was obtained about the weather and the shape and the height of the glacier in the southern part. The London Geographical Society awarded Nansen Victoria Medal of Honor; the Paris Academy of Sciences elected him a corresponding member[1].

Four years in the high Arctic. The idea of Nansen was to use the ice drift motion for a research vessel in the circumpolar ocean sector. The ship "Fram" was built to withstand the strong ice pressure by being pushed out of it. It was equipped with everything necessary for five-year duration. On June 24, 1893, "Fram" sailed from Kristiania. In Russia, they acquired sledge dogs. In September, "Fram" got into impassible ice in the Laptev Sea. Thus its drift in the ice-prison began. On January 5, 1895, "Fram" experienced terrible pressure, shocks, and blows to its careened down left side (Fig. 2). It was almost wave-covered. Thirteen members of the expedition were heroically rescuing their ship.

On March 14, 1895, Nansen and Johansen, using teams of dogs, were headed to the North Pole. During the expedition's traverse through the ice desert they came closer, than anyone else before, to the North Pole (86°13.6'N) and turned to the Franz Josef Land where they stayed through the winter. In the spring, on lashed kayaks, they sailed along the islands. On June 12, 1896, Nansen, in the icy water, miraculously caught the wind-ripped catamaran made of two kayaks that carried all their life support. This was their salvation from death. Sailing continued. On June 17, on the Nordbruk Island, Nansen went in the direction of sounds of a dog barking and met F. Jackson, head of the British expedition (Fig. 3). The British, stationed at the Cape Flora's Russian hut, warmly received two Norwegians (Fig. 4). On August 13, 1896, Nansen and Johansen arrived at Vardo, in the north of Norway, on the British ship "Vindvard" (Fig. 5). On August 24, "Fram" came back to Norway. Nansen became a true national hero. The merits of all the members of the expedition were marked by the king and the government (Fig. 6).

The scientific results have been invaluable[2].

"...we have demonstrated that the sea in the immediate neighbourhood of the Pole, and in which, in my opinion, the Pole itself in all probability lies, is a deep basin, not a shallow one containing many expanses of land and islands, as people were formerly inclined to assume" (p. 631).

"The force which sets this ice in motion is certainly for the most part supplied by the winds..." (p. 634);

[1] Fridtjof Nansen "The First Crossing of Greenland". London, Longmans, Green, 1890.

[2] Fridtjof Nansen "Farthest North". V.2. London, Archibald Constable and Company, 1897

Fig. 3. The meeting of Jackson and Nansen

"The hydrographic observations made during the expedition furnished some surprising data. Thus, for instance, it was customary to look upon the polar basin as being filled with cold water, the temperature of which stood somewhere about –1.5°C. Consequently our observations showing that under the cold surface there was warmer water, sometimes at a temperature as high as +1°C, were surprising. Again, this water was more briny than the water of the polar basin has been assumed to be. This warmer and more strongly saline water must clearly originate from the warmer current of the Atlantic Ocean (the Gulf Stream), flowing in a north and north-easterly direction off Novaya Zemlya and along the west coast of Spitzbergen, and then diving under the colder, but lighter and less briny, water of the Polar Sea, and filling up the depths of the polar basin. As I have stated in the course of my narrative, this more briny water was, as a rule, warmest at a depth of from 200 to 250 fathoms, beyond which it would decrease in temperature, though not uniformly, as the depth increased. Near the bottom the temperature rose again, though only slightly" (p. 634–635).

Fig. 4. Nansen in the hut at Cape Flora, the Nordbruk Island

It has been established that a discovery of F. Nansen's advection of warmer and salty waters of the Atlantic under the colder waters of the Arctic Ocean takes place nowadays. In the past, for example, in the period between 10.8 and 9.0 thousand calendar years ago, cyclic amplification of advection of Atlantic heat in the marine and continental Arctic has been the cause of repeated climate warming superior in scale to the modern one[3].

