Chapter 15
Prerequisites for Sustainable Development and Maintaining Ecosystems by Country and Continent. Russia's "Special Project"

It would likely be no exaggeration to say that our planet, from poles to equator, has already long been suffocating in the human embrace known as anthropogenic pressure. Notably, however, not only people distant from science but many specialized ecologists have not yet recognized the central point of the current global problem. It isn't air pollution in major cities, from which millions of people suffer, and not industrial runoff poisoning our rivers. It isn't even climate change, the anthropogenic share of which might still be debated. The main ecological result of human economic activity, as we have tried to show throughout this book, is the destruction of ecosystems over enormous swaths of land, as well as the water areas of semi-enclosed seas and offshore ocean zones. This sharp weakening of the biota's functions to form and stabilize the environment threatens the biosphere with the most catastrophic consequences. And only an orientation toward natural strengths, toward the preserved biotic potential could, perhaps, prevent the worst possible outcome of these unfolding events.

And if the primary task of sustainable development is to lessen anthropogenic pressure to a level corresponding to the biosphere's carrying capacity, we should, therefore, speak not only of ceasing every variety of "assault" upon nature, but as was said in *Beyond the Limits*, "drawing back, easing down, healing" (Meadows et al. 1992, p. xv). And this means not at all a metaphorical retreat, but an entirely real one in the form of humans emancipating part of the territory they have conquered, as necessary for the biota to perform its planetary mission.

It's probably not worth mentioning how complex and unprecedented this task is, for the resolution of which, in the phrase of Russian Academy member Nikita Moiseyev, humanity will have to walk along a razor's edge. By the way, it would be just as fair to say through the eye of a needle, particularly taking into account the diversity and inequality of starting conditions the various countries find themselves in today in terms of their transition to sustainable development. It is enough, for example, to compare some states in Asia and Africa with all their endemic traits of late feudalism with the countries of Western Europe and North America, truly having reached an information society, to understand the whole depth of the cultural and socio-economic rift which complicates the already difficult problems before the

V. I. Danilov-Danil'yan, I. E. Reyf, *The Biosphere and Civilization: In the Throes of a Global Crisis*, https://doi.org/10.1007/978-3-319-67193-2_15

global community. Add to this also examples of striking divergence in mentality, national traditions and religious beliefs. How then, you might ask, do we reduce this to the common denominator on whose basis alone we can come to a general consensus in developing a global sustainable development strategy?

Yet there exists, at least, one common criteria for all that allows us to compare and contrast the countries of the world in the aspect that interests us, regardless of their social and cultural particularities, their industrial infrastructure development or their mineral wealth. That is the extent to which their natural ecosystems are preserved. That, too, is wealth in the long term—a wealth far more substantive than diamond veins or gold ingots in a bank vault. Only it is a wealth thus far not totally appraised. And if we see the preservation and rebirth of wild nature areas as one of the goals of sustainable development, that means we must consider countries where such nature remains whole to be the stewards of our common patrimony. By the same token, the countries whose territory has lost all or nearly all of its natural ecosystems are "ecological debtors" to the biosphere, even if their environment (as often happened in third world countries) suffered as a result of exploitation by others, including industrialized states. From this position, we will try to assess their starting potential for transition to sustainable development focusing primarily on social and natural parameters and temporarily disengaging ourselves from the others.

In order to put together an image of ecosystem destruction by country and continent, it is best to turn to satellite data. This presents us with a reliable image of the state of the biosphere. Granted, the estimates used differ, which is natural. But most of them still coalesce around the relative value of 60% (totally or partially utilized portion of land) to 40% (unutilized portion). The most notable research was carried out by Lee Hannah and his coauthors (1994).

According to their published data, Earth retains 39.5% undestroyed and 24% partially destroyed ecosystems, occupying altogether 94 million km^2. Undestroyed ecosystems are characterized by the presence of natural vegetative cover and low population density (less than ten people per km^2). Partially destroyed ecosystems pertain to territories on which temporary or permanent agricultural lands abut secondary but naturally restored vegetation and traces of human activity are observed: logging, livestock grazing in which density exceeds pasture restoration capacity, etc. If you throw out ice-covered territory and mountain heights such as Antarctica, Greenland or the Himalayas which have zero biological productivity, the area occupied by undestroyed and partially destroyed ecosystems falls to 52 million km^2 (Maksakovskiy 2008, Book 1). These ecosystems, however, are distributed very unevenly across the land's surface.

So, along with islands of wild nature left whole from 0.1 to one million km^2 in size, we also see preserved enormous territorial masses of many millions of square kilometers, spread principally within the bounds of Earth's two main forest belts—North and South.

The first of these, occupying an area of twenty million km^2 between 45^o and 70^o north latitude, takes up most of Siberia and the Russian Far East besides its southern regions, the north of European Russia and Scandinavian nations, as well as the northern part of Canada and Alaska. This is mainly boreal forest specific to the cold zone, made up of two-thirds coniferous breeds, and it occupies 38% of all forest-covered land. Roughly half of boreal forests belong to undestroyed forest ecosystems, having so far suffered insignificant anthropogenic influence (Olsson 2009).

The southern forest belt is made up of tropical rainforest in the equatorial and subequatorial zones between 25° north latitude and 30° south latitude. It also occupies about 20 million km^2. The greatest mass of tropical rainforest is spread across South America (the Amazon Basin), Southeast Asia, the islands of Oceania and Africa (the Congo Basin and the area around the Gulf of Guinea). Almost half of all species dwell in these rain forest areas, where more than half of the Earth's phytomass is located. Trees on a single acre grow several times faster than in the northern belt, so the southern belt creates 70% of all net primary production (Forest Encyclopedia 1986). Along with this, due to year-round high temperatures and moisture, organic matter decomposes here very quickly, as a result of which tropical forests deposit just over half as much carbon as boreal forests.

Periodicals have long resorted to the trite if not entirely fitting cliché—comparing forests to the Earth's lungs. We might more justly call them Earth's kidneys, since they filter out excess quantities of nutrients and remove them from circulation, carbon dioxide first among them. Some authors even refer to soil humus and peat bogs as "eternal" carbon sinks, where under corresponding temperature conditions it might stay, as it does embedded in the ocean floor, for an interminably long time (Vompersky 1994).

But all of this holds true only for undisturbed ecosystems, including for example, the virgin climax forests that carry primary responsibility for environmental stability. Disturbed ecosystems, such as forests that undergo logging or cutting back, behave entirely differently. So, on territories utilized by humans, as research data shows, the biota not only fails to swallow up excess atmospheric carbon, it serves as a source of emissions itself. And reserves of carbon accumulated in such forests, according to data from the UN Food and Agriculture Organization, fall at a rate of 1.1 gigatons per year (Global Forest Resources Assessment 2005).

A multitude of samples, taken from 1958 at various observatories around the world, testify to the unflagging growth of CO_2 concentrations in the atmosphere (Fig. 15.1). Analysis of the gas makeup of air bubbles in Antarctic ice cores allows us to form a conception of trends in its atmospheric concentrations before and after the global disruption of the biosphere coinciding with the Industrial Revolution (late eighteenth-early nineteenth century) (Friedli et al. 1986; Staffelbach et al. 1991; Raynaud et al. 1993). As the research shows, deposited CO_2 concentrations adding up to 280 parts per million (ppm) and remaining nearly unchanged over the course of several millennia have now reached 340 ppm, i.e. 28% higher than the preindustrial level (Lorius and Oescher 1994). This increase began before wide-scale use of fossil fuels and overlaps with carbon emissions caused by land usage. From that time to the end of the nineteenth century, the biosphere maintained its sustainability mainly through the efforts of the little-disrupted ecosystems of the World Ocean, the compensatory capacities of which reached their limits at the start of the twentieth century. Thereafter began a process of global change to the environment.

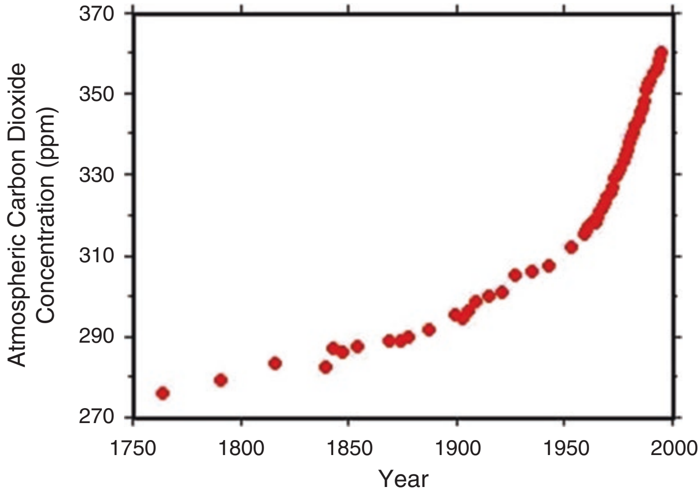

Fig. 15.1 Growth in world carbon dioxide emissions as a result of organic fuel combustion. Source: Worldwatch Database (2000)

In recent decades, several attempts have been made to calculate the balance of atmospheric CO_2 on the basis of the law of conservation of mass and the stoichiometric (volume-mass) ratio of O_2/CO_2 for the main pools of anthropogenic carbon sources and sinks. One of the best known belongs to John Houghton and his co-authors (1996). This research laid the groundwork for the understanding that changes to carbon content occur for communicating media—the atmosphere, the ocean, land biosphere and the hydrocarbon fuel deposits added to them over the past two centuries. The total of these combined flows should, in principle, be equal to zero, i.e. sources of carbon dioxide emissions should be compensated by sinks.

Besides hydrocarbon fuel, combusted in gasoline engines and the furnaces of power plants, large quantities of carbon dioxide enter the atmosphere in the process of cement making, burning of associated petroleum gas and as a result of agricultural activity where biomass is destroyed (clear-cutting forests, destruction of soil humus in tilling, etc.). In turn, the atmosphere, World Ocean and undestroyed ecosystems serve as sinks, where carbon dioxide gas can go and accumulate.

