World Applied Sciences Journal 22 (7): 956-963, 2013
ISSN 1818-4952

DOI: 10.5829/idosi.wasj.2013.22.07.2999

The Characteristics of the State of Protected Areas of Perm Krai

S.A. Buzmakov, G.A.Voronov and A.A. Zaytsev

Department of Biogeocenology and Nature Protection, Perm State University, Perm, Russia

Abstract: The article is devoted to the characteristics of the contemporary state of the protected areas of the Perm Krai (Russia). The zoning of the Perm Krai is identified for the research. In Perm Krai 6 natural areas are allocated: middle taiga, southern taiga, broadleaved-coniferous forests, Kungur forest-steppe, Western Ural, Central Ural.The condition of protected area changes from nondegraded to very severe degraded. The most part of protected areas are nondegraded and very low degraded. The factors of man's impact on protected areas are determined. Leading factors of anthropogenous influence are creation of forest infrastructure, cabin and recreation. The state of the protected areas according to geographic areas and categories is assessed. According to the protected areas categories the degradation increases in the row: protected landscapes – nature reserves – natural monuments, Species management area – historical-natural object. Territorially the degradation is increasing in the row: middle taiga – south taiga – Western Ural – Central Ural – broadleaved-coniferous forests – Kungur forest steppe.

Key words: Protected area · Ecological assessment · Soil · Vegetation · Ecosystem · Anthropogenic transformation · Degradation

INTRODUCTION

In protected areas changes of natural constituents and complexes take place under direct or indirect influence of man's activity. Protected areas assessment is important for negative changes control. The research is aimed at assessment state of ecosystem of the regional protected areas of the Perm Krai (Russia). The following tasks were accomplished: natural areas of the Perm Krai with diversity of the environment were identified, factors of man's influence were determined and protected areas of different categories and natural areas were characterized.

MATERIALS AND METHODS

In the Perm Krai there are 263 regional protected areas covering the total area of 0,75 mln. ha. The protected areas of regional significance in the Perm Krai are protected landscapes, species management area, natural monuments, nature reserves and historical- natural complexes (Table 1).

The present zoning analysis showed [1-5] that the plain is subdivided into middle and south taiga, i.e. broadleaved and coniferous forest. In the south-east of the Perm region there is Kungur forest-steppe. The mountains are divided either in the Northern and Middle Urals or Western and Central Urals (Fig. 1). The zone between the mountains of the north-east of the Perm Krai and the rest of Ural is characterized by significant geologic-geomorphologic, soil and botanical differences. In the north-east there is the vertical zonality, whereas in other parts of the mountains there is the vertical zonality only on separate summits.

Table 1: Perm Krai protected areas of regional significance

Protected areas category	Number, pcs.	Square, ths ha
Protected landscapes	97	731,1
Natural monuments	114	5,6
Nature reserves	46	8,6
Historical-natural object	5	0,5
species management area	1	2,3
Total number	263	748,1

The research is based on the technique "Ecological assessment of the state of specially protected natural areas of regional significance" [6] which rests on the regulatory technical and methodical documents of the Russian Federation and on the modern concepts of environmental assessment [7-14].

Corresponding Author: Dr. A.A. Zaytsev, Department of Biogeocenology and Nature Protection, Perm State University, Bukireva str. 15, Perm, 614990, Russia.

Table 2: Protected areas degradation scale, points

Protected areas degradation degree	Protected areas characteristic
0 -<1	Nondegraded; no impact
1 -<2	Very low degradation; insignificant changes
2-<3	Low degradation; obvious changes
3 -<4	Medium degradation; significant changes
4 -<5	Severe degradation; drastic changes
5	Very severe degradation; drastic disturbances

Table 3: Key criteria for determination soil degradation degree

	Degradation degree					
Criteria	0	1	2	3	4	5
Square of outcropping accumulative horizon (A); % of total square	0	<10	10-20	21-50	51-90	>90
Thickness of abiotic deposit, % of total square	0	<2	2-10	11-20	21-40	>40
Square of outcropping parent material horizon (Ñ) or D-horizon rock (D), % of total square	0	<5	6-10	11-15	16-25	>25