By vast expanses of Siberia and the Far East. A prominent Siberian businessman V.V. Lid has repeatedly asked Nansen to determine whether there were annual passages through

[3] Lavrushin Yu. A. High resolution stratigraphy of the important natural events during last 20Ka in the Atlantic arctic areas. In: Nature of the shelf and archipelagos of the European Arctic. Issue 8, Moscow: GEOS, 2008, 432 p.

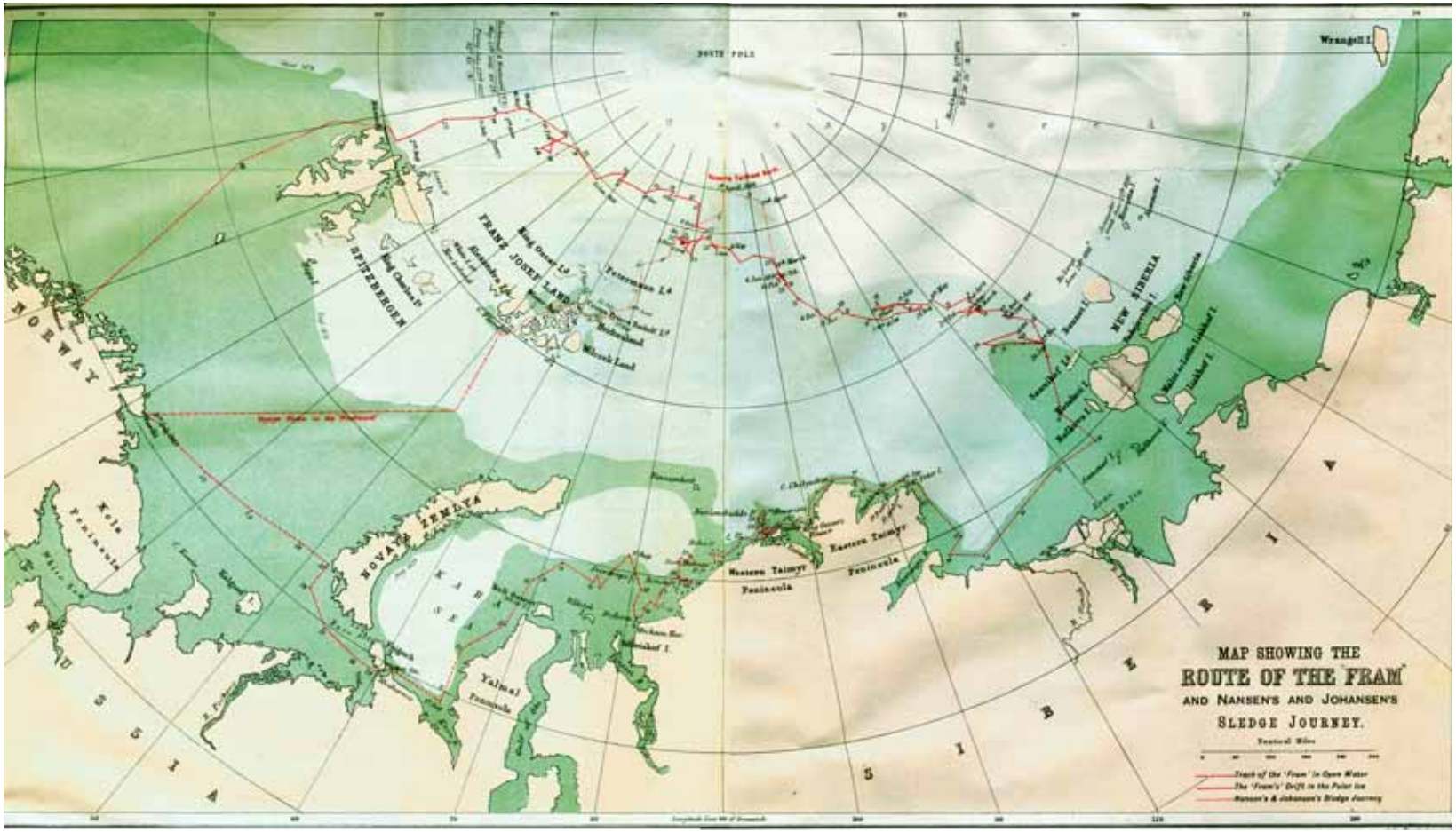

Fig. 5 The map of routes of the "Fram" and Nansen's and Iohansen's

Fig. 6. Members of the expedition on the "Fram" (F. Nansen is second sitting from the right)

the Kara Sea to Europe. Managing director of the state-owned Siberian railways E.D. Vurtsel invited Nansen to travel along the Yenisei River to see the newly built eastern part of the Trans-Siberian Railway. Minister of Transport decided to treat Nansen as the guest of Russia. On August 5 to October 27, 1913, Nansen and his companions (Fig. 7) went from Tromsø by sea aboard the "Correct" to the mouth of the Yenisei River; then Nansen, Vostrotin, and Loris-Melikov sailed up the river to Yeniseisk by "Omul" that looked more like a boat than the steamer. On the way, the scientist was studying life, farming, resettlement, and social characteristics of the indigenous peoples of the Russian North. In the Kara Sea, he studied ice conditions and because of his knowledge and intuition, "Correct" made it into the mouth of the Yenisei River. While traveling on the river in the valley, Nansen recorded geology, geomorphologic features, presence of permafrost, change and types of vegetation, wildlife and fish resources, river systems, land use, forest management, reindeer herding, animal husbandry, crop production, transport networks, settlement, problems of development of Siberia by settlers, and even Chinese issues.

From Yeniseisk they traveled on chaise to Krasnoyarsk and then, the three, together with Vurtsel, went by the Trans-Siberian Railway to Baikal. Next, Nansen and Vurtsel went from the station Karymskaya (90 km pass Chita) by Chinese Eastern Railway to Vladivostok. They traveled back along the Trans-Siberian Railway: in some places by train, by car, on the chaise, and on the boat. From Chita to St Petersburg – by rail.