The scale of CO_2 emissions from fossil fuel combustion since the beginning of the industrial era has been studied quite well. At present, when recalculated as carbon, it is estimated to be 5.9 plus or minus 0.5 gigatons of carbon per year. We also know the speed at which CO_2 accumulates in the atmosphere—on the order of 2.2 GtC/year. Finally, from the ratio of $^{13}C/^{12}C$ isotopes in ocean water and air, we can determine the rate at which the ocean absorbs carbon dioxide gas accounting for physical and chemical processes. Excess CO_2 diffuses through the surface at the air-water divide, evening out its concentration according to Henry's Law. It's estimated to be 2.6 GtC/year (Zalikhanov et al. 2006).

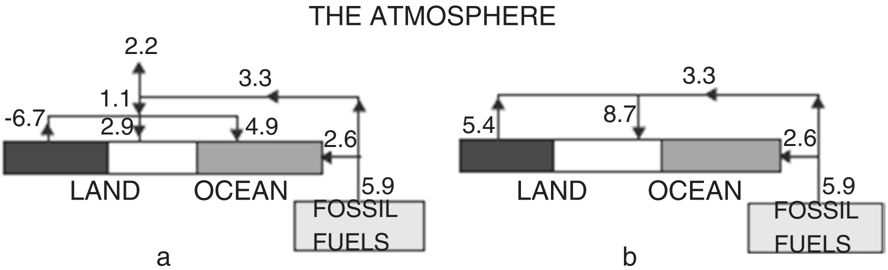

Fig. 15.2 Global carbon flows: (**a**) under current biospheric conditions; (**b**) in the event of partial restoration of forest-land ecosystems, enabling us to stop the process of atmospheric CO_2 accumulation at existing levels of fossil fuel combustion. White boxes—unutilized, virgin biota; black—economically utilized portion of land. Relative size of boxes corresponds to their share of net primary production out of the biosphere's whole production: (**a**) World Ocean—40%; utilized land—30%; unutilized—24%; (**b**) World Ocean—40%; utilized land—29%; unutilized 31%. Numbers on arrows—carbon flows in GtC/year (Gorshkov et al. 2000, p. 170)

The business of evaluating carbon emissions as a result of land usage is a bit more complicated. Here we must determine the reduction in biomass on a given territory and its absorption by undestroyed land and ocean ecosystems. The lack of exact methods to calculate production and destruction of organic material presents a particular difficulty which does not always allow us to avoid mistakes. So, for example, carbon might come out of the territorial biota as a result of ecosystem elimination, primarily of the forest type, and destruction of soil cover. But while, after its exploitation is finished and it has not gone too far, a forest retains its capacity to restore plant biomass and absorb excess CO_2 accumulating in the atmosphere, we cannot say the same of soil, land's greatest reservoir of nutrients. Soil gathers carbon extremely slowly, and loses it very fast. Thus average carbon losses in soil during cultivation add up to 30%, sometimes reaching 70% in the tropics. That means that alongside restoration of damaged ecosystems, as a rule, we observe a reduction in soil carbon content, and as a result, the compensation proves incomplete (Vitousek et al. 1986; Wofsy et al. 1993).

Here we present a precise balance of the global carbon cycle, recalculated by Viktor Gorshkov, Kirill Kondratyev and their coauthors (Gorshkov 1998; Gorshkov et al. 2000, pp. 168-171) accounting for the "biotic pump" effect of the ocean and the contribution made by disrupted and undisrupted land ecosystems (Fig. 15.2a*).* It is based on data for yearly flows of net primary production in the biosphere as a whole (on order of 100 GtC/year) as well as the World Ocean separately (40 GtC/year) and land (60 GtC/year). The latter, in turn, is divided into two unequal parts—economically utilized land, which makes up 36% of the biosphere's overall flow of net primary production, and the undisrupted biota, making up 24%. But while undisturbed ecosystems, in accordance with Le Chatelier's Principle, bind carbon accumulated in the atmosphere by way of organic synthesis, disrupted ones, on the contrary, themselves give rise to its emission.

Another source of global CO_2 emissions, which the majority of authors traditionally assign the leading role, is organic fossil fuels. And here there is no unanimity of opinion among scholars concerning the fate of "lost" carbon that comes up in attempts to settle the balance between CO_2 emissions formed from fossil fuel combustion (5.9 GtC/year) and CO_2 accumulated in the atmosphere (2.2 GtC/year), as well as carbon dioxide swallowed up by the World Ocean accounting for processes of physiochemical absorption (2.6 GtC/year). Meanwhile, these scholars far too often underestimate the roles of the ocean biota and land ecosystems, which, in our view, is deeply mistaken. First of all, because in long-passed geological epochs it was precisely through the mediation of the oceanic "biotic pump" that enormous quantities were removed from the atmosphere and buried in the sea floor, to which paleontological data bears witness. Second of all, because undisrupted land ecosystems with their soil humus, tundra bogs and boreal forest turf in their long-term (in the opinion of some authors, "eternal") role as carbon reservoirs, truly "model" analogous ocean systems with their floor deposits and little-mixed cold waters of the deep.

Artificial agrocenoses, however, such as harvested forest, tilled land, pasture, etc., behave completely differently. Permeation of the biological cycle goes above 10%. As we said in Chap. 12, carbon emissions from disrupted ecosystems match the order of magnitude of those from burning coal, oil and gas (Watts 1982; Houghton 1989) and, according to Gorshkov's calculations, even go beyond them (−6.7 GtC/year). By the way, for these emissions, the absorptive power of the little-disturbed ocean biota (4.9 GtC/year) and undisturbed land ecosystems (2.9 GtC/year) suffices for now. With regard to the problem of "lost carbon," according to the same calculations, it is solved as follows. Of the 5.9 GtC formed by fossil fuel combustion each year, 2.6 GtC/year dilutes into the ocean as a result of physiochemical absorption, 1.1 GtC/year is swallowed up by the ocean biota and the remaining land ecosystems, and the other 2.2 GtC/year accumulates in the atmosphere (Fig. 15.2a).

This accumulation of CO_2, incurring the growth of the greenhouse effect and climate destabilization, represents one of the central problems of modern civilization and must be stopped by any means necessary. For this purpose, humanity has two paths. The first of them is a rejection of fossil fuel use, which but 20 years ago seemed totally unthinkable. The unbelievable progress in renewable electric energy production, however, has radically changed the situation, and plans to reduce fossil fuel combustion by five-ten times by 2050 no longer look utopian.

But there is another opinion. Among its supporters is Viktor Gorshkov, who considers the primary root of this evil to be expanding energy usage itself. What follows is the crux of his argument. If humans had not succeeded so well in exterminating wild nature and anthropogenic disruption of the land biota were much lower than the threshold of destruction, then absorption of fossil carbon by the land and ocean biota would entirely compensate its emissions. At the same time, a transition to ecologically clean energy sources would not, in his view, solve the problem, since disruption to the global biota is determined by the scale of energy usage rather than its source. Thus, for example, the installation of a large number of solar generators in the desert should, in accordance with the Stefan-Boltzmann law,[1] lead to an increase in surface temperature caused by the transformation of light energy into heat. Diverting the expended heat energy from the Earth's surface to avoid its warming is impossible by the laws of physics. "Therefore, the rate of global environmental destruction cannot be reduced by changing one energy source for another while maintaining or increasing the source's power. Improvement of the ecological situation can occur only with a reduction in energy usage power to the ecological limit" (Gorshkov 1995, pp. 402–403).

In this way, according to Gorshkov, the highway out of this ecological dead end runs through the restoration of destroyed ecosystems, forest ones first of all, which naturally does not exclude the introduction of innovative energy technologies, especially for energy conservation. And he envisions this route in terms of a concrete scenario that allows us to stop further accumulation of carbon dioxide in the atmosphere even if we continued burning fossil fuels at year 2000 level volumes, the year this scenario was calculated (Fig. 15.2b).

This scenario requires people to reduce consumption of net primary production from the current 36 to 29%—by 7%. In that event, CO_2 emissions from human-utilized land decrease to 5.4 GtC per year, and total absorption of carbon emitted into the atmosphere (5.4 GtC/year +3.3 GtC formed by fossil fuel combustion not absorbed by the ocean) can be provided by the ocean biota and undisrupted land ecosystems. And then, as you can see from the diagram, further accumulation of atmospheric CO_2 could be prevented.

But it's easy to limit consumption of net primary production on paper. How about in real life? After all, against the backdrop of a growing deficit of land suitable for cultivation, the specter of famine once again stalks the population of many developing countries despite the successes of the green revolution. Therefore, it is clearly harder to reduce the area of cultivated land than to reject the use of raw hydrocarbons. Thus, in this connection, it is more realistic to imagine limiting exploitation of forests used for economic activity, which today makes up half (18 of 36%) of consumed net primary production. Reaching the above mentioned 7% mark requires people to remove 40% of exploited forests from economic use (18% × 0.4~7%), liberating the corresponding portion of settled territory from the human presence and thereby making possible the restoration of forest ecosystems harmed by man's deformation.[2] In particular this concerns forests of the tropical belt, whose productivity is equivalent to four times the unit area occupied by forests and bogs of the temperate belt. With regard to the world timber harvest, some portion could be replaced by artificial materials, and more modern energy sources can be used in place of firewood (Gorshkov et al. 2000, p. 171).

---

[1] The law establishing the physical dependency between a body's temperature change and its irradiance.

[2] Let us note that we are not talking about artificial recultivation, but the natural rebirth of ecosystems on the basis of evolutionary processes. Only such naturally arising biotic communities are able to compensate for environmental disruption in accordance with Le Chatelier's Principle. Artificial agrocenoses such as cultivated forests, as a rule, involve an arbitrary selection of species and are not only incapable of providing for their own stability, but also, as a result of high biological productivity, themselves serve as a source of environmental disruption.

Clearly, in terms of reaching global sustainability, such a measure represents a certain palliative. However, it would allow humanity to give some breathing room to nature in exchange for the time we need to solve other fundamental global problems such as stopping and reversing worldwide population growth, changing the model of consumption in developed countries, universal introduction of energy-conserving technologies, etc.

