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Tibor Faragó

OUR COMMON ENVIRONMENT AND GLOBALIZATION

SHADOWS AND HOPES

Only One Earth
(Conference on Human Environment, 1972)

In Our Hands
(Conference on Environment and Development, 1992)

Towards Sustainable Development
(World Summit, 2002)

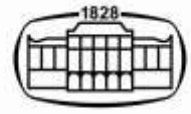
The Future We Want
(Conference on Sustainable Development, 2012)

Transforming Our World
(Summit on 2030 Agenda for Sustainable Development, 2015)

RECOGNITION OF HAZARDS

DEVELOPMENT AND ORGANIZATIONS OF SCIENTIFIC COLLABORATION

HISTORY AND EVALUATION OF INTERNATIONAL POLICY COOPERATION



AKADÉMIAI KIADÓ

2024

Our Common Environment and Globalization – Shadows and Hopes

Cover illustrations: logos of the world summits
on global environmental and sustainability issues
"Only One Earth": UN Conference on Human Environment, 1972;
"In Our Hands": UN Conference on Environment and Development, 1992;
"Towards Sustainable Development": World Summit, 2002;
"The Future We Want": UN Sustainable Development Conference, 2012;
"Transforming Our World": Summit on Sustainable Development Goals, 2015

Globalization has had significant and severe impacts on the Earth's environment, which is the common home of all human societies, and on which state and resources the life and the well-being of present and future generations depend. This book is devoted to the analysis of the evolution of the environmental globalization process, its drivers and dangerous consequences, and the development of international environmental scientific and policy cooperation. The most important international organizations, programs, and agreements are presented that deal with global environmental problems, and their effectiveness is also evaluated. Based on this comprehensive overview, the most essential conclusions and lessons are defined.

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FOREWORD

Environmental issues and changes in the global environmental system have been the focus of scientific research activities both in the past and present. The current harmful human-induced processes, their cause-effect relations, and their potential future hazardous consequences (insofar as these remain unabated) are known with more or less accuracy.

The author has written this comprehensive book based on his environmental science and policy knowledge and experience obtained in this field in recent decades, as well as his participation in numerous international forums.

It is noted in the introductory chapter that, as concerns dealing with large-scale environmental problems, "the 'world' of scientists and the 'world' of policymakers have been represented prominently in all such cases, but often with rather limited knowledge and understanding of each other. However, this situation has gradually changed."

Nevertheless, there are still considerable gaps in this science-policy interface, and this book may go a long way toward filling that gap.

Environmental policy measures do not always keep pace with factual warnings based on scientific knowledge about such hazards, and there is no complete common denominator between those two 'worlds.' This is probably primarily due to the contradiction that while science is global and indivisible, environmental policy formulation varies by country, region, and even continent.

According to the author, "This governance system has become extremely complex due to the proliferation and complexity of environmental problems, with a multitude of institutions, forms of cooperation, policy and regulatory instruments. The significant variation in the effectiveness of all these can be attributed to the different situations and priorities of countries and interest groups."

Even though the international bodies referred to by the author are trying to bridge the distance between the two ‘worlds,’ there is still more to be done in this area.

This book will be useful in higher education, especially in the areas of international law and environmental science, and may also be an excellent repository of knowledge for professionals who deal with environmental problems and policies. They will be assisted by the large number of references, through which those who are interested can immerse themselves in the topic in even more detail.

Dr. László Horváth

After a good fifty years in the field, I was initially rather skeptical about the author's enterprise when I saw the title. The subtitle, 'Shadows and Hopes,' had already piqued my interest, and then, on reading the work, it became clear that this was not just one book among many but that it was exciting and special enough to be worth reading even for someone who had read many books on the subject.

It is clear from the introduction that the author knows the profession from the inside, having been involved in the work of several international organizations, and also from personal experience.

What makes the work credible is that the author was not only an observer but also a shaper and participant. It is perhaps no coincidence that the author is not entirely satisfied with what international organizations, programs, and conventions have achieved in terms of addressing the various global challenges. One possible reason for this failure of international policymaking is the lack of understanding of the causal links, and another one is the complex interdisciplinary character of these problems. It is perhaps these science-policy 'gaps' that the author seeks to reduce through this book.

The book is a synthesis of all that science has explored and represented on the subject over the last seventy to eighty years, on the basis of which international organizations have drawn up goals and action plans for the countries of the world. In this context, the author explores the genesis of almost every globalizing environmental problem from its inception to its perceived or real solution.

In addition to processing the authoritative international literature, the author systematically endeavors to refer to the related key results of Hungarian science. As a consequence, this publication will also be of benefit to the domestic and international academic world as the objective synthesis that is presented shows that, over recent decades, domestic researchers have almost been up to date in following international research results about specific global problems.

As regards the spirit of the book, it should be stressed that it is free of extremes and conveys only knowledge that can be proven by science. The

author also effectively helps uncover hazards that are not yet well understood and gives readers the necessary ‘hope’ that if we are willing to change, we can escape the trap associated with global problems.

I congratulate the author and recommend this book with professional conviction and sincere pleasure.

Dr. Sándor Kerekes

INTRODUCTION

> "In the discussions held by the General Assembly at its twenty-third session it was emphasized that for the first time in the history of mankind, there is arising a crisis of world-wide proportions involving developed and developing countries alike, - the crisis of the human environment. […] It is urgent, therefore, to focus world attention on those problems which threaten humanity in an environment that permits the realization of the highest human aspirations, and on the action necessary to deal with them."
>
> *U Thant, Secretary-General of the UN, 1969*[1]

> "The world is crying out for a new, more humane, more ecological economics. The good news is that thousands of people all over the world are working hard to bring that economics into being."
>
> *Donella H. Meadows, 1994*[2]

> "[I]t seems to us more than appropriate to emphasize the central role of mankind in geology and ecology by proposing to use the term "anthropocene" for the current geological epoch."
>
> *Paul J. Crutzen & Eugene F. Stoermer, 2000*[3]

The environmental aspects of globalization and the environmental globalization

As human activities have come to rely more and more on the extensive use of the natural environment, their effects on its state have multiplied, enhanced, and become global in scale, as part of globalization in the broad sense. International cooperation in the field of environmental science has facilitated the recognition and investigation of those globalizing

[1] Problems of the human environment [UNSG, 1969]
[2] A New Society for a New Economics [Meadows, 1994]
[3] The "Anthropocene" [Crutzen & Stoermer, 2000]

environmental processes, the clarification of their causal links, and the possible longer-term consequences. Subsequently, these discoveries have catalyzed the development of regional and global-level international relations devoted to environmental policies.

In this book, the process of 'environmental globalization' is described and assessed, including its main stages of development and achievements in the evolution and strengthening of international environmental governance. Reference is also made to more recently established cooperation frameworks dealing with environmental sustainability and sustainable development from a broader perspective.[4]

In addition to providing an overview of the general elements and results of the process of the scientific cognition of hazardous, globalization-related environmental problems (including the detection/realization and increasingly precise understanding of those problems), and the political recognition process (i.e., the acknowledgment of the possibility/existence of those hazards), the key milestones in the exploration of cause-effect relationships and the history of the establishment of the international scientific and policy organizations are also presented, as well as the most important programs and agreements that address these global issues.

The analysis of developments in science and policy on globalizing environmental problems leads to important conclusions and lessons for the present and the future. This is the primary purpose of writing this book; namely, to help others – especially those less familiar with the subject or some of its substantial components but who are interested in the topic – to understand these critical processes, the evolution of their scientific research, and the international policy responses. That is, why and how:

- the increasing (over)use of natural resources and growing environmental pressures have occurred, creating globalizing environmental problems that have significantly amplified the interdependence of societies,
- international and interdisciplinary research cooperation has developed for studying and assessing these processes, and

[4] The contents of this book reflect the knowledge and experience that the author obtained in practice through participation in many global, European, and national cooperation forums on these subject areas, including his involvement in the development and negotiations related to various programs and agreements. During this process, it was possible to learn about different visions, approaches, negotiating skills, ways of finding reasonable solutions, and compromises from many highly knowledgeable people, both in Hungary and abroad, who were committed to increasing the harmony between society and nature. Several of them are referred to in this book and also in the former book published in Hungarian on the same subject [Faragó, 2022].

- environmental and sustainability governance has been strengthened globally, albeit with limited overall effectiveness.

In the case of large-scale environmental hazards already identified with a degree of certainty by the research community, the levels and means of their consideration and treatment within an intergovernmental framework have been primarily determined by the relationship between the relevant international research institutions/bodies and policymaking organizations. These two communities – the 'world' of scientists/researchers and the 'world' of policymakers – have been represented prominently in all such cases, but often with rather limited knowledge and understanding of each other. The situation has gradually changed, inter alia, through:

- the development of programs for the study of complex environmental processes (such as the research programs during the International Geophysical Year in 1957/58), the proliferation and improvement of environmental monitoring systems and the widespread availability of data from them (e.g., WCMC, GAW),[5] and the regular compilation of scientific assessment reports on environment-related investigations conducted and/or supported by various international institutions (e.g., SCOPE, IIASA)[6];
- the recognition by researchers of the importance of multi- and interdisciplinary cooperation and the need for widespread scientific communication of the key findings and science-based recommendations in a more focused way, especially for policymakers; and better-targeted science-policy dialogue and cooperation when specific international fora and organizations were created and dedicated to such purposes (e.g., IFCS, IPCC, IPBES)[7];
- the collaboration of intergovernmental organizations with pertinent scientific bodies and reliance on their assessments and recommendations – albeit in rather variable ways and to varying extents – in the course of the development and implementation of international environmental policy programs and agreements; occasionally, the need for such scientific entities was recognized and then actualized within the framework of specific intergovernmental organizations to assist their decision-

[5] WCMC: World Conservation Monitoring Centre (1982–); GAW: Global Atmosphere Watch (1989–).

[6] ICSU/SCOPE: Scientific Committee on Problems of the Environment (1969–); IIASA: International Institute for Applied Systems Analysis (1972–).

[7] IFCS: Intergovernmental Forum on Chemical Safety (1994–); IPCC: Intergovernmental Panel on Climate Change (1988–); IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2012–).

making (such as the scientific advisory bodies established in line with the conventions on ozone layer protection and biological diversity).[8]

In order to highlight the importance of these science-policy relationships, the development of global environmental and sustainability policies based on the achievements of and cooperation with the scientific community is also presented in the following chapters. Particular attention is paid to numerous international institutions/organizations that have contributed to elaborating such response policies and measures, environmental programs and agreements, and monitoring and promoting their implementation.

The development of environmental science and policy cooperation: key lessons

In the first chapter of this book, we describe the interaction between societies and the natural environment that has become complex and global in scale. We also refer to some particularly striking cases. This covers the growing environmental impacts of human activities in general, and more specifically, societies' vulnerability, resilience, and adaptability to (recurring) extreme and changing environmental conditions and the concept of environmental security. Then, the scientific process that eventually leads to the identification and clarification of gradually globalizing hazardous social-environmental interactions is presented and evaluated, including its typical stages. Namely:

- the observation/perception of large-scale environmental phenomena (trends and recurring extremes) that are potentially caused or amplified partially or wholly by human activities and which have or may generate widespread and harmful effects;
- the formulation of various hypotheses about the natural and/or human (anthropogenic) causes and cause-effect relationships of these processes;
- scientific dispute (and sometimes even heated debate) about those hypotheses, with arguments leading to their confirmation or rejection (i.e., supporting or casting doubt on their validity), or 'merely' questioning the relevance or importance of those environmental problems and/or the severity of their effects.

The second and third chapters review the main developments, turning points, and accomplishments during the approximately century-long history of international environmental science and policy cooperation, including:

[8] Montreal Protocol (1987), SAP: Scientific Assessment Panel; Convention on Biological Diversity (1992), SBSTTA: Subsidiary Body on Scientific, Technical and Technological Advice.

- the establishment of institutions and regular forums (in particular, inter- and multidisciplinary research programs and institutional frameworks for scientific cooperation) associated with the studying of the global environmental system as a whole; 'historical' multilateral events (conferences, summits) and the activities of some international bodies that have facilitated dialogue between the representatives of science and policy;
- the development and diversification of international cooperation in environmental policymaking aimed at solving problems that have been identified as hazardous or which have already proved to be harmful, transboundary, or global in scale; the international principles, action plans, programs, and legal instruments that have been adopted to address these challenges, and assessments of their effectiveness.

In the fourth and final chapter, we summarize the conclusions and lessons considered the most important. Here, some particularly instructive findings from the history of the development of environmental science and policies are anticipated.

- The study of the highly complex processes of the global environmental system and human impacts on it has been accompanied by a lively debate about various ideas and hypotheses about the 'functioning' of this system[9] since the nineteenth century. Further, as observations, theories, and models have evolved and improved, the level of scientific certainty concerning the knowledge of those processes (their causes and effects) has gradually increased.
- The history of these scientific developments suggests many lessons for the future, such as the importance of systematically verifying the validity of hypotheses or theories; clarifying and communicating the degree and possible sources of (remaining) uncertainties about such hypotheses or theories; and consideration of the needs and means of improving and refining observations, revisiting previous assumptions, and facilitating more effective interdisciplinary cooperation given such multifaceted problems.
- Significant delays in appropriate policy 'responses' or interventions have occurred mainly in the case of large-scale environmental hazards caused or reinforced by human activities when the interannual or longer-term natural variability of environmental processes has been relatively large *versus* slowly strengthening 'danger warning signals.' The best-known cases are precisely of this nature: long periods have elapsed between the initial scientific assumptions about the potentially harmful environmental (side-)effects of certain human activities on the one hand and the adoption of the first international programs and agreements for tackling the hazards (which provisions are at least based on the precautionary principle) on the other.

[9] The driving/forcing factors, internal processes and feedback mechanisms, variability and changes in its state.

- In the international arena, there have always been numerous issues at stake and many different points of view and positions expressed by representatives of countries with different situations and interests concerning these matters, so it has been quite challenging to find common ground for action, especially with emerging and worsening environment-related problems.
- The above-mentioned 'diversity' is reflected in the programs and agreements referred to in this book and, for most of them, in their implementation, which usually further decreases the effectiveness of those international policy instruments. This is why the role of science has been and remains of paramount importance: namely, for monitoring and analyzing various globalizing processes, communicating and regularly updating assessments of their state and consequences, and providing science-based recommendations for interventions that appear necessary and appropriate.
- Since the 1970s, observations, methodologies, and models have gradually improved, providing a clearer picture of evolving dangerous environmental processes and their cause-effect relations (anthropogenic drivers and potential/actual disadvantageous impacts). This ultimately created the basis for developing international strategies, programs, action plans, and/or agreements to deal with those emerging and expanding problems. Nevertheless, such environmental processes could only be slowed down in most cases.
- It appears that more effort and more effective response policies are necessary for addressing environmental globalization, its harmful components, and adverse effects because, without achieving 'environmental sustainability' (the long-term sustainable functioning of our natural environment), it is impossible to attain the social or socio-economic sustainability associated with the universal goals of social wellbeing and sustain the ability of future generations to meet their own needs.[10]
- The latter conclusion is perhaps the most important of those presented in the last chapter of this book and one which should remind us that much more attention needs to be paid to the interaction between societies and the natural environment at all levels.

The conclusions and lessons that can be drawn from the review and assessment of what has happened so far in relation to environmental globalization can help ensure that associated harmful processes, causes, and impacts can be more effectively tackled in the future and that any novel and inadvertently widespread hazardous phenomena can be identified, avoided or at least effectively mitigated in a timely manner.

[10] Without 'environmental sustainability' it will also be impossible to achieve 'sustainable economic development,' which is still considered the priority by many experts, although a highly debatable goal by others.

1. ENVIRONMENTAL GLOBALIZATION: ITS COMPONENTS AND EVOLUTION

> "[T]he world has already been transformed by the scale and nature of human actions to the point where humanity is threatening its own future. The chief threats stem from pressure on scarce and finite natural resources, living and non-living, by the waste of those resources through over-consumption, degradation and competitive exploitation […]. The lesson for this meeting is that while science is essential, as a basis for the understanding and action humanity needs, our first concern should be to analyse how we can alter people's perceptions of the world and then change their behaviour so that they can serve it more wisely for the sake of the future."
>
> *Martin W. Holdgate, 1990*[11]

1.1. Globalization and the environment

1.1.1 Globalization, the global environment, and environmental governance

For a very long time, human activities had no impact on the order and processes of nature on a planetary or even continental scale. The impact of land use, resource use and pollutant emissions, which have intensified at a variable rate with population growth, on the state of Earth's environmental system was, until the 1990s, far less than the changes caused by natural processes. By the beginning of the nineteenth century, the world population had reached one billion, and utilized land accounted for slightly more than

[11] Martin W. Holdgate (IUCN director-general): keynote lecture at the international conference on environmental future, Budapest, 22–27 April 1990 [Holdgate, 1990: pp. 17–18]

ten percent of all 'habitable' land area. The amount of land occupied and utilized (e.g., for agricultural purposes) by humanity continued to increase at an accelerating pace from the turn of the twentieth century onwards, as did the rate of the extraction and exploitation of a wide range of raw materials (e.g., fossil fuels, iron ore) in parallel with industrialization.

This period also witnessed many other signs of rapid changes, such as the introduction of new industrial technologies, the transformation of consumption patterns and lifestyles, and the development of economic conditions and means of transport that contributed to the rapid growth of international trade.

Depending on the evaluation of the scale of economic, commercial and technological developments, the initial stages of globalization are claimed to date back one and a half to two centuries [O'Rourke & Williamson, 2002[12]; Nayyar, 2006[13]]. The relationship between socio-economic globalization and the global environment has gradually become more complex, as has the system of international institutions and instruments that help monitor, research, understand, and mitigate the harms arising from the widening human interactions with the environment. All these institutions and instruments are part of global environmental governance.

Environmental aspects and impacts of globalization. In the 1960s, some researchers of globalization began to analyze in more detail the growing large-scale environmental aspects and consequences of economic, trade, population, and other economic and social processes [e.g., Carson, 1962; Ward, 1966[14]; Hardin, 1968; Ehrlich, 1968]. Over the next two decades, the study of globalizing environmental issues became much more comprehensive and integrated into research on globalization in general and

[12] "If the world historian is looking for a globalisation big bang, she will find it in the 1820s […], it required the breakdown of monopolies controlling long distance trade, and a technological revolution making possible the movement of bulk commodities between continents so much more cheaply that domestic prices, and domestic resource allocation, were significantly affected by international trade." (pp. 44–45)

[13] "The late nineteenth century. The period from 1870 to 1914 was the age of laissez-faire. The movement of goods, capital and labour across national boundaries was almost unhindered. […] The openness of economies that characterised this era was associated with a rapid expansion in trade, investment and finance across borders." (p. 138)

[14] "Our planet is not much more than the capsule within which we have to live as human beings […]. We depend upon a little envelope of soil and a rather larger envelope of atmosphere for life itself. And both can be contaminated and destroyed." (p. 15)

its various branches (e.g., the studies of interlinkages among environment and migration).