Poorly developed Asian Russia, for Nansen as a whole – Siberia, the country of the future. We can read excerpts from his book since the beginning of their trip on the Yenisei River[4].

"What a huge, broad mass of water flows out into the Arctic Ocean here; it makes a powerful impression. It gives one the feeling of being at the entrance to one of the great water-arteries of the world" (p. 70).

"It is curious to think of the long journey that has been made by much of the water that runs out here; all the way from the mountains of Mongolia. The Yenisei, with the Angara and Selenga, is reckoned as the fifth longest river in the world, about 3000 miles long" (p. 70). "It was a fine night. When I came on deck, about midnight, the sunset glow lay deep red, like a slow, smoldering fire, over the surface of the river on the north, with dark shreds of smoke-like cloud in front of it. Venus shone just above, and over Venus and sunset gleamed an arch of northern lights. It was an extraordinarily beautiful sight. High up the sky was deep blue and starry, beside us the surface of the water reflected the

[4] Fridtjof Nansen "Through Siberia. The Land of the Future". London, William Heinemann, 1914.

Fig. 7. Aboard the "Correct" from Tromsø to the mouth of the Yenisei River. Left to right: Captain J. Samuelson, entrepreneurs V.V Lid and V.V. Vostrotin, secretary of the Russian Embassy in Norway I.I. Loris–Melikov, Prof. F. Nansen

sky, and beyond it lay the low bank and the endless tundra" (p. 134).

"It was curious to see the different types of Russians in this country. Many of them bore a great resemblance to Scandinavians; there was in particular a fair, mild-mannered boy of eighteen here; if one had not known, one would have taken him for a Norwegian peasant boy. Many of these Russians were fair, with blue eyes and tawny hair, often curly. Tall, powerful fellows many of them were too. One might almost be tempted to think there had been some connection with Scandinavia here" (p. 143–144).