***

And now let us temporarily distance ourselves from theoretical discussion and try to contrast natural conditions in the different countries of the world from the point of view of their potential transition to sustainable development. After all, while we may consider the World Ocean our common patrimony, inviolate land ecosystems that serve as the primary anthropogenic carbon sink belong to distinct countries where, by the grace of unfolding circumstances, they have managed to be preserved. Here we are aided by the statistical ratings of the global Footprint Network (GFN), an international nongovernmental organization that follows trends in global footprint accounts and bio-capacity status for different countries and regions. In Chap. 3 we introduced GFN data regarding the states that occupy the top niches in lists of "ecological debtors" (whose ecological footprint exceeds bio-capacity) and "ecological creditors (with the opposite ratio). Here we will name them again.

China heads up the first of these groups with an ecological footprint 1652 million global hectares (gha) over its carrying capacity. That's more than twice as high! Next comes the USA (carrying capacity deficit: −1274 million gha), Japan (−532 million gha) and India (−469 gha). Granted, when recalculated per capita, the same rating looks a bit different: Japan - 4.1 gha/person, USA—3.7 gha/person, China −1.2 gha/person, India −0.4 gha/person.

After them comes Germany at −260 million gha (−3.1 gha/person), Italy at −228 million gha (3.9 gha/person), England and South Korea at about −217 million gha (−3.5 and −4.6 gha/person, respectively), and a total of about 100 countries in debt to the biosphere to one extent or another. The countries occupying the first eleven places on that rating list make up 53% of humanity's total ecological footprint.

If we look at that list, we see that most members of this club form part of three **global centers of environmental destabilization** (Fig. 15.3):

- *European*, including the states of Western, Central and Eastern Europe (and excluding Scandinavia), as well as European Russia, Ukraine, Belarus and the Baltic nations—an overall area of 8 million km^2 with 8% preserved ecosystem.
- *North American* with the USA (minus Alaska), southern Canada and northern Mexico—9 million km^2 with less than 10% preserved ecosystems.
- *South and East Asian,* bringing in China (except for Tibet), the Indian subcontinent, Japan, the Koreas, Indochina as well as the Philippines—seven million km in all with less than 5% undisturbed ecosystems (Maksakovskiy 2008, Book 1).

It's hard not to notice that of the three centers, two belong to the industrially developed states of Europe and North America, while on the other side of the world,

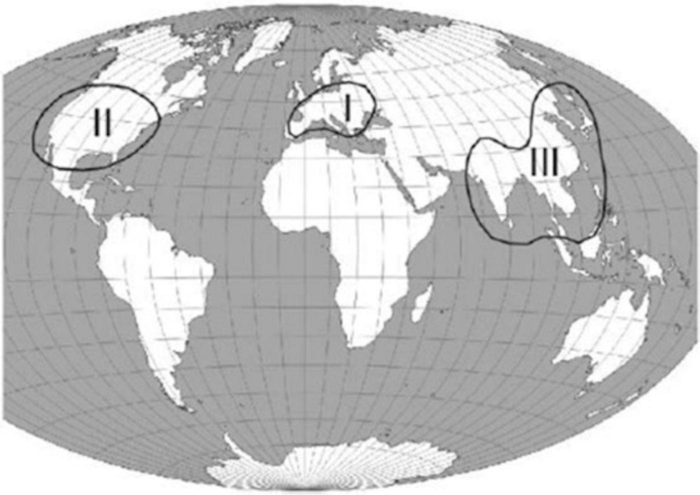

Fig. 15.3 Centers of global environmental destabilization (as described by K. S. Losev): I-European, II-North American, III-South-and-East Asian

we have the developing countries of Asia with high population growth and low-to-medium standards of living. This third region also includes the very different states of Japan, South Korea, Taiwan and Singapore.

The European and Asian centers have roots running deep into history. These were the domains of ancient civilizations, and so the natural environment has undergone great anthropogenic pressure over the long course of changing centuries. Thus the forests of the Apennine Peninsula were wiped out back when Rome stood at its apex. Western and Central Europe followed in the Middle Ages as agriculture quickly developed, cities sprung up, and ironwork demanded charcoal for smelting.

The discovery of America and consequent industrial revolution sharply accelerated the process of ecosystem destruction on both continents, for which the United Kingdom might serve as a textbook example. As it is written in some history books, sheep "devoured" England's forests. Indeed, textile factories, first appearing in the eighteenth century, demanded more and more wool, and shepherds' pastures were created at the expense of clear-cut forests. The forests also went to build the British fleet, as well as metallurgy. Ever since then, the United Kingdom has been a deforested country with the remains of forest masses covering less than 10% of the country, mainly in the northeast part of Scotland.

But while economically successful countries ran through the peak of their nature-destroying activity in the late nineteenth and early twentieth centuries and now have sufficient means to invest in a partial restoration of what has been destroyed, the catch-up states of East Asia have only recently begun to address issues of nature. At the same time, mounting problems connected to overpopulation and the impoverished state of the environment keep these nations in fetters, unable to maneuver.

So, for example, the most acute problem for China, India and the countries between them is the depletion of agricultural land and shortage of fresh water, the vast majority of which (up to 9/10) is expended on irrigation. Water deficits threaten China with particular danger, becoming what might be called a life-or-death question despite coverage of its territory by a lush network of rivers and having the fourth most plentiful water resources of any country on Earth. At the same time, China's per-capita water usage—460 m^3 per person each year—falls within the 90th percentile among the world's countries. Things stand no better with regard to farmland. Tillage shrank by the beginning of the twenty-first century to 0.07 ha/person. This demographic burden on the land has led to tragic consequences, first among them, soil erosion and desertification. According to data from China's Desert Research Institute, these processes have come upon 13 provinces in the country's north and northwest at a rate of 1500 km^2 per year (Maksakovskiy 2008, Book 2).

With regard to preserved nature, China has received a bitter inheritance from its previous regimes. When the People's Republic of China was founded in 1949, forests covered a mere 8–9% of its territory, and the South China rainforests had been almost completely wiped out. The periods of the Great Leap Forward and Cultural Revolution took an enormous toll on the environment. To resolve grain shortages, the central government ordered the plowing of millions of acres of pastureland and the clear-cutting of forests, including in the headlands of the Yangtse and Yellow Rivers. It then comes as no surprise that catastrophic floods have become a common backdrop of modern Chinese life, and yearly losses to natural disasters reach one-fourth of the state budget (Maksakovskiy 2008, Book 2). China has only managed to buck this trend in the past 15–20 years, when, thanks to the adoption of nature conservation laws and reforestation measures, the area occupied by forest (mainly secondary) grew to 14%.

Of special importance to the structure of China's ecological footprint is the carbon portion, 1612 gha. The main polluters are thermal power plants, which run on coal, along with domestic and industrial furnaces. In quantity of carbon dioxide emissions released into the atmosphere, China occupies second place in the world after the USA. At the same time, it is the greatest worldwide emitter of another powerful greenhouse gas, methane, which finds it source in coal mines and several branches of agriculture, especially rice-growing and livestock raising.

Many ecological problems unite China and India, which occupies second place in population and third in ecological footprint (1063 gha). First of all, these common problems include degradation of agricultural land and insufficient land resources, due to which tillage adds up to a mere 0.17 hectares per person. Granted, the water issue does not affect India as acutely, but it will grow more pressing with time. While fresh water resources are judged sufficient for now, a growing population will demand a constant increase in water diversion to fill its needs, for irrigation, first of all. Along with this, there is a high level of pollution in surface waters from industrial and domestic runoff, which as a rule flows into rivers without purification, and water is being removed from aquifers at twice the rate of replenishment. As a result, water tables are falling by 1–3 m/year, and, as specialists estimate, this house of cards may collapse at any moment. After that, grain production in India will fall by more than a quarter (Danilov-Danil'yan and Losev 2006, p. 138).

Table 15.1 "Ecological debtor" countries of South and East Asia. The order of the countries corresponds to their biocapacity deficit

Country	Ecological footprint millions ha	Bio-capacity, millions ha	Biocapacity deficit, millions gha/per capita		Population, millions	Population density, people/km^2	Population growth rate
China	2959	1307	−1652	−1.2	1336	141	0.5
Japan	602	76	−532	−4.1	127	334	−0.3
India	1063	594	−469	−0.4	1164	362	1.3
S. Korea	233	16	−217	−4.6	47	489	0.2
Thailand	158	77	−81	−1.2	67	130	0.6
Malaysia	129	69	−60	−2.3	26	87	1.6
Philippines	115	55	−60	−2.3	88	339	1.9
Pakistan	132	74	−58	−0.3	173	253	1.6
Bangladesh	98	59	−39	−0.25	157	1101	1.6

Source: The Ecological Footprint Atlas 2010, Worldstat info. Data on Population, ecological footprint and bio-capacity based on 2007 figures, numbers rounded

Unlike China, India has 20% forest cover, but this fifth of the country's territory is largely secondary forest, scrubland and man-made savannah. At that, it should come as no surprise that, under conditions of land shortage, deforestation reaches a rate of 1.5 million ha/year. The reason behind this lies at the surface. It is a critical need for tilled land and the use of timber as fuel. At the same time, the country's demand for firewood and industrial lumber stands seven times higher than what could be provided by the natural growth of forest resources. Thus, the cutting down of forests will clearly continue in India, with the elimination of virgin forest in the Himalayan foothills arousing particular worry (Maksakovskiy 2008, Book 2).

In Table 15.1, we have also presented a number of other countries in the region that have the greatest deficits in biological capacity and heaviest ecological footprints. The group is extremely diverse. Along with impoverished countries primarily made up of subsistence farmers practicing semi-natural agriculture, such as Pakistan, Bangladesh and the Philippines, it also includes economically developed Japan with South Korea right behind it, members of the "Asian tigers"—states that made a decisive breakthrough in development in the later twentieth century. There are countries such as Malaysia, where rich forest vegetation still covers half of the territory, but the same countries also belong to the number of world leaders in forest destruction (Malaysia, Thailand, the Philippines). As a percentage, this crown goes to Bangladesh, which destroys 4.1% of its forest land each year, while occupying second place in absolute rate of deforestation. Pakistan and Thailand follow at 3.5% each year, and then the Philippines at 3.4% (Maksakovskiy 2008, Book 2).

Another commonality of the countries figuring in this list is high population density, which more often than not surpasses that of Western European States. Bangladesh also claims a tragic leadership here occupying one of the highest positions in the world by this indicator. And if you combine this with a high birth rate (Philippines—1.9%,

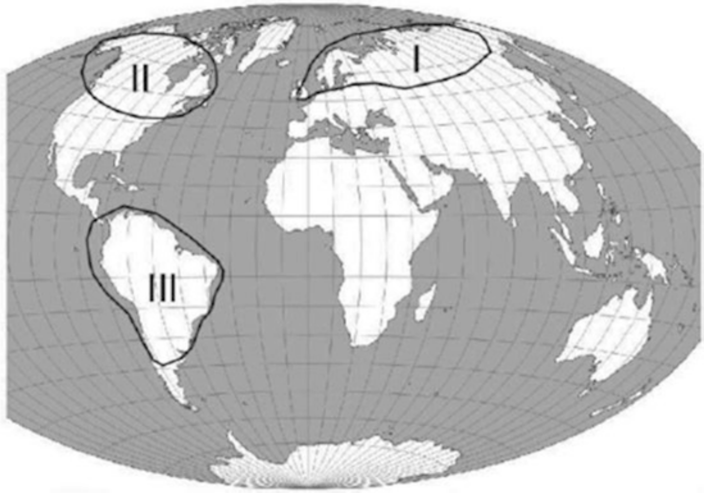

Fig. 15.4 Centers of environmental stabilization (as described by K. S. Losev). I-North Eurasian, II-North American, III-South American

Pakistan, Bangladesh, Malaysia—1.6%), you come to understand the myriad of pitfalls this region must step across in its path to sustainable development, beyond accounting for its role as the weightiest climate destabilizer on the planet by scale of CO_2 emissions (Zalikhanov et al. 2006).

And, now, let us cast our gaze upon the other end of the scale, on those countries belonging to the number of "ecological donors," where ecological capacity exceeds ecological footprint. Beyond comparison in biological capacity size stand Brazil at 1708 million gha, Russia at 816 million gha and Canada at 492 gha, occupying the top three places in the world rating for this indicator (See Chap. 3, Table 3.1), and by no coincidence. After all, it is their territories where you find the world's largest untouched masses of forest, with an overall area of more than 16 million km^2. And when combined with the forest ecosystems of their surrounding regions—Scandinavia, Alaska, and Amazonian Bolivia, Colombia, and Peru—we see the contours of the three **global centers of environmental stabilization** (Fig. 15.4):

- North Eurasian (11 million km^2), which includes the north of Scandinavia and European Russia as well as most of Siberia and the Russian Far East except for its southernmost part;
- North American (9 million km^2), including Northern Canada and Alaska;
- South American (10 million km^2), Amazonia and the neighboring mountain territories (Maksakovskiy 2008, book 1).

It is these, along with the World Ocean with its still little-disturbed ecosystems, that, like the turtles ancients once imagined to carry the Earth upon their backs, play the decisive part in maintaining the stability of the biosphere, allowing it to more or less successfully resist the yearly mounting anthropogenic pressure.

If we go down the list of countries that, along with the three above-mentioned, carry the most weight in stabilizing the Earth's environment, then we see that most of them also belong to the number of countries richest in forest resources. Just ten countries of the Southern Forest Zone possess three-fourths of the world's tropical rainforest. These would be Papua New Guinea (63% forest cover), the Democratic Republic of the Congo (57%), Brazil (55%), Peru, Colombia, Bolivia (52% each), Venezuela (52%), Myanmar (46%), Indonesia (44%), and India (23%). Granted, that last one, with its large ecological footprint, belongs to the biospheric "debtor" column.

There is, however, a paradox in the fact that many of the countries in this top ten are also leaders in yearly removal of forests. First among them stands Brazil, at an astonishing 20,000 km^2 of forest each year. This list of "record holders" includes Indonesia (10.8 thousand km^2), Bolivia (5.8 thousand km^2), Venezuela (5000 km^2), Myanmar (13.4 thousand km^2) and Paraguay (3.3 thousand km^2) (Maksakovskiy 2008, Book 1). In all, according to data from the FAO, for the period from 2000 to 2010, the world lost 3.2% of all its year 2000 forests, an area as large as the Republic of South Africa. When accounting for forest restoration, net losses came to 1.3% (State of the World's Forests 2012 pp. 19–20). And while a recent FAO overview on forest resources, presented by its general director at the 14th World Forestry Congress in Durban, South Africa, in 2015, expressed hope for positive changes, this is the type of cautious optimism one acquires when wishing to take the desired result for the true one.

Granted, on the plus side, the trend toward deforestation in roughly half of the world's countries has been stopped or even reversed. As a result, net global forest losses have fallen from 0.18% in the early '90s to 0.08% in 2010–2015, i.e. by more than 50%. And global carbon emissions linked to forest degradation fell by 25% over a decade and a half—from 3.9 GtC per year in 2001 to 2.9 GtC per year in 2015. Brazil achieved the most impressive successes in this area, accounting for over half of the reduction in carbon emissions (Global Forest Resources Assessment 2015). But, nonetheless, according to the latest satellite data, tropical forests continue to disappear at an accelerated rate, falling by an additional two thousand km^2 each year (Hansen et al. 2013). On the whole, the tropical belt carries about half of the world's total forest loss, and it is here that we observe the most staggering ratio of losses to growth (see Table 15.2). We witness the highest rate of forest degradation in the countries of South America, especially Argentina, Paraguay and Bolivia.

As you can see from the table, the overall area of forest losses over the 12 years added up to 2.2 million km^2, while growth reached just 0.8 million km^2. Tropical forests disappear or are degraded fastest of all. Causes for forest loss differ materially depending on climate zone. While forest fires cause most of the losses at moderate and northernmost latitudes, human activity occupies the primary role in the death of tropical forests, especially intensive clear-cutting meant to free up land for agricultural needs or obtain timber for fuel and commercial use. For more than two billion people on Earth, firewood serves as the main source of household fuel. In Africa, 80% of cut timber goes to this purpose (FAO 2010).

Unfortunately, the short term gain to be had from cutting down forests, measured in current market prices, pales in comparison to the long-term and less obvious advantages of sustainable forestry. Many of these advantages, such as climate

Table 15.2 Overall number balance of forest degradation and growth by climate zones, 2002–2012 (Hansen et al. 2013)

Forest by zone	Losses (km^2)	Increase (km^2)
Tropical	1,105,786	247,233
Boreal	606,841	207,100
Subtropical	305,835	194,103
Temperate	273,390	155,989
Total	2,291,851	804,425

Source: Naymark (2013) and Hansen et al. (2013)

stability, water system maintenance, defense against soil erosion, or preserving biodiversity, have no market price at all, and as such are not compensated by corresponding economic mechanisms. As the UNEP analytical group stated in their report, *The Economics of Ecosystems and Biodiversity*, "In most countries, these market signals do not take account of the full value of ecosystem services; moreover, some of them unintentionally have negative side effects on natural capital" (TEEB 2010, p. 27). As a result, cost assessments of forests often go down, creating the preconditions for their unencumbered elimination.

Overall, forest usage is an area where national and human interests deeply conflict with those of private business. Here the safeguard must, primarily, be provided by the state. Brazil's experience testifies to this by a certain measure. All the way back in 1988, that country developed its forest defense program, including the repeal of subsidies and credit for agricultural projects in the Amazon Basin. In 1996, Brazil's legislature adopted a special law meant to hold back the process of tropical forest destruction and forbidding farmers to remove more than 20% of virgin forest growing on their land. Thanks to these efforts, Brazil has managed to slow the rate of forest extirpation by half since 2005—from 40 to 20 thousand km^2 per year (Maksakovskiy 2008**,** Book 2; Naymark 2013).

Another cause for mass perishing of forests in recent decades has been epidemics spread along with tree parasites. In the opinion of British specialists, this comes as a side-effect of opening international trade and transport routes. As a result, the number of introduced species constantly increases, including those of a pathogenic nature to which local plants have not acquired immunity. Thereafter, illnesses in trees often grow to epidemic proportions (Boyd et al. 2013).

Earlier, we introduced calculations by Viktor Gorshkov concerning the possible end to the process of accumulating atmospheric CO_2 in the event that 40% of exploited forests are removed from economic use. Unfortunately, far too few countries have the corresponding resources to achieve this purpose. And so, in our view, we must put our hopes in the countries of the northern and southern forest belts. Their broad expanses of wooded territory and areas of low population density will allow them, at limited cost to themselves, to emancipate a part of their destroyed forest ecosystems form anthropogenic pressure. Among others, these countries include Russia, Canada, most states of South America, and the Democratic Republic of the Congo, each capable of making a distinct guarantee for global environmental stability.

The great misfortune, however, is that for most tropical countries, the primary task concerns less the increase of their forest wealth and more its defense from predatory destruction. And if developed countries are seriously troubled by the dangerous degradation of the biosphere, they cannot stand aside as this problem unfolds. All the more so because, as powerful sources of greenhouse gas emissions, they are practically living off a kind of "ecological rent," extracted from countries with preserved ecosystems, i.e. off of the exploitation of other people's ecological resources.

Unfortunately, this problem has still not been recognized on an intergovernmental level, just as, up to now, there is still no complete transparency regarding the true price of what we call ecological resources. In any case, it is not the price that city-dwellers pay, for example, for water (i.e. to collect and supply the water plus amortization of facilities), or what farmers and real-estate owners pay for rent and mortgage. After all, the latter's price is not determined by the natural communities that "take up house" there, so much as supply and demand for the concrete "services" the land is able to provide. That might be, of course, a picturesque landscape of some wooded area where a resort could be constructed, but more often we are speaking of a plot of land's fertility (when accounting for agricultural suitability), location (usefulness for urban or industrial construction), or mineral wealth. In this way, assessments almost always concern some financial advantage or another that might be obtained from a developed plot of land and not, as a rule, its overall biological value as an element of the biosphere, fulfilling its share of the work to maintain stability.