Table 4: Key criteria for determination of vegetation degradation degree

	Degradation degree					
Criteria	0	1	2	3	4	5
Disturbance of vegetative cover	No impact; the vegetative cover is not disturbed	The vegetative cover is not disturbed	Total square of disturbed areas is no more than 2-3% of the contour	Total square of disturbed areas is 10% of the contour	Total square of disturbed areas is 10%-20% of the contour	The vegetative cover is disturbed on the area which exceeds 20% of the contour
Disturbance of the forest stand	No impact; tree and shrub layers are not disturbed	Tree and shrub layers are not disturbed	The forest stand is partially thinned by selective felling	The forest stand is thinned by selective falling	The forest stand is partially disturbed; dead trees, top-drying	The forest stand is disturbed on the whole contour; everywhere are top-drying trees
Dominant sanitary condition of the forest stand: coniferous species	Fir needle is green and shining, the crown is thick, current year increment is normal	Fir needle is often lighter than usual, the crown is partially open, increment is lessen no more than a half in comparison with normal	Fir needle is light green or grey opaque, the crown is open, increment is lessen more than a half in comparison with normal	Fir needle is grey, yellow or yellow-green, the crown is obviously thin, either there is or there is no current year increment	Current year fir needle is grey, yellow or grey-brown, the crown is very thin, lops, the bark is alive or partially shelled	Fir needle has shed or is partially alive, tiny branches, as a rule, have broken, the bark is crumbling
- broadleaved species	Foliage is green, the crown is thick, current year increment is normal for this wood species, age, habitat conditions and season	Foliage is green; the crown is partially open, increment may be more impaired	Foliage is smaller and lighter in colour than usual, it prematurely falls, the crown is thin, sphacelated branches are from ¼ to ½	Foliage is smaller, lighter in colour and more yellow than usual, it prematurely falls or droops, the crown is thin, sphacelated branches are from ½ to ¾	Foliage is sphacelated; it is dry or has prematurely fallen, sphacelated branches are more than ¾, lops and bark are alive	Foliage and some branches have broken, the bark is destroyed or has crumbled on the most part of the stem
Degree of phytosenoses synantropization	No stress tolerant species	In the grass and suffruticose layer there are sporadical plant units of stress tolerant shrub species	In the suffruticose layer there are sporadical plant units of stress tolerant shrub species	No less than a half of the crown closure of the suffruticose layer is formed by stress tolerant species	The basis of the suffruticose layer is stress tolerant species	There is no shrub layer, only sporadical stress tolerant shrub species

Table 5: Transformation phases of basic ecosystems

	Degradation degree					
Criteria	0	1	2	3	4	5
Transformation phase (degradation) for forest ecosystems	Native (zonal) community	Quasi-native community	Temperate forest	Small leaved forest	Poium	Debris, pioneer community

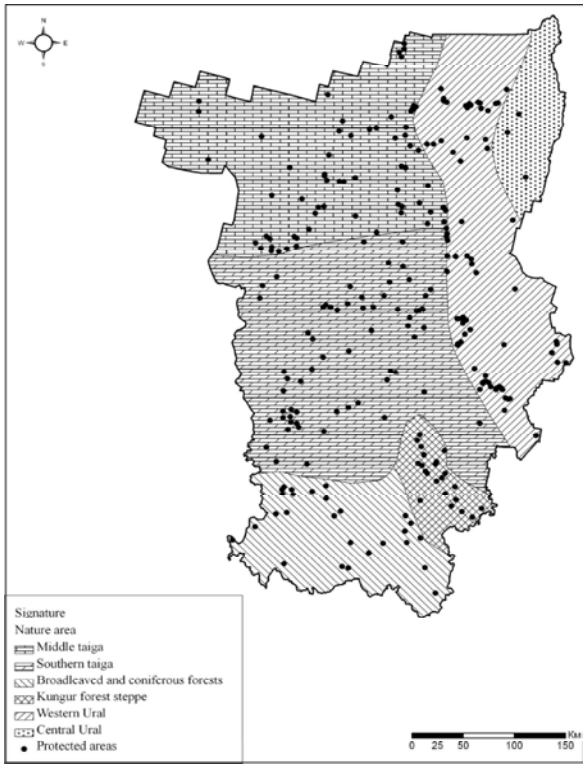

Fig. 1: Natural areas in Perm Krai and protected areas

The key protected areas indicator is the weighted average degradation factor (Table 2) which is appraised by points.