"There was a nice-looking Russian boy with such a pleasant smile and such splendid teeth that I could not take my eyes off him" (p. 151).

"I have come to love it, this boundless land, mighty as the ocean itself, with its infinite plains and its mountains – its frozen Arctic coast – its free and desolate tundra – its deep, mysterious taiga, from the Ural to the Pacific – its grass-grown, rolling steppes – its purple, wooded hills – and its little scattered patches of human life" (p. 436).

"But the turn of these regions come... What a rich country, what immense future possibilities" (p. 240).

"But one day, when the nation is fully awake and the latent forces are set free, we may perhaps hear new voices even from Siberia; for it has a future before it, of that we may be sure" (p. 256).

Nansen was a brilliant researcher and scholar. His interests included oceanography, hydrology, climatology, glaciology, geocryology, geomorphology, geology, paleontology, biology, forestry, agronomy, ichthyology, zoology, ethnography, sociology, political science, and economics. His qualities encompassed a great performance and the ability to write about scientific issues in clear and captivating way and to solve the great scientific challenges, taking risk. He combined humility, kindness, courage, stoutness, tact, good humor, altruism, and penetrating perception of the beauty of nature. Nansen expressed his attitude to Russia in words and deeds that are always remembered. He was a globally minded person. On the geographical map of the world, there are Nansen Basin at the center of the Arctic Ocean, Nansen Peak in the Tien Shan, and Mount Nansen in Land Victoria, the Antarctic. In the lower reaches of the Stony Tunguska River, in a new, after severe floods, residential area in Ket village Sulomai, there is Nansen Street of six duplexes of sawn timber built with the funds of his grandson.

Sergei P.Gorshkov

EXPEDITION "IN THE FOOTSTEPS OF L.A. ZAGOSKIN". YUKON-2009. ALASKA-2010*

In recent years, there has been a growing interest in studying Russian heritage abroad. One of the clearest examples of this heritage is Russian America. This area has become a special junction of several cultures and civilizations. For centuries, aboriginal culture of the Aleuts, Eskimos, and Indians had been forming there and, then, it was faced with a powerful Russian civilization, which was replaced by European civilization in its Anglo-American version. Synthesis of different cultures in Alaska makes it a unique field of research.

In 2009–2010, two research expeditions to the rivers Yukon, Kuskokwim, and Innoko were conducted in Alaska. The expeditions went the way of the famous Russian explorer of Alaska, Lavrentyi A. Zagoskin, who, in 1842–1844, studied internal territories of Russian America. In 2009, the first phase of the expedition took place (Fig. 1). The project participants have repeated part of the historic route of the Yukon River. The path length was 1400 km. During the expedition, research on the ethnography and history of local communities in Alaska, public meetings, and cultural events were carried out. In the Orthodox Church at the settlement Russian Mission in the Yukon, parish registers of the Russian period in Alaska were found. Some of them belonged to the 1860s, when Yacov Netsvetov, who was later canonized, was the priest at the church.

The second stage of the expedition took place in 2010 (Fig. 2). Two groups repeated Zagoskin's routes along the rivers Kuskokwim and Innoko. The route of the northern group went along the Innoko River, from the village Shagelyuk to the confluence of the river with the Yukon, then, by the Yukon to the settlement Russian Mission. Of this settlement, the northern group portaged to the Kuskokwim River, where it connected with the southern group. Then, the combined group travelled to the village of Bethel, on the Kuskokwim. Overall, 600 km were covered, including 146 km of portage from the Yukon to the Kuskokwim.

The southern route went by the Kuskokwim River from the village Mac Grat to the meeting point with the northern group in Kalskag. Then, the combined group reached Bethel. The southern group covered about 700 km.

During two seasons, the expedition carried out research in 35 remote villages. For the first time in 160 years after the sale of Alaska, the Russian people visited these places. Compared with the available, for research, the Kodiak, the Anchorage, and the Fairbanks regions, the interior of the expedition region is still virtually unknown.