In the late Soviet Union, at the end of the 1980s, an attempt was made according to expert assessment to determine the resource-conserving and resource-restoring role of national parks in monetary terms, i.e. to evaluate how they contributed to environmental stabilization. In the experts' opinion, the land could be assessed at 2000 rubles per hectare, or $1000 per hectare when recalculated for the established (non-market) course of the US dollar (Losyev et al. 1993). In this way, they valued the work carried out by ecosystems—and national parks are textbook examples of undisturbed ecosystems—their function in maintaining environmental stability, very conditionally, to be sure, at $1000 per hectare.

Meanwhile, for 2014 alone, on the 86 million km^2 of partially and completely destroyed ecosystems, humanity obtained a gross product on the order of $78 trillion (CIA World Factbook n.d.). Therefore, one hectare of deformed or destroyed ecosystems contributes to the gross world product at a rate of about $9000 per year. Accounting for inflation, which by statistical estimates has been 50% over the past 25 years (Statbureau.org 2007–2015), we could equate this to $4500 in 1988–89 prices. The difference, we see, is 4.5 times. Even when accounting for inaccuracies of comparing market and non-market values for the dollar, it is still very real. And so any economist unconcerned with the environment can, if they wish, easily "prove" the disadvantageousness of conserving natural ecosystems.

But this is today's disadvantage, and that line of thinking now arouses doubt among many people of common sense even without a particular knowledge of ecology. After all, clean river water, forests of berries and mushrooms, and the joy of experiencing unencumbered wild nature are all disappearing from the world of modern humans. A future-focused life, with thought for grandchildren and great-grandchildren, obviously demands a different strategy. And since hope for ecological stability on the territory of one's own country, "fenced off" from the rest of the world as it exists, a number of developed countries' plans for sustainable development cannot withstand serious scientific argumentation, their populations will sooner or later have to make a decision. Better sooner than later. A decision between a boom of unrestrained consumption and reasonable self-limitation. Between expensive and ambitious projects such as corporate skyscrapers, fashionable flagship hotels or spectacles observed by millions and investment in the business of protecting the environment which promises no quick profit but which should, in theory, be a point of prestige for big and medium companies. That is to say it is a choice between corporate and national egotism on the one hand and concern for the fate of humanity on the other.

And so all of this doesn't look like a tangential abstraction, let us try to make it concrete with the example of Russia, whose geographic position and natural particularities provide it a key role in the global ecological layout.

***

Like any industrialized country, Russia makes its own contribution to the pollution and degradation of the environment, including anthropogenic carbon emissions, especially those from fossil fuels. Fossil fuel combustion makes up about 80% of Russia's greenhouse gas pollution. In 2000–2001, these emissions were estimated on the order of 0.54 GtC/year, 5.7% of the world total. At the same time, net absorption of atmospheric CO_2 by Russian forests added up, by different estimates, to anywhere from 0.2 to 0.5 GtC/year. The summary flow of CO_2 to all the country's undisturbed ecosystems added up to 1.0 GtC/year. From this, it follows that not only does Russia not serve as a source of increase to CO_2 concentrations in the atmosphere, it provides an unused resource of its absorption, of a size estimated to be on an order no less than 0.3 GtC/year (Contribution of Russian Forests…, 2004; Zalikhanov et al. 2006). Obviously, other states are using this resource, whose available area of preserved ecosystems is not adequate to the task of absorbing their own CO_2 emissions. In other words, Russia's ecological space is offering them a free ride.

Yet rather than solidifying its natural position and status as an ecological great power, Russia has moved ever more distant from its past environmental priorities, which, in the early 1990's allowed it to join the worldwide movement toward sustainable development. Domestic policy in the years from 2000 to 2015 we cannot call otherwise than de-greening. Meanwhile, cause for concern with the ecological situation in the country has not, in any case, diminished.

So, for example, despite 11 million km^2 of territory with preserved ecosystems (about 65% of the country's whole area and 22% of territory with undisturbed ecosystems worldwide) two-thirds of residents live in environmentally degraded areas, home to hundreds of cities including the nation's largest. In most of them are found permanently unacceptably high concentrations of toxic substances in both the air and drinking water supply sources. But while, in the 1990s, pollutant emissions into the atmosphere gradually decreased, from the year 2000 they began growing yearly. And in urban and suburban garbage dumps and areas little different from the typical garbage dumps, 110 billion metric tons of solid industrial and domestic waste have accumulated, poisoning the groundwater as well as surface water sources and filling the air with dangerously unhealthy dioxins (Danilov-Danil'yan 2006). You wouldn't see such things in any other developed country in the world today. Thus a degraded ecological backdrop has become for the majority of Russia's population an everyday reality.

This reality, however, does not join itself in the average Russian's consciousness to the issue of sustainable development, having no relation, so he imagines, to his life today or tomorrow. Is that not because the Russian citizen's perception of tomorrow, as research by the Club of Rome has shown, does not usually extend further than a few weeks? To go along with this, both television and the press, in tune with mass psychology and, to no small extent, forming it, fill up their channels and pages primarily with so-called breaking news, practically starving all thought of the country's fate, the future of its people or of the world as a whole.

As concerns statesmen and politicians, the majority of them suppose that, in a period of structural reform, questions of sustainable development are not as relevant to Russia. The logic here is simple: first we need to overcome the difficulties of today, and then think about a transition to sustainability. Furthermore, with the apathy of the voting public toward any general ecological problem not directly affecting their town or subdivision, such issues are pushed off the electoral platform. Thus, for a person entering power, it is clearly not a winning theme. After an outpouring of environmental activity in the years of perestroika and post-perestroika, interest in ecological problems began to fall sharply from the first or second popular priority in 1989 to the ninth or tenth in 2000 (Losev 2001). And while, in most developed countries, issues of sustainable development consistently fall within the field of public attention, in Russia they remain the narrow province of professionals, only to be discussed at specially dedicated conferences and symposiums.

Highly indicative in this regard are also the metamorphoses that have occurred over the last two decades in Russia's state environmental institutions. While in the first post-perestroika years, the primary institution held ministry status, it was then downgraded to the level of State Committee for Environmental Protection and Natural Resources. After Vladimir Putin was elected in 2000, the Committee, too, was dissolved, and its functions were not given to the Natural Resource Ministry or any other executive organ. In the President's order to dissolve the committee, no successor institution was determined at all, an unprecedented event in the history of Russian bureaucracy. Only after several years did a new article appear in the Natural Resource Ministry's charter, delegating it environmental protection functions. That is, a return took place to the vicious Soviet-era practice: let he who destroys nature regulate it himself.

Results did not delay in coming. Strictness declined in ecological demands of businesses. Access to natural resources was materially eased for large- and medium-sized companies. The best natural nooks around big cities began to be refitted as elite suburbs, and national parks had to constantly defend themselves from encroachments on their seemingly inviolate territory by local governments and their business associates.

In 1994, Boris-Yeltsin issued the presidential order "On the State Development Strategy of the Russian Federation in Environmental Protection and Providing Sustainable Development." Two years later, another presidential order was confirmed, "Concept of the Russian Federation's Transition to Sustainable Development." By that order, the federal administration was directed to design "A Strategy of the RF's Transition to Sustainable Development."

This document, however, foundational for so many counties and recommended for passing by the Rio Conference of 1992, designed in 1997 by the Economic Development Ministry with the involvement of specialists and public figures, did not go on to become law. It was reviewed by the government in late 1997 and sent for final corrections according to standard practice. But then the economic crisis of 1998 interfered, followed by a default in August. The Strategy project was simply forgotten, removed from the agenda. In its own way, though, Russia's failure to adopt the program for transition to sustainable development was symptomatic. What would come in its place?

For today, Russia has a few palliative documents which make a bare attempt to resolve the tasks put forward in the strategy. This included the 2002 adoption of "The Ecological Doctrine of Russia," which then Prime Minister Mikhail Kasyanov presented to the 2002 Johannesburg Summit as some great achievement, though it brought no noticeable results. This was later supplemented by the administration's approval of the "Socio-Economic Development Strategy of the RF for the Period up to 2010" and the parallel adoption of select, more focused development strategies up to 2020. But these documents could not unfortunately replace the country's mothballed strategy for transition to sustainable development.

In 2008 the Ministry of Natural Resources added the words "and ecology" to its name, though ecology itself gained nothing from this changing of the shingle. Today, responsibility for ecological problems is shared between about twenty ministries and federal agencies. But as they say, too many cooks spoil the broth, and the lack of a single organ working on environmental questions and nothing else has told very negatively upon green policy (Danilov-Danil'yan 2001; Fomin 2005). In that respect, Russia is falling dangerously behind the majority of other states. The country's anti-ecological drift has ended in an increase of relative power for nature-exploiting and polluting industries, the growth of energy consumption per production unit, and ultimately the orientation of the economy on an unlimited resource base. But if the economic system carries "anti-ecology" in its genes, then how can state environmental protection resist it while following in its wake?

Especially dangerous in view of this, we witness the assault on Russia's "ecological bastions"—Siberian taiga forests and bogs, experiencing ever greater pressure from business. As stated in the *Atlas of Russia's Intact Forest Landscapes* (Aksenov et al. 2003), one often happens to hear that Russia is a country where the greater part is still covered in endless slumbering forests, practically unpeopled and untouched. That is what many experts in the area of environmental protection think when they say that two-thirds of Russia's whole forest zone is made up of "completely wild nature."

Sadly, the atlas concludes, "These findings refute the myth that ancient or virgin forests still dominate Russia. Such forests now dominate only the northern parts of Eastern Siberia and the Russian Far East…In most parts of European Russia and Western Siberia, and the southern parts of Eastern Siberia and the Russian Far East, the forest vegetation has been fundamentally transformed by human activity. No large intact landscapes remain in many of these western and southern areas, while the intact forests that remain are broken up into fragments, too small to sustain the full array of components and functions characteristic of a natural forest landscape" (Danilov-Danil'yan 2001; Fomin 2005).

In Russia, however, not only is little thought given to maintaining the sparsely-populated regions of Siberia and the Far North, but just the opposite. Preparations are made for their further conquest. One such project, the planned construction of the Evenkiskaya Hydroelectric Station on the Lower Tunguska, to be one of the world's largest dams with an output of about 8 gigawatts, a height of 200 m and a flood area on the order of a million ha. Construction time is estimated at 18 years. Planned simultaneously are two high-voltage power lines running from the dam to Tyumen, at distances of 600 and 800 km, as well as the installation of three additional generators at the Nizhe-Kureyskaya Hydroelectric Station to provide energy requirements for construction (Nefyodov 2008). And that is on territory recognized by UNESCO as the environmentally cleanest on the planet!

Mikhail Lomonosov once uttered the prescient words that, "Russian strength will grow through Siberia." But today it looks like we are undermining this strength, understanding it too narrowly and literally. Although it would seem the situation of ecological crisis itself is giving the old prophesy a new meaning and life. After all, through the nature of Siberia and the Far East, preserved inviolate, Russia will carry its weight in preserving the whole biosphere, stabilizing concentrations of atmospheric CO_2, maintaining the continental water cycle, providing soil formation and so on. Thus without dredging up any more oil from the Earth's depths, which we have freely squandered not thinking of our descendants, and without any more nuclear weapons, but precisely with this priceless patrimony, can we affirm our status as a world power, and at the same time, like the many countries that have lost their natural resources, look concernedly into the future and try to dodge the threat approaching from further environmental degradation.

By the way, one should not understand the word "priceless" to mean that it has no concrete price at all. Experts have tried to calculate, measure and weigh out this price. They base them on the economic losses incurred by the US, Japan and the countries of Europe in the course of fulfilling the obligations of the Kyoto Protocol for lowering carbon emissions. These expenses, as the international specialists determined, add up to between 550 and 1100 dollars per metric ton of non-emitted carbon. And if, as we said above, the summary flow of Russia's anthropogenic carbon into its own ecosystems equals about 1 GtC/year, surpassing CO_2 emissions on Russian territory by 0.3 GtC/year, then Russia's ecosystems also remove other people's carbon from the atmosphere at a value of between 165 and 330 billion dollars a year. These are billions that our country is practically investing in the world community, including in developed countries (Zalikhanov et al. 2006).

Carbon sources and sinks were evaluated simultaneously for other continental-scale regions as well—Asia (besides the CIS), former Soviet Republics, Africa, Western and Central Europe, the Americas and Australia (Kondrat'yev et al. 2005). As has already been said, today South and South-East Asia serve as the greatest destabilizers of the Earth's climate. North America and Europe follow behind them, largely due to industrial emissions. Africa stands close to a neutral result for the time being. Australia and especially South America remain areas that stabilize the climate thanks to the undisturbed ecosystems preserved there. The balance of anthropogenic carbon within the CIS is close to even due to Russian ecosystems.

In Table 15.3, we have shown evaluations anthropogenic carbon sinks in undisturbed and partially disturbed forest ecosystems of the Northern Hemisphere (Russia, USA, Canada), as determined by various methods and contrasted with satellite data (Myneni et al. 2001).

Table 15.3 Carbon sinks in forests of Canada, Russia and the USA

Country	By satellite date			By other data		
	Stores, GtC	Sinks, GtC/year	Area, ha (millions)	Stores, GtC	Sinks, GtC/year	Area, ha (millions)
Canada	10.56	0.0731	239.5	11.89	0.093 0.085	244.6
Russia	24.39	0.2836	642.2	32.86	0.429 0.058	816.5 763.5
USA	12.48	0.1415	215.5	13.85	0.167 0.098 0.020	217.3 247.0

Source: Zalikhanov et al. (2006)

Unfortunately, the focus of the Kyoto Protocol as well as the 2015 Paris Accord that replaced it on CO_2 emissions from fossil fuel combustion turns to the disadvantages of a number of countries, including Russia, through the clear undervaluation of factors such as carbon emissions that result from land usage or their deposits in preserved ecosystems. In the meantime, the interests of stabilizing the global environment demand a fundamental revision of our attitude toward planetary wealth. First of all, this means more efficacious measures for investing financial capital in the protection and restoration of forests which would outbalance the advantages of annihilating them. Or as Viktor Gorshkov proposes, introducing an international tax that developed countries would pay to countries possessed of a biota untouched by civilization on a scale that exceeds the potential profit of exploiting it (Gorshkov 1995, p. 36). And then, perhaps, in Russia a different scheme of motivations would go to work, and the damage russians are doing to our national interests would become obvious. Preserving the forest masses of Siberia, the Far East and the north of European Russia would become a strategic priority.

If you compare the area taken up by undisrupted and little-disrupted ecosystems in Russia at the start of the twentieth century, before the first symptoms of the ecological crisis, with today, you get the ratio of 80–65% (Losev 2001). Therefore, over the century and mainly over the course of the 70-year reign of centralized economics, the country lost 15%, or 2.5 million km^2 of its ecosystems. In this a significant role was played by an irresponsible attitude toward the land, which was generously given to any project, needed or unjustifiable.

You can still recognize the results of this "management" today. The area of agricultural land per capita, 1.5 ha, of it 0.88 ha under the plow, spreads twice or three times as wide as in most developed countries. In Finland, for example, the same indicators stand at 0.44 and 0.43 ha, Sweden—0.35 and 0.29 ha (Worldstat Info n.d.), and these northern countries are crop exporters. While the rest of the world experienced a Green Revolution with its intensive farming methods and reduced area of tilled land, Soviet agriculture went down the opposite path, expanding tillage at a low level of production efficiency.

In his tract, *Rebuilding Russia* (Solzenitsyn 1990), Aleksandr Solzhenitsyn brings in the words of famed early twentieth century statesman Sergey Kryzhanovsky, a supporter of Prime Minister Pyotr Stolypin and final State Secretary of the Russian

Empire: "Native Russia is not disposed of the store of cultural and moral strengths for the assimilation of all outlying territories. It is sapping the Russian national core." No, at the moment that essay appeared, the ecological aspect did not concern its author, having written of "the spiritual and bodily salvation of our people" appearing still before the fall of the Soviet Union. But if instead of the nation's outlying imperial territories—the former Soviet Republics—we put the sparsely populated regions of Siberia, the Far East and northern European Russia, the ideological vector of Solzhenitsyn's musings in many ways joins up to that which troubles today's ecologists. Imperial ambitions weigh ever more upon our national consciousness, including our relationship with nature. A gradual retreat, a leaving behind of these regions like never before coincides with the task of propping up the well peopled Russian lands occupying the space within the so-called "triangle of cities"—St. Petersburg, Irkutsk and Sochi. And if we add to that Vladivostok and the greater part of Primorsky and Khabarovsk Krais, we get the areola of ideal natural and climatic conditions in which 95% of the country's population lives.

On this territory of 5 million km^2, stretching south from the 55th or 60th parallel and including the Urals, European Russia and the southern parts of Siberia and the Far East, is concentrated 95% of the country's industrial potential and 100% of its agricultural wealth. For the great majority of the population, that makes the process of liberating weakly conquered territory practically painless (Losev 2001). Along with this, the native peoples of the North will benefit, being today for all purposes on the edge of extinction or faced with the choice of leaving their homelands and fully losing their cultural identify. First of all, they will regain, at their disposal, a pure natural environment, and, secondly, the possibility to return to their cultural roots and traditional ways of life.

With regard to the masses of wild nature left whole, they should all, just like national parks, be restored to state property with a total ban on their economic use beyond special cases—the development of geological deposits with low-impact technologies, construction of strategically important objects, etc. But compensatory mechanisms should be arranged for them in the form of ecosystem restoration on another, naturally similar territory. A ban on economic activity within undisturbed ecosystems does not mean depriving people of the opportunity to communicate with wild nature, so long as they strictly obey certain rules (ecological tourism), the most important of which is performing any type of activity on reserved territory exclusively under their own kinetic power.

***

All of this, however, is not the end of Russia's ecological potential which it could direct to the welfare of the rest of the world. As Russian geographer Boris Rodoman notes, the landscape of the average Russian *glubinka,* or deep backwater, fundamentally differs from the countryside of most European countries. The fact is, centuries of a strict power vertical on the territory now called post-Soviet Space, sparsely peopled "dead zones" arose around the edges of most provinces, where traditional settlements disappeared in the Soviet era. As a result, a unique "polarized" landscape formed. As power flowed "vertically" from Moscow down to the provincial administration centers, the "horizontal" infrastructure weakened decidedly

(Rodoman 2012). For good reason does one hardly encounter the understanding of a glubinka outside the Russian language.

In the ancient Roman Empire, they said "all roads lead to Rome." A similar situation arose, too, in the Soviet Empire, and in post-Soviet Russia, which is particularly clear from non-Chernozem areas. So while half a century ago, every village was linked to its neighbors by three or four roads serviced by motorized transport, today you can only get to them on foot, or by bicycle at best. In more-or-less tolerable condition are only those roads along which the leadership travels. Along this **"**vertical axis", too, run the bus routes, oriented in the direction of the nearest provincial or district center. The closer you get to the district's edge, the quieter and more transparent life becomes, thus at direct proximity to the edge, especially at the crossroads of several provinces, do you see the formation of true backwoods practically without any transport network. In its place forms a natural network of transcontinental ecological corridors, a kind of econet uniting the territories of undisturbed and little-disturbed ecosystems.

For good reason do we use the term transcontinental, since that is precisely where the econet aims. Rodoman writes, "To support the vitality and wholeness of the biosphere, natural acreage should occupy not only enough area but make up a solid, contiguous mass by way of green corridors" (Rodoman 2012). But while in Western European countries, the realization of such an idea would require purchasing and recultivating land in private holding, we have no need to exert such efforts. It is enough to maintain the status quo, that is, not to restore deserted roads but to keep what exists in order, providing transport along axial highways. And there is no surer way to kill off nature than to build a road through it.

Rodoman points to one more reservoir of barely-touched wild nature. That would be military bases and training grounds. He writes, "The Russian Ministry of Defense is the world's biggest consolidated landholder. Inside the barbed wire of our forbidden zones, judging, for example, by greater Moscow, could lie a whole tenth part of our country." At that, the officers are even better preserving the natural landscape they occupy, so long, of course, as they don't use it for its intended purpose, than the impoverished and scarcely dependable National Park Service. Therefore, along with state-run dachas, hunting reserves, oligarchs' estates, and so on, it is these military training grounds that de-facto serve as our truly protected nature preserves, and it is in our interests that these lands remain under the defense and security organs as long as possible**.**[3]

But of particular interest in Boris Rodoman's concept comes its geopolitical aspect, despite a number of controversial points contained within. We are speaking of Russia's ecological specialization, as the cited article is titled as well. Though the ideas he expresses are not entirely new and have already come under discussion by Russian ecologists (Losyev et al. 1993; Kondratyev et al. 1993; Arsky et al. 1997; Danilov-

[3] In fairness, it is worth recalling that a famous ecologist wrote about this in the late 1980s, during perestroika, correspondent member of the Russian Academy of Sciences Alexey Yablokov. Granted, then the question was of giving over the territory of defense objects to the Russia environmental protection system, which, unfortunately, met with little understanding from either government bureaucrats or officers.

Danil'yan 1999), the topic has received little hearing since the year 2000. Under the conditions of a de-ecologizing Russian politics, many participants of that discussion had to switch to questions of the environmental protection system's survival. The role Russia could play in preserving the planet's ecological balance went onto the back burner, disappearing from the public eye. Thus the very fact that Rodoman addressed this problem in a new historical go-around serves as proof that the idea itself is still alive, and, contrary to accepted policy, is being reborn in popular consciousness.

In short, Rodoman formulated the dilemma before our country as this: shall we remain in the role of a backward outsider playing catch up, aiming to enter the world system as an equal player at any cost? Or shall we, making use of our geographical advantages, secure a role as the leading ecological donor. "There's no need to try and catch a leaving train, or have to come even with other countries by some economic indicator…Russia could specialize in the role of ecological guardian, protecting the natural landscape in the interests of all humanity. Perhaps we might depend on military force as well, most likely international, to prevent, say, the settlement of our Siberia. We cannot accept to happen there what occurred with Manchuria over a mere century. It was just as much taiga, just as sparsely populated as Siberia" (Rodoman 2004).

Of course, this is not the first time someone has expressed the idea that Russia, with its wide open spaces and relatively low population density, will have a hard time holding onto Siberia and the Far East. But, in the writer's opinion, the situation is not all that simple and, under certain circumstances, could be turned to Russia's advantage—if it can put its rich natural potential in the service of the rest of humanity. To that end, he expressed doubt concerning our established approach toward the issue of depopulation. Does depopulation truly represent an absolute evil to our country, threatening to blot out its future? And does it need a stream of immigrants to supplement lost population and labor power?

Granted, immigration policy could solve a few problems—stabilizing population numbers, providing workers to the fields where they are most needed—but it does not promise fundamental change to the state of affairs in the country. For the simple reason that 80% of its residents are "economically redundant." Rodoman writes that they are unattached to the oil-and-gas pipeline and of questionable potential as producers and consumers, and so destined for degradation and extinction. Whole socio-professional castes, according to research by economics professor Natalya Rimashevskaya, are sinking like rocks (Rimashevskaya 2003). Thus, against the background of the country's current export-import orientation, we should more likely be speaking of its economic overpopulation. Overall, to see only the negative in Russia's low population means being governed by the logic of bygone days. To fulfill its ecological mission, Russia has a more than adequate population.

Rodoman, to this end, brings in the analogy between individual professional orientation and the specialization of a country or region. Just as each person most reasonably seeks to apply their strengths to the sphere of activity for which they have a calling, so, too, it makes little sense for backward countries to attempt copying the achievements of the economic leaders that have surpassed them, and they should rather realize themselves in the area of least competition, i.e. occupy their own, inimitable niche. For Russia, this niche unquestionably lies in its natural resources, thanks to which it might become the ecological magnet of the whole eastern hemisphere. And here we will use another simile brought forward by Rodoman, comparing Russia to the forest park of a large city. (Today one might look upon the whole Earth's landmass as a type of worldwide city—*Ecumenopolis*.)

"By rejecting 'heavy industry' and 'medium engineering,' our country could march decisively into post industrial society—not into the business center, of course, and not onto skid row, but to the peripheral green zone…Russia could occupy, in relation to Western Europe, the role that park regions around Moscow play for the capital, i.e. take upon itself the global function of 'the world's garden district'—to be a source and reservoir for clean water and air, a place of physical and spiritual recovery for its visitors…"(Rodoman 2012).

Therefore, only in connection with developed countries could Russia obtain a truly worthy position in the capacity of an equal ecological partner. But for that both sides need to recognize the great benefit that such strategic cooperation lays before them. First of all, of course, this means preserving Siberian and Far East taiga as well as other remaining areas of virgin Russian nature as an ecological resource of global significance which often concerns economically advanced countries more than Russians themselves. There are also broad possibilities for ecological tourism, exposure to the world of untouched nature, demand for which grows with each passing year. Rodoman considers, "precisely a global, international approach to the Russia's environmental protection mission would best enable its preservation as a unique country with a very specific civilization" (Rodoman 2012).

Russia, for its part, might stake a claim for corresponding compensation ("a buyout") for declining to exploit its forest resources, apply agrochemicals, pollute the environment with industrial technology or engage in any other ecophobic activity. In other words…for doing nothing. Yes, the eternal Russian question should be reformulated: not as "What is to be done?" but "What is not to be done?" as the country exits onto the path of ecological specialization. And though the mania for that activity—a disease of modern humanity fraught with destructive consequences for the biosphere—has gripped many nations, Russia, it seems, takes home the gold here. Indeed, a rejection of schemes possible and impossible would surely turn to the benefit of our country. Let us merely recall the upturning of virgin lands, the draining out of bogs (which later had to be refilled), the planned redirection of Siberian rivers or other grandiose projects to vanquish nature.

Thus, in the case of a directed ecologization of Russia, it has something to relinquish in both its present and its past. That includes artificially inflated defense spending (the second most numerous army in the world and one of the highest shares of GDP—5.4%—devoted to defense), and the projected construction of the gigantic Evenkiskaya Hydroelectric Station in the wilds of the Lower Tunguska, and the development of new geological deposits which brings harm to the environment (for the sake of carrying out one or two suitcases of diamonds from Yakutia, Rodoman notes**,** an area the size of Switzerland has been disfigured), and state support for uncompetitive production. Granted, rolling up inefficient and harmful activity comes at the price of swelling the numbers of "economically redundant" Russian citizens. But for that, in theory, rich countries ought to pay, so as not to lose the forest riches of Siberia and preserve as part of the global common wealth, the purity of the Sayan and Altai Mountains or Lake Baikal.

Sociological research declares that outside our cities a multi-million person army of pension and welfare recipients lives year round. This public dole must be increased to support rural resettlement. After all, if millions of Soviet people once received a miserly paycheck from the government for then-useless pseudo-labor (recall the sad joke of those years: We pretend to work, you pretend to pay us), then why couldn't their children and grandchildren receive from other governments a fair reward for refraining from harmful ecophobic activity? At the same time, a life on welfare is far from always the same as parasitism and idleness. Just the opposite, with the right frame of mind, it allows a person to find their way to the kind of activity they are truly meant for, whether it is communing with nature and actively caring for it, looking after children, household management, artistic creation or starting a small business.

From the other end, residents of Russia's major cities would have a healthier natural environment for everyday life and creative activity. Active mental labor not only combines beautifully with ecological tourism, it could not exist without it. For good reason were the most ardent fans of tourism in the USSR engineers and scientific workers from academic institutions and the Military-Industrial Complex who intuitively found a curative outlet for themselves in mountain climbing, canoe trips along the rapids and other forms of extreme leisure, along with the usual excursions into nature on weekends and holidays.

It's hard to say what role tourism played in the realization of our space program or in establishing the Soviet nuclear umbrella, but it is beyond doubt that it could still serve our scientific and engineering thought. And while we have already lost our working class, engineering and scientific thought is still warm and can be born again…if we establish the right circumstances. And instead of organizing routine assembly line production—clothing and shoes, telephones and computers—in competition with China, Russia could focus on a skilled construction orientation, on experimental and low-circulation production, then selling our ready-to-introduce technical designs to China, India or Indonesia.

But if, let's say, the United States is in essence an urban civilization (Ecumenopolis), beginning its history three centuries ago with a blank slate, then Russia's rural roots go still deeper, no matter how far seven Soviet decades have uprooted them. To this, in part, speaks the irresistible pull of urbanites newfound and trueborn alike to acreages beyond the city lines. Indeed, this passion often turns to misfortune for nature, since the division of plots belongs, as a rule, to corrupt bureaucrats who approach this business God only knows how, but in any case without considering the interests of the surrounding landscape, often turning it into a single human anthill. And dacha colonies in the forest, by Vladimir Kagansky's estimate, ruin an area five to six times greater than they themselves occupy (Rodoman 2002).

And, meanwhile, without the traditional villages and landed estates, without the inimitable middle-Russian landscape located just above the line of sight that once inspired great Russian artists, the people, according to Rodoman, cannot remain as one. Developed countries know this danger well. Therefore, the widespread practice of government support for agriculture—that clearly anti-market policy which begets serious battles in the EU and WTO—takes place not only in the interest of providing food security, but for the preservation of a rural way of life that corresponds to modern ecological, technological and economic standards.

In all likelihood, much of what we have said above may seem like a dream beyond the scope of real life, an impossible utopia, and it's hard to find words to disagree. Anyway, many also view the idea of sustainable development as utopian. What looks utopian today, however, might tomorrow look like an unjustifiably missed opportunity. Such it has been more than once in history. But one thing seems beyond question: the future of Russia is unthinkable in separation from the countries of civilized Europe, and fate itself calls on them to complete and enrich one another. This fact, long obvious to many, should enter the consciousness of all the peoples living in that space.

References

Aksenov, D. E., Dobrynin, D. V., Dubinin, M. Y., et al. (2003). *Atlas of Russia's intact forest landscapes*. Moscow: Izdatel'stvo MSoES. Washington: World Resources Institute. Retrieved from http://old.forest.ru/eng/publications/intact/2.html.

Arsky, Y. M., Danilov-Danil'yan, V. I., Zalikhanov, M. C., Kondratyev, K. Y., Kotlyakov, V. M., & Losev, K. S. (1997). *Ecological problems: What's happening, Who is to blame, and What is to be done?* Moscow: MNEPU. [in Russian].

Boyd, I. L., Freer-Smith, P. H., Gilligan, C. A., & Godfray, H. C .J. (2013 November - 15). The Consequence of tree pests and diseases for ecosystem. *Science, 342* (6160).

CIA World Factbook. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/index.html

Contribution of Russian Forests to the World Carbon Balance and Tasks of the Forestry Service After Ratification of the Kyoto Protocol. (2004). *Ustoychivoe lesopol'zovanie, 4*(6), 16–20. [in Russian].

Danilov-Danil'yan, V. I. (1999). *Sustainable development and problems of environmental policy*. Moscow: Ekosinform. [in Russian].

Danilov-Danil'yan, V. I. (2001). Russian ecology: Awaiting a breakthrough? In V. I. Danilov-Danil'yan (Ed.), *Race to the market: Ten years later*. MNEPU: Moscow. [in Russian].

Danilov-Danil'yan, V. I. (2006). The ecological significance of energy conservation. Energetika Rossii: problem i perspektivy. *Trudy Nauchnoy sessii RAN* (pp. 196–207). Moscow: Nauka. [in Russian].

Danilov-Danil'yan, V. I., & Losev, K. S. (2006). *Water usage: Ecological, economic, social and political aspects*. Moscow: Nauka. [in Russian].

FAO. (2010). *Global forest resources assessment: Key findings*. Rome: FAO.

Fomin, S. A. (2005). Main Government exectutive organs in the area of environmental management in Russia in 2005. *Rossiya v okruzhayushchem mire: 2005*. Moscow: Modus-K; Eterna.

Forest Encyclopedia. (1986). In two volumes. Volume 2. G. I. Vorobyov (Ed.). Moscow: Sovietskaya entsiklopedia. Retrieved from http://forest.geoman.ru/forest/item/f00/s02/e0002857/index.shtml [in Russian].

Friedli, H., Lotscher, H., Oeschger, H., Siegenthaler, U., & Stauffer, B. (1986). Ice core record of the 13C/12C-Racio in atmospheric CO2 in the past two centuries. *Nature, 324*, 237–238.

Global Forest Resources Assessment. (2005). 15 key findings. Retrieved from http://www.fao.org/forestry/foris/data/fra2005/kf/common/GlobalForestA4-ENsmall.pdf

Global Forest Resources Assessment. (2015). www.fao.org/3/a-i4793r.pdf

Gorshkov, V. G. (1995). *Physical and biological bases for sustainable life* (472 p). Moscow: VINITI [in Russian].

Gorshkov, V. G., Gorshkov, V. V., & Makarieva, A. M. (2000). *Biotic regulation of the environment: Key issue of global change*. London: Springer.

Gorskov, V. G., Kondratyev, R. Y., & Losev, K. S. (1998). Global eco-dynamics and sustainable development: scientific aspects and the "human measurement". *Ekologia, 3*, 163–170. [in Russian].

Hannah, L., Lohse, D., Hutchinson, C., Carr, J. L., & Lankerani, A. (1994). A preliminary inventory of human disturbance of world ecosystems. *Ambio, 23*, 246–250.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, A., Tyukavina, A., Thau, D., Stehman, S. V., Goetz, S. J., Loveland, T. R., Kommareddy, A., Egorov, A., Chini, L., Justice, C. O., & Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science, 342*, 850–853.

Houghton, R. A. (1989). The long-term flux of carbon to the atmosphere from changes in land use. Extended abstracts of papers presented on the Third International Conference on analysis and evaluation at atmospheric CO2 data. Heidelberg: W.M.O. University. pp. 80–85.

Houghton, J. T., Meira Filho, L. G., Callander, B. A., Harris, N., & Kattenberg, A. (1996). Climate change 1995. In K. Maskels (Ed.), *The science of climate change*. Cambridge, Cambridge University Press.

Kondrat'yev, K. Y., Karapivin, V. F., & Potapov, I. I. (2005). Natural disaster statistics. In Environmental problems and natural resources: General information (pp. 57–76). Moscow. [in Russian].

Kondratyev, K. Y., Danilov-Danil'yan, V. I., Donchenko, V. K., & Losev, K. S. (1993). *Ecology and politics*. St. Petersburg: Sankt-Peterburgsky Naucho-Isledovatelny Tsentr ekologicheskoy bezopasnosti RAN. [in Russian].

Lorius, C., & Oescher, H. (1994). Paleo-perspectives: Reducing uncertainties in global change? *Ambio, 3*(1), 30–36.

Losev, K. S. (2001). *Ecological problems and prospects for sustainable development in Russia in the 21st century*. Moscow: Kosmosinform. [in Russian].

Losyev, K. S., Gorshkov, V. G., Kondratyev, K. Y., Kotlyakov, V. M., Zalikhanov, M. C., Danilov Danil'yan, V. I., Golubev, G. N., Gavrilov, I. T., Revyakin, V. S., & Grakovich, V. F. (1993). In V. I. Danilov Danil'yan & V. M. Kotlyakov (Eds.), *Problems of Russian ecology*. Moscow: VINITI. [in Russian].

Maksakovskiy, V. P. (2008). A geographical portait of the world (in two books). Moscow: DROFA. [in Russian]. Book 1. Retrieved from http://www.twirpx.com/file/997779/. Book 2. Retrieved from http://www.twirpx.com/file/997899/

Meadows, D. H., Meadows, D. L., & Randers, J. (1992). *Beyond the limits*. Post Mills: Chelsea Green.

Myneni, R. B., Dong, J., Tucker, C. J., Kaufman, R. K., Kauppi, P. E., Liski, J., Zhou, L., & Alekseev, V. (2001). A large carbon sink in woody biomass of Northern forests. *Proceedings of the National Academy of Sciences of the United States of America, 98*, 14784–14789.

Naymark, E. (2013). *World forest masses are gradually being studied*. Website "Elementy". Retrieved from http://elementy.ru/news/432137 [in Russian].

Nefyodov, A. V. (2008, Aug 25). "Those Russians, did they use to have rivers? On the question of building the Evenkiyskaya (Turukhanskaya) hydropower on the Nizhnyaya Tunguska river". *Turukhanskaya Shirota, 35*. Retrieved from http://www.bioticregulation.ru/life/life10.php

Olsson, R. (2009). *Boreal forests and climate change*. Goteborg: Air Pollution & Climate Secretariat & Taiga Rescue Network.

Raynaud, D., Jouzel, J., Barnola, J. M., Chapellaz, J., Delmas, D. J., & Lorius, C. (1993). The ice record of Greenhause gases. *Science, 59*, 926–934.

Rimashevskaya, N. M. (2003). In *Just and unjust social inequality in Modern Russia* (pp. 129–145). Moscow: Referendum. [in Russian].
Rodoman, B. B. (2002). The Great Landing (Paradoxes of Russian Suburbanization). *Otechestvennye zapisi, 6*(7), 404–416. [in Russian].
Rodoman, B. B. (2004). Russia in an Administrative-Territorial Monster November 4, 2004. POLIT.RU. Retrieved from http://polit.ru/article/2004/11/04/rodoman/ [in Russian].
Rodoman, B. B. (2012). Russia's ecological specialization. INTELROS—Intelektual'naya Rossia. Retrieved from http://www.intelros.ru/subject/figures/boris-rodoman/12628-ekologicheskaya-specializaciya-rossii.html [in Russian].
Solzenitsyn, A. I. (1990). *Kak nam obustroit Rossiyu? Posil'nye coobrazheniya (Rebuilding Russia: Reflections and Tentative Proposals)*. Leningrad: Sovetskiy Pisatel'.
Staffelbach, T., Stauffer, B., Sigg, A., & Oeschger, H. (1991). CO2 measurements from polar ice cores: more data from different sites. *Tellus, 43B*(2), 91–96.
StatBureau.org. (2007–2015). Retrieved from https://www.statbureau.org/ru/united-states/inflation-tables
State of the World's Forests 2012. (2012). Rome: FAO. Retrieved from http://www.fao.org/3/a-i3010e.pdf
TEEB. (2010). *The economics of ecosystems and biodiversity: Mainstreaming the economics of nature: A synthesis of the approach, conclusions and recommendations of TEEB*. Retrieved from http://www.biodiversity.ru/programs/international/teeb/materials_teeb/TEEB_SynthReport_English.pdf
The Ecological Footprint Atlas. (2010). *Global footprint network*. Oakland.: Retrieved from http://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Atlas_2010.pdf.
Vitousek, P. M., Ehrlich, P. R., Ehrlich, A. H. E., & Matson, P. A. (1986). Human appropriation of the product of photosynthesis. *Bioscience, 36*(5), 368–375.
Vompersky, S. E. (1994). The biospheric significance of Bogs in the carbon cycle. *Priroda, 7*, 44–55. [in Russian].
Watts, J. A. (1982). The carbon dioxide questions: data sampler. In W. C. Clark (Ed.), *Carbon dioxide review*. New York: Clarendon Press.
Wofsy, S. C., Goulden, M. L., Munger, J. W., Fan, S.-M., Bakwin, P. S., Daube, B. C., Bassow, S. L., & Bazzaz, F. A. (1993). Net exchange of CO2 in a mid-latitude forest. *Science, 260*(5112), 1314–1317.
Worldstat Info. (n.d.) Retrieved from http://en.worldstat.info/
Worldwatch Database. (2000). Washington: Worldwatch Institute.
Zalikhanov, M. C., Losyev, K. S., & Shelekhov, A. M. (2006). Natural ecosystems as the key natural resource of humanity. *Vestnik rossiiskoi akademii nauk., 76*(7), 612–614. [in Russian].