CHAPTER-1

ANTHROPOGENIC IMPACT ON ENVIRONMENT

This chapter deals with one of today’s most vital problem: man’s relationships with nature or more specifically, with the environment. This is a complicated and many-sided problem. By virtue of it’s natural history all the components and processes of the environment are intimately inter connected. On a broader plane, this interaction may be described as the use by society of all natural resources- power, mineral, timber, agriculture, recreational, etc.

This many-sided association of human society with nature, whose properties tend to change in space (geographically) and in time (evolutionally), exposes man to varied environmental influences.

In the history of geographical concepts, there have been various approaches and schools of thought of study man-nature interaction. Determinism is one of the most important philosophies which persisted up to the Second World War in one shape or the other. The point of view is that the environment controls the course of human action. The determinists generally consider man as a passive agent on which the physical factors are constantly acting and thus determining his attitude and process of decision making. ¹

Furthermore, the exploitation of natural resources inevitably involves changes in the environment itself, in its internal links and processes. These changes are both minor and major in this intensity and scale may also be purposive, as is the case with

forestland or grass meadows brought under the plough, irrigation of arid land and drainage of marshland, the building of water reservoirs, afforestation, and etc. changes that may be brought about by man’s activities are also at times unpredictable.

As the Earth’s resources are deployed by man and his influence on nature grows the influence of the transformed natural environment incorporating many technogenic elements becomes increasingly greater than that of virgin or slightly changed nature.²

The focus of interest in the problem of interaction between society and nature changes accordingly, as is well illustrated by the history of science and social practices.

For a long time, scientists and philosophers concentrated on problems of harnessing the forces of nature to meet human needs and on the study of nature’s influence on the material and cultural life of society. Later the attention was focussed on the problem of sufficiency of the Earth’s natural resources to meet the rapidly growing demand for power and raw materials due to the population increase, as well as scientific and technological progress.

The broad application of mineral fertilizers and chemical weed and pest killer in agriculture secures a large increment in crop yields, increasing land productivity and the efficiency of farming. At the same time, it involves soil and water pollution causing the death of many species of animal and damaging existing natural biogeocenoses. For a long time, soil erosion was regarded mostly as a cause of diminishing fertility of cultivated land. Soil erosion, however, involves. Other formidable hazards, such as dust pollution of the atmosphere, silting of bodies of water and other environmental damage outside agriculture.

Finally, protection of the environment has come to be regarded as the main condition for the very existence of human society.³

Today, the growing environmental hazards to the life of society have riveted the attention not only of the scientific community. These ecological hazards have become a matter of concern for the world public, many national and international organisations.⁴ What is more, an acute ideological controversy has flared up over these problems, above all, their socio-political interpretation and corresponding practical conclusions and recommendations.

Human activities which have harmed ecosystems have resulted in a loss of diversity in both living things and the nonliving environment. Examples of these changes include land use, the cutting of vast areas of forest, and pollution of the soil, air, and water. Another way humans have changed ecosystems in a harmful way is by adding or removing specific organisms from these ecosystems. Our ever increasing demand for energy has impacted ecosystems negatively as well. Many environmental risks are associated with our use of fossil and nuclear fuels. Many factors associated with human populations have influenced environmental quality. These include population growth and distribution on our planet, our use of resources, the ability of technology to solve environmental problems, as well as the role of economic, political, ethical, and cultural views in solving these problems.

³ ibid.
1.1 Ecosystem Processes

Natural ecosystems are involved in a wide variety of natural processes influencing humans and other organisms. The activities of humans in the environment are changing many of these natural processes in a harmful fashion. Some of these natural processes and a brief description of a human influence on these processes are shown in the table below.

<table>
<thead>
<tr>
<th>Ecosystem Process</th>
<th>Human Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation of Soils</td>
<td>Agricultural practices have exposed soil to the weather resulting in great loss of topsoil.</td>
</tr>
<tr>
<td>Control of the Water Cycle</td>
<td>The cutting of forests and other human activities have allowed increased uncontrolled runoff leading to increased erosion and flooding.</td>
</tr>
<tr>
<td>Removal of Wastes</td>
<td>Untreated sewage wastes and runoff from farms and feedlots have led to increased water pollution.</td>
</tr>
<tr>
<td>Energy Flow</td>
<td>Some industries and nuclear plants have added thermal pollution to the environment. The release of some gases from the burning of fossil fuels may be slowly increasing the Earth's temperature. (Greenhouse Effect).</td>
</tr>
<tr>
<td>Nutrient Recycling</td>
<td>The use of packaging material which does not break down, burning of refuse, and the placing of materials in landfills prevents the return of some useful materials to the environment.</td>
</tr>
</tbody>
</table>

1.2 Some Detrimental Human Activities

Humans are part of the Earth's ecosystem. Human activities can either deliberately or inadvertently alter the balance of an ecosystem. This destruction of habitat, whether accidental or intentional, is threatening the stability of the planet's ecosystems. If these human influences are not addressed, the stability of many ecosystems may be
irreversibly affected. Some of the ways that humans damage and destroy ecosystems are indicated in the table below.