The diversity of protected areas ecosystems determines the necessity to point out basic ecosystems which are relatively homogeneous parts of protected areas. The basic ecosystems were identified due to the satellite data, land and forest schemes according to the following principles: homogeneity of land (forest) contours; bog formation; part of drainage basin and vertical belt; and position in the relief.

In Arcgis 9.2 satellite data was visually analyzed; thematic and geographical maps were also analyzed: one-dimensional objects and reception areas, etc. were identified and their geometric parameters were determined. But this data does not allow to assess the basic ecosystems state on a number of criteria, thus, field reconnaissance was carried out, i.e. sample plots were established to study the soil, vegetation and ecosystem.

The following are the criteria for the soil assessment: 1. Square of outcropping accumulative horizon; 2. Soil cluttering up; 3. Square of outcropping parent material horizon and D-horizon rock (Table 3).

Assessment criteria for vegetation were the following: 1. Disturbance of vegetative cover; 2. Disturbance of forest stand; 3. Sanitary conditions of coniferous species; 4. Sanitary conditions of broadleaved species; 5. Phytosenoses synantropization (Table 4). The ecosystems were assessed on the basis of the characteristic of the succession series, for which we used the criterion "phase of the ecosystem transformation" (Table 5).

The obtained indexes determined the degradation degree, which allowed to assess the ecological state of protected areas. The protected areas degradation degree is a sum of degradation degrees of the basic ecosystems.

$$O = \sum_{i=1}^{n} Obei \quad (1)$$

where *O is protected areas degradation degree*;
Obe*i is degradation degree of the basic ecosystem.*

In the same way protected areas factorial degradation, protected areas degradation in categories and in natural areas were calculated.

The obtained indexes allowed to assess the impact factors; state of soil; vegetation, ecosystems, protected areas; and protected areas space degradation.

RESULTS

The state of the protected areas soil changes from "non-degraded" to "severely degraded". The differences between states of soil are traced between separate protected areas and between basic ecosystems within one object. The exposed humus horizon is found in 169 protected areas, debris-strewn soil is found in 116 objects and parent rock material is exposed in 22 protected areas. The weighted average degree of soil degradation in the protected areas is 0,8 points. The protected areas with non-degraded and very low degraded soils predominate (Table 6).

Table 6: Weighted average assessment of protected areas state of soil

	Protected areas, number		Protected areas square, ha	
State of soil	pcs.	% of protected areas total number	ha	% of protected areas total square
Nondegraded	86	33,5	504634,55	67,9
Very low degraded	163	63,4	238280,75	32,1
Low degraded	4	1,6	42,5	0,0
Medium degraded	1	0,4	0,8	0,0
Severely degraded	1	0,4	42	0,0
Very severely degraded	2	0,8	15	0,0
Total	257	100,0	743015,6	100,0

Table 7: Weighted average assessment of state of protected areas vegetation

	Protected areas, number		Protected areas square, ha	
Vegetation state	pcs.	% of protected areas total number	ha	% of protected areas total square
Nondegraded	-	-	-	-
Very low degraded	58	22,5	464235,7	62,5
Low degraded	168	65,5	244685,8	33
Medium degraded	24	9,0	33987,5	4,5
Severely degraded	4	1	71,6	0,01
Very severely degraded	3	0,5	35	0,005
Total	257	100,0%	743015,6	100,0%

Very severely degraded soils are in “Gubakhinskaya (Mariinskaya) peshera”, where degradation is determined by mineral resources mining (the protected area is the quarry while excavating which the entrance to the cave was opened) and on “Chaechnoe ozero” where cattle constantly pasture. The square of these protected areas is 15 ha (it is less than 0,01 % of the total square of the regional protected areas).

Severely degraded soils are found on the territory of the natural monument “Ezhovo” where more than 80% of the territory is occupied by cultivated plough land (the humus horizon is exposed up to 90-95%).

Medium degraded soils are found in the natural monument “Plakoon” whose square is 0,8 ha. The degradation is determined by recreational impact, which caused the humus horizon expose in the half of the protected area square.

Low degraded soils are found in “Kamenny gorod”, “Kuzminka”“Listvenichnaia roscha” and “Chekardah”. The total square of these protected areas is 42,5 ha. The degradation is determined by recreation (“Kuzminka” and “Kamenny gorod”) and farming (about 70% of the “Chekardah” square is occupied by cultivated plough land; “Listvinichnaia rosha” is near the settlement Bor, on this object cattle pasture and there is a cemetery here).

Very low degraded soils are in 163 objects (63% of the total number) with the total square of 238,3 ths. ha (32% of the total square of the regional protected areas). Nondegraded soils are in 86 objects (33% of the total number); their square is 504,5 ha (68% of the total square of the regional protected areas).

The vegetation varies from “nondegraded” to “severely degraded” (Table 7), weighted average degree is 1,8 points. The vegetative cover is disturbed in 183 Protected areas, stress tolerant species are found in 74 protected areas. Deterioration of sanitary conditions of coniferous trees is observed in 32 objects, while deterioration in broadleaved trees is observed in 14 Protected areas.

Very low degraded vegetation is in the natural monuments “Gubakhinskaya (Mariinskaya) peshera”, “Kamenny gorod” and “Chaechnoe lake”. In the quarry for construction raw materials, where “Gubakhinskay (Mariinskaya) peshera” is located, primary phytocenosis is formed with the prevalence of stress tolerant species. Due to the recreational impact in “Kamenni gorod” the disturbance of the vegetative cover is 30-50% of the total square of the natural monument. The vegetation of “Chaechnoe ozero” is mechanically disturbed by pasturing cattle; stress tolerant species prevail.

Very severely degraded vegetation is on the territories of the natural monuments “Ezhovo”, “Plakoon”, Stolbovoi kamen” and “Sokolia gora”. On “Ezhovo” about ¾ of the square is cultivated plough land. On “Plakoon” the degradation is determined by recreation, on “Stolbovoi kamen” and “Sokolia gora” the vegetation is damaged by windblow.

24 protected areas are medium degraded; they are the following: protected landscapes, natural monuments, nature reserves and historical-natural objects. The square of mechanical disturbances on these areas is 10% of their square, the forest stand is thinned by selective felling and there are only few stress tolerant species. The degradation on these protected areas is determined by the impact of recreation, felling, farming and building factors. As a rule, the impact spreads over all the territory of the objects. On several medium degraded Protected areas, besides the named factors, transport and mineral resources mining had great impact.

Vegetation on 168 protected areas is low degraded; this state of phytosenoses is the most wide spread. Mechanical damage of the vegetation is not too large, no more than 3% of the total square of the protected areas, there are few stress-tolerant species and not on all objects. The forest stand is partly thinned by selective and natural felling. On the whole the degradation is determined by the impact of forest infrastructure, selective felling and recreational loading.

In 58 protected areas the vegetation is very low degraded; these are, first of all, high-land bogs. There is no mechanical damage of the vegetation; stress tolerant species are not observed.

The state of the ecosystems is variable: from “non-degraded” to “very severely degraded”. The weighted average degradation degree of the ecosystem on the protected areas is 1,2 points.

The vast area (297 ths. ha) is occupied by nondegraded ecosystems. These are azonal complexes, i.e. high-land and transition bogs of protected landscapes, ecosystems of the subalpine belt and bare mountains of the Ural Mountains, which have not been changed by man.

There are practically no zonal taiga nondegraded ecosystems. Instead of them there are quasinative (very low degraded) ecosystems (200 ths. ha), mixed forests (166 ths. ha) and small leaved forests (76 ths. ha). These are the natural complexes which determine the state of “forest” protected areas.

Pratal (severely degraded) ecosystems and debris places (very severely degraded ecosystems) are often found, but their square is quite small – 12 and 7 ths. ha respectively.

The key role on the protected areas is played by nondegraded, very low and low degraded and medium degraded ecosystems (Table 8).

Very low degraded, nondegraded and low degraded areas are wide spread, such objects occupy 99,7% of the total square of the regional protected areas.

“Gubakhiskaia (Mariinskaya) peshera” is very severely degraded and “Vynyrka”, “Ezhovo” and “Chaechnoe ozero” are severely degraded. All the square of “Vynyrka” is covered with poium, 80% of “Ezhovo” is covered with cultivated plough land and around “Chaechnoe ozero” there is a pratal severely degraded ecosystem. These protected areas are natural monuments of small size (the total area is 52,9 ha). They are located in south taiga, broad-leaved coniferous forests and in Kungur forest steppe.

The degradation of the specially protected areas is variable. Most part of the protected areas is very low degraded; they occupy more than half of the territory of the square of the all protected areas. There are fewer nondegraded and low degraded protected areas, though, if the square of the former is 39,2% of the total square of the regional protected areas, the square of the latter is less than 6,8%. Some protected areas are medium degraded (“Chekardha”, “Sokolia gora” and “Plakoon”, severely degraded (“Ezhovo”, “Chaechnoe ozero”), very severely degraded (“Gubakhinskaia (Mariinskaya) peshera”). The square of these objects is 67,2 ha (0,0091% of the total area of the regional protected areas); they all are natural monuments (Table 9).

We have found 9 impact factors of the regional protected areas (Table 10).

The most wide spread factors are the creation of forest infrastructures (forestry road laying and narrow clearing), felling and recreation. They cause the most severe degradation and determine the protected areas state. The other factors cause significant degradation of small square ecosystems which are sharply distinct from the baseline state of the protected areas. However, the impact is local; it does not spread far beyond the areas due to which the protected areas total degradation is much lower than within such areas.

The protected areas state is also determined by natural specifics of the ecosystems, i.e. the degradation of forest ecosystems is more severe than of bog masses ecosystems.

The weighted average degree of degradation for the regional protected areas in the Perm Krai is 1,2 points; and, thus, it says that they are very low degraded (Table 11).

Table 8: Degradation of ecosystems on protected areas

	Protected areas number		Protected areas square, ha	
State of ecosystem	pcs.	% of protected areas total number	ha	% of protected areas total square
Nondegraded	40	15,6-	295015,4	39,7
Very low degraded	113	44	373330,85	50,24
Low degraded	85	33,1	72358,45	9,74
Medium degraded	15	5,8	2250,8	0,30
Severely degraded	3	1,2	51,9	0,007
Very severely degraded	1	0,4	1	0,0001
Total	257	100,0	743015,6	100,0

Table 9: Degradation of protected areas of regional significance in Perm Krai

	Protected areas number		Protected areas square, ha	
Protected areas state	pcs.	% of protected areas total number	ha	% of protected areas total square
Nondegraded	44	17,1	291407,2	39,2
Very low degraded	164	63,8	401146,7	54,0
Low degraded	43	16,7	50394,5	6,8
Medium degraded	3	1,2	10,2	0,001
Severely degraded	2	0,8	56	0,008
Very severely degraded	1	0,4	1	0,0001
TOTAL	257	100,0	743015,6	100,0

Table 10: Protected areas impact factors

Impact factor	Protected areas impact factor number	Square of basic ecosystems, ths. ha	Basic ecosystems degradation	Protected areas degradation
Forest infrastructure creation	190	657,9	1,6	1,4
Felling	240	448,9	1,8	1,1
Recreational	146	323,6	1,2	1,0
Blowdown	8	0,4	4,4	0,8
Building	30	4,4	1,5	0,7
Agricultural	72	19,2	2,9	0,6
Pyrogenic	8	0,1	2,3	0,5
Transport	10	0,9	4,5	0,3
Mineral resources mining	10	2,8	4,4	0,1

Table 11: Protected areas space-categorical degradation

	Natural areas									
Protected areas categories	Protected areas number	Protected areas square	Middle taiga	Southern taiga	Broadleaved and coniferous forests	Kungur forest steppe	Western Ural	Central Ural	Range	Weighted average assessment
Protected landscapes	96	725946,1	0,9	1,3	1,9	2,6	1,4	1,5	1,7	1,2
Natural monuments	110	5682,85	1,5	1,8	1,7	2,0	1,7	1,9	0,5	1,7
Historical-natural object	5	463,6	-	1,5	-	2,0	-	-	0,5	2
Natural reserves	45	8634,05	1,0	1,6	1,7	1,7	1,8	1,1	0,8	1,5
Species management area	1	2289,0	-	-	-	1,7	-	-	-	1,7
Range	-	-	0,6	0,5	0,2	0,9	0,4	0,8	-	0,8
Weighted average assessment	-	-	0,9	1,3	1,9	2,0	1,4	1,5	1,1	*1,2*

According to the protected areas categories the degradation increases in the row: protected landscapes – nature reserves – natural monuments, Species management area – historical-natural object.

The historical-natural objects are low degraded. The degradation is the result of building impact, farming, recreation and felling. The historical-natural objects of southern taiga are very low degraded as the recreational loading is lower here and there is no farmland.

The natural monuments are very low degraded Protected areas. The degradation is caused by forest infrastructure, recreation and felling. Only in Kungur forest steppe the areas are low degraded; and it is caused by farming and recreation impact.

Nature reserves are very low degraded protected territories; the impact factors are forest infrastructure, felling and recreation. The nature reserves of western Ural are the most degraded; and it is caused by recreation and felling. The less degraded nature reserves in middle taiga are bog ecosystems where there are no recreation and felling.

Protected landscapes have the weighted average degree of degradation 1,2 but may be nondegraded, very low degraded and low degraded. It can be explained by the fact that this category comprises various Protected areas. Bog ecosystems are nondegraded. Very low degraded objects are the objects with forest ecosystems where there are forest infrastructure, recreational loading, selective felling and protected landscapes where there is mineral resources mining. Protected landscapes with high percentage of meadows and plough lands are low degraded.

Territorially the degradation is increasing in the row: middle taiga – south taiga – Western Ural – Central Ural – broadleaved-coniferous forests – Kungur forest steppe. The less degraded are the Protected areas of middle taiga. It is explained by the fact that there are the objects with large bog ecosystems, man's influence on which is minimal. The most degraded are the protected areas of Kungur forest steppe. Here, besides the wide spread recreation, is a large number of farming lands; there is rural and transport impact. In broadleaved-coniferous forests the protected areas are very low degraded and low degraded. They significantly change due to felling, farming and transport impact.In south taiga, Western and Central Ural the protected areas are very low degraded, their degradation degree is mostly close to the average of the Krai.

CONCLUSIONS

The weighted average degree of degradation of protected areas in the Perm Krai is 1,2 points; and, thus, it says that they are very low degraded.

Territorially the degradation is increasing in the row: middle taiga – south taiga – Western Ural – Central Ural – broadleaved-coniferous forests – Kungur forest-steppe.

In categories the degradation is increasing in the row: protected landscapes – species management area – natural reserves – historical-natural object – natural monuments.

The most wide spread factors are the creation of forest infrastructures (forestry road laying and narrow clearing), felling and recreation. The other factors cause significant degradation of small square ecosystems.

REFERENCES

1. Chazov, B.A., 1960. To results of work on physiographic zoning of Ural. Issues of geography and conservation of Ural., 1(1): 1-9.
2. Dyrenkov S.D., O.E. Shergold and O.I. Voronova, 1977. Forest site and forest mensuration zoning of Perm region. Lenuprizdat, pp: 35.
3. Korotayev, N.Y.A., 1962. Soils of Perm region, pp: 279.
4. Nazarov, N.N., 1996. Classification of landscapes of Perm region. Issues of physical geography and geoecology of Ural., 1(1): 4-10.
5. Ovesnov, S.A., 2000. Botanical-geographical zoning of Perm region. Herald of Perm State University. Series: Biology, 1(2): 13-21.
6. Buzmakov, S.A., S.A. Ovesnov, A.I. Shepel and A.A. Zaitsev, 2011. Methodical instructions: "Ecological assessment of the state of specially protected natural areas of regional significance". Vestnik of Geography, 2(8): 49-59.
7. Henry D. Foth, 1990. Fundamental of Soil Science, pp: 360.
8. Huber, S., G. Prokop and D. Arrouays, 2008. Environmental Assessment of Soil for Monitoring Volume VI: Soil monitoring system for Europe. Luxembourg, pp: 72.
9. Natural Resources Assessment and Ratings Methodology. 2003. Center for State of the Parks., pp: 32.
10. Eckelmann, W., R. Baritz and S. Bialousz, 2006. Common Criteria for Risk Area Identification according to Soil Threats. European Soil Bureau., pp: 358.
11. Jensen, M.E., N.L. Cristensen, Jr and P.S. Bourgeron, 2001. An Owerwiew of ecological assessment principles and applications. A guidebook for integrated ecological assessment. Springer-Verlag, New York, pp: 13-28.

12. Jorgensen, S.E., 1992a. Integration of Ecosystem Theories: a Pattern. Dordrecht: Kluwer.
13. Kay, J.J. and E.D. Schneider, 1991. // Ecological Indicators / Ed. McKenzie D. Elsevier: Amsterdam, pp: 159.
14. National Research Council, 2000. Ecological indicators for nation. National academy press, Washington, D.C.