In addition to political and educational objectives associated with maintaining Russia's international prestige and with perpetuating the memory of Russian travelers not only in our country, but in the U.S., the expedition allowed us to identify and study previously unknown documents of the Russian period in Alaska, to collect a large ethnographic material, to perform a reconnaissance survey of the terrain, to study linguistic features of the local population and to gather a wealth of material about religious beliefs and practices.

The expeditions are the largest expedition in Alaska since the Russian-American Company. Due to the wide geographical coverage, they have identified the most important aspects related to the development of Russian history in Alaska. The results of the expedition include various fields of science and demonstrate the richness of Russian heritage in Alaska.

* The article has been prepared in the course of scientific research work under the realization of the Federal Target Program "Scientific and Scientific-Pedagogical Staff of Innovative Russia" for 2009-2013.

Fig. 1. Route of 2009 expedition

Historical and ethnographic research. During the expeditions, ethnographic surveys based on a specially developed method were conducted; they included polling, collection of official data, and observation of realities of the indigenous population. The structure of the collected data allows one to perform a comparative analysis of ethnographic information in relation to the book by L.A. Zagoskin.

Most of the settlements studied by the expedition are small in number (300–500), and are highly mono-ethnic. The main occupation of indigenous peoples is self-relying, i.e., hunting and fishing. In all the villages, there is a high level of technical equipment of households. Income level recorded officially is low (approximately 30–40 thousand dollars per year per household). Important sources of income are wages at the shifts, as well as income derived from activities of corporations of the indigenous peoples formed in 1970 under the law on the recognition of claims of the indigenous peoples.

Data were collected on the character of settlements' structure, the presence of domesticated animals, clothing, household plots, diet, etc. Members of the expedition were able to visit a traditional *potlatch* feast, as well

Fig. 2. Route of 2010 expedition

as personally try desserts of the ancient Eskimo delicacies – *akichak, agudak* – which, according to Russian sources of the XIX century, are known as *tolokusha*. It is a finely chopped red or white fish, mixed with fat and frozen berries.

Historical research. During the expedition, church documents (parish registers and records of the population) found in the archives of Exaltation of the Holy Cross church at the settlement Russian Mission were studied. The documents that have never before been used for scientific research have led to the conclusion that the influence of Russian culture was great, even after the sale of Alaska to the United States. All the paperwork was conducted in Russian; there are Russian names and surnames of local residents. Mixed population (descendants of Russian and Eskimo and Aleut) was significant; the actual ethnic Russian immigrants from the provinces of Russia, who lived in Alaska after its transfer to the United States, are also mentioned.

In 2010, a unique historical experiment to study the routes of Russian travelers and potential for transport and trade communications of rivers and lakes of Alaska has been implemented. The northern expedition group "Alaska 2010" made

a water-land transition from the Yukon River to the Kuskokwim Rive (Fog. 3). The transition (portage) was performed along the same route that was used by the local population of Alaska and by the Russian explorers, including the L.A. Zagoskin. In the course of this experiment, it has been shown that the role of climate, water level, time of year, and other natural phenomena were underestimated by researchers, who studied the local population of Russian America and the history of colonization of these territories.

Historical and archaeological research. In 1844, L.A. Zagoskin discovered and gave a brief description of a downfallen fortification, seven miles of the mouth of the extreme right arm of the Yukon River – the Aphun River. This fortified settlement described by L.A. Zagoskin is typical of many central Russian and Siberian forts – ***ostrogs*** – and fits in well with the Russian tradition. Meanwhile, Russian settlements at the mouth of the Yukon River have been unknown to science and the tribes that, according to American archaeologists, have never built fortifications. Thus, Zagoskin's data do not fit into the accepted pattern of development in Alaska. Perhaps, this settlement relates to an old legend about the first Russian settlement in Alaska, founded in the XVII century by people from the lost ships of Semen Dezhnev or some other expedition. During the expedition in 2009, a reconnaissance survey of the assumed site of this fortified settlement was carried out. At this location, the Yukon noticeably recedes from the shore, exposing a number of shore ridges. The settlement is now at a distance from the modern river. The coordinates of the location: 62°59'38.40"N, 163°47'21.29"E.

The southern group examined the Kolmakovsky redoubt, founded in 1841 by Russian manufacturers. This is one of the monuments of Russian Alaska recognized, in the U.S., among the national historic treasures. The members of the expedition corrected the data on the location of the redoubt. The exact location is 61°34.197'N, 158°53.907'W. During the last century, there were two excavations at the redoubt. The blockhouse and other buildings were moved to the University Museum, Fairbanks,

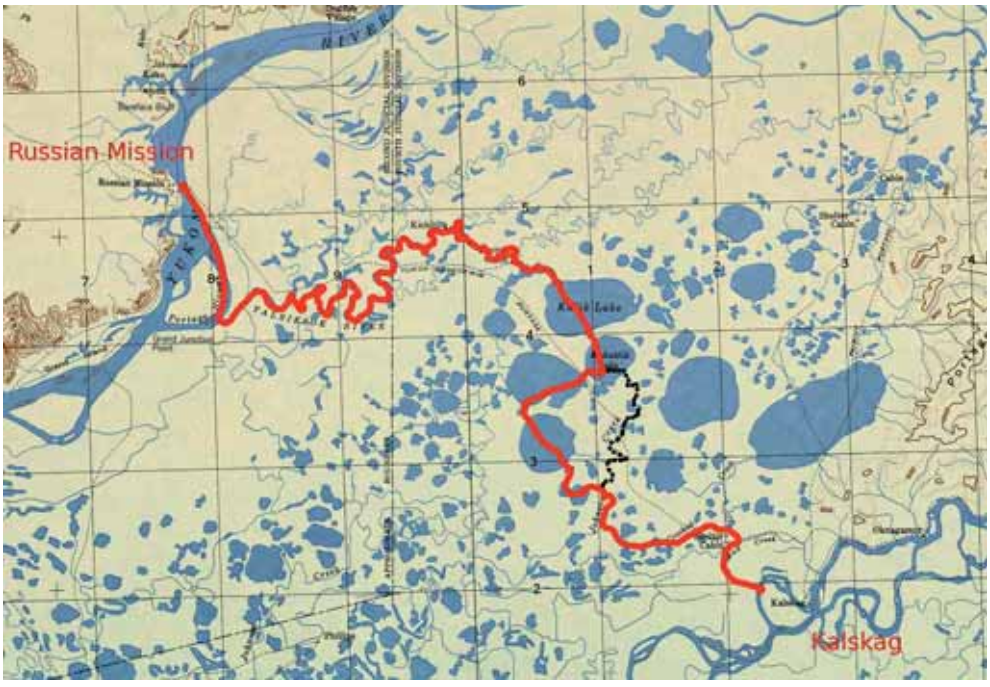

Fig. 3. Route of 2010 land portage

Alaska. Currently, among thickets, there are the foundations of six structures and the foundation of the fence.

Linguistic research. Many elements of the influence of Russian culture have survived to our time and play an important role in the lives of indigenous peoples. Among these naturalized elements, are Russian words that are used in the language of the Indians and Eskimos. During the expedition, a small vocabulary of Russian words, prevailing in popular culture, was collected. Among them, are words for food and household items, *"chai", "sakhar", "moloko", "lozhka", "nozhik", "platok", "banya",* etc (i.e., "tea", "sugar", "milk", "spoon", "knife", "scarf", "bath"). Until now, there was no such dictionary.

Study on the history of religions in the region. In the lower reaches of the Yukon and Kuskokima, Eastern Orthodoxy is widespread; it has been also actively developing after the sale of Alaska to the United States as a way of resistance to segregation and forced Americanization. After the sale of Alaska, its territory was divided among various denominations for missionary work. Currently, the population of Alaska Orthodox is 8–10% (the highest in the U.S.); in the study area, the vast majority of the indigenous population professes the Orthodox faith. Orthodox churches and chapels were built in the period of Russian America. Some of them served 80–100 years and are now abandoned. In the second half of the XX century, Orthodox communities have built new temples that are currently active.

Orthodoxy is the most striking influence of the Russian period on the modern Alaska. It is through the lens of Orthodoxy that many representatives of the indigenous peoples perceive and understand Russian period in their history.

In general, the study area in Alaska (basins of the Yukon, Kuskokwim, and Innoko) is a unique scientific ground. Here, traditional cultures of Athabaskan Indians and Yupik Eskimos have been formed and existed for centuries. It included life-support systems such as game hunting, traditional beliefs, and cultural practices. Natural and climatic conditions (i.e., harsh climate, the presence of land rich in game but hard-to-access, permafrost, the abundance of water bodies – lakes, rivers, and wetlands) had a great influence on these cultures. The steady traditional civilization of the local population provided for their existence in this harsh environment.

In 1840s–1860s, the civilization of the local population (Athabaskan and Eskimo) came into contact with the powerful Russian civilization, which had completely different life-support systems, based on cultivation, rather than on appropriation of food, and on other cultural traditions, based on the Christian Orthodox faith.

Beginning in the 1860s to the present period, European civilization has emerged in the region; it began to exert its Anglo-American influence on the local population. It was close to Russian in its economic structure and life-support system, that is, it was based on cultivation rather than on appropriation. However, culturally it was based on other principles of Christianity, i.e., on its Protestant form.

The groups of Alaska's population studied (Athabasca and Eskimos) living at the present, were under the influence of two powerful civilizations that have passed like waves in the area. The traditional Indian and Inuit ways of life were, at first, influenced by the Russian civilizationand and, then, by the Anglo-American. The study showed that despite the short period of time when the Russian people were in close contact with the local population, they had a serious impact on their traditional way of life, both material and spiritual. Therefore, the task of further study and promotion of heritage of Russian America is extremely important, both politically and in social and cultural aspects.

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CORRECTIONS

to the paper "Assessment of overbank sedimentation rates and associated pollutant transport within the Severnaya Dvina River basin" by Belyaev V.R. et al, published in the previous issue of the journal (Geography, Environment, Sustainability, № 03 (v.04) 2011, p. 68–84)

Dear readers,

The authors apologize for three errors that have been found in the table 1. The corrected version of the table is presented below with corrections highlighted by gray fill.

Table 1. Total contents of selected heavy metals in floodplain overbank deposits of the Severnaya Dvina River basin in 6 analyzed sediment sections in comparison with global clarke concentrations in soils, global clarke concentrations in clay deposits and maximum allowable concentrations (MAC) for soils according to the Russian health and safety standards (mg/kg)

Values in excess of the MAC (AAC) are shown in bold

Heavy metals	Global clarke in soils	Global clarke in clay deposits	MAC (AAC)[1]	Overbank deposits of the Severnaya Dvina River basin (n = 90)[2]	
				Average	Maximum
Mn	200–500	700	**1500**	431	**3210**
Cu	20–25	60	55	11	30
Zn	60	90	**100**	39	**114**
Pb	20–30	20	30	5	13
Ni	20–30	60	85	23	76
Co	8–10	20	(30–40)	7	22
V	100	120	150	32	98
Cd	0.5	0.3	(2)	0.1	0.7
Cr	50–70	110	(100–200)	25	68
Sr	90–120	220	–	30	136
As	4–9	6.6	**(10)**	4.0	**15.7**

[1] Approximate allowable concentrations (AAC) are given in brackets for elements if MACs are not stated in the Russian health and safety standards.

[2] n – number of samples.

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