- For a long time, research on globalization focused mainly on the driving forces, economic and social effects, and repercussions of globalization, as well as its international economic, trade, and political trends [Keynes, 1919[15]; Simai, 2000[16]]. The relations and effects of these changes (in production, consumption, transport and technologies) concerning the use of natural resources and/or harmful environmental impacts (to different ways and degrees in various sectors) have received less attention. This is because, for a long time, they were not seen as limiting the growth of the world economy and trade, inhibiting the expansion of the business companies concerned, and/or constraining the spread of profitable production processes and newer consumption patterns.
- Just as the impact of this socio-economic globalization on the natural environment has increased, subsequently changing environmental conditions have had more influence on societies, lifestyles and economic activities. Hazardous and already global-level direct environmental impacts and those transmitted through environmental media caused wholly or partially by human activities have included, for instance, the dangerous impacts caused by the release and spread of various chemicals into the environment (e.g., DDT and other persistent organic pollutants, and ozone-depleting substances). In addition, specific natural forces and extreme events may also induce severe socio-economic consequences similar to the unforeseen harmful effects of the globalization of trade, transport and tourism (as occurred in the case of the extraordinary tsunami in the Indian Ocean in 2004 and the eruption of a volcano in Iceland in 2010).

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[15] "The great events of history are often due to secular changes in the growth of population and other fundamental economic causes […]" (p. 7); "All that is now open to us is to redirect, so far as lies in our power, the fundamental economic tendencies which underlie the events of the hour, so that they promote the re-establishment of prosperity and order, instead of leading us deeper into misfortune." (p. 122)

[16] "One very important consequence of globalisation is the increasing complexity of international relations. It is not simply that the world economic system has become more complex, more difficult to understand and more complicated to manage. The globalisation process has significantly increased the interplay of political, economic, social and institutional, legal, organisational and ecological relationships and changes." (p. 15)

- Environmental globalization has been understood above all as a set of widespread environmental impacts resulting from the expansion of economic and commercial activities, with the greatest attention being paid to inadvertent but explicitly harmful impacts [Martin & Schuman, 1997]. The essence of the conclusions drawn from related cases and studies has been the need to limit or at least carefully regulate globalization [Yearly, 2008; Benyon & Dunkerley, 2014[17]]. However, some have claimed that such adverse impacts have also been accompanied by beneficial, environment-related opportunities, which should be taken into account [Esty & Ivanova, 2003[18]].
- However, the environmental aspects of globalization cannot be interpreted merely as consequences of the latter process since the intensifying exploitation of mineral, biological and other natural resources is also a constituent of globalizing economic activities; investment (especially greenfield investment) and the development and application of various technologies that use the environment are themselves socio-economic activities; and extensive land use and land use change (such as deforestation) involve directly modifying and transforming environmental space.
- There is increasing interaction between globalizing social, economic, and environmental change [Kates et al., 2001; Rakonczai, 2018; Kerényi & McIntosh, 2020]. The process of globalization, and the state of the world it creates, i.e., 'globalism' cannot be reduced to, for example, the world economy and trade because the globalization process and its stages have multiple closely interconnected forms, including environmental ones [Keohane & Nye, 2000[19]]. Environmental globalization and the related extensive processes, including the widespread use of natural resources and the environment in general, growing environmental pressures, and environmental

[17] "In some regards, environmental globalization is in direct opposition to economic globalization".

[18] "Globalization can have both positive and negative effects on the environment. It can exacerbate environmental problems as well as provide new means for addressing them". (p. 3)

[19] "Interdependence and globalism are both multidimensional phenomena. […] there are several, equally important forms of globalism: Economic globalism […] Military globalism […] Environmental globalism […]. Some environmental globalism may be entirely natural, but much of the recent change has been induced by human activity. Social and cultural globalism …". (p. 106)

degradation, are also part of globalization broadly understood. As is the case with globalization processes in general, the transboundary impacts and international implications of the more and more extensive use of natural resources and growing emissions of various pollutants have been accompanied by an increase in the interdependence of societies and the consequent need for their cooperation [Faragó, 2009].

Global environmental governance. In parallel with globalization processes, instruments for 'controlling' them have been created to help avoid or at least mitigate dangerous or already obviously harmful impacts. In addition to policy and regulatory instruments, global environmental governance encompasses the institutional and cooperative system for dealing with globalizing environmental challenges. However, according to a different approach – too narrow, in our view – only the latter constitutes "environmental globalization" [Zimmerer, 2006[20]].

- Typically, the concept of environmental globalization includes both environmental processes (e.g., long-range environmental flows of energy and materials), related impacts and the 'policy responses' to them, by which is meant specific components of environmental governance such as international environmental 'norms' and the types (configurations) of cooperation between different actors [Clark, 2000].
- It goes without saying that there are different views about the functioning of global environmental governance institutions and the effectiveness of programs and agreements: considering them ineffective at solving environmental problems [Lányi, 2007[21]]; accepting their creation as important but their objectives and implementation as insufficient and in need of further strengthening [Speth, 2002; Simai, 2016; McInerney, 2017]; or only disapproving of some elements of their content, such as how differences in situations and/or responsibilities among countries are taken into account in relation to a shared environmental hazard or how 'targets' are defined

[20] "The term environmental globalization refers to the increased role of globally organized management institutions, knowledge systems and monitoring, and coordinated strategies aimed at resource, energy, and conservation issues." (p. 1)

[21] "International political attempts to limit pressures and mitigate environmental degradation are often unsuccessful, and agreements are often inadequate or ineffective." (p. 29)

(e.g., in terms of the reduction of pollution emissions) [Kerekes & Kiss, 2000[22]].

- This governance system has become extremely complex due to the proliferation and complexity of environmental problems, with a multitude of institutions, forms of cooperation, policy, and regulatory instruments. The significant variation in the effectiveness of all these can be attributed to the different situations and priorities of countries and interest groups.

Environmental globalization is, therefore, an integral and particularly critical part of globalization. As referred to above, this concept encompasses environmental processes of global significance that are partly or wholly related to human activities, i.e., are induced by them, and which in turn also have considerable socio-economic impacts. Extensive hazardous impacts can also occur when societies are unprepared for extreme natural events or gradually changing environmental conditions. Furthermore, in a broad sense, the term 'environmental globalization' also covers global environmental governance, i.e., the international system of institutions and instruments that address the causes and effects of global environmental processes and the prevention or at least mitigation of adverse impacts.

1.1.2. Increasing use of the environment and the environmental impacts of human activities

The period of industrialization (the 'industrial revolution') marked the beginning of the accelerating use of natural resources and the simultaneous growing environmental pressures in many other forms. The tremendous change of pace in this process started in the mid-twentieth century. The timing and extent of these changes have been very different in the developing and developed world, but also in the 'second world,' that is, in the countries of Central and Eastern Europe (also called at that time the states of the 'Eastern Bloc'). The impact of intensifying economic activities on individual societies and social groups has also been substantially different. While disadvantageous effects have been apparent in various regions, it was gradually realized that the process could even lead to global-level harmful consequences.

[22] "In particular, it is dissonant that international environmental conventions often require reductions in relation to existing pollution levels, largely ignoring the level itself." (p. 178)

The 'Great Acceleration' has fundamentally affected how societies and the natural environment interact globally. The population boom and rapidly changing production processes and consumption patterns have been the main drivers of these accelerated trends. The speed of these changes has been unprecedented in human history [Steffen et al., 2004[23]], and particularly pessimistic assessments suggest it could even lead to the collapse of the global environmental system [Laybourn-Langton et al., 2019[24]].

- In the second half of the last century, that is, within five decades, the world's population more than doubled, and the global economy grew several times faster. Half of the world's population was already living in cities at the turn of the century. Several other phenomena marked this acceleration (such as the increase in the number of vehicles on the road and the amount of plastic and fertilizer produced and utilized) [Steffen et al., 2007; McNeill & Engelke, 2016[25]]. As a result, key economic sectors – energy, transport, agriculture and food, metallurgy, and the chemical industry – not only became particularly heavy users of natural resources but also significantly contributed to the destruction of ecosystems and created air, water, and soil pollution, along with waste. For the study of these complex issues, a specialized institution[26] was set up to compile, regularly update, and analyze key data and time series. It is based on this information that the theories of the

[23] "The second half of the 20th century is unique in the entire history of human existence on Earth. Many human activities reached take-off points sometime in the 20th century and have accelerated sharply towards the end of the century. The last 50 years have without doubt seen the most rapid transformation of the human relationship with the natural world in the history of humankind." (p. 18)

[24] "The scale and pace of environmental breakdown. Environmental change resulting from human activity has reached a global scale and is occurring at unprecedented speed. Aggregate human impacts on the environment range from local to global scales and are overwhelmingly negative, altering and destabilising the function of the natural systems on which human societies depend." (p. 9)

[25] "The escalation since 1945 has been so fast that it sometimes goes by the name the Great Acceleration. […] The number of motor vehicles on Earth increased from 40 million to 850 million. The number of people nearly tripled, and the number of city dwellers rose from about 700 million to 3.7 billion. In 1950 the world produced about one million tons of plastics but by 2015 that rose to nearly 300 million tons. In the same time span, the quantities of nitrogen synthetized (mainly for fertilizers) climbed from under 4 million tons to more than 85 million tons."

[26] Stockholm Resilience Centre: "Great Acceleration graphs" and "Planetary dashboard"

'Anthropocene' and 'Planetary Boundaries' have crystallized [Rockström et al., 2009; Steffen et al., 2015].

- Barbara Ward and René Dubos pointed out, even at the early stages of this hazardous process, that "our sudden vast accelerations – in numbers, in the use of energy and new materials, in urbanization, in consumptive ideals, in consequent pollution – have set technological man on a course which could alter dangerously, and perhaps irreversibly, the natural systems of this planet upon which his biological survival depends." [Ward & Dubos, 1972: p. 46] According to Ervin László: "In a globally extended industrial civilization wielding powerful technologies, the belief in the inexhaustibility of nature gives free rein to the overuse and impairment of the resources of the planet and the unreflective overload of nature's self-regenerative capacities" [László, 2006: p. 84]. Consequently, the belief in nature's limitless capacity, established since man's early history, should be finally abandoned. In Attila Kerényi's very clear formulation, the uncontrolled growth of economic activities at the global level has resulted in "the functioning of the global social system being out of harmony with the functioning of the global earth system [...]. The fundamental task of humanity in the future is to resolve this contradiction" [Kerényi, 2003: p. 401].
- With the rapid development of international trade, transport, and communication, the interconnectedness of societies has been so transformed that the world's population may now be considered to live together in a 'global village.' In the context of the emergence of this situation and the likely future of these processes, the author of this book, like many other researchers of environmental globalization, is primarily concerned with the state of the Earth's environment, shared as our common planetary home and threatened in many ways by all of us, its changes being due to anthropogenic influences and the various consequences thereof.

Contradictory views about the harmful and beneficial consequences of these changes. There are basically two opposing views (and often some combinations) concerning the assessment of the effects of these rapid and intense globalization-driven changes.

- The emergence of a global economic system is at the root of most of the world's environmental problems, as Jennifer Clapp has suggested. Still, the concept of sustainable development may be a way out of this

situation if it is accompanied by proper regulation of the global economy [Clapp, 1997[27]]. According to Robert Colvile: "In the aggregate, the great acceleration is an extraordinarily good thing for humanity. But its benefits are distributed unevenly, and its dangers are almost as great as its opportunities. [...] the great acceleration is transforming our society. In every sphere, it is disrupting our lives in ways both good and bad, bringing us new opportunities and fresh dangers all at the same time." [Colvile, 2016]

- The beneficial social effects of globalization are primarily seen in the reduction of deep poverty, while this and many other socio-economic effects are also accompanied by the considerable degradation of the natural environment in many regions [EEA, 2020[28]]. Simon R. Bush, however, has argued that it is entirely possible to develop institutional (governance) solutions, with the help of social scientists, to make environmental globalization work in a positive direction [Bush, 2017[29]].
- In the longer term, however, these globalization processes, through their various influences, may transform environmental conditions to such an extent and at such a speed that even the social effects that

[27] "Although globalization may, in theory, have the potential to improve the quality of the environment, history has shown that this is unlikely to occur without some sort of positive intervention in the global economy on behalf the environment. […] This identification of global economic processes as being at the heart of many of the world's environmental problems has led to calls for sustainable development over the past decade. […] Nearly a decade later, there has not been much improvement on that front." (pp. 126–127)

[28] "The great acceleration has undoubtedly delivered major benefits, alleviating suffering and enhancing prosperity in many parts of the world. For example, the share of the global population living in extreme poverty has decreased sharply from 42 % in 1981 to less than 10 % in 2015. Yet the same developments have also caused widespread damage to ecosystems. Globally, about 75 % of the terrestrial environment and 40 % of the marine environment are now severely altered." (p. 10)

[29] "To steer society towards reflexive and socially inclusive outcomes we need effective governance arrangements that can proactively shape the conditions of global modernity. This then creates space for a new research agenda of understanding how reflexive and inclusive environmental globalisation can contribute to positive environmental change. I am convinced that to realise this agenda social scientists need to move to transdisciplinary modes of science. […] Through these partnerships we should contribute to the co-design, and in many instances re-design, of institutional arrangements to reveal and deal with new and existing environmental problems." (p. 22)

seemed beneficial no longer prevail, and the majority of societies can no longer adapt to changing conditions. The prevention of these dangers is the focus of many international environmental and sustainability reports, programs, and agreements (including those on biodiversity, climate change, chemicals and wastes, and sustainable development and its goals).

Environmental globalization has gained momentum with the 'Great Acceleration.' It has proceeded with the escalating exploitation of natural resources, the increasingly unsustainable use of natural resources, and the growth in dangerous or already clearly harmful impacts on the environment worldwide. Human-induced environmental changes and their consequences have become planetary in scale, with significant international implications, including inter alia natural resource conflicts and the strengthening of environment-related international cooperation, although there are some indications that anthropogenic environmental degradation has slowed down somewhat [Steffen et al., 2015[30]; McNeill & Engelke, 2016[31]].

1.2. Societies and the natural environment: increasing interference

Societies can be significantly affected if their environmental conditions change substantially over a short or long period. These changes may be of natural or human origin. Many disciplines are engaged in the study of such historical events and the lessons to be drawn from them. Before reviewing and evaluating the more general concepts, international scientific and political frameworks and developments in this area, some instructive cases are briefly presented that illustrate how globalization processes have magnified the impact of various disasters and dangerous natural processes. The research of such phenomena has also contributed to the elaboration of

[30] "Hitherto human activities were insignificant compared with the biophysical Earth System, and the two could operate independently. However, it is now impossible to view one as separate from the other. The Great Acceleration trends provide a dynamic view of the emergent, planetary-scale coupling, via globalisation, between the socio-economic system and the biophysical Earth System. We have reached a point, where many biophysical indicators have clearly moved beyond the bounds of Holocene variability." (p. 93)

[31] "The Great Acceleration in its present form cannot last long. There are not enough big rivers to dam up, enough oil left to burn, enough forests left to fell, enough marine fish left to catch, enough groundwater left to pump up. Indeed, there are several indications that the accelerations are tapering off, and in a few cases reversing".

science-based measures to help prepare for short- and longer-term extreme events, prevent or at least moderate their adverse effects, provide greater protection against such recurring phenomena, and recognize the need for closer interdisciplinary cooperation in this field [El-Sabh & Murty, 1986[32]]. It has also led to the development of the discipline of 'hazard science' specializing in this broad subject.

1.2.1 Impacts of extreme natural events: some enlightening international cases

Abrupt extreme environmental events and longer-term changes in environmental conditions with harmful socio-economic impacts have occurred repeatedly throughout human history.[33] While such extremes vary in type and hazardous impacts from region to region (such as volcanic eruptions, earthquakes, tsunamis, floods, droughts, and hurricanes), globalization has also led to an increase in the number of some (human-induced) extreme natural incidents that have caused considerable societal and economic impacts and damage. In addition, more frequent, recurrent meteorological and hydrometeorological extremes may also indicate the beginning of, or already ongoing, relatively slow unidirectional environmental change. In other words, such trends might be anticipated based on time series analysis (based on the frequencies and 'amplitudes' of such extremes).[34] Some instructive examples of social, economic, and

[32] "Research in natural hazards is moving recently to a new era of theoretical advances, large-scale field experiments, expensive experimental testing facilities, use of super computers, access to global monitoring and communication facilities. However, these studies are often dealt with separately from an academic point of view and do not take an interdisciplinary approach to encourage interaction among various scientists, engineers, administrators, civil defense officials and policy makers dealing with hazard mitigation." (p. ix)

[33] For example, the 'Little Ice Age' that spanned centuries of the modern era of human history, and those with shorter time scales: dry or cold periods that lasted for several years, such as the severe drought and famine in ancient Egypt, the extraordinary drought in the USA in 1930s, and extreme cold in the sixth century (around the years 535-536) across the northern hemisphere, which some researchers believe may have been caused by the eruption of the Krakatau volcano.

[34] In the framework of the World Climate Program, such extreme events have also been monitored and analyzed from this point of view [WMO, 1979]; there are also references to these issues in two papers co-authored by the author of this book [Antal, Faragó & Glantz, 1988; Faragó & Katz, 1990: p. 2]: "extreme phenomena might act as a catalyst in alerting societies to their vulnerability to fluctuations or permanent changes in climate."

environmental interactions with severe outcomes that have had significant international consequences (such as mass migration and the need for international aid and humanitarian cooperation) are recalled below.

The effects of climate variability on food security have repeatedly led to humanitarian disasters with international implications.