<table>
<thead>
<tr>
<th>Human Influence</th>
<th>Effect on Ecosystems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population growth</td>
<td>Our increasing numbers are using excessive amounts of the Earth's limited resources.</td>
</tr>
<tr>
<td>Over consumption</td>
<td>Industrialized societies are using more resources per person from our planet than people from poor nations.</td>
</tr>
<tr>
<td>Advancing Technologies</td>
<td>Often we introduce technology without knowing how it will influence the environment</td>
</tr>
<tr>
<td>Direct Harvesting</td>
<td>This has resulted in a large loss of rainforest and the many products associated with its biodiversity.</td>
</tr>
<tr>
<td>Pollution</td>
<td>Land, air, water, and nuclear pollution have had many adverse influences on ecosystems.</td>
</tr>
<tr>
<td>Atmospheric Changes</td>
<td>These include the addition of Greenhouse gases mostly due to the burning of fossil fuels and depletion of our stratospheric ozone layer. Other pollutants also have negative effects on living things.</td>
</tr>
</tbody>
</table>

1.3 Environmental Changes: Global, Regional or local

The growing uncontrolled utilisation of natural resources, the continuous air and water pollution, ill considered changes in the natural environment have brought mankind in some areas to complete or near exhaustion of natural resources indispensable for production and thus threatening to all life on earth, including man himself. A view that is widely expressed states that this is a “worldwide disaster” more formidable than any social or political problem. It calls for austerity measures to curtail demand, in particular through birth control, and slow down technological

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progress, as well as to established international supervision of the use of natural resources.6

The surge in concern about environmental quality over the last decades has been uniquely widespread. The international ‘Environmental Movement’ has a long history and no sharp beginning. In part, it is the successor to the great voyages of discovery and exploration that made people aware of the shape of the world and the diversity of land and waters, rocks, vegetation, flora, fauna and cultures.

The other major evolution on the environmental issues had been in the wider public’s appreciation of environmental issues. In the developed countries a conservation movement appeared in the last decade of the nineteenth and first decade of twentieth centuries. It was concerned with both the efficient management of natural resources and the preservation of natural habitats and historic monuments. Bodies like the Moscow Society of Nature Investigators, the National Audubon Society, Wilderness Society of Sierra Club, the National Trust and the Societies like Federation Francis des Societies de Protection de la Nature and its Germany, Netherlands, Swedish and Swiss counterparts emerged as the guardians of environment.7

But the expansion of the ‘environment movement’ in the second half of the twentieth century brought about three developments of major importance.8 First, the scientific and nature protection components grew together, especially under the influence of professional ecologists. Second, appreciation of the environment grew in many countries outside Europe and North America. Third and most important, the

6 Ibid.
character of the approach changed. Whereas the earlier nature protection movement was concerned with safeguarding certain grounds of prudence or aesthetics, the new movement while including this, became very concerned with the belief that the violation of ecological principles had reached the point where, at best, the quality of life is under threat and, at worst, the long term survival of humanity could be imperilled.

These concerns were strengthened during the 1950s and 60s by a number of events brought about by human activities – the air pollution episodes in London and New York between 1952 and 1966, the fatal instances of mercury poisoning at Minamata and Niigata between 1953 and 1965, the reductions in aquatic life in some of the North American Great Lakes, the deaths of birds caused by the unexpected side effects of dichloro-diphenyl-trichloro-ethane (DDT) and other organochlorine pesticides and the massive oil pollution from the wreck of the 'Torrey Canyon' in 1966. Radioactive fallout from nuclear bomb tests brought home the message of a shared atmosphere. Projections of an exploding world population raised fears that the world would run short of food and resources and that the last vestiges of wilderness would be overwhelmed. Representative of a much larger literature were Stewart Udall’s *The Quiet Crisis* (1963), Jean Dorst’s *Before Nature Dies* (1965) and Rolf Edberg’s *On the Shred of A Cloud* (1966) aroused both public and official apprehension. The publication of Rachel Carson’s *Silent Spring* (1962) introduced many to the challenges posed by persistent toxic chemicals.

However, there is a apprehension that on the pretext of concern for nature conservation, that will benefit all mankind, the enormous burden of spending required

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to repair the damage caused by the predatory activities of monopolies will get shifted onto the shoulders of the mass of the taxpayers. What is more serious "ecological" arguments are invoked to justify attempts to delay the economic progress of the newly independent countries of the third world and perpetuate, allegedly for the sake of a "clean environment", then tremendous economic lag of these countries in relation to developed countries.

In view of this, the Soviet Union and other socialist countries resolutely opposed any efforts, justified by references to the urgency of the nature conservation problem, to relegate to the background or to remove from the order of business such burning social and political problems as the struggle for peace, against wars of aggression for exposing and eradicating the political and economic vestiges of colonialism and neocolonialism. They gave their all-out support to the economic and social progress organise an integration and comprehensive utilisation of their natural resources on the basis of the latest scientific and technological achievements. Although the problem "Man, Society and Environment is becoming increasingly urgent, many of it's aspects are local or national in character, and, therefore, they can and should be tackled by the countries concerned, using their own ways and means. However some hazards to the environment, such as the pollution of the atmosphere, rivers and the World Ocean, etc. are on global scale, affecting the interests of many nations. Hence the growing importance attached now a days to international cooperation and exchange of information in the field of research into the ways to keep the environment clean and in the field of planning nature conservation measures in relations to technique, organisation etc.

1.4 Civilisation in Progress: its impact on environment

Archaeological excavations over the past few decades have produced a host of new discoveries which have largely widened scientific concepts of the history of primitive society. New data throw light on the extent of primitive man’s dependence on nature and on the character of changes in man’s environment at the dawn of civilization.

Signs of primitive man using fire and traced back to the time of Archanthropes. In the upper Palaeolithic primitive man could without great difficulty make fire and use it widely for cooking and heating in the cold season of the year. At the same, the demand for fire was so habitual that even in epochs when the main source of fire-wood-disappeared in places inhabited by primitive men, they would use bines of large mammals as fuel. Hearths containing bone cinders have been discovered at many camp sites of the late Palaeolithic. Primitive men, however, not only adopted caves for dwelling but also built homes on the planes as evidenced by camp sites remains found there. 11

Primitive man’s migration and settlement over the earth is one of the most striking geographical features of interaction between primitive society and the natural environment. It may be regarded also as the “rudimentary” stage of new land discoveries in the history of geographical exploration of the earth. The origination of geographical knowledge in that period is witnessed by existing primitive drawings of islands, rivers and lakes. Man’s migration and settlement in land illustrate his progress

11 A.A. Velichko, Man, Society and Environment(ed.)Natural Resources and Nature Conservation, (Progress publishers, Moscow, 1975), p.32
in material culture, social relations, and intellectual evolution. In other words, this striking geographical feature was a criterion of the development of primitive society.\textsuperscript{12}

The Neolithic marked the transition to a new stage of primitive society, when in addition to tribes of primitive hunters and plant pickers there appeared crop-farming and stock-breeding tribes. This process described as the "Neolithic revolution" in some works, dates on the whole only from archaeological finds of the Neolithic. In several areas, crop farming appeared before animal husbandry, and under definite conditions. for all the variety of this process, it's best general description in the division, proposed by Frederick Engles, of the history of primitive society into the "period in which appropriation of natural products, ready for use, predominated; the period in which knowledge of cattle-breeding and land cultivation was acquired, in which methods of increasing the productivity of nature through human activity were learnt".\textsuperscript{13}

In the history of interaction between primitive society and the natural environment, the emergence of crop farming is a major milestone in the transition from simple adaptation to nature for extraction of products fit for use to remaking the natural environment.\textsuperscript{14} At the same time, differences in the natural environment are basic factors responsible for the local features peculiar to the emergence and spread of crop farming in its early history.

To sum up, with natural factors enabling a primitive tribe to cultivate crops and to breed cattle, combination of crop farming with animal husbandry proved more


\textsuperscript{14} ibid.
effective. The most progressive forms of interaction between man and the environment in class societies of antiquity and the Middle Ages were based on such combinations.\textsuperscript{15}

1.4.1 \textbf{Industrialisation}: History has witnessed two major developments in the utilisation of new natural resources and the growing complexity of relationships between society and nature. Both are due to progress in material production in the slave-owning and feudal countries of the ancient and medieval worlds. The first was the invention of iron-smelting methods, the manufacture of tools and weapons from iron instead of bronze. The other was the discovery of new types of energy viz. water and wind used in the paddle-wheel, water and wind mills.\textsuperscript{16}

The advent of the industrial revolution and large scale machine industry and the development capitalism in the nineteenth century down to it's transition to the imperialist stage were events which had a great bearing on the evolution of relationship between society and it's natural environment.

During September 2000, at a special millennia! session of United Nations, four of its agencies and partners – The World Bank, The United Nations Development Programme, the United Nations Environment Programme and the World Resources Institute presented a report based on condition of our Earth. The Report titled as "People and Ecosystems: The Fraying Web of Life" has revealed the stunning scale and character of human impact on the ecosystems- forests, freshwater systems,

\textsuperscript{15} A.A. Velichko, \textit{Man, Society and Environment}, (ed.)Natural Resources and Nature Conservation, (Progress publishers, Moscow, 1975), p.32

coastal/marine habitats, grass land and agricultural lands from which it seems difficult to bounce back to restore it.\textsuperscript{17}

\section*{1.5 Anthropogenic Impact in the Sea and Marine Pollution}

First of all, we need to note the extreme diversity and mosaic nature of anthropogenic impact on the hydrosphere. It includes such multifactorial phenomena as changes in temperature regime and radioactive background, discharges of toxic effluents and inflow of nutrients, irretrievable water consumption and damage of water organisms during seismic surveys, landing of commercial species and their cultivation, destruction of the shoreline and construction of drilling rigs.

Underestimation of the striking complexity of anthropogenic impact on the water ecosystems and the use of a single-factorial approach to analyze their state, focusing on some single aspect of human activity, generally lead to a distorted picture of the consequences of such activity. Simultaneous impacts of several factors can cause synergetic effects when the consequences can exceed the mere sum of the effects caused by each factor separately. Such situations are quite possible, for example, when radioactive, chemical, and thermal impacts are combined.

Another important circumstance is that many kinds of economic activities are rather difficult to differentiate based on their effects in the marine and freshwater systems. Many pure inland activities can lead to the ecological changes in the marine environment. Examples include dam construction, removal of river water for irrigation, cutting of forests, use of chemicals in agriculture, atmospheric emissions

\textsuperscript{17} UNEP/World Bank/ UNDP, \textit{People and Ecosystems: The Fraying Web of Life}, UN, 2000.
from factories and automobiles, sewage discharges into lakes and rivers, and many other impacts that take place hundreds and thousands of kilometres away from the seashore. Sooner or later, these activities affect the ecology of estuaries, bays, coastal waters, and sometimes of entire seas. The situations that developed, for example, in the Aral and Caspian Seas, the Sea of Asov, the Baltic and Black Seas clearly show that dividing the ecological problems and environmental protection programs into marine and freshwater ones is artificial and inept. From a broader perspective, we may state that effective protection of the water environment is impossible without protection of the inland ecosystems and vice versa.

Anthropogenic impact on the water environment should be defined as a cumulative manifestation of all kinds of human activity which causes obvious and/or hidden disturbances in the natural structure and functions of water biotic communities, anomalies in their habitats, changes in the hydrology and geomorphology of water bodies, diminishing their fisheries and recreational value, and other negative effects of ecological, economic, or socioeconomic nature. This definition is based on the concept of a multifactorial nature of anthropogenic impact on the hydrosphere. This impact cumulatively results in structural and functional responses of the water ecosystems and biota.

The concept of anthropogenic impact is extremely important for analyzing the ecology of coastal and shelf zone. For centuries this zone has been the centre of various human activities. These include urbanization, construction of seaports and harbours, development of natural resources (including oil production and fishing),

18 http://www.offshore.environment.com/anthropogenicimpact.html
19 ibid.
marine aquaculture, shipping, recreation, and many others. Various activities that are in progress in the narrow area on both sides of the shoreline provide 50% and more of the gross national product of many countries.\textsuperscript{20} All of these activities affect (usually directly and hazardously) the shelf ecology. At present, the anthropogenic disturbances of the shelf zone are found on a global scale. In many areas, they have reached critical limits. This is the prize for the unjustifiably rapid economic growth and short sighted environmental policy (or rather for its absence).

1.5.1 Marine fisheries:

Marine resources, especially large predators, are fast vanishing. The ocean's protein-rich fisheries, which were previously assumed as abundant, have had a catastrophic decline. Oceans are on the brink of becoming the 'Last Frontier'. Latest research by the marine biologists, Ransom Myer and Boris Worm, of Dalhousie University in the Halifax (major fish landing coast of Canada) revealed that 90 percent of the world's large predatory fish are gone, thanks to mechanised fishing. The most shocking revelation is that during the last 50 years, over fishing has driven nine of 10 large predators to extinction.\textsuperscript{21} And that includes major commercial and sport fishing species like cod and bluefin tuna, grouper and blue marlin.

The report is the latest and most comprehensive study of the state of the world's fisheries. Some studies reported only regional fisheries of North Atlantic (1980s), North Sea and water off Japan (1990s) and more recently, western Africa. Collecting data for the last 10 years on large fish in four continental shelf and nine oceanic systems, the report reveals the global scenario.

\textsuperscript{20} http://www.priroda.ru

\textsuperscript{21} http://www.offshore.environment.com/anthropogenicimpact.html
The ‘high-tech-fishing’ through giant factory trawlers, floating processing plants that can stay at sea for long periods, and longliners — hook-studded lines trailing 120 km behind the boats — have exhausted the oceans’ marine life. Technology has enabled humans to haul more fish than the oceans can replace. Besides, pollution like oil spills, nuclear wastage dumping, climate change, invasive species and massive coastal development also reduces fish stocks. Technologically advanced countries have depleted their seas more than the developing countries. The major fishing countries include China, Japan, India, and the US.

Marine biologists have zeroed in on the predators of marine ecosystem. The marine food chain risks losing its upper layer, predators, permanently. In 1992, the Canadian government imposed a moratorium on cod fishing. After 11 years, tens of thousands of unemployed fishermen are still waiting in despair for the cod to return to the waters of Labrador and Newfoundland. Now, the cod has been enlisted as endangered species in Canada. A recent National Oceanic and Atmospheric Administration (NOAA) report found 97 fish stocks in the US waters in danger.

With the decline of shallow-bottom feeders like cod and halibut, the fishing industry has accelerated its efforts in the open seas. But, the report unmasks that catch rates for all types of fish had dropped through longline fishing. The average rate of increase of marine fish production declined in the 1970s and the 1980s and has been falling almost to zero in 1990s.

Undoubtedly, the oceans are interrelated. Thus, the elimination of predators in one region can have far reaching consequences in the other. Scientists believe that in a

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22 ibid.
worst case scenario, the oceans could turn into deserts—dead-zones, areas of complete ecosystem collapse. Microbes like urchin could fill the void left by the fish and others. Dead zones are already found in the Gulf of Mexico, Chesapeake Bay and the Baltic and Adriatic seas and they are spreading. However, there is a shortage of general information on the relationship between the state of marine ecosystems and fisheries.

If overfishing continues for the big predators, scientists believe that many of them may not recover for sustainable harvest. That would push millions of people depending on the fishing industry out of work. To arrest the decline of fish stocks, an ecosystem type of approach to the ocean is needed. In other words, countries must declare fish landing zones as 'no take reserves' that prohibit all fishing through unilateral or multilateral negotiations. Another measure of enforceable quota system on fishing would halt the damage to the world’s fisheries. But conservationists are not optimistic.

### 1.5.2 Marine pollution

At least two reasons allow us to consider pollution as the main, most widespread, and most dangerous factor of anthropogenic impact on the hydrosphere. First, pollution accompanies most kinds of human activities, including offshore oil and gas production and marine oil transportation. Second, in contrast with land ecosystems, in the water environment, pollutants quickly spread over large distances from the sources of pollution.\(^\text{24}\) In the freshwater and inland ecosystems, the effects of pollution are obvious. They literally appear right in front of our eyes. In contrast, the World Ocean has a large inertia of response to all forms of external impact. It requires

a long hidden (latent) period to manifest the evidence of non-obvious consequences of this impact. The danger of the situation is complicated by the fact that when it happens, it will be too late to do anything. This is true as there are large numbers of ‘dead zones’ are now found all over the ocean coast due to large scale of flushing of land pollution into the sea.

1.5.3 Pollutant input into the marine environment

Among all the diversity of human activities and sources of pollution, we can distinguish three main ways that pollutants enter the marine environment:

• direct discharge of effluents and solid wastes into the seas and oceans (industrial discharge, municipal waste discharge, coastal sewage, and others);
• land runoff into the coastal zone, mainly with rivers;
• atmospheric fallout of pollutants transferred by the air mass onto the seas' surface.

Certainly, the relative contribution of each of these channels into the combined pollution input into the sea will be different for different substances and in different situations. Quantitative estimates of these processes are difficult because of the lack of reliable data and the extreme complexity of the natural processes, especially at the sea-land and sea-atmosphere boundaries.

For a number of pollutants (metals, nitrates, phosphates, oil and some other hydrocarbons), this task is even more complicated. They are distributed in the marine environment in the background of natural biogeochemical cycles of the same substances. There are numerous examples when extremely high concentrations of oil and gas hydrocarbons, heavy metals, radionuclide, nutrients, and suspended
substances are not connected with human activity at all. It can happen as a result of such natural processes as volcanic activity; oil and gas seepage on the bottom; splits and breaks of the earth's crust; algae blooms; mud flows; river flooding; and many others. These phenomena should be taken into consideration in order to get the objective assessment of anthropogenic impact and its consequences in the hydrosphere.

Recognizing these complications explains why many earlier conclusions about the levels, flows, and balance of many substances in the hydrosphere are currently under revision. Developing new approaches and more precise analytical methods to determine trace amounts of contaminants allowed to get more reliable estimates of the contribution of different channels into the total contamination of the marine environment. The data show that land-based and atmospheric sources account for about two-thirds of the total input of contaminants into the marine environment, constituting 44% and 33%, respectively. The main pollution press undoubtedly falls on the shelf zones and especially on the coastal areas.

1.5.4 Sources, composition, and degree of hazards of pollution components

We need to mention the extreme diversity of marine pollution components, variety of their sources, scales of distribution, and degree of hazards. These pollutants can be classified in different ways, depending on their composition, toxicity, persistence, sources, volumes, and so on.

In order to analyze large-scale pollution and its global effects, it is common to distinguish a group of the most widespread pollutants. These include chlorinated hydrocarbons, heavy metals, nutrients, oil hydrocarbons, surface-active substances,
and artificial radionuclides. These substances form the so-called background contamination that exists at present in any place in the hydrosphere.

Depending on the type of impact on the water organisms, communities, and ecosystems, the pollutants can be grouped in the following order of increasing hazard:

- substances causing mechanical impacts (suspensions, films, solid wastes) that damage the respiratory organs, digestive system, and receptive ability;
- substances provoking eutrophic effects (e.g., mineral compounds of nitrogen and phosphorus, and organic substances) that cause mass rapid growth of phytoplankton and disturbances of the balance, structure, and functions of the water ecosystems;
- substances with saprogenic properties (sewage with a high content of easily decomposing organic matter) that cause oxygen deficiency followed by mass mortality of water organisms, and appearance of specific microphlora;
- substances causing toxic effects (e.g., heavy metals, chlorinated hydrocarbons, dioxins, and furans) that damage the physiological processes and functions of reproduction, feeding, and respiration;
- substances with mutagenic properties (e.g., benzo(a)pyrene and other polycyclic aromatic compounds, biphenyls, radionuclides) that cause carcinogenic, mutagenic, and teratogenic effects. Some of these pollutants (especially chlorinated hydrocarbons) cause toxic and mutagenic effects. Others (decomposing organic substances) lead to eutrophic and saprogenic effects. Oil and oil products are a group of pollutants that have complex and diverse composition and various impacts on living organisms - from physical and physicochemical damage to carcinogenic effects.
To estimate the hazard of different pollutants, we should take into account not only their hazardous properties but other factors, too. These include the volumes of their input into the environment, the ways and scale of their distribution, the patterns of their behaviour in the water ecosystems, their ability to accumulate in living organisms, the stability of their composition, and other properties.

It is significant that at the regional and local levels, the intensity of anthropogenic press on the marine environment generally increases. Different marine regions are subjected to various and specific impact factors. The combination of these factors under specific conditions ultimately defines the ecological situation in a given area. In particular, we want to stress the alarming features of the ecological situation in many Russian marine areas. The pollution levels here very often exceed the maximum permissible limits. This fact was one of the reasons why during the United Nations Conference on Environment and Development in 1992, Russia was rated as one of the most polluted countries of the world.

1.6 Arctic Melting

Scientists say changes in the earth's climate from human influences are occurring particularly intensely in the Arctic region, evidenced by widespread melting of glaciers, thinning sea ice and rising permafrost temperatures.

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26 ibid.
A recent study revealed that the annual average amount of sea ice in the Arctic has decreased by about 8 percent in the past 30 years, resulting in the loss of 386,100 square miles of sea ice -- an area bigger than Texas and Arizona combined.\(^{27}\)

In the past half-century, average yearly temperatures in Alaska and Siberia rose by about 3.6 degrees to 5.4 degrees Fahrenheit and winters in Alaska and western Canada warmed by an average of 5 degrees to 7 degrees Fahrenheit.

With "some of the most rapid and severe climate change on earth," the Arctic regions' melting contributed to sea levels rising globally by an average of about three inches in the past 20 years, the report said.\(^{28}\)

"These changes in the Arctic provide an early indication of the environmental and societal significance of global warming," says the Arctic Climate Impact Assessment, a four-year study by 300 scientists in eight Arctic-bordering nations, including the United States.

This most comprehensive study of Arctic warming to date adds yet more impetus to the projections by many of the world's climate scientists that there will be a steady rise in global temperature as the result of greenhouse gases released into the atmosphere from the burning of fossil fuels and other sources. Nations participating in the study besides the United States are Canada, Denmark, Finland, Iceland, Norway, Russia and Sweden. The process is only likely to accelerate in the Arctic, a region that provides important resources such as oil, gas and fish.

\(^{28}\) Ibid.
That would wreak havoc on polar bears, ice-dependent seals, caribou and reindeer herds -- and local people such as Inuit whose main food source comes from hunting those animals. Some endangered migratory birds are projected to lose more than half their breeding areas.

Forests would expand into the Arctic tundra, which in turn would expand into the polar ice deserts, because rising temperatures would favour taller, denser vegetation. The areas of Arctic tundra would shrink to their smallest extent since 21,000 years ago when, humans began emerging from the last Ice Age.²⁹

Sea levels globally already are expected to rise between another four inches to three feet or more this century. Longer term, sea levels would rise alarmingly if temperatures continue to rise unabated, in the range of 5 degrees to 11 degrees Fahrenheit over the next several centuries.³⁰

1.7 Human impact on environment: A case of Russia’s Barents Sea Area

Global Changes are understood as effects of global and regional climatic variations and anthropogenic activities. The anthropogenic impacts on terrestrial ecosystems, particularly forests, in the Russian land area around the Barents Sea, which comprises the sub-regions of Murmansk on the Kola Peninsula and of Archangelsk, particularly Nenetz autonomous district could be a pointer to the environmental degradation. The direct anthropogenic impacts are so severe in this area that they are of even greater concern than potential climate change can affect the region over the next century.

Over the past 50 years the negative impacts of economic activity on the environment

²⁹ http://www.publiceyestv.org/global_warming_news.htm
³⁰ ibid.
have become evident not only regionally but even globally, presenting a problem of international importance. The problem is circular, since the negative consequences of local or sub-regional economic activity in the study area are a result of unbalanced nature protection, social and technological-economical policy at regional, federal and international levels.\textsuperscript{31}

Three impact stages are known in the history of the exposure of the Russian environment to anthropogenic/industrial activity.\textsuperscript{32} The first, pre-industrial stage, which started several centuries ago, has manifested itself as a slow but steady progressing destruction of open sub-arctic forests and a southward shift of the forest Boundary.

Forests were mainly cut down for heating the houses in settlements and towns. Frequent man-made fires were equally responsible for the destruction of forest areas. Those anthropogenic processes have resulted in deforestation of the former polar thin forest area.

The second stage is directly linked with the impact of machinery. The forties to sixties of the current century is characterised by intensive activity of northern expeditions equipped with engineering facilities and caterpillar vehicles. Those activities have resulted in the annihilation of vegetation cover giving rise to the destruction of soil, geomorphology and underlying lithogenic strata.


The third, technological/chemical stage relates to chemical pollution and mechanical disturbances around major new industrial zones of mining and metallurgy (e.g., Pechenga-Nikel, Monchegorsk).\textsuperscript{33}

This has caused environmental degradation of vast territories, often exceeding the local scale.

1.8 Chemical Pollution: An Overview

Chemical pollution is the leader of environmental impact. The pollutants, most abundant in occurrence and most hazardous in consequences, are sulphur and nitrogen oxides (together known as ‘acid rain’), carbon oxides and heavy metals. Via the atmosphere these substances penetrate the surface and contaminate soils, water bodies and plants. They also alter properties of the lower atmosphere itself. Metal flows from man-made sources often surpass the relevant flows of natural origin (Table 1).

Table 1: Penetration of elements from natural and man-made sources into the terrestrial atmosphere

<table>
<thead>
<tr>
<th>Element</th>
<th>Basic sources of Emissions</th>
<th>Naturally arriving k t/year</th>
<th>Arriving from man-made sources k t/year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Natural</td>
<td>Man-made</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Volcanoes, Soil and wind erosion</td>
<td>3-13</td>
<td>25-80</td>
</tr>
<tr>
<td></td>
<td>Ferrous metallurgy Fuel combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>Forest fires, Volcanoes</td>
<td>0.3-7</td>
<td>5.5-11</td>
</tr>
<tr>
<td></td>
<td>Ferrous and non-Ferrous metallurgy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuel combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cobalt</td>
<td>Soil and Wind erosion</td>
<td>3.4-13</td>
<td>2.7-5</td>
</tr>
<tr>
<td></td>
<td>Fuel combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td>Soil and Wind erosion</td>
<td>18-22</td>
<td>56-260</td>
</tr>
<tr>
<td></td>
<td>Ferrous metallurgy Fuel combustion</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginets</td>
<td>Soil and Wind</td>
<td>516-750</td>
<td>107-320</td>
</tr>
<tr>
<td></td>
<td>Non-Ferrous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{33} Igamberdiev, V. M., “On the question of estimating the state of terrestrial ecosystems of the impact regions of the North”, Izv. of Russian Academy of Science, Biology series, 6, 907-913, 1994
The most severe environmental degradation is caused by metallurgy, mining and processing industries, paper-and-pulp and other forest industries as well as heat and power generating industries. These different industries are to some degree separated geographically. Additional sources of chemical pollution, as discussed elsewhere in the proceedings, include are linked to the exploitation of oil and gas fields in the tundra belt of the Archangelsk sub region, especially the Nenetz District and to missile launching activity at the Plisetsk space port.34

1.8.1 Metallurgy, Mining and Processing

Enterprises linked to metallurgy and mining are important sources of emissions containing sulphur dioxide, carbon and nitrogen oxides, heavy metals and formaldehyde. Sulphur dioxide and heavy metals pose problems of particular importance in the Murmansk area (Table 2). Since commissioning of the Severonikel plant in the town of Monchegorsk in 1939, emissions of sulphur dioxide have been continuous.


<table>
<thead>
<tr>
<th>Mn</th>
<th>erosion</th>
<th>metallurgy Fuel combustion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>Soil and Wind erosion</td>
<td>Ferrous and non-Ferrous metallurgy Fuel combustion</td>
</tr>
<tr>
<td>Plumbum</td>
<td>Soil and Wind erosion, Volcanoes, Forest fires</td>
<td>Motor transport, Ferrous and non-Ferrous metallurgy</td>
</tr>
</tbody>
</table>

(Source: Ostromogilny and Petrokhin, 1984; Paeyna, 1986; Sournin et al. 1986)
Table 2: Atmospheric Emissions of Pollutants from Severonikel and Pechenganikel in 1993 (Tonnes)

<table>
<thead>
<tr>
<th>Substances</th>
<th>Severonikel Monchegorsk</th>
<th>Pechenganikel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mass of Pollutants</td>
<td>157566</td>
<td>164586</td>
<td>71170</td>
</tr>
<tr>
<td>Benz(a)pyrene</td>
<td>0.06</td>
<td>0.01</td>
<td>-</td>
</tr>
<tr>
<td>Dust</td>
<td>12529</td>
<td>3600</td>
<td>4100</td>
</tr>
<tr>
<td>Nickel</td>
<td>1960</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Copper</td>
<td>1049</td>
<td>87</td>
<td>5</td>
</tr>
<tr>
<td>Cobalt</td>
<td>89</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Vanadium Pentoxide</td>
<td>57</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Gaseous and Liquid Pollutants</td>
<td>145038</td>
<td>161101</td>
<td>67313</td>
</tr>
<tr>
<td>Sulphurous anhydrite</td>
<td>136759</td>
<td>160629</td>
<td>66607</td>
</tr>
<tr>
<td>Carbon Oxide</td>
<td>1200</td>
<td>267</td>
<td>427</td>
</tr>
<tr>
<td>Nitrogen Oxide</td>
<td>5100</td>
<td>168</td>
<td>21</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>1162</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td>244</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Chlorine</td>
<td>365</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nickel Aerosols</td>
<td>115</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Formal Dehyde</td>
<td>533</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

(Source: Report by Murmansk Ecology and Resource Committee, 1994)

As early as 1941 heavy wilting of tree leaves in the forest was recorded. By 1969, emissions of sulphur dioxide and other gases from this plant had changed the character of plant communities within a 17-20 km radius.\(^{35}\) In 1996 in the Murmansk area the total atmospheric emissions amounted to 386.5 kilotons (kt): 122 kt from Severonikel (towns of Monchegorsk) and 246.5 kt from Pechenganikel (towns of Zapolyarny and Nickel). On the Kola Peninsula, such major enterprises are responsible for 86% of the total emissions of sulphur dioxide, as against 14% due to forest-related and power generating industry (State Report, 1997). Table 2 illustrates the identity and volume of emissions from major plants in the Murmansk area in 1993, with additional recent figures for atmospheric pollutants in Table 3. According to the 1996 record (State Report, 1997), the following amounts of heavy metals were

emitted by the same plants: Severonikel: nickel 1309.3 t; copper 699.2 t; cobalt 40.5 t; Pechenganikel: nickel 298.4 t; copper 177.1 t; cobalt 10.7 t

Near Monchegorsk the distribution zone of sulphur, copper and nickel recently reached as far as 100 km from the source. The area, where the current level of background concentrations of these elements in snow and vegetation is currently 10-fold exceeded reaches 13,000 km², accounting for 10% of the total area of the Kola Peninsula (Berlin, 1991). Annual fallout from the Severonikel and Pechenganikel plants amounts to 20-30 t/km² of soil; the total amount of metal reaches 5-6 t/km².

Besides the above enterprises, other major contributors to environmental degradation, again particularly in the Murmansk area, are mining enterprises. Compared to impact zones of metallurgy, those of mining are characterized by stronger mechanical disturbances. In contrast, chemical atmospheric pollution from mining is largely released during transfer of large amounts of toxic waste in the form of dust from enrichment plants, pits, tailing dams and dumps. Such emissions may give rise to maximum concentrations of 200-270 g/m³ of dust. In the impact area of Apatit Co. (towns of Apatity, Kirovsk) the annual storage of rock waste amounts to over 30 million t. The resulting 'aero technological' pollutants have affected an area of about 3000 km². Toxic compounds from enrichment plants and tailing dams of the Apatit get into the soil and vegetation in the form of dust, up to 70 kt annually.

This dust contains strontium and other heavy metals.36

1.8.2 Forest based industry and power generation

The main contributors to atmospheric pollution in the Archangelsk sub-region (towns of Archangelsk, Severodinsk and Novodvinsk) are pulp-and-paper and heat power

generating industries, which emitted 356.6 kt of hazardous substances in 1996 (State Report, 1997). Specific culprits were the Archangelsk paper-and-pulp plant (town of Novodvinsk) (47.0 kt), the Severodvinsk dual-purpose plant (28.8 kt), the Archangelsk dual-purpose plant (23.1 kt), as well as the paper-and-pulp plants at Kotlassky (town of Koriyhma) (18.8 kt) and Solombalsky (towns of Archangelsk) (4.5 kt). Activities of the paper-and-pulp industry are largely responsible for the release of phenols, Benz (a) pyrene, formaldehyde and related compounds into the environment. Such hazardous compounds are of particular environmental concern in this sub region.

Table 3.

Table 3: Excess of MPC (Maximum Permissible Concentration) of Pollutants in the Atmosphere of Industrial Centres and Bordering Areas of the New Russian Subarctic (Numerator: Average Annual Concentrations of Pollutants in the Air; Denominator: Maximum One Time Concentrations of the same)

<table>
<thead>
<tr>
<th>Towns/ Emissions</th>
<th>Kandalaksha</th>
<th>Archangelsk</th>
<th>Monchegorsk</th>
<th>Nikel</th>
<th>Zapolyarny</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide</td>
<td>-</td>
<td>/1.2</td>
<td>/5.6</td>
<td>1.1/4.8</td>
<td>/4.6</td>
</tr>
<tr>
<td>Carbon Oxide</td>
<td>-</td>
<td>/2.8</td>
<td>/2.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrogen Oxide</td>
<td>/2.6</td>
<td>/3.2</td>
<td>/1.6</td>
<td>/1.9</td>
<td>-</td>
</tr>
<tr>
<td>Formal Dehyde</td>
<td>-</td>
<td>2.0/</td>
<td>1.5/</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Solid Fluoride</td>
<td>4.8/</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hydrogen Fluoride</td>
<td>/11.9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Benz(a)pyrene</td>
<td>-</td>
<td>4.8/13.2</td>
<td>1.3/</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carbon Bisulphate</td>
<td>-</td>
<td>1.7/</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Methyl Mercaptan</td>
<td>-</td>
<td>7.8/83.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Furfural</td>
<td>-</td>
<td>/4.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dust</td>
<td>-</td>
<td>-</td>
<td>1.2/</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

(Source: State Report, 1997)

In 1966 average maximum permissible concentrations (MPC) of methylmercaptan in the air amounted to 7 MPC in Archangelsk, 16 MPC in Novodvinsk, 12 MPC in Koryazhma. Maximum concentrations of methylmercaptan are reported as 52 MPC in
Pollutions by dioxin and dioxin compounds represent one of the most severe hazards to the environment. Reports estimate rising concentrations of these super toxins around paper-and-pulp enterprises. Pollution by these compounds of the territory between the North Dvina and Onega rivers in the Archangelsk sub region can be traced back to paper-and-pulp production.  

1.8.3 Potential Regional and Global Impacts of Chemical Pollution

Some of the pollutants mentioned above are prone to long-distance transfer through the atmosphere. Indeed, it has been disclosed that 13% of the sulphur compounds emitted by Pechenganikel is precipitated onto the surrounding area of 12,000 km², while the remaining 87% is transferred over larger distances. Acidification associated with emissions from the Kola Peninsula have been reported for an area as large as 100,000 km². Relatively pristine areas in the Arctic have already been affected. For instance, sulphur emissions from the Kola Peninsula have been registered in the Norwegian North and even Medvezhy Island. As evidenced by observations by the station at Barentsburg, Svalbard (Spitzbergen) in the High Arctic, enhanced concentrations of sulphur dioxide and sulphates in air masses were correlated with southwesterly, south-easterly and northwesterly flows of these air masses. Long-term observations of quantitative and qualitative composition of atmospheric aerosol at high latitudes have disclosed that its main components are sulphates, sulphur dioxide, soot, heavy metals and hydrocarbons.
Table 4: The Condition of Forests in the Murmansk Region

<table>
<thead>
<tr>
<th>Enterprises</th>
<th>Total Area of Affected Forests (to sq. km)</th>
<th>Area of Destroyed Forests (to sq. km)</th>
<th>Forest Area in terms of Degree of Injury (to sq. km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Heavy</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Pechenganikel</td>
<td>399</td>
<td>37</td>
<td>33</td>
</tr>
<tr>
<td>Severonikel</td>
<td>936</td>
<td>37</td>
<td>103</td>
</tr>
<tr>
<td>Total</td>
<td>1336</td>
<td>75</td>
<td>136</td>
</tr>
</tbody>
</table>

(Source: State Report 1997)

Emissions of the mobile nitrogen oxides and carbon dioxide from metallurgy, forest-related industry and fires in the study area (Tables 2 and 3) can affect the global climate through contributions to the ‘greenhouse effect’. Impacts of chemical pollution from the study area on the Barents Sea itself are evident but are beyond the scope of this paper.

1.8.4 Non-Chemical Environmental Degradation

Mechanical disturbances and erosion have already been mentioned in relation to mining; so has the loss of forest through fire. 93 % of the total number of fires in 1996 in Russian Federation was man-made (State Report, 1997). Another source of loss of forest and soil is deforestation and the infrastructure associated with it. Although forest logging activity is moderate in the study area, this environmental degradation factor seems significant, given the great nature protective value of these forests. Self-recovery from logging proceeds very slowly (if at all), due to rapid swamping of deforested soils and low potential growth rates due to long, cold winters and low summer temperatures.

Man-made environmental impact shows itself in alterations of physical and chemical characteristics of the environment as well as structure and functioning of ecosystems.
When these alterations acquire regional and global level, negative impact zone would finally cover ecosystems located at natural terrestrial zones considerably distanced from man-made impact sources. Negative ecological consequences from economic activity in the studied region should be considered, a result of utterly unbalanced nature protection, social and technical-economic policy on the regional, federal and international levels.

Environmental pollution from industrial sources on the Kola Peninsula has become a global problem incorporated into international agreements signed by Russia with the governments of Finland and other Nordic nations as well as in the Convention on Tran boundary Transfer of Pollutants.

The anthropogenic impact on environment is not confined to the local, regional level. The cascading effect of this environmental crisis can be seen beyond the national boundary of the state. During communist regime in the Former Soviet Union, the rapid lopsided industrial growth had contributed to environmental degradation in the whole world (common heritage) as well as to itself.