- One such example is the famine in Ireland in the mid-nineteenth century. General climatic conditions were particularly favorable for potato growing, but 'potato blight', a disease brought over (also) from the American continent, caused enormous devastation to crops for several years from 1845 onwards. This emergency was compounded by much wetter weather conditions than usual. The famine took the lives of many victims, while many fled to other European countries and even other continents [Edwards & Williams, 1956]. This event, which occurred partially due to extraordinary environmental influences, highlighted that higher social vulnerability might be a consequence of the relative stability of favorable features of a region's natural environment over several years or decades. This may lead to the development of excessively one-sided patterns of production/cultivation and consumption, combined with forgetting about the potential variability in environmental conditions. The early stages of globalization were already marked not only by massive international migration (forced by environmental factors) but also by international aid initiatives.
- About a century later, a prolonged drought in the Sahelian countries of Africa also had dramatic impacts: in the period between 1968 and 1974, grasslands dried up, mass starvation set in, and large-scale population movements – the displacement of '*environmental refugees*' – to less drought-stricken areas in other countries occurred. The 'overgrazing' with increasingly large herds that had taken place during the previous relatively wetter period also contributed to this unexpected and dramatic situation. The experience of this event significantly impacted the development of humanitarian cooperation [Glantz, 1976; UNEP, 2006].
- More recent such situations include, for example, the drought-induced crop failures in several vital grain-exporting countries during 2006–2008, which were one of the leading causes of the doubling of international grain prices and the social tension in several particularly grain-import-dependent countries in the MENA region.[35] The latter

[35] MENA: Middle East and North Africa

were partly considered 'hunger riots' [Mitchell, 2008; Ianchovichina et al., 2012; Enghiad et al., 2017].

Among the extreme geophysical events, we recall two recent cases to illustrate how some socio-economic globalization processes have contributed to the extensive and severe international effects of hazardous natural phenomena.

- The population of coastal areas, including low-lying areas,[36] has increased over the centuries, and some are particularly exposed to extreme natural events. The tsunami of 2004, triggered by an earthquake under the Indian Ocean, left enormous devastation behind in the coastal regions of many countries and had many victims, including tourists from developed countries. This led to virtually global identification with this disaster and the provision of assistance by many governments and organizations [Sharpley, 2005[37]; Birnbaum et al., 2013]. The disaster highlighted that while international tourism in the coastal areas of that Southeast Asian region had grown rapidly in the preceding decades, an early warning system for undersea earthquakes had not been developed. This dramatic event was described in detail at the 2005 World Conference on Disaster Reduction and reinforced the need for much more international cooperation in the areas of prevention, mitigation, and recovery.
- Unlike that tsunami, the 2010 eruption of the Icelandic volcano Eyjafjallajökull had no victims but led to the almost complete paralysis of air freight and passenger traffic to and from Europe. Obviously, while that traffic has expanded enormously over the decades, technical preparedness for major extraordinary circumstances has not been 'proportional.' However, the severe disruption and damage caused by that volcanic eruption were followed by the rapid development of the international aviation safety monitoring and information system [Parker, 2015].

The accumulated experience of and knowledge about such extreme natural events have helped understand them better (in terms of their possible precursors, severities, and impacts), and recognition of the need for improved resilience that may lessen harmful consequences in the future. Such phenomena have also shown that it is helpful to look at such

[36] Population in the low-elevation coastal zone (LECZ).

[37] "[T]he fact that many places impacted upon by the tsunami are tourist destinations has undoubtedly contributed to the unprecedented global response to the disaster. International tourists and local communities shared in the loss and suffering and, in a sense, tourism has provided a lens through which the world has been able to focus on and respond to the disaster, both generally and in specific contexts." (p. 349)

problems from a broader perspective, i.e., in the general context of the relationship between nature and society [Czelnai, 1980[38]; Bogardi, 2006[39]; Birkman, 2006[40]; Faragó, 1996; 2011]. One emblematic example of the development of international cooperation in this field was the creation of the UN World Food Programme (WFP) at the beginning of the 1960s, aimed at alleviating hunger in the wake of humanitarian disasters, including those triggered by natural disasters [FAO, 2017[41]]; for its work, the organization was awarded the Nobel Peace Prize in 2020.

1.2.2. Anthropogenic environmental impacts and their widespread repercussions

Globalization has increased the scale and diversity of human activities that use, shape, and burden the natural environment. The resulting environmental and socio-economic consequences have become much more damaging and widespread. The latter are in fact the repercussions of human activities that cause environmental spillovers. As with the natural processes referred to above, time plays an important role here, too [Brauch, 2005[42]]: the two extremes are (i) phenomena with very short time scales (abrupt incidents) associated with widespread damage and (ii) cases with large-scale adverse outcomes that unfold over decades or centuries. We refer to

[38] "Impacts of short-, and long-term climatic variations. […] the impact of a slow and gradual climatic change on society and economy usually appears in the shape of difficulties caused by the changing recurrence times of certain extreme values. […] It would be a depressing perspective if decision-makers remained separated in two distinct groups: one group dealing with short-term decisions, and the other group dealing with the long-term ones. The two types of decisions are often conflicting." (p. 151)

[39] "Thus vulnerability, once it is properly assessed and preferably quantified, is the crucial feature that could serve to estimate the potential consequences of both rapid onset and/or creeping (natural) hazard events on the affected entities. By following this line of thought, we can imagine that vulnerability assessment will become the crucial component of disaster preparedness." (p. 3)

[40] "[A] broader and long-term reduction of vulnerability would require also the analysis and reflection of how we construe our relationship with nature. […] the integrated perspective of the environmental sphere seems to be more appropriate for taking a holistic view of vulnerabilities to hazards of natural origin" (p. 48)

[41] "Five years of very low rainfall brought severe drought and tragedy to Burkina Faso and other Sahelian countries. The UN Secretary-General designated FAO as the focal point for coordinating emergency relief operations. A major part of the relief was emergency food aid, with the World Food Programme allocating more than 57 000 tonnes to six countries in the first eight months of 1973." (p. 105)

[42] Rapid-onset hazards, slow-onset or creeping long-term processes.

such examples below and return to some of them when discussing the development of international environmental cooperation.

By far the most significant industrial or technological accident that occurred rapidly and had major international consequences was the Chernobyl nuclear power plant disaster in 1986. An extensive literature describes in detail the accident and assesses the adverse health and environmental effects of the spread and fallout of radioactive pollution; here, we will limit ourselves to highlighting the general context and policy responses at the global level.

- Energy demand and production have grown rapidly since the middle of the last century. While studying globalization, for a long time, less attention was paid to energy management processes [Overland, 2016[43]]. Presumably, this was due to the lack of the sector's broader international dimension until the oil crises of the 1970s made clear the growing global economic interdependence of the natural resources that are involved. But beyond the ever-increasing international trade and transport of crude oil, various petroleum products, and natural gas – and hence the emergence of their global market and global price volatility – '*energy globalization*' emerged as a much broader issue that also covers, among other phenomena, the related environmental risks and emissions, and the development and spread of energy technologies, including nuclear power generation technology.
- Although nuclear accidents with significant consequences have also occurred in the past,[44] the immediate effects of the Chernobyl explosion reached many countries and led to much greater international attention to developing safe conditions for the peaceful use of nuclear energy. At the global level, this led to the development of cooperation and regulation within the framework of the International Atomic Energy Agency (IAEA), and at the pan-European level, *inter alia*, to the adoption of the 1992 convention on industrial accidents [CTEIA, 1992]. Similarly, accidents involving oil tankers that occurred from the 1960s onwards[45] led

[43] "Energy resources are transported long distances and create powerful interlinkages between countries. Energy thus contributes to the globalization of the world, but has received little attention in the globalization literature. […] energy globalization can be defined as the growing interconnectedness of the world's energy supplies through the movement of growing volumes of energy over greater distances across international borders." (pp. 122–123)

[44] 1957: Majak (Kistim); 1979: Three Mile Island.

[45] 1967: Torrey Canyon; 1978: Amoco Cadiz.

to the elaboration of international regulatory instruments for strengthening the safety of the transport of dangerous goods.

Processes that become global in scale and impact over decades or centuries include activities that result in significant environmental pressure, degradation, and pollution, such as the worldwide land use, land use change for agricultural and other purposes, the rapidly growing utilization of fossil fuels for energy generation, the production of a wide range of chemicals and large amounts of waste, of which considerable quantities are released to the environment.

- These are typically 'accumulative' processes: for instance, the emissions and growing concentrations of pollutants with long atmospheric residence times or the gradual increase in the amount of microplastics in the seas. Their environmental consequences – depletion of the ozone layer, strengthening of the atmospheric greenhouse effect, and environmental degradation caused by toxic chemicals and hazardous waste – are themselves 'cumulative' trends. Moreover, these processes are also mutually interacting and have repercussions for societies [Young et al., 2006[46]]. The extraction and use of finite (non-renewable, therefore gradually depleting) natural resources is a similar problem, however, one associated with a 'negative sign' (as, for instance, in the case of some critical raw materials and crude oil).[47]
- Impacts can become particularly damaging when the extent or speed of the process that generates them reaches and then exceeds a critical limit ('tipping point') [ICSU, 2010[48]]. Often, such processes are detected, and their causal links and potentially harmful consequences are scientifically identified with some certainty only when they reach and/or surpass such thresholds. Sometimes this can take quite a long

[46] "Whether changes are systemic (e. g. climate change and variability) or cumulative (e. g. aggregate loss of biological diversity), the biophysical changes occurring today are global in scope. What is more, the large-scale environmental changes that mark the present era are increasingly anthropogenic in origin. […] Global social change and global environmental change interact with each other. In many cases, these changes can be expected to amplify or dampen one another through the operation of feedback mechanisms." (p. 307)

[47] The author of this book has reviewed and evaluated the global 'petroleum problem' in a recently published article [Faragó, 2018].

[48] "[T]here is evidence that society is pushing the planet's climate and other critical physical processes towards thresholds. If these thresholds are crossed, society risks planetary-scale and regional-scale state changes with a potential to cause large-scale economic and ecological disruptions and unprecedented humanitarian challenges." (p. 1)

time (several or more decades) in the case of relatively slowly unfolding processes associated with a gradually increasing range of adverse effects and/or the escalating international conflicts triggered by them. (Historical examples include the case of the overfishing of marine fish species and the widespread use of DDT).

Thus, shorter or longer-term extreme changes in the state of the natural environment caused by human activity have already impacted large regions and many countries in the past. However, due to globalization processes, on the one hand, anthropogenic environmental change has reached the global level and appeared in more diverse forms; on the other, the resulting large-scale modification of environmental conditions has resulted in much greater ecological and socio-economic impact than before.

1.2.3. The environmental vulnerability, resilience, and adaptability of societies

The effects of environmental changes depend not only on their speed and extent but also on the vulnerability of the system subject to the changes and its 'resilience' to these alterations [UNEP, 2002]. The latter concept covers the tolerance of living organisms, societies, and groups or individuals to external impacts and stresses [Székely, 2015], but there are many different forms of its manifestation and interpretation. In the case of the exposure of living organisms to potentially harmful substances (e.g., toxic chemicals), the harm also depends on the duration and the strength of the exposure. Such more or less significant impacts and consequences have accompanied the history of humanity. However, since the 1970s, scientific investigation and cooperation in this field have developed strongly in parallel with the increasing extent of such environmental impacts and the realization of their international and even possibly global dimensions. This problem area has become linked to the issue of environmental security.

The development-vulnerability paradox. Since the middle of the last century, rapid socio-economic development has not reduced social vulnerability in some areas, despite the higher attention paid to the latter – for example, in developing new technologies and improving planning, impact assessment and standardization procedures. In many regions, the transfer and utilization of 'customary' or 'proven' (but obsolete) technologies and/or the introduction of newer ones have accelerated together with the rapidly growing production volumes and consumption demands. These include the development of more concentrated production lines for expanding industrial and agricultural systems, satisfying the consumption demands of an increasing

population, supporting the functioning of growing human settlements, and sustaining the expansion of building stocks and service infrastructure. However, these technological changes generally have *not* been accompanied by sufficient improvements in their operational safety, including their protection against the considerable variability in natural conditions and some extreme natural events that may influence their operation.

- In contrast to the natural processes that drive the long-term evolution of living organisms (biotic systems), stimulate their adaptation, and reduce their vulnerability to varying environmental conditions, in the case of human societies, it is more the consciousness, consideration and transfer of experience, foresight, and multi-faceted planning that contribute to improving resilience and adaptability. The effectiveness of the latter, however, largely depends, on the one hand, on the intensity and rapidity of changes in environmental conditions, and on the other, on social responsiveness, including the ability to recognize those changes in a timely and accurate manner [Hannan & Freeman, 1984[49]].
- In addition, antecedents are also relevant. If development in a region or sector takes place over a long period under natural conditions that are relatively stable, then there is usually no incentive to prepare for "adaptive optimization" [Faragó, 1981], as illustrated by some of the historical examples described above. In such periods more or less uniform patterns of cultivation, production, supply, service structures, methods, techniques, and consumption patterns may emerge and become dominant that are optimal or ideal under those environmental conditions. This phenomenon is also known in economics as a 'structural trap' due to the strong inertia of the direction of development. The result is that the system becomes unable to adjust in a timely manner to slowly or abruptly changing environmental conditions [Young et al., 2006; Bulla, 2008; Faragó, 2011]. Socioeconomic structures (production and consumption systems, infrastructure) that are formed under relatively stable and lasting conditions may become unable to withstand the adverse impacts of 'extraordinary' changes because the latter exceed the limits of resilience and adaptability of the former.

The impact of globalization on vulnerability, resilience, and the adaptability of socioeconomic systems. Many analyses have addressed these issues using a general systems theory approach or by examining the

[49] "Are typical changes small or large, regular or irregular, rapid or slow? […] How long does it take to obtain, process, and evaluate information on key environments? […] How quickly can an organization be reorganized?" (p. 151)

impacts of specific processes [Young et al., 2006[50]; MEA, 2005; IPCC, 2007]. The degradation of natural systems due to human activities also implies an increase in the vulnerability of the societies interacting with these natural systems. Recognition of this specific form of adverse feedback could facilitate the formulation of appropriate policies, internationally agreed measures, and their implementation, helping mitigate harmful anthropogenic impacts on the natural environment – hence on the quality of its components that are also vital for human societies and the 'ecological services' provided by various biological systems [UNEP, 2002].

- The environmental changes societies are contributing to and now feeling the repercussions of have reached a global scale. They include the depletion of the stratospheric ozone layer, the rapid loss of biodiversity, and the enhanced threat of global climate change. In such circumstances, it is not possible to limit responses to mitigating adverse consequences, but the drivers and the direct causes of such problems should first be addressed. Without eliminating or at least substantial reducing our dangerous and already global-level environmental interventions, the range of options for managing the resulting harmful effects and adaptation to them will be limited [e.g., Hulme et al., 2009[51]].
- In the case of specific social groups and/or regions exposed to natural disasters, it is particularly important, building on previous experience, to enhance resilience and adaptive capacity, including through advancing 'contingency planning'. It was due to thorough case studies and research findings in this area that in 1989, the UN General Assembly adopted a resolution on the International Decade for Natural Disaster Reduction [IDNDR, 1989]. In addition, a system of specialized UN institutions (e.g., UN/OCHA, UNDAC, UNDRR)[52] was established for dealing with risk assessment of such disasters, means of their prevention, mitigation, damage reduction, and disaster relief. The internationally agreed tasks were incorporated into disaster reduction strategies and action plans from 1994 onwards.

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[50] "In most systems, whether social or biophysical, external or internal disturbances trigger a number of reactions across spatial and temporal scales. Which of these reactions eventually overcomes the disturbance and returns the system to normal functioning and whether the episode will affect the future dynamics of the system, depends on the persistence of the disturbance as well as on the size of its impact." (p. 306)

[51] "Global crop yields in agriculture are projected to be adversely impacted by climate change in the absence of both adaptation and mitigation action. Without stringent mitigation, adaptation could contain the negative impacts, but not remove them." (p. 9)

[52] UN-OCHA: United Nations Office for the Coordination of Humanitarian Affairs (1991–); UNDAC: United Nations Disaster Assessment and Coordination (1993–); UNDRR: UN Office for Disaster Risk Reduction (1999–).

The vulnerability of ecological and social systems and their resilience to environmental hazards continue to be dealt with in-depth within the framework of international cooperation in the field of the environment and sustainable development. The effective reduction of vulnerability and strengthening of resilience can be achieved primarily through a focus on prevention. It is also essential to simultaneously take into account the interlinkages between different hazardous processes, the expected outcomes of potential response policies, and, more generally, the presumed effects of different paths of socio-economic development [UNEP/GEO, 2019[53]; UNEP, 2021[54]]. Such specific targets were also included in the global sustainable development program approved in 2015 [UN, 2015[55]].

1.2.4. Environmental security at the global level

The concept of security was developed and extended in relation to specific production processes and technologies, then more generally, in the context of social and economic issues. As the safety of societies has been increasingly threatened by dangerous environmental impacts of different origins and nature (although obviously to varying degrees depending on their location, exposure, and vulnerability), the methods, and means of maintaining safety by preventing or mitigating those threats – that is, the various components of 'environmental security' – have been more closely studied, characterized and assessed since the 1980s [El-Sabh & Murty,

[53] "GEO-6 underlines that people are part of ecosystems and depend on them, emphasizing the importance of conserving nature not only for its intrinsic value, but also because it is crucial for the well-being of humanity. Such an approach is urgently needed to help address the vulnerability and different conditions and capabilities enabling people to react to hazards and disruptions in daily life (resilience)" (p. 8)

[54] "Combined environmental changes increase the risks of crossing thresholds beyond which ecological and climatic shifts accelerate and become very hard to reverse. Socioeconomic development patterns strongly determine the vulnerability and exposure of people, and thus related impacts, as well as the groups in society that would bear the brunt of these impacts." (p. 25)

[55] "1.5. By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters."; "13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries."

1986; Myers, 1989[56]; Láng, 1996; Boda, 2004[57]; Faragó, 1996, 2011]. According to Peter H. Gleick, security can be affected by flows of capital, both in terms of economic capital and natural capital, and the 'signs' of global environmental problems should be viewed with as much concern as the risks posed by military arsenals [Gleick, 1991[58]].

Security as the protection of society against dangerous environmental influences. This concept was initially and primarily identified with protection against extreme natural events or disasters (rapidly or slowly emerging hazardous processes) that threaten the livelihood of human communities in various regions (i.e., their safe/stable living conditions) and the mitigation of their adverse effects [Jovanovic, 1986; DHA, 1995].

- The main components of improving environmental security are, first and foremost, the assessment and, as far as possible, prevention and mitigation of such hazards and their harmful consequences, together with a reduction in the vulnerability of the respective systems by improving their preparedness, resilience, and adaptability,[59] and measures for mitigating adverse impacts and promoting recovery [Láng, 1996[60]; UNDP, 1994[61]; Faragó, 1996].
- In addition, applying a *precautionary approach* to enhance environmental security in the case when the possibility of severe hazards is not yet sufficiently scientifically explored – i.e., there is still a considerable

[56] "[T]here is a need to incorporate an environmental dimension into security planning. The conventional approach to security interests surely reflects an overly narrow perception of security problems and of available responses, largely military, to security threats. Could the time be coming when as much lasting security can be purchased through trees as through tanks?" (p. 41)

[57] "The question is whether the concept of safety itself can and should be redefined to encompass non-military threats, including environmental threats, and the responses to them." (p. 100)

[58] "[A] nation or region bent on protecting its security in the future will have to concern itself as much with the flows of the planet's geophysical capital as it does today with the flows of economic capital; as much with the balance of atmospheric trace gases as with the balance of military power; as much with monitoring the earth's vital signs as with monitoring the arsenals of destruction." (p. 19)

[59] improvement of adaptive capacities and adaptation capabilities

[60] "According to one definition and interpretation, environmental security is a state in which the probability of the occurrence of events of social origin and harmful effects on the environment, as well as disasters of technical origin, is minimized by appropriate measures, and in the event of a disaster, the damage caused is limited in such a way that the impact does not endanger the quality of the natural environment or the health of the population. [...] the primary factor in guaranteeing environmental security is prevention" (pp. 20–21)

[61] "Human security is easier to ensure through early prevention than later intervention. It is less costly to meet these threats upstream than downstream." (p. 22)

lack of full scientific certainty – plays an essential role. (This is discussed in more detail below.)

The globalizing components and challenges of environmental security. Since the late 1980s, in addition to the impacts of extreme natural events, much more attention has been paid to international security issues arising from environmental pollution and the exploitation of various natural resources. According to a report adopted by the UN General Assembly [WCED, 1987: p. 24]: "The whole notion of security as traditionally understood in terms of political and military threats to national sovereignty – must be expanded to include the growing impacts of environmental stress – locally, nationally, regionally, and globally."

- Regardless of the source (i.e., its location) of the anthropogenic emissions of certain pollutants, their adverse effects threaten all societies, albeit to different degrees and in different ways, because of their long-range transmission. Such global-level environmental issues include inter alia, the emissions of ozone-depleting substances, greenhouse gases, and releases of toxic chemicals.
- Resource-related security problems have also been on the scientific and policy agenda for some time: in particular, international food, water, and energy security [Meadows et al., 1972[62]; Schumacher, 1973; Lipschutz & Holdren, 1990[63]] and, more generally, the global environmental security issues associated with natural resources (because of growing demand, supply, utilization, and the resulting international conflicts) [Mathews, 1989[64]; Berzsenyi, 2013[65]].
- Therefore, the globalization process has generally increased societies' environmental security concerns and challenges, both in their above-mentioned more concrete forms and in their totality, to a global level.

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[62] "[W]e have discussed only one possible limit to food production – arable land. There are other possible limits […]. The most obvious one, second in importance only to land, is the availability of fresh water. There is an upper limit to the fresh water runoff from the land areas of the earth each year, and there is also an exponentially increasing demand for that water." (pp. 53–54)

[63] "[T]he material appetite of civilization has been rapidly growing along with its salience for international affairs: the environmental one. […] it includes impacts on the environmental conditions and processes that control the supply of indispensable renewable resources such as food, water, biomass fuels, and forest products." (p. 126)

[64] "The 1990s will demand a redefinition of what constitutes national security. […] Global developments now suggest the need for another analogous, broadening definition of national security to include resource, environmental and demographic issues." (p. 162)

[65] "As the human population grows, the demand for natural resources increases, and this growing demand coupled with gradual resource depletion is a potential source of conflict. [...] Attempts to gain control over natural resources, triggered by the unequal distribution of natural assets or the degradation of the environment, can lead to violence." (pp. 31–32)

2. GLOBAL ENVIRONMENTAL CHANGE: THE SCIENTIFIC RECOGNITION OF CAUSE-EFFECT RELATIONSHIPS

> "The global consequences of human activity are not something to face in the future […], they are with us now. All of these changes are ongoing, and in many cases accelerating; many of them were entrained long before their importance was recognized. […] we are changing Earth more rapidly than we are understanding it."
>
> *Vitousek et. al., 1997*[66]

2.1. Global change: researchers' diagnoses, scenarios, and proposals for therapy

Since the 1960s, there has been a revival of research into the potential large-scale environmental impacts of human activities. This was catalyzed by the experience and data obtained during the International Geophysical Year (1957/58) and then facilitated by the growing amount of information from gradually developing environmental monitoring systems and international socio-economic databases.

2.1.1. Society and environment: research into intensifying interactions

The study of globalizing environmental problems has involved clarifying their causes and effects and estimating their outcomes depending on various assumptions. Researchers have also considered the feasibility of intervening and modifying 'business as usual' economic, production, and

[66] Vitousek, P.M. et al., 1997: Human domination of Earth's ecosystems. *Science*, 277 (5325), pp. 494–499.

consumption patterns to manage these problems or at least lessen their adverse impacts. Special attention has been paid, in particular, to reducing the use of non-renewable (and conditionally renewable) natural resources and the variety of rapidly increasing environmental pressures. Among these 'diagnostic' analyses and 'therapeutic' proposals, we refer below (without claiming to be exhaustive) to those which have significantly influenced the development of international scientific and political cooperation on the subject of environmental globalization.

High-impact studies on the dangerous environmental aspects of globalization. These studies have become the starting points for a process that has led to a broader understanding of some critical issues, to the identification of further research directions and the involvement of more researchers, and ultimately also to the development of programs and agreements that address these problems.

- ***The dangerous (side-)effects of substances produced by the chemical industry*** and transported over long distances, particularly DDT, were highlighted by Rachel L. Carson in her book *Silent Spring* [Carson, 1962[67]]. Eventually, this led, through higher public awareness and concern, first of all to the banning or restriction of the use of DDT and later several other hazardous (synthetic) chemicals in many countries, and subsequently to the elaboration of global programs and agreements aimed at reducing the health and environmental damage caused by such chemicals (the Cairo Guidelines, SAICM, POP convention, etc.).
- ***Global environmental commons***. The increasing demand for and utilization of common natural resources was analyzed by Garrett Hardin, with particular reference to the resulting conflicts and even "tragedies." The examples he cites include those of international significance, such as ocean areas and their resources (that are not under the jurisdiction of any single state) and the pollution released into air

[67] "[T]he central problem of our age has therefore become the contamination of man's total environment with such substances of incredible potential for harm – substances that accumulate in the tissues of plants and animals and even penetrate the germ cells to shatter or alter the very material of heredity upon which the shape of the future depends. […] Future historians may well be amazed by our distorted sense of proportion. How could intelligent beings seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind?" (p. 8)

and international waters [Hardin, 1968[68]]. Since the 1970s the environmental degradation of global commons (such as the atmosphere, high seas, Antarctic, and outer space) and the foreseeable consequences of this have been more intensively examined, and over time (albeit at the cost of major compromises) international recommendations, guidelines, and legal instruments have been adopted concerning the prohibition of various harmful activities in those areas (e.g., the prevention of marine pollution, and the protection of the Antarctic environment).

- ***The importance of the biosphere***. Michel Batisse's scientific work was instrumental in the launch of the international program *Man and the Biosphere* in 1971 [Batisse, 1969[69]], which also helped to speed up ecological research and establish a series of conventions on nature conservation (e.g., the *Ramsar Convention* of 1971 and the most comprehensive *Convention on Biological Diversity* in 1992).
- ***Environmental hazards***. In their book *Only One Earth*, Barbara Ward and René Dubos summarized knowledge about hazardous environmental trends caused and/or amplified by human activities, setting the tone for the 1972 UN environmental conference held in Stockholm: "The first step towards devising a strategy for Planet Earth is for the nations to accept a collective responsibility for discovering more – much more – about the natural system and how it is affected by man's activities and vice-versa. This implies cooperative monitoring, research and study on an unprecedented scale." [Ward & Dubos, 1972: p. 290]
- ***Increasing resource demands***. The report entitled *The Limits to Growth* was published by the scientists Donella H. Meadows, Dennis L. Meadows, Jørgen Randers and William W. Behrens from the Club

[68] "[T]he oceans of the world continue to suffer from the survival of the philosophy of the commons. Maritime nations still respond automatically to the shibboleth of the 'freedom of the seas'. […] the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the commons, but of putting something in – sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air" (p. 1245).

[69] "Notre planète devient-elle inhabitable? […] Sur une période très courte de sa relativement courte histoire, l'homme a si bien maitrisé la nature qu'il est en train de la tuer. […] Telles sont les menaces de mort qui pèsent sur la biosphère – cette mince couche du globe terrestre, au point de rencontre du sol, de l'air et des eaux, où la vie peut exister" (p. 4).

of Rome. They sharply contrasted the resource demands of the increasing human population and rapid global economic growth with the "limits" of the exploitable natural resources of the Earth [Meadows et al., 1972].

- ***The interrelationship between globalizing social and environmental processes*** was critically assessed by Lester R. Brown in his book *World Without Borders* [Brown, 1972]. Later, in reports published annually from 1984 onwards entitled the *State of the World*, he and his co-authors did the same in even greater detail in relation to a variety of environment-related international (i.e., 'transborder') problems and conflicts [Brown et al., 1984].
- ***Rapid consumption of environmental assets***. The book *Small is Beautiful* was written by Ernst F. Schumacher. The title clearly indicates its central message – namely, that there is an urgent need to realize that the accelerating process of industrialization and resource use that started after World War II and the continuing economic growth is leading to the rapid "using up a certain kind of irreplaceable capital asset, […] which benign nature always provides". Moreover, the vast differences in living standards between developed and developing countries (i.e., the huge well-being/poverty gaps) and their differing responsibilities for globalizing environmental problems have become the prime factors determining 'North–South relations' since the 1960s-1970s. This was already strongly articulated at the above-mentioned 1972 UN conference and then in the critical evaluation of the international development aid provided to developing countries [Schumacher, 1973[70]].
- ***The 'ecological footprint'*** indicator was introduced by Mathis Wackernagel and William E. Rees to characterize the worsening environmental

[70] "Scientific or technological 'solutions' which poison the environment or degrade the social structure and man himself are of no benefit […]. Ever bigger machines, entailing ever bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful. […] We must look for a revolution in technology to give us inventions and machines which reverse the destructive trends now threatening us all." (p. 20) "The failure of the first development decade is attributed simply to an insufficiency of aid appropriations or, worse still, to certain alleged defects inherent in the societies and populations of the developing countries." (p. 141)

situation at a global level [Wackernagel & Rees, 1996]. They argued that the value of this indicator should not exceed the biocapacity of the Earth. As applied to countries, the ecological footprint should remain within the biological capacity (the capacity of ecosystems) of the respective area.

- ***Planetary boundaries***. Johan Rockström and his colleagues developed a more nuanced, multidimensional concept to demonstrate trends in global processes related to natural resources and environmental pollution and their critical planetary boundaries [Rockström et al., 2009]. With their literally 'epochalizing' introduction of the term *Anthropocene*, they suggested the arrival of a new era in Earth's history in which humanity now plays a central role in shaping the planetary environment (i.e., affecting its state and changes) [Crutzen & Stoermer, 2000; Vida, 2012].

New paradigms and theoretical policy options for addressing globalizing environmental problems have emerged since the early 1980s. Subsequently, their different (modified or extended) versions, methods, applicability, and 'limitations' have also been explored. Obviously, the actual international policy impact of some of these concepts has depended to a large extent on the effectiveness/failures of the application of pre-existing policy approaches, as well as on newer environmental observations and model results that identify whether the hazardous phenomena in question are still unresolved (or even strengthening). Another essential consideration for policymakers is the extent to which implementing a new paradigm or policy concept may also lead to other environmental effects and/or have substantially favorable/unfavorable socio-economic implications. Some of these options and considerations are mentioned below that have had a significant impact on the 'world of science,' but only sometimes on international politics.

- ***Globalization was criticized for its adverse environmental and social effects*** by Lester R. Brown, who called for a halt to the trend of globalization and the abandonment of economic policies that generally prioritized growth [Brown, 1981[71]]. A growing number of experts shared his views, and, albeit not in such a potent form, the emphasis on

[71] "[T]he growth in international interdependence may shortly come to an end, reversing a trend that began with industrialization. […] As the eighties begin, there is already in evidence a subtle but unmistakable shift in investment away from that designed to achieve growth and toward that designed to ensure sustainability." (pp. 279–281)

the overriding priority of economic growth has been avoided in the global development and sustainable development programs adopted since the early 1990s [UN, 1990[72]; UN, 1992[73]; Faragó, 2013].

- ***The positive environmental impacts of growth?*** In the same period, it was suggested that there could be positive effects on at least some environmental processes above a certain level of economic growth. This was typically illustrated by the Environmental Kuznets Curve (EKC), which tracks the link between decreasing (income) inequality and growing GDP (beyond some high threshold), as deduced earlier by Simon Kuznets. This simple and apparent correlation was also used to provide environmentally justified support for economic growth, particularly for developing countries [Grossman & Krueger, 1991[74]; Beckerman, 1992[75]]. It has also been subject to considerable criticism in subsequent studies based on more data and more thorough analysis [e.g., Roberts & Grimes, 1997[76]]. In what followed, both adverse and potentially beneficial environmental aspects were better considered in international development programs.
- ***The 'Contraction and Convergence'*** proposal for global climate policies was formulated by Aubrey Meyer in 1990. According to this, atmospheric greenhouse gas (GHG) concentrations should be stabilized

[72] "78. […] But economic growth by itself does not ensure that its benefits will be equitably distributed or that the physical environment will be protected and improved."

[73] "4.11. Consideration should also be given to the present concepts of economic growth and the need for new concepts of wealth and prosperity which allow higher standards of living through changed lifestyles and are less dependent on the Earth's finite resources and more in harmony with the Earth's carrying capacity."

[74] "[W]e find that ambient levels of both sulphur dioxide and dark matter suspended in the air increase with per capita GDP at low levels of national income, but decrease with per capita GDP at higher levels of income […]. Thus, more stringent pollution standards and stricter enforcement of existing laws may be a natural political response to economic growth." (p. 5)

[75] "The main conclusion emerging from the above is that, although in the course of their development some features of the environment in developing countries may get worse, in the longer run they will be able to reverse the trends in more common forms of air pollution, and attain levels of water supply and sanitation essential to an acceptable, decent and healthy standard of living. On the whole, there is a strong positive relationship between income level and environmental quality – at least, as measured by the particular environmental factors noted here." (p. 21)

[76] "[T]he relationship between economic growth and environmental protection should not be seen as necessary or stage-based. Rather than countries passing through stages and eventually reducing their pollution through economic development". (p. 196)

at a safe level, and anthropogenic GHG emissions reduced by bringing average per capita emissions closer [Meyer, 2000, 2004[77]]. This global environmental solution was later promoted as the fair access to and use of natural resources everywhere and for everybody; in other words, the proposal that per capita resource use should be more equitable while total resource consumption should not increase beyond a certain level [UNEP/IRP, 2011[78]].

- ***Development: improving quality should be the priority rather than growth***. The limits of the environment's 'carrying capacity', i.e., its capacity to regenerate and absorb pollution, should not be exceeded according to Herman E. Daly, who argued for development consistent with that requirement. Consequently, the priority should be qualitative improvement rather than the 'dogma' of economic growth [Daly, 1996[79]].
- ***The concept of 'decoupling'*** is less radical from an environmental perspective. It means less increasing (or even decreasing) resource use and pollution in relation to the rate of economic growth. To achieve this, the role of eco-efficiency was emphasized by Stephan Schmidheiny in the volume that is also the founding document of the World Business Council for Sustainable Development (WBCSD) [Schmidheiny, 1992[80]]. However, a distinction must be made between relative and absolute decoupling [Jackson, 2009; Faragó, 2011]

[77] "A full-term contraction budget for global emissions consistent with stabilising atmospheric concentrations of greenhouse gases at a pre-agreed concentration maximum deemed to be safe […]. The international sharing of this budget as 'entitlements' results from a negotiable rate of linear convergence to equal shares per person globally by an agreed date". (p. 190)

[78] "Tough contraction and convergence. […] In this scenario, the level of global resource consumption in 2050 is limited to equal the global resource consumption of the year 2000. It is anticipated in this scenario that metabolic rates of industrial and developing countries converge at around 6 tons per capita." (pp. 29–30)

[79] "Our simple definition is development without growth beyond environmental carrying capacity, where development means qualitative improvement and growth means quantitative increase". (p. 15)

[80] "[T]he decoupling of energy consumption from production growth following the two oil price shocks. Higher energy prices, combined with a drive for efficiency improvements, have meant that while the output of the chemicals industry has more than doubled since 1970, for example, its energy consumption per unit of production has fallen by 57 percent. Furthermore, the combination of ever more efficient resource use and tightening environmental regulation has significantly reduced certain types of pollution." (p. 97)

because, in the former, the environmental burden is not reduced, only the rate of its increase.

- ***Resource efficiency***. In essence, Ernst U. Weizsäcker advocated the same concept, focusing on reducing the environmental impact of economic growth, showing how the same economic performance may be achieved by greatly improving resource efficiency – that is, by reducing resource use by a factor of 4–10 [Weizsäcker, 1997]. This scientifically based methodology and policy option has had a major influence on cooperation within UNEP to the extent that the International Resource Panel (IRP) was created under its auspices in 2007.[81]
- ***'DeGrowth'***. A variety of analyses ('diagnoses') of hazardous or already obviously harmful consequences of continuing economic growth have been conducted and published with various possible solutions ('therapies') for counteracting those consequences, although in general, the need for growth has not been rejected. The authors and promoters of these proposals considered it necessary 'only' to limit the resulting growth-related environmental problems, which may be the reason why approaches based on such compromises have been included in and approved by consensus within most international programs that deal with the development-environment policy nexus. Fundamentally different directions of action are represented by the zero or even 'negative growth' concepts pioneered by Nicholas Georgescu-Roegen, founder of the rather influential 'degrowth' movement [Georgescu-Roegen, 1971, 1975[82]; Kocsis & Harangozó, 2018]. The feasibility of that proposal, its relationship with other paradigms, and its connection with 'strong sustainability' have been examined by many experts [e.g.,

[81] The IRP was established in Budapest; the author of this book participated in this event and provided assistance in its organization.

[82] "[U]ndoubtedly, the current growth must cease, nay, be reversed". (p. 369)

Latouche, 2003[83]; Levallois, 2010; Köves, 2015[84]]. The 'degrowth' concept has also become an integral part of international cooperation in environmental science and environmental economics, but for the reasons mentioned above, it has not been echoed in 'official' international development and environmental policy programs, one of the pillars of which remains the 'indispensability' of economic growth.

In the case of some specific human activities, important scientific findings have also been published, marking a turning point in identifying and assessing their unintentional consequences. Ultimately, these discoveries have led to the elaboration, adoption, and implementation of policies that handle their driving factors and harmful effects.

- ***Depletion of the ozone layer***. In 1985, Joseph C. Farman, Brian G. Gardiner, and Jonathan D. Shanklin, scientists at the British Antarctic Station, published the results of their observations about the decrease in the stratospheric ozone concentration over the Antarctic [Farman et al., 1985]. This ended the doubt about the danger of emissions of chlorofluorocarbons (CFCs) and other 'ozone-depleting substances' and resulted in the intensification and conclusion of international negotiations on protecting the ozone layer (Montreal Protocol, 1987).
- ***Environmental acidification*** caused by emissions of sulfur dioxide "as a result of increasing use of sulfurous fuels," its long-range atmospheric transmission, and the acid precipitation, and acidification in the Scandinavian region were revealed by Svante Odén and precisely described in a paper [Odén, 1968]. This was preceded for many years and even followed for several more by heated debate about the possibility/impossibility of the respective cause-effect relationship by many experts. Eventually, this transboundary air pollution problem was addressed by a pan-European convention in 1979, which, after a few

[83] "[L]a société de croissance n'est ni soutenable ni souhaitable. Il est donc urgent de penser une société de 'décroissance' si possible sereine et conviviale. […] Le mot d'ordre de décroissance a surtout pour objet de marquer fortement l'abandon de l'objectif insensé de la croissance pour la croissance."

[84] "[E]cological economics is a quest to overcome the primacy of economic growth both in theory and in practice. The extent of self-restraint and the path to transform the current economy into one that respects boundaries varies significantly among ecological economists from Daly's steady state economy (1977) to Latouche's de-growth (2011). These are the two most important theoretical directions that exist in ecological economics." (p. 22)

years, was followed by a series of complementary legal instruments that already included concrete emission reduction goals and commitments (from 1985 onwards).

- ***Climate change***. Guy S. Callendar published detailed calculations of the link between the enhancing atmospheric carbon dioxide emissions ("due to the artificial production" of that gas from fossil fuel combustion during the preceding several decades) and rising mean surface temperatures [Callendar, 1938]. Two decades later, he repeated the analysis based on more precise data and reconfirmed that correlation [Callendar, 1958]. At the same time, Bert Bolin and Erik Eriksson demonstrated that the environmental carbon cycle is much more complex, therefore, a longer period was needed to ascertain the carbon dioxide build-up rate in the atmosphere and assess its implications [Bolin & Eriksson, 1958]. Nevertheless, the studies mentioned above and a few others catalyzed the growing interest in the various natural and human factors potentially influencing global climatic conditions. Finally, the policy-making community acknowledged this hazard and approved a global convention to "protect the climate system for the benefit of present and future generations of humankind" in 1992.
- ***The waste problem***. Vance Packard drew attention to the huge volume of waste from rapidly expanding production and consumption activities, primarily in developed countries [Packard, 1960]. He could not foresee that in the coming decades, not only would waste production and its 'unpleasant' effects become a global-level challenge, but the international 'waste trade' would also begin to develop at a rapid pace. The latter often meant simply getting rid of the hazardous waste generated in some developed countries – that is, transporting that waste to developing countries 'for disposal.' It took a long time for the international community to control (halt or at least restrict) this practice using global regulations from the late 1980s onwards.
- ***Mercury and its compounds*** have long been used for multiple purposes since the ancient times without realizing their toxic effects. The latter were systematically confirmed and taken much more seriously only after the mass poisoning cases in Japan and Iraq in the middle of the previous century. Moreover, it was not until the late 1970s that mercury was recognized as a global-scale health and environmental hazard by Anders W. Andren, Jerome O. Nriagu, and Cyrill Brosset in their

publications [Andren & Nriagu, 1979; Brosset, 1982]. Even after these 'landmark' research reports, it took three more decades before a global agreement on the gradual phase-out of mercury was elaborated and then approved [Faragó, 2015].

- ***In the context of natural resources***, we have referred to the analyses and conclusions published by the Club of Rome and Ernst F. Schumacher [Meadows et al., 1972; Schumacher, 1973], but this problem area became much more critical when the countries of the developing world began to assert their own natural resource needs and interests concerning fair conditions for international trade (i.e., regulations on the export of such resources from their countries) more forcefully. In this respect, the OPEC countries' strong position and decisive action are particularly noteworthy [Brown, 1981[85]]. The Brundtland Commission in its report, which in some respects created the foundation of multilateral cooperation for sustainable development, pointed to the need for a substantial change in the relationship between developed and developing countries, including in the areas of the exploitation of and trade in natural resources [WCED, 1987[86]].

[85] "During the late sixties and seventies, the developing countries had been pressing for a new international economic order, one that would improve both their international terms of trade and their access to investment capital and technology. While these countries, organized as the Group of 77, were calling for a new international economic order, the 'Group of 13' OPEC was in fact implementing one." (p. 66); "With slower growth in prospect for the industrial societies, developing-country dependence is thus ultimately an economic dead end. Faced with this clearly untenable situation, developing countries would seem to have little choice but to decouple their economies gradually from those of the industrial countries and to concentrate instead on expanding their trade and investment ties with each other." (p. 276)

[86] (17.) "Over the past few decades, life-threatening environmental concerns have surfaced in the developing world. […] developing countries just operate in a world in which the resources gap between most developing and industrial nations is widening, in which the industrial world dominates in the rule-making of some key international bodies and in which the industrial world has already used much of the planet's ecological capital." (62.) "Industrialized countries must recognize that their energy consumption is polluting the biosphere and eating into scarce fossil fuel supplies. […] The simple duplication in the developing world of industrial countries' energy use patterns is neither feasible nor desirable." (63.) "immediate needs include modifying the pattern of world trade in minerals to allow exporters a higher share in the value added from mineral use, and improving the access of developing countries to mineral supplies, as their demands increase."

Environmental movements. Assessments published since the 1960s, based on more and more observational data concerning activities harmful to the natural environment, have led not only to the development of international cooperation in environmental science, national and international policies and measures but also to the strengthening of environmental movements. The related organizations have played an increasingly significant role in many countries, moreover, becoming influential international (f)actors in global-level nature conservation and environmental protection efforts.

- Since the 1970s, some previously established nature conservation organizations such as BirdLife International (BLI), the International Union for Conservation of Nature (IUCN), and the World Wide Fund for Nature (WWF) have been actively involved in shaping international environmental policy.[87] This was exemplified by the support for the creation and implementation of programs and legal instruments such as the *Ramsar Convention* (1971), *CITES* (1974), and the *European Birds Directive* (1970).
- The same period also saw the launch of the 'Earth Day' movement (1970) and the formation of non-governmental organizations such as Friends of the Earth (1971) and Greenpeace (1971), which later became global networks and strongly influenced environmental protection affairs at the global level.[88]

2.1.2. Levels of scientific certainty/uncertainty and precaution

The scientific exploration of natural systems is a gradual process, especially when researching large-scale, complex systems that involve many variables (external driving/forcing factors, internal processes, and feedback mechanisms). In such cases, it is the formulation, verification, justification and/or rejection of various hypotheses and the clashes of arguments and counter-arguments by scientists that have led and continue to lead to a better understanding of such systems, their behavior, and their potential/assumed future states.

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[87] These organizations are referred to here by their present names.

[88] The author of this book was a staff member ('policy officer') of WWF-Hungary in 2000 and many years ago joined the Hungarian member organization of the Friends of the Earth (Foe-Hungary: National Society of Conservationists).

In this cognitive process, raising doubts about the validity of an explanation or creating a theory to help explain an environmental problem and its cause-effect relationship(s) is in line with the famous statement expressed by Denis Diderot – namely, that "skepticism is the first step towards truth" (Diderot, 1746).[89] Quite a few concrete environment-related examples can be cited of when one of the contending parties firmly appealed to the revealed facts (observations, measurements, etc.), which approach may be referred to as 'eppur' argumentation [Faragó, 2018[90]].

In scientific communication about the investigation of complex environmental phenomena, it is also essential to state and confirm the 'level of justification' of (level of confidence in) findings and/or the degree of remaining scientific uncertainty, and depending on this, to formulate claims and conclusions accurately but carefully. There may be multiple objective causes and sources of such uncertainty. Their proper understanding and indication are essential, mainly because of the implications for the legislative and decision-making process [Sulyok, 2018, 2020[91]].

Determining and communicating the level of certainty or uncertainty of scientific assessments and conclusions is not only a credibility issue for scientists, but awareness of this information is essential for decision-makers and the public.

- To provide a correct and consistent indication of such certainty/uncertainty levels, the Intergovernmental Panel on Climate Change [IPCC, 2010] has adopted a very detailed set of guidelines that

[89] Diderot, D., 1746: Pensées philosophiques ("Le scepticisme est le premier pas vers la vérité").

[90] "In the debate between Robert A. Kehoe, who asserted the harmlessness of emissions from lead additives, and Clair C. Patterson, who warned of serious effects, the latter's 'intransigence' – in line with the saying attributed to Galileo Galilei – could also be called an 'eppur' argument, according to which stubborn facts must be accepted." (p. 1292)

[91] "Scientific uncertainty is not the same as the lack or inconsistency of relevant evidence, as the colloquial meaning of uncertainty would suggest. […] Emphasizing the true nature of scientific uncertainty in the context of environmental liability is also particularly important because legal decision-makers – legislators and law enforcers – can sometimes misunderstand the true nature of uncertainty, which can lead to them setting unfulfillable criteria against scientific results. According to these criteria, the experts in their opinions, which can be considered legally binding, must prove beyond doubt the causal relationship between the user of the environment and the pollution caused." (p. 69)

specifically emphasize the need to communicate the degree of plausibility of knowledge and certainty of findings and statements about potential risks (associated with changing climatic conditions): "Sound decision-making [...] depends on information about the full range of possible consequences and associated probabilities. Such decisions often include a risk management perspective. Because risk is a function of probability and consequence, information on the tails of the distribution of outcomes can be especially important." This guidance also recommends that a set of terms and categories be consistently used to present the degree of certainty and scientific consensus.[92]

- These communication requirements and procedures should apply to all complex global environmental problems. However, the specific means of doing this depends on many factors, as reflected, for instance, in recent global environmental reports [UNEP/GEO, 2019; IPBES, 2019].

The precautionary principle is closely linked to the level of scientific certainty/uncertainty outlined above. This is particularly valid in the relationship between environmental science and environmental policymaking.

- In the context of international environmental cooperation, 'precaution' (the precautionary principle) is generally understood as defined in 1992 at the UN Conference on Environment and Development: "[W]here there is a threat of serious or irreversible damage, the absence of full scientific certainty should not be used as a justification for postponing cost-effective measures to prevent environmental degradation" [UN, 1992].
- The application of this principle has played an important role in setting targets and defining commitments associated with several multilateral agreements. However, there are severe doubts about the interpretation of 'cost-effectiveness' in this context because the latter criterion depends on how the use of the relevant natural resources and ecological services

[92] "8. Use the following dimensions to evaluate the validity of a finding: the type, amount, quality, and consistency of evidence (summary terms: limited, medium, or robust), and the degree of agreement (summary terms: low, medium, or high). […] 9. A level of confidence is expressed using five qualifiers: very low, low, medium, high, and very high. […] 10. Likelihood provides calibrated language for describing quantified uncertainty. It can be used to express a probabilistic estimate of the occurrence of a single event or of an outcome".

are evaluated and how potential/actual environmental and socio-economic risks and adverse impacts are taken into account [Driesen, 2013[93]]. Consequently, consideration of the application of 'precaution' to global environmental problems ought not to be limited only to narrow and short-term economic or cost-effectiveness estimates.

2.1.3. Sustainability: various theoretical concepts and interpretations

The notion of 'sustainability' is an old one, even if variations of this term have been used to express the same aspects in various disciplines/sectors and languages (e.g., in forestry, agriculture, and ecology). However, in the age of globalization, especially since the 1980s, its meaning has become much more widely used and interpreted in many contexts. We focus here on research areas (and then science-based policies) grounded on the narrower concept of 'environmental sustainability' and the broader concept of 'sustainable development,' which have become the foundations of more or less independent scientific disciplines. The former, in essence, means socio-economic development that 'ab ovo' takes into account environmental conditions and stringent requirements for protecting the natural environment and (sustainable) use of its resources. In contrast, in the latter approach, the broad system of interactions between social, economic, and environmental processes are considered, albeit more generally, with the priority on (sustainable) social development besides striving for 'harmony' among these three pillars/dimensions of (sustainable) development.

What should be sustained in first place? First and foremost, we need to look at the main scientific ideas about sustainability that have emerged to address the problems identified in connection with globalization processes that have also become global in scope and are considered to have hazardous or 'unsustainable' consequences. These are based on a variety of interpretations of what should primarily be sustained and what is meant by sustainability and sustainable development.

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[93] "Quantitative risk assessment poses many problems for CBA (cost-benefit analysis). Often, science does not generate data sufficient to support a responsible quantitative estimate of predictable and serious consequences, even qualitatively well-understood ones. As a result of this frequent inability to quantify qualitatively well-understood impacts, the CBA calculations used to formulate environmental policies simply leave out information about important abatement benefits. […] Moreover, significant uncertainties about future consequences' magnitude make quantification problematic, even when some information exists that can permit quantitative risk assessment." (pp. 777–778)

- ***Understanding development***. The participants of an international conference of social, environmental, and economic scientists in 1974 identified the causes of the world's social problems above all in adverse changes in the relations between societies and in environmental conditions, which primarily evolved due to an inappropriate development path, economic growth objectives and programs (Cocoyoc, Mexico, October 1974). As a result, a review of the purpose of development was proposed at this meeting [UNCTAD-UNEP, 1974][94]. In the same spirit, Lester Brown expressed his views on the changes in economic development priorities, population trends, production processes, and consumption patterns necessary to accomplish sustainable social goals while taking into account environmental factors [Brown 1981][95].
- ***Environment-centered and economy-centered concepts of development*** have been based on quite different ways to achieving social sustainability associated with the universal provision of decent living conditions. Even early experiences from the mid-twentieth century signaled the significant environmental implications of globalizing socio-economic processes such as the 'population explosion,' rapidly growing international trade, and the increase in investment projects in many developing countries during the first UN Development Decades. (These decadal programs aimed to facilitate economic development in the developing world and establish a new basis for cooperation between developed and developing countries.) The expert meeting held in June 1971 (Founex, Switzerland) on this subject concluded that the objectives and directions of development – including those of international development cooperation – must be reconciled with environmental

[94] "Our first concern is to redefine the whole purpose of development. This should not be to develop things but to develop man. Human beings have basic needs: food, shelter, clothing, health, education. Any process of growth that does not lead to their fulfilment – or, even worse, disrupts them – is a travesty of the idea of development. […] We recognize the threats to both the 'inner limits' of basic human needs and the 'outer limits' of the planet's physical resources. […] We believe that ways of life and social systems can be evolved that are more just, less arrogant in their material demands, more respectful of the whole planetary environment."

[95] "Creating a sustainable society will require fundamental economic and social changes, a wholesale alteration of economic priorities and population policies. The magnitude of these changes is scarcely in question. Every facet of human existence, diet, employment, leisure, values, politics, and habits will be touched." (p. 8) "A sustainable society will differ from the one we now know in several respects. Population size will more or less be stationary, energy will be used far more efficiently, and the economy will be fueled largely with renewable sources of energy." (p. 247)

considerations [UN, 1971]. The proposals agreed at that meeting substantially impacted the outcome of the 1972 UN Conference (UNCHE). In general, the views on development (its priorities and most essential prerequisites) represented by environmentalists and most economists have remained either quite contradictory or have overlapped to only some extent, particularly with regard to the environmental aspects of economic development, and rejection/support of the need for ('sustained') economic growth. Michael Redclift has dealt with several such approaches, finding that they all might have a rational direction only if their representatives take a broader view that includes acknowledging the requirement of the sustainability of development [Redclift, 1987][96]. The World Commission on Environment and Development completed its report in 1987, in which this dichotomy was also discussed but the members of that body ultimately concluded that economic growth was absolutely essential,[97] which position was also reconfirmed by the 1992 UN Conference on Environment and Development.

- ***Studies on these themes by Hungarian researchers***, appeared after the publication of and obviously under the influence of the above-mentioned report and the outcomes of that historic UN Conference. György Enyedi referred to the 'economically biased' interpretation of sustainable development, which he described as a contradiction in terms – "the growth paradigm that plunders natural resources" must be changed, but "growth itself can be maintained" through more effective environmental protection [Enyedi, 1994].[98] The diversity of answers to

[96] "Sustainable development requires a broader view of both economics and ecology than most practitioners in either discipline are prepared to admit, together with a political commitment to ensure that development is 'sustainable'. The practical implications of such a position are important and cannot easily be avoided. It is possible to undertake environmental planning and management in a way that does minimum damage to ecological processes without putting a brake on human aspirations for economic and social improvement?" (p. 33)

[97] "We see instead the possibility for a new era of economic growth, one that must be based on policies that sustain and expand the environmental resource base. And we believe such growth to be absolutely essential to relieve the great poverty that is deepening in much of the developing world." [WCED, 1987: IV.3.]

[98] The meeting of the Committee of Environmental Science of the Hungarian Academy of Sciences (HAS) in 1994, was devoted to sustainable development; several papers based on the lectures were published in the October 1994 issue of the journal of the HAS: György Enyedi's article referred to above, Rudolf Czelnai's treatise on the sustainability 'challenge' [Czelnai, 1994], Csaba Mátyás's paper on the importance of forests and sustainable forestry [Mátyás, 1994], and the essay by György Major, Tibor Faragó and Tamás Pálvölgyi on global atmospheric problems [Major et al., 1994].

the question ‘what should be the priority for achieving sustainability?’ in the context of ‘greening’ economic activities is presented by Sándor Kerekes and József Kindler as follows: “One way is perceived by the philosopher who classifies it as a shift from a human-centered system to an ecocentric system, another by the ecologist who professes to preserve the integrity of ecosystems, another by the sociologist who evaluates the process of the transformation of social institutions, another by the economist who discusses the ‘internalization of externalities,’ another by the natural scientists, and so on.” [Kerekes & Kindler, 1997] Whichever interpretation is considered, it is useful first of all to clarify what ‘unsustainable processes’ have emerged and strengthened and why, and which require urgent intervention at global, regional, and national levels to curb them. By the 1990s, it had become clear that – in the process of inventing and applying newer, even more effective economic instruments – the operation and management of the economy at the global level must take account of the threat to the environment [Szlávik & Valkó, 1991, 1995[99]]. The need to clarify and take account of the interaction between development and the environment and enforce sustainability requirements also became apparent in changing domestic circumstances [Bulla/KTM, 1992[100]; Faragó, 1999[101]]. Nevertheless, the representatives of the two main trends in economics – environmental economics and ecological economics – which were developed to research the environmental factors associated with economic development and the options for resolving global and/or national-level economy-environment

[99] “There can be no doubt that a sustainable world economy should operate within the framework provided by the global ecological system of our planet. […] The signs of environmental tensions testing the tolerance of the ecological system can now be seen everywhere on Earth; their reasons are obvious: the exponential growth of the population and economic activity, the finiteness of the natural resources that provide their basis, and the reduction of their ability to renew.” (1995: p. 14)

[100] “Instead of unlimited growth and maximum consumption, we must strive for sustainable development in harmony with the natural environment.” (p. 63)

[101] “One of the basic goals of our 1995 act on environmental protection was ‘to ensure the environmental conditions of sustainable development’ and in accordance with this, the act also included the relevant principles. […] The environmental action program of the European Community and the national environmental protection program were also already based on these principles. In addition to the above, the latter clearly indicated that according to sustainable development, the quality of human life is to be improved while the natural resources and life supporting ecosystems remain within their carrying and renewal capacities.”

'collisions' judged the significance of the environmental factors of sustainability quite differently [Kocsis, 1999].

- Following the 1992 UN Conference, several international organizations also dealt with interpreting and extending sustainable development principles, including an expert group of the UN Commission on Sustainable Development and the International Law Association. Primarily based on the latter's statement on this issue, Gyula Bándi, Ákos Szalai, and Marcell Szabó considered that the most important principle from the point of view of sustainable development is probably the principle of integration, according to which the obligation to protect the environment must be included in all social policy measures [Bándi et al., 2014].[102] But let us quote a particularly clear thought on the relationship between environmental protection and economic development, as expressed by Tamás Pálvölgyi: "The accumulation of environmental damage beyond some limits across borders can become an obstacle to economic growth and prosperity, the wasteful use of natural resources can undermine competitiveness and weaken the potential for social cohesion. Natural resources are key components of economic performance, and their decline and degradation can increase economic disadvantage." [Pálvölgyi, 2004]

The formulation of the requirements for global environmental sustainability – and, in that context, the related sustainability criteria for society and economy – has been guided by analyzing environmental processes (and their cause-effect relationships) that appeared to be hazardous even at the global level. Among the key anthropogenic factors catalyzing such unsustainable environmental processes, the population explosion, accelerating economic growth, and the exploitation of various natural resources were identified. This was followed by recognizing the threats from the environmental releases and long-range transport of increasingly large volumes of pollutants. These processes and their

[102] "The principle of integration is perhaps the most important principle set out in the New Delhi Declaration. The principle points to the significance of the interplay and correlation of economic, financial, environmental and human rights aspects of relevant international legal principles and rules. According to the principle of integration, the imperative of the protection of the environment must be included in all social considerations and policies determining state actions. Environmental protection should not remain at the level of particularity, it should much rather radiate in all actions of the state." (p. 18)

research began to unfold rapidly from the middle of the last century, but the need to address problems arising from the depletion/degradation of biotic and other natural resources was recognized long before that [Vernadsky, 1926; Kaán, 1932; Hotelling, 1931[103]]. Alongside the notion of 'environmental sustainability' (i.e., in parallel or symbiosis with it), the concepts of a 'sustainable society' and 'sustainable economy' (sustainable economic development and sustained economic growth) began to mature within the framework of scientific disciplines such as environmental sociology, human ecology, environmental economics, and ecological economics.

- ***Demands for natural resources***. The conclusion drawn from assessing and projecting the limits to economic development imposed by finite or only conditionally renewable natural resources is that the established development pattern ('business as usual') cannot be continued. Regarding the most 'successful' countries in terms of economic growth, their economic development has been accompanied not only by the exploitation of their own such resources but also by a rise in their demand for resources available elsewhere, i.e., those located in territories under the jurisdiction of other countries or in areas beyond national jurisdiction. When these tendencies are generalized to the global level, it leads to a worrying vision of the future. The former refers, for example, to wealth derived from colonies [Mahatma Gandhi as quoted by Bawa, 1996[104]], and the latter to the rapid rate of resource depletion and deepening international conflicts that can result from the unregulated exploitation and overuse of such 'global commons' [Hardin, 1968[105]; Meadows et al., 1972[106]].

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[103] "Contemplation of the world's disappearing supplies of minerals, forests, and other exhaustible assets has led to demands for regulation of their exploitation. […] The method ordinarily proposed to stop the wholesale devastation of irreplaceable natural resources, or of natural resources replaceable only with difficulty and long delay, is to forbid production at certain times and in certain regions or to hamper production by insisting that obsolete and inefficient methods be continued." (p. 137)

[104] "It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require!" (p. 3048)

[105] "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all." (p. 162)

[106] "The outcome can only be disaster […]. The world system is simply not ample enough nor generous enough to accommodate much longer such egocentric and conflictive behavior by its inhabitants. The closer we come to the material limits to the planet, the more difficult this problem will be to tackle." (p. 192)

- ***Environmental pollution***. Increasing emissions and the spread and accumulation of pollutants in the environment have become more distinguishable since the 1970s, as have improvements in the detectability of their adverse effects (e.g., in the case of sulfur dioxide or toxic chemicals). Therefore, in addition to the rapidly expanding use of natural resources, the environmental releases of various harmful substances have 'caught up with' and strengthened the other disadvantageous consequences of globalization. These growing environmental pressures have been particularly evident with the combustion of a large amount of fossil fuels, the exploitation of a multitude of other natural resources, and the production of a diversity of synthetic chemicals [Schumacher, 1973[107]; Daly, 1977[108]; Daly, 1980]. Are all these the inevitable 'collateral phenomena' of economic growth?
- ***Globalizing anthropogenic environmental effects*** can be more precisely assessed thanks to extending and denser monitoring networks and better computers for information processing and numerical modeling [Láng, 1980[109]; Brown, 1981[110]]. The threats arising from

[107] "If we squander our fossil fuels, we threaten civilisation; but if we squander the capital represented by living nature around us, we threaten life itself. […] why it is that all these terms – pollution, environment, ecology etc. – have so suddenly come into prominence. After all, we have had an industrial system for quite some time, yet only five or ten years ago these words were virtually unknown. […] Our scientists and technologists have learned to compound substances unknown to nature, against many of them, nature is virtually defenceless. […] It is only in the last twenty years or so that they have made their appearance in bulk. Because they have no natural enemies, they tend to accumulate, and the long-term consequences of this accumulation are in many cases known to be extremely dangerous, and in other gases totally unpredictable." (p. 7–8)

[108] "As more people transform more raw materials per person into commodities, we experience higher rates of depletion; as more people transform more commodities into waste, we experience higher rates of pollution." (p. 9)

[109] "The development of the last fifty years and the adverse consequences of the environmental degradation that has accompanied it have become apparent in the last 8-10 years. Political, state and science leaders worldwide have recognized the need for caution [...]. For the first time, they have realized that the fate of humanity is at stake, even in peaceful conditions." (p. 16)

[110] "Viewed in per capita terms, global resource trends are both illuminating and disturbing. They show the relationship between multiplying human numbers and the carrying capacity of the earth's life-support systems, a relationship that has received too little attention. But they also show that expanding human demands are becoming unsustainable." (pp. 49–50)

socio-economic development approaching the 'ecological carrying capacity' of our planet, often referred to as the risk of global or Earth 'overshoot' of this capacity limit was described by William R. Catton as long as four decades ago [Catton, 1982[111]]. Alongside the signs of hazards arising from the unsustainable use of natural resources and environmental pollution, the associated social, economic, and sectoral problems, which are now global in scale, have also become increasingly discernible and assessable [Ward, 1976[112]; Brown & Wolf, 1986[113]]. Identifying processes considered unsustainable has been followed by discussions about the requirements for environmental sustainability and the ways and means of attaining it. At the same time, scientific publications on measures and instruments for achieving a 'sustainable society' and 'sustainable economy' have proliferated.

The idea of social sustainability cannot be separated from identifying the basic environmental conditions required for human needs, such as a healthy environment and access to the natural resources essential for a decent life. In addition to the care of the environmental conditions that ensure adequate living conditions/standards for all members of present generations (i.e., 'intra-generational equity'), the preservation of appropriate environmental conditions – maintaining environmental

[111] "The growth and progress upon which we looked back with such pride had committed mankind to living on a scale that exceeds the sustainable carrying capacity of this finite planet, and the leaders of nations continued to devote far more effort toward attempting to prolong overshoot than toward undoing it. Reluctance to face facts was driving us to make bad matters worse. […] Yet most contemporary political proposals for solving problems of economic stagnation or inequity amount to plans for speeding up the rate of drawdown of non-renewable resources." (p. 38)

[112] "Mankind is in fact engaged in a kind of race for survival between the inner and outer boundaries of social pressure and physical constraint while the doubling of the world's peoples and emergence of a half-urban world takes place in only four decades." (p. 9) "We have at least reached the point of talking together about the great common tasks of humanity preserving our living environment, feeding the hungry, giving shelter to all our fellow creatures, treating with greater care and fraternal sharing the fundamental resources of water, of minerals, of energy, upon which our common life depends." (p. 249)

[113] "Throughout much of the period of rapid global economic expansion since World War II, economists have been able to ignore ecological concepts such as carrying capacity, largely because the human demands on biological systems were well below their sustainable yields. With the quadrupling of world economic activity since midcentury, however, human demands are beginning to exceed sustainable yield thresholds in country after country." (p. 38)

sustainability – is also a prerequisite for ensuring such well-being opportunities for future generations (i.e., 'intergenerational equity').

- ***Studies of development that took account of the actual needs of society*** offered an alternative to approaches that emphasized economic growth for meeting continuously increasing demands at the 'expense' of natural resources [Brown, 1981; Daly & Cobb, 1989]. The analyses published in the above-mentioned annual volumes of the Worldwatch Institute (WWI) since 1984 [Brown et al., 1984[114]] focused on the issues of social sustainability and its environmental aspects and the relevant directions for development and courses of action.
- ***Environmental conditions for the well-being of present and future generations***. Much earlier than the authors mentioned above, Kenneth E. Boulding illustrated the difference between an 'open economy' with unlimited environmental resources and a 'closed economy' based on the 'circulation' of resources and the difference between a society concerned only with its own living conditions in the present ("After us, the deluge") and one that takes into account the needs of future generations [Boulding, 1966]. He argued for the latter so that in the course of global economic processes, environmental conditions should be taken into consideration – that is, the environmental limits of the planet as a closed system, both in terms of resources and harmful emissions.[115] Consequently, production, consumption, and material flows should be controlled accordingly.
- ***Circular economy***. The 'pattern' of economic operations as a criterion of social sustainability presented by Boulding played an important role in further elaborating the 'circular economy' model. David W. Pearce and his co-authors, through a detailed analysis of the relationship between the economy and the environment (and moreover, the social and economic functions/services provided by the natural environment)

[114] "State of the World" reports (Worldwatch Institute Report on Progress Toward a Sustainable Society) have been published annually since 1984.

[115] "I am tempted to call the open economy the 'cowboy economy', the cowboy being symbolic of the illimitable plains […]. The closed economy of the future might similarly be called the 'spaceman' economy, in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution […]. Why should we not maximize the welfare of this generation at the cost of posterity? 'Après nous, le déluge' has been the motto of not insignificant numbers of human societies. The only answer to this, as far as I can see, is […] that the most satisfactory individual identity is that which identifies not only with a community in space but also with a community extending over time from the past into the future …". (pp. 4–6)

defined the main characteristics of the 'circular economy' versus the 'linear economy' [Pearce & Turner, 1990[116]]. They also introduced the concept of the 'green economy' [Pearce et al., 1989; Pearce, 1992[117]; Turner et al., 1993[118]]. These models did not articulate only the proper functioning of the economy and its crucial environmental conditions, but ultimately, how to achieve and maintain a good quality of life. The relevant objectives were defined as follows: "the end purpose of the economy is to create utility" for society, "non-declining human welfare," and "to generate wellbeing."[119] This model attracted many proponents, both along more 'anthropocentric' (social sustainability) and more environmental lines (environmental sustainability). The results of further research based on the 'strong environmental sustainability' requirement [e.g., Pearce & Atkinson, 1992] subsequently significantly influenced international scientific cooperation and environmental movements but had a much smaller impact on global high politics. However, the 'circular economy' as well as the 'green economy' models have been widely recognized; they have been interpreted and referred to in many ways as fundamental elements of ecological economics [Rizos et al., 2017; Prieto-Sandoval & Ormazabal, 2018;

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[116] "Boulding's essay was pointing to the need to contemplate Earth as a closed economic system: one in which the economy and environment are not characterised by linear interlinkages, but by a circular relationship. Everything is an input into everything else." (p. 38) "The three economic functions, resource supply, waste assimilation and aesthetic commodity, can be regarded as components of one general function of natural environments – the function of life support. Some sort of existence might be imaginable without most natural resources, though not without all of them. But for the foreseeable future we need to survive and, more so, we need them to fulfil human values." (p. 41)

[117] "A green economy is one that has the capability of replicating itself on a sustainable basis. […] while the form of an economy changes over time, its chances of self-replication will greatly increase the lower is the ratio of materials and energy to economic output over time. […] This green economy is therefore consistent with non-declining human welfare and with the sustainable use of natural resources." (p. 4)

[118] "A green economy must, over time, evolve in such a way as to decouple the growth in economic output (activity) from the environmental impacts of that activity." (p. 29) "A more difficult task is to determine the necessary and sufficient conditions for achieving SD. […] this generation makes sure that it leaves the next generation a stock of capital no less than this generation has now. Capital provides the capability to generate wellbeing […] through the creation of goods and services upon which human wellbeing depends." (p. 55)

[119] [Pearce & Turner, 1990; Pearce, 1992; Turner et al., 1993]

Kerekes et al., 2018[120]]. These models are now taken into account in the implementation of international environmental and economic policies and sustainable development programs [UN, 2012a; UN, 2012b; UN, 2015; EC, 2020].

Sustained economic growth (being the opposite of the above 'strong sustainability' orientation) has been considered by other authors as absolutely essential for society, but they also thought it feasible to combine the goals of environmental sustainability with this economic development path using various economic, technological, and regulatory interventions.

- After a thorough critique of the earlier proposals, Harold J. Barnett and Chandler Morse, drawing on more recent data, found that economic growth also brings with it ways of solving the resulting environmental problems; above all, those related to the depletion of natural resources (for example through greater resource efficiency) [Barnett & Morse, 1963[121]].
- Joseph E. Stiglitz, who later won the Nobel Memorial Prize in Economic Sciences, argued for ensuring an optimal rate of economic growth, taking into account the availability of finite and exhaustible natural resources [Stiglitz, 1974[122]]. This scientific trend gained in strength and, from the late 1980s onwards, became a vital element of the global economic, trade, development, and sustainable development programs adopted under the auspices of the United Nations and other intergovernmental organizations. The necessity and promotion of economic growth were and remained a basic premise for these programs, but the related environmental aspects, consequences, and tasks (including those stemming from the 'polluter pays' principle and the integration of 'environmental externalities') have always been addressed in some detail and depth.

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[120] "One of the main efforts of ecological economics is to 'stop' energy and matter throughput, and turn economic activity into – or come as close as possible to – a 'circular' process, as seen in nature." (p. 21)

[121] "The process of growth thus generates antidotes to a general increase of resource scarcity. […] Induced resource-saving technology includes all ways of reducing waste, increasing the efficient recovery of scrap, extending the life of durable products, reducing the resource content of existing products, developing less resource-intensive new products, increasing the efficiency of engines and processes, and so on." (p. 240)

[122] "We have analysed a model of economic growth in which national resources are exhaustible, in limited supply, and essential for production. If one views the simple model presented as a reasonable first approximation, not only is sustained growth in consumption per capita feasible, but the optimal rates of utilization of the resources …" (p. 136).

- The economic theories of sustainable development have also attracted the attention of Hungarian researchers. The basic outcomes of such studies are of particular interest to us, primarily from the point of view of environmental globalization. According to Sándor Kerekes, the premises of 'weak sustainability' and even 'strong sustainability' raise doubts in the minds of ecologists and ecological economists [Kerekes, 2012[123]]. Tamás Kocsis, in a review of the history of theories of economics concerning the relationship between the environment and society, concluded that both main schools of thought (namely, environmental economics and ecological economics), "attempt to alleviate or solve the problems of the natural environment caused by human activity" [Kocsis, 1999]. As a final thought, however, he takes a stand in favor of the latter: "If humanity recognizes the meaning of its own existence on Earth, and its values and preferences are formed accordingly […], then the recommendations of ecological economics, which presuppose the transcendence of raw materialism and selfishness on the part of human beings, will no longer be so frightening for the majority. Then the replacement of current economic views may occur." György Málovics and Zoltán Bajmócy, and later Gábor Harangozó, Mária Csutora, and Tamás Kocsis, also discussed the difference between these two main theoretical trends in economics. They concluded that the paradigm of environmental economics needs to be overcome as soon as possible if economics is to make a real

[123] "For understandable reasons, ecologists and natural scientists in general do not accept the substitutability of elements of natural capital and thus weak sustainability, and even have problems with strong sustainability, since it presupposes some substitutability of natural capital. The majority of ecological economists insist that strict sustainability must not lead to irreversible changes in nature (e.g., species extinction). This condition cannot, of course, be met in practice, and thus ecological economists and their followers end up with a concept on which environmental policy cannot be built." (p. 19) This conclusion was reiterated in a later study [Kerekes et al., 2018]: "Ecologists (and scientists in general) for obvious reasons reject the idea that capitals are interchangeable and thus the concept of weak sustainability; moreover, they also have problems with strong sustainability since the latter also allows for compensation and interchangeability within the realm of natural capital." (p. 33)

contribution to sustainable development [Málovics & Bajmócy, 2009[124]; Harangozó et al., 2018[125]].

Sustainability science has partly combined and partly transcended pre-existing concepts and approaches to sustainable development promoted by different disciplines. Besides these particular scientific trends, the need for an interdisciplinary research into conditions of the long-term 'stable' (balanced or harmonious) relationship between society and the environment was recognized in the second half of the 1980s. The scientific community was confronted with the fact that interventions based on then-prevailing sustainable development theories had not proved sufficiently effective and that many global environmental and social processes had reached an even more critical stage than before. These included continuing global population growth (albeit at a somewhat reduced rate), rapidly increasing environmental degradation, widening global inequalities in human livelihoods, and disparities in quality of life (also largely dependent on many environmental factors such as access to safe drinking water). István Láng put it this way: "The 1980s saw a major shift in perception: it became clear that environmental degradation was not only a regional but already a global problem, most of the damage that had been caused could be eliminated only over a long period, and the nature of the problem was complex: it involved natural, economic and social elements. [...] However, on a global scale, the depletion of resources and environmental degradation has continued, mainly due to the growth of the world population, urban overcrowding (due to the continuing influx of people), and the persistence of material- and energy-intensive consumption patterns. [...] an interconnection between the environmental, economic, and social spheres is emerging. This implies a fundamentally new way of thinking and approaching the problems." [Láng, 2001]

- First and foremost, the need to reconsider the relationship between society and environment, rethink the purpose of social development, and redefine global sustainability has emerged. Achieving a 'sustainable

[124] Ecological economics "sees the causes of environmental problems as going much deeper than a market failure problem […]. This does not mean that, in the view of ecological economics – which we believe to be well founded – there are already precise scientific-social answers to make progress towards sustainability at present. It merely means that the effectiveness of the solutions of the current environmental economic paradigm is very limited, and that much more complex and profound changes than those suggested by them are needed, based on our present knowledge, if the ultimate societal goal is to achieve a state of sustainability." (p. 479)

[125] "Whether it is positive, zero or negative growth that is most appropriate for creating a sustainable future, the present conventional growth paradigm must be changed as soon as possible." (p. 179)

world' presupposes the proper functioning of the ecological systems that support the needs of present and future human generations. Therefore, it is also essential to ensure the sustainability of these systems and their 'ecological services' [Brown et al., 1987[126]]. In accordance with a 1983 UN resolution, the members of the World Commission on Environment and Development began their activity evaluating the most critical socio-economic and environmental problems in the world and making forward-looking proposals for solutions. In their report, they devoted much attention to the concept of sustainable development. They also offered a simple, succinct, and the most frequently quoted quasi-definition of it [WCED, 1987: IV.1]: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[127] They also repeatedly stressed that the environment and development are interlinked issues and that in the course of development planning and processes, the condition and 'integrity' of natural systems and environmental resource constraints should be taken into account.[128] Perhaps the most severe criticism was directed at their overemphasis on economic growth, although the latter was described by the chairman of the commission as "a new era of economic growth – growth that is forceful and at the same time socially and environmentally sustainable."[129]

- The 'messages' contained in the above-mentioned report have contributed to the emergence of sustainability science and significantly impacted

[126] "Having defined a sustainable world as one in which humans can survive without jeopardizing the continued survival of future generations of humans in a healthy environment, what will ensure a sustainable future?" All basic human needs are "closely tied to the continued functioning of the supporting ecological systems which maintain nutrient, air, and water cycles, and to the maintenance of renewable biological resources such as forests and fisheries stocks. Beyond the basic, biological survival needs, however, there are variations in social and cultural perspectives on what is needed for a quality existence and in ecological perspectives on what is needed for a sustainable biosphere." (p. 717)

[127] That simple description of the essence of sustainable development can also be found in other chapters of the report: "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (I.3.27.) "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future." (II. 49.)

[128] (II. 40.): "Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction. These problems cannot be treated separately by fragmented institutions and policies. They are linked in a complex system of cause and effect."

[129] [WCED, 1987: Chairman's Foreword]

global political cooperation on sustainable development, starting with the 1992 UN Conference on Environment and Development and the principles and the program agreed there. In those years, many researchers critically evaluated previous interpretations of sustainable development and investigated the possibility of establishing a new comprehensive concept and its applicability [e.g., Ruckelshaus, 1989; Foy, 1990; Goodland, 1991[130]; Munasinghe & Shearer, 1995; Baden, 1997; Costanza et al.,1997[131]; Carley & Spapens, 1998]. Arguing for the need for a new interdisciplinary direction in the face of global environmental threats, Michael Redclift wrote that: "sustainable development has become a 'global' project, and our capacity to find solutions is seriously reduced by our inability to recognize we are the prisoners of our history. The global project is being developed in ignorance of intellectual history, which contributed to global environmental problems in the first place and made us poorly equipped to deal with them. It is time to redraw the frontiers of knowledge and belief and to recognize that they both have a part to play in avoiding global nemesis." [Redclift, 1993: p. 19]

[130] "The global ecosystem's source and sink functions have limited capacity to support the economic subsystem. The imperative, therefore, is to maintain the size of the global economy to within the capacity of the ecosystem to sustain it." (p. 6) "Sustainability will be achieved only to the extent quantitative throughput growth stabilizes and is replaced by qualitative development, holding inputs constant." (p. 13)

[131] "Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of humans in the biosphere. The economies of the Earth would grind to a halt without the services of ecological life-support systems …" (p. 253)

- International institutes such as IIASA and SEI[132] have launched new projects on this topic [Shaw et al., 1992[133]; Raskin et al., 1996, 1998[134]]. The National Research Council (USA) decided to support a major scientific program to explore the interdependence of societies and the environment more substantially and to establish a general framework for the 'science of sustainability' and related research priorities [NRC, 1999[135]].
- The new sustainability-related ideas and international programs and their national implications have also been considered and studied in Hungary, with even greater interest after the international scientific conferences held in Budapest in 1999 and Tokyo in 2000 [Náray-Szabó, 1999; Meskó, 2000; MTA, 2000], and then also in connection with the more recent UN sustainable development conferences [Gyulai, 2000, 2012, 2013; Simai, 2001, 2005[136], 2016; Bulla, 2002, 2013; Mészáros, 2010; Pálvölgyi &

[132] The author of this book was invited to participate in the related project of the Stockholm Environment Institute.

[133] "[T]he linkages among population, development, and the environment are indeed complicated. It is essential to examine these linkages in a holistic way if we are to formulate truly sustainable development strategies" (p. 2). "It is possible to formulate holistic conceptual models of the socioecological system in which we live. The model that is described in this report comprises three subsystems: societal, ecological, and economic. The linkages within the model are capable of describing both the causes of unsustainable development and possible remedies." (p. 27)

[134] "Science for Sustainability. Science has much to contribute to the sustainability transition, supporting discussion and action with analysis, information and solutions. […] Conventional disciplinary boundaries have been transcended as the needs are acknowledged for interdisciplinary approaches and for scientific participation in the discussion of social choices. Indeed, we hope this study will be seen as part of the initiative to build bridges between scientific discourse, social values and the policy agenda." (p. 12)

[135] "The reconciliation of society's developmental goals with the planet's environmental limits over the long term is the foundation of an idea known as sustainable development. This idea emerged in the early 1980s from scientific perspectives on the interdependence of society and environment" (p. 2) Priorities for Research: Sustainability Science: "Develop a research framework that integrates global and local perspectives to shape a 'place-based' understanding of the interactions between environment and society." (p. 10)

[136] The theory of sustainable development: "The focus on the importance of sustainable development in the second half of the 20th century is related to social problems, the increasing global degradation of the ecosystem and a specific ecological crisis, which is global in nature but which manifests itself in many different ways in different regions of the world. The rise to prominence of the concept of sustainable development is also linked to the development of science." (p. 119)

Csete, 2011; Bartus, 2013; Faragó, 2013[137]]. István Láng characterized this new period as follows: "a new concept, Sustainability Science, has appeared in the literature. […] the process of its emergence began some years ago. The term sustainability began to be used instead of sustainable development. This was probably done to avoid the often abstract and endless debates around development and growth." [Láng, 2001: p. 1422]

- Since the turn of the millennium, the justification of 'sustainability science' has been sufficiently accepted, and more and more studies on its broadening and multidisciplinary nature have been published. The favorable scientific atmosphere and political climate for international cooperation on this issue have undoubtedly contributed to this, as reflected in the declarations adopted at the (above-mentioned) Tokyo conference of the international organization of the scientific academies (InterAcademy Panel) in 2000 and at the UN Millennium Summit (to which we shall return below). The basic principles of this holistic scientific approach were formulated by the participants of the international meeting held at Friibergh Manor (Sweden) in October 2000 [Kates et al., 2000]. A summary of their jointly approved discussion paper was also published, from which we quote here [Kates et al., 2001: p. 641]: "A new field of sustainability science is emerging that seeks to understand the fundamental character of interactions between nature and society. [...] we propose an initial set of core questions for sustainability science. These are meant to focus research attention on both the fundamental character of interactions between nature and society and on society's capacity to guide those interactions along more sustainable trajectories. [...] The sustainability science that is necessary to address these questions differs to a considerable degree in structure, methods, and content from science as we know it." Subsequently, a series of studies on the concomitant dangerous global-level environmental, social and economic processes and the new sustainability approach have been published [e.g., Michelcic et al., 2003; Swart et al., 2004; McNeill, 2004; Komiyama & Takeuchi,

[137] Some of the studies cited here were published in the 2013 special issue of the Hungarian Statistical Review on sustainable development, including an article by the author of this book on the parallelism of and contradictions between international sustainability and international development programs and on the lack of a holistic approach.

2006[138]; Dasgupta, 2007; Atkinson et al., 2009; Brown, 2011; Kates, 2011; Spangenberg, 2011; Bakari, 2013].

- The two strands continued to go their separate ways, but the more recent sustainability science had much less influence on policy agendas dealing with unsustainable processes than the classical sustainable development science, which was seen as more 'balanced' in comparison (i.e., did not demand completely different economic development strategies/solutions compared to 'customary' or business-as-usual ones, but only taking into account the other – environmental and social – dimensions/pillars of sustainable development). One striking example is Jeffrey D. Sachs' voluminous book on the era of sustainable development, in which he made no reference to the newer scientific sustainability discipline but dealt in detail with global environmental, social, and economic issues, their interconnections,[139] and the very trade-offs that permeated the new global sustainable development agenda endorsed in 2015 [Sachs, 2015]. A more careful view was expressed by Sándor Kerekes, Zsuzsa Szerényi, and Tamás Kocsis, who warned that sustainable development is a complex concept and strategy, within which the state of the environment must be taken into account; however, ensuring the sustainability of nature cannot be the sole priority of sustainable development [Kerekes et al., 2018[140]].

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[138] "Two obstacles that impede efforts to deal with the issues associated with sustainability […]. First, the sustainability crisis is caused by a multitude of factors, the complexity of global environmental problems being a classic example. It is, therefore, no easy task to gain a comprehensive view of such problems, let alone solve them. Second, the disciplines that examine these complex problems have themselves grown increasingly fragmented in recent years, so much research is conducted from a highly restricted perspective with regard to both phenomena identification and problem solving." (pp. 3–4)

[139] "I will refer to sustainable development as an analytical field of study, one that aims to explain and predict the complex and nonlinear interactions of human and natural systems. […] In addition to being a normative (ethical) concept, sustainable development is also a science of complex systems. A system is a group of interacting components that together with the rules for their interaction constitute an interconnected whole. […] Sustainable development involves not just one but four complex interacting systems. It deals with a global economy that now spans every part of the world; it focuses on social interactions […]; it analyzes the changes to complex Earth systems such as climate and ecosystems; and it studies the problems of governance. […] Complex systems require a certain complexity of thinking as well. It is a mistake to believe that the world's sustainable development problems can be boiled down to one idea or one solution." (pp. 6–8)

[140] "[W]hile still underlining the need to award priority to promoting the sufficient quality of natural and built environments in terms of both quality of human life and functioning of the economy, sustainable development strategy should not exclusively prioritise the sustainability of nature." (p. 18)

> Perhaps the most concise and clear explanation of the problems with the former concepts (interpretations of sustainable development and the formulations of the essence of sustainability and sustainability science) was provided by John Blewitt: “Neither modern nor postmodern, sustainable development requires an understanding of the natural world and the human social world as being not so much ‘connected’ as one and the same. Sustainable development is a process that requires us to view our lives as elements of a larger entity. It requires a holistic way of looking at the world and human life. […] Sustainability is often referred to as a goal of living and producing within the Earth’s biological and ecological limits. Sustainability science: a new largely applied academic discipline designed to advance understanding of the dynamics of human–environmental systems.” [Blewitt, 2018]

2.2. The development of environmental science cooperation

Broad interdisciplinary and international cooperation has been established, involving experts from different professional fields and regions, to identify human-induced globalizing environmental processes, clarify their causal links, and estimate their potential future development. Further, depending on the outcomes of these studies, to create the solid scientific basis for establishing viable means of intervening. The complexity and global scale of the examined issues particularly justified this cooperation. In addition to the scientific analysis that focused on environmental processes, the much more comprehensive sustainable development and sustainability research programs have gained ground.

The effort to properly communicate the scientific results achieved in the exploration of hazardous environmental processes or, in a broader sense, unsustainable processes in a concise, ‘synthesized’ way has also strengthened. The main goals of this have been to raise awareness of these globalizing issues, promote dialogue between science and political representatives, and facilitate the development of adequate policies and measures for responding to the discovered hazards.

2.2.1. Global environmental observations

Environmental studies should be based first and foremost on information derived from observations. Monitoring of the various environmental elements and processes has gradually become global in scope over the last

century and a half. Still, it is only since the 1970s that the need for comprehensive observations of the Earth's environmental system has strengthened, in parallel with the rapid development of monitoring technology.

The beginnings of international monitoring systems and programs. First, observations were and are necessary for studying, exploring, and understanding large-scale environmental processes. Cooperation in this field has unfolded, expanded, and become multifaceted since the mid-twentieth century, even if the political circumstances were not initially favorable due to Cold War tensions. The quality and international accessibility of the observational data have improved with the betterment of measuring devices, information transmission and processing devices. For a long time, such monitoring systems (international observational networks and data centers) were created in isolation for different environmental elements (basic meteorological, atmospheric chemistry, hydrological, oceanographic, biosphere-related parameters, etc.). In this regard, the first two International Polar Years and the International Geophysical Year (IPY, 1882–1883, 1932–1933; IGY, 1957–1958), organized as scientific programs for studying primarily the Arctic's environment, were exceptional to some extent. The first of these was initiated by Karl Weyprecht (1838–1881), who, based on his experiences during the Austro-Hungarian Arctic Expedition of 1872/73, summarized some of the key principles for the organization of the first IPY.[141] The milder international political climate – in the late nineteenth century, in the mid-1970s, and from the 1990s onwards – was conducive to truly broad international support for the first International Polar Year program, the GARP Atlantic Tropical Experiment[142] of 1974, and the most recent International Polar Year program (2007–2008).

- ***Atmosphere***. International research cooperation on the atmosphere began with the Societas Meteorologica Palatina, founded in 1780 (!) that operated for about a decade and a half and continued in the second half of the nineteenth century with the formation of the International Meteorological Organization (IMO, 1873–). Its successor, the World Meteorological Organization (WMO), established the Global Observing System of the World Weather Watch (WWW/GOS, 1963–)

[141] Weyprecht, K., 1875: Grundprinzipien der arktischen Forschung. (Tammiksaar, E. et al., 2010: The International Polar Year 1882–1883. In: The History of the International Polar Years – From Pole to Pole (eds: S. Barr, C. Lüdecke). Springer (pp. 7–33).

[142] GARP: Global Atmospheric Research Programme; GATE: GARP Atlantic Tropical Experiment.

and later the Background Air Pollution Monitoring Network (BAPMoN, 1969–). Two decades later, the monitoring program of that network was broadened with the addition of air quality measurements and renamed/transformed to the Global Atmospheric Watch (GAW, 1989–). Quasi-parallel to these developments, the Global Ozone Observing System was set up (GO3OS, 1957–), but the recognition of ozone layer depletion and its hazardous consequences occurred only after 1984 when the 'ozone hole' above the Antarctic was discovered (by researchers from the British Antarctic Survey). Regarding the atmospheric content of carbon dioxide, it was a similar historical turning point for scientists and policymakers when rising concentrations were detected in the series of data measured since 1958 in Hawaii at the Mauna Loa Observatory. However, the comprehensive monitoring of Earth's climate system (and the identification of its potential changes partially due to human activities) required much more: the Global Climate Observing System (GCOS) was set up in 1992 through the collaboration of several organizations (WMO, UNESCO/IOC, ICSU, and UNEP). The rapidly increasing and high-resolution data flow from that system has become indispensable for climate change science and policy cooperation (WCRP, IPCC, UNFCCC).[143]

- ***Water bodies***. Separate global monitoring systems were developed for oceans (and all seas) and freshwater bodies (rivers, lakes, etc.). The latter have partly been managed by UN specialized agencies (UNESCO/IHP, 1975–; UNEP/Water, 1978–; WMO/WHOS, 2013–) and partly by another organization (GWP, 1996–).[144] Oceanographic cooperation was institutionalized in the framework of UNESCO in 1960 by setting up the Intergovernmental Oceanographic Commission (IOC), but only three decades later – at the call of the 1990 World Climate Conference – was the initiative to establish the Global Ocean Observing System adopted (GOOS, 1991–). Its operation is jointly supported by several organizations (UNESCO/IOC, ICSU, UNEP, WMO).
- ***Land areas***. The formation of a global system for land areas was primarily initiated by the FAO after the development of the global monitoring systems for the oceans and the climate began in 1991/1992. The decision concerning the Global Terrestrial Observing System (GTOS) was made in 1996, and the 'founders' included, besides the

[143] WCRP: World Climate Research Programme; IPCC: Intergovernmental Panel on Climate Change; UNFCCC: UN Framework Convention on Climate Change.

[144] UNESCO/IHP: UNESCO Intergovernmental Hydrological Programme; WMO/WHOS: WMO Hydrological Observing System; GWP: Global Water Partnership.

FAO, a few other organizations (ICSU, UNEP, UNESCO, and WMO). The GTOS is actually a system of thematic networks specialized in monitoring forests, glaciers, lakes, etc.

- ***Biosphere***. Compared to the cases mentioned above, it has been more challenging to launch cooperation to monitor the state and processes of the biosphere globally, aggregate the resulting data, and to use them to define, calculate, and evaluate indicators of any tendencies/changes. The need for such a monitoring system was identified as early as in the preliminary evaluation of the International Biological Programme (IBP, 1964–1974), coordinated by UNESCO, and in preparation of the subsequent Man and the Biosphere Programme. Assessing and evaluating the state of the biosphere seemed more complex than determining the physical and chemical characteristics of the environment which, of course, were also interrelated with biological ones. This is why the rationality of creating an integrated global environmental monitoring system was raised [ICSU, 1971[145]]. Nevertheless, the IUCN first set up a database for observations and estimates of endangered species in 1979 that was later expanded by the foundation of the Conservation Monitoring Centre in 1986. It was 'upgraded' and operated as a world center, first jointly managed by IUCN, UNEP, and WWF, and after that, since 2000, officially under UNEP.[146] Even more accurate and specific data on wildlife were needed to assess the implementation of the various nature conservation conventions (including the 1992 Convention on Biological Diversity). To this end, the ICSU has been operating the World Data Center for Biodiversity and Ecology (WDC-BE) since 2009.

Monitoring the global environmental system. As can be seen from the above, a highly diversified and fragmented international institutional system for environmental monitoring has developed over many decades. However, for the systemic analysis and modeling of the state and changes

[145] "The variables referred to as 'biological' are much more difficult to measure and interpret than the physical and chemical ones." (p. 48) "Within the International Biological Programme, several activities are of importance as potential pilot projects. […] Other parts of the present International Biological Programme may also be used for the selection of proper variables for global monitoring. […] Co-ordination between these pilot projects with other similar activities aiming to have similar parts included in the permanent global environmental monitoring is essential. […] When the International Biological Programme is replaced by a new international programme, these activities may be taken up in a more extensive way in order to find useful variables for global monitoring." (p. 55)

[146] UNEP-WCMC: World Conservation Monitoring Centre.

of the Earth's environment, detailed and coherent monitoring data were needed on the whole environmental system, including all its interacting components and processes.

- The ICSU very clearly argued in 1971 about why and based on what criteria a holistic monitoring system should be established. In essence, it was because there was insufficient knowledge to adequately assess the increasing environmental problems and use of natural resources and to evaluate the effectiveness of pre-existing environmental management. Consequently, there was an urgent need for more intense international research cooperation and a global environmental monitoring system at the UN level [ICSU, 1971[147]]. The latter would have been realized by the Global Environmental Monitoring System (GEMS) as part of Earthwatch to be developed by UNEP, as envisaged in the *Action Plan* adopted at the UN Conference on Environment and Development in 1972 [UN, 1972a[148]; UNEP, 1973]. Contrary to the ambitious plans, this overarching global system as a framework of then separately operating specific monitoring networks did not materialize, and UNEP only succeeded in establishing bilateral and/or multilateral cooperation with other organizations[149] without achieving effective and comprehensive inter-organizational and intergovernmental coordination [Gwynne, 1982[150]; Wallen, 1995[151]].

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[147] "[T]he present machinery for environmental management and resource exploitation is based on insufficient knowledge. […] We have determined that a global environmental monitoring system is desirable, timely and feasible. We have also determined that such a global system can best be created through national efforts and by inter-governmental co-operation at the level of the United Nations …". (p. 5)

[148] Global environmental assessment programme (Earthwatch). This category includes the functions of Evaluation and Review, Research, and Monitoring "to gather certain data on specific environmental variables and to evaluate such data in order to determine and predict important environmental conditions and trends", Information exchange. (p. 27)

[149] FAO, ILO, UNESCO, WHO, WMO, IUCN.

[150] "The Global Environment Monitoring System (GEMS) is a collective effort of the world community to acquire, through monitoring, the data needed for rational management of the environment. […] UNEP moved into the field of monitoring in a deliberate and systematic manner in 1975 with the establishment of the Programme Activity Centre (PAC) for GEMS. […] UNEP, including the GEMS PAC, works mostly through the intermediary of the Specialized Agencies …". (p. 35)

[151] "[I]t has become obvious that the processing of available information and the filling of gaps in monitoring of the environment, as well as in producing assessments on global issues, would require the participation of governments to a larger degree than was thought twenty years ago."

- The 1992 and the 2002 World Summits confirmed that neither the previous concept of global monitoring and assessment (Earthwatch, GEMS) nor the more recent cooperation between the 'isolated' specialized monitoring systems (GCOS, GOOS, GTOS) is adequate for identifying (discovering and studying) the even faster globalizing environmental and related socio-economic processes and developing internationally agreed response policies [Fritz, 1997; UN, 2002[152]].
- The way out of this situation was the agreement on the establishment of the Global Environmental Observing System of Systems (GEOSS, 2005–), which also marked "the beginning of a new era in the history of earth sciences" [Czelnai, 2007]. None of the existing institutions relinquished their sovereignty, and instead of accepting the coordinating role of UNEP, a new intergovernmental body was entrusted with the harmonization and coordination of cooperation (GEO[153]). In fact, the objectives of GEOSS were little or no different from those set out in 1972, namely, to provide a more comprehensive and detailed assessment of the state of the environmental system, to better understand its processes and predict future changes, and based on this knowledge to make "decisions and actions for the benefit of humankind" [GEOSS, 2009[154]].
- After 2005, UNEP saw its leadership role and coordinating options as supporting the production of comprehensive environmental assessments.

[152] "[U]rgent actions at all levels to: (a) Strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need for building capacity and sharing of data from ground-based observations, satellite remote sensing and other sources among all countries; (b) Develop information systems that make the sharing of valuable data possible, including the active exchange of Earth observation data; (c) Encourage initiatives and partnerships for global mapping." (para. 132)

[153] GEO: Intergovernmental Group on Earth Observations.

[154] "The purpose of GEOSS is to achieve comprehensive, coordinated and sustained observations of the Earth system, in order to improve monitoring of the state of the Earth, increase understanding of Earth processes, and enhance prediction of the behaviour of the Earth system." (p. 5)

One of the main results of this new vision and strategy[155] was that the regularly compiled and published reports on global environment processes and scenarios – Global Environmental Outlooks – have comprehensively presented the key problems and their cause-effect relationships and indicated the most relevant policy aspects and options.

World centers of environmental information. As a matter of course, collecting and managing environmental data was primarily the responsibility of international organizations or national institutions that developed and operated the monitoring systems for one or more environmental elements. Obtaining access to such databases was of cardinal importance for researchers.

- We have already referred to the ICSU's World Data Center for Biodiversity and Ecology. Additionally, the World Data System initiated by the ISC (the successor organization of the ICSU in 2018) also includes hydrological, soil, glacier, oceanographic, and natural resource data centers, which were established in cooperation with other organizations (FAO, UNEP, UNESCO, WMO, etc.). Institutions specializing in international meteorological, climatological, ozone layer, and greenhouse gas information have been set up, primarily in conjunction with the WMO. UNEP has operated a database on toxic chemicals since 1976 (IRPTC)[156] that has played an essential role in developing and implementing global chemical conventions and programs (i.e., evaluating their potential effectiveness and actual implementation). Other international organizations have specialized in collecting and aggregating the international social and economic information necessary, inter alia, for analyzing the drivers and impacts of large-scale environmental processes (e.g., UNSD, World Bank, OECD, Eurostat, and ISSC).[157]

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[155] Between 1993 and 2010, the author of this book was responsible (as the 'national focal point') for facilitating cooperation with the UNEP on several environmental topics, including participation at the sessions and in the decision-making process of the UNEP's Governing Council. After Hungary acceded to the European Union, this task primarily meant contributing to the formation of the common positions of the EU Member States (e.g., on the role of the UNEP, more effective international environmental governance, and the synergy of the various environmental agreements).

[156] IRPTC: International Register of Potentially Toxic Chemicals.

[157] UNSD: United Nations Statistics Division; ISSC: International Social Science Council (The ISSC merged with ICSU in 2018 and the new organization was named the International Science Council, ISC.)

- As in the case of environmental observations, it seemed appropriate to harmonize and/or interlink the separate environmental databases into a system covering all environmental factors and parameters to facilitate research on the environment in its complexity. In other words, besides cooperation among the specialized observing systems (realized under the umbrella of GEOSS), cooperation was needed among the different environmental information systems [GEOSS, 2005[158]]. This recognition was followed by defining the objective and principles of the above-mentioned World Data System (WDS) in 2008. However, earlier examples, such as UNEP's general environmental information system (Infoterra, 1977–) and the Global Resources Information Database (GRID, 1985–), can also be cited.

The significance of global environmental monitoring and information systems. Without the monitoring programs and observational data, it would have been impossible to comprehensively analyze large-scale environmental processes, including identifying and assessing the anthropogenic factors that trigger or amplify them. The development of these networks and programs and access to their data facilitated the discovery and improvement in knowledge of such intensifying environmental phenomena from the 1970s onwards, as well as the proliferation of publications of related research results, and the strengthening of international cooperation in environmental science. Eventually, it led to the elaboration of policy programs and agreements to address dangerous processes such as ozone layer depletion, the rapid loss of biodiversity, the growing hazard of climate change, and increasing environmental releases of harmful pollutants, chemicals, and waste. However, to explore the interactions and feedback mechanisms associated with specific processes, it has become essential for scientists to have information that describes the global environmental system's general state and the relevant socio-economic processes. (As a matter of fact, it has also become essential to have all these data at proper quality, spatial and temporal resolution, etc.). This is why, among other things, the above-mentioned complex systems (GEOSS, WDS) have become of crucial importance. Despite some improvements in such data and their accessibility, all recent

[158] "The vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information."

assessment reports [e.g., IPCC, 2014; IPBES, 2019; UNEP/GEO, 2019[159]] still highlight significant problems (insufficient geographical coverage and resolution, data gaps, etc.), which are among the main obstacles to more effective international scientific cooperation on these matters.

2.2.2. Thematic environmental science organizations, programs, and assessments

The increasing human pressures on the environment were already being studied by scientists in the first decades of the twentieth century. The diversity and extent of the unintended consequences of accelerating economic and technological development have rapidly grown since the middle of the previous century. As soon as these globalizing and complex processes were realized, the advancement of multidisciplinary international research cooperation proved crucial for their proper analysis, deriving precise assessments, and formulating science-based recommendations. This was made possible by the availability of sufficiently detailed and accurate observational data and the fact that some effects of the above-mentioned global processes reached clearly identifiable critical levels after a few decades. As concerns specific environmental components and problems collaboration has generally evolved within the framework of different environment-related scientific disciplines. This has included establishing various international organizations (institutions, unions, and associations), holding scientific conferences, launching research programs, and issuing assessments (reports, outlooks, etc.). In addition, institutional, inter- and multidisciplinary links have facilitated joint research and 'synthesizing' activities in some fields (e.g., as occurred within the interdisciplinary committees of the ICSU). The evolution of such international cooperation in environmental science is presented below for some globalizing problem areas. Regarding a number of other environmental issues, cooperation and its institutionalization developed in a more or less similar manner with corresponding stages but was obviously different in substance (e.g., concerning ozone-layer depletion, natural

[159] "Gaps in the collection, monitoring, analysis and interpretation of data identified in GEO-5 continue to challenge the reliability of Big Data as a tool in environmental assessment […]. For Big Data to become an effective tool for environmental assessment and development, this emerging form of data and knowledge should be seen as a valuable asset. Big-data analytics involve not only compiling information but also creating a comprehensible view of the environment and its social attributes as a basis for proposing solutions and drafting policies." (p. 608)

disasters and their effects, and the environmental/biogeochemical cycles of nitrogen and phosphorus[160]).

The anthropogenic factors affecting the biosphere and the repercussions and options for controlling (abandoning or at least mitigating) nature-damaging human activities have received higher attention from several international scientific organizations since the middle of the last century.

- The International Union of Biological Sciences (IUBS, 1919-) started to deal more thoroughly with ecosystems only a few decades after its foundation. Its assessments contributed to the creation of the International Union for the Protection of Nature (IUPN) in 1948, and it also participated in the design of UNESCO's International Biological Programme (IBP, 1964–1974) [Irwin, 1970[161]]. Parallel to the ICSU's International Geosphere-Biosphere Programme (IGBP), the IUBS formulated its own scientific program on biodiversity changes and ecological functions in 1988 ('Diversitas').
- The International Union for the Protection of Nature (1948–) changed its name first to the International Union for the Conservation of Nature and Natural Resources (IUCN) and later to the World Conservation Union but remained dedicated to analyzing global threats to wildlife, protecting wild animal and plant species and their habitats [IUCN,

[160] These two issues (the nitrogen and phosphorus cycles in the environment) also became key components of the 'planetary boundaries' theory. Moreover, expert cooperation regarding them was institutionalized at the international level with the foundation of the International Nitrogen Initiative in 2003 and the European Sustainable Phosphorus Platform in 2013.

[161] "IUBS has responded early and in several ways to the problems of alterations of the environment […]. With the International Unions of Physiological Sciences, of Nutritional Sciences, of Biochemistry, and for the Conservation of Nature, it assumed leadership in developing plans for the International Biological Programme […]. The objective of the programme […] can be achieved only on the basis of scientific knowledge that, in many fields of biology and in many parts of the world, is now inadequate at the very time when human activities are creating rapid and comprehensive changes in the environment." (p. 1115)

1948[162]]. According to its founding charter, the association's activities should involve education, training, regulation, and research. Two decades on – based on new observations, analyses, and effective cooperation between the organizations most involved in this matter (FAO, IUCN, UNESCO, WWF) – a 'diagnostic' report on the global status of wildlife was published, according to which the rehabilitative action, the mitigation of adverse effects and especially, the protection of endangered species were urgently needed [UNESCO, 1970[163]; IUCN, 1971[164]]. Drawing also on their own assessments, these organizations played a significant role in initiating a more focused and ambitious international program (MAB) and in supporting the adoption of global conventions on the protection of wetlands, cultural and natural heritage, the regulation of trade in endangered species, and the conservation of wild migratory animal species [RCW, 1971; WHC, 1972; CITES, 1973; CMS, 1979].

- In 1971, UNESCO launched the Man and the Biosphere (MAB) scientific program to comprehensively assess the increasing environmental impacts of human activities and identify measures for conserving natural conditions that are suitable for wildlife, and policies

[162] Article I. Objects. "2. The Union shall promote and recommend national and international action in respect to: (a) The preservation in all parts of the world of wild life and the natural environment, soils, water, forests, including the protection and preservation of areas, objects and fauna and flora having scientific, historic, or aesthetic significance by appropriate legislation […]; (b) The spread of public knowledge […]; (c) The promotion of an extensive programme of education […]; (d) The preparation of international draft agreements and a worldwide convention for the 'Protection of Nature'; (e) Scientific research".

[163] "[I]n the present century we have seen men speaking proudly of their duty and their success in pushing back the wilderness. […] When was the moment critical that man should have arrived at consciousness of that fuller kind that would have led him to call a halt to bald exploitation and to match exploitation with rehabilitation? It is possible we have reached that moment now, though overall the planet is still losing out. The fear now is whether we can rehabilitate, or are causes and consequences setting up their own percussive oscillations to an extent we cannot control." (p. 32)

[164] "Growth in land-use, from development, expanding agriculture, and activities associated with the taking of natural resources, has resulted in particular difficulties for wildlife, a direct concern of IUCN. […] Quite apart from scientific, educational, ethical, moral and aesthetic considerations, the 'wild' has always supported and nourished the settled world in ways too numerous to list. Threatened species, which have been monitored for years through IUCN's Red Data Book system, are a biological measure of the impact of man on his environment." (p. 18)

for sustainable resource use [UNESCO, 1971, 1972[165]]. This program led to the founding of the World Network of Biosphere Reserves, which by 2015 included 651 sites in 120 countries, and the latest MAB strategy has also envisaged the importance of the proper functioning of this network [UNESCO, 2017].[166]

- The state of the natural environment (its components, processes, and resources) and the main courses of action (policies and measures) to be taken were described in the *World Conservation Strategy* [IUCN-UNEP-WWF, 1980]. Its key conclusions were that humanity must conserve living resources and use them with care, i.e., sustainably, for its own well-being and future. The scientific basis was later expanded, inter alia, by the assessment of the carrying capacity of the environment in a new report [IUCN-UNEP-WWF, 1991]. The findings were taken into account during the negotiations that finally resulted in the 1992 *Convention on Biological Diversity* [CBD, 1992].
- Under this Convention, the Subsidiary Body on Scientific, Technical and Technological Advice (COP-SBSTTA)[167] was established, and as part of its tasks, it coordinated the regular preparation of the *Global Biodiversity Outlook*. These reports contained evaluations of biodiversity changes (based on the most recent monitoring and research results) and proposals for further international measures. The first report provided science-based guidance for developing a strategic plan for implementation of the Convention for the period 2002–2010

[165] "Life today is inseparable from the biosphere; human activity has altered man's immediate environment. Many species of plants and animals have become extinct; millions of acres of land have been lost to agriculture […] rivers, lakes and the oceans themselves have become polluted." (p. 88) "The Man and the Biosphere programme […] will cover a wide range of subjects connected with the relationships between man and the biosphere, measures to improve the productivity of the biosphere and biogeocenoses, and urgent steps to preserve the conditions of life necessary for human existence." (p. 90)

[166] According to the most recent data, the network already included 748 biosphere reserves in 134 countries.

[167] Conference of the Parties – Subsidiary Body on Scientific, Technical and Technological Advice: "(a) Provide scientific and technical assessments of the status of biological diversity; […] (d) Provide advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity …".

[CBD/GBO, 2001[168]]. The *Millennium Ecosystem Assessment* published by the UN in 2005 indicated that much more effective measures than those already in place would be needed to meet the 2010 targets of the strategy [UN, 2005]. Further assessments also clearly demonstrated the shortcomings of both the initial and the newer implementation strategy that was formulated in 2010 and specified targets to be met by 2020 (CBD/GBO, 2005, 2010, 2014). The latest version of these 'outlooks' included the international scientific community's recommendations for the post-2020 strategic framework [CBD/GBO, 2020[169]].

- The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was set up in 2012, twenty years after the approval of the *Convention on Biological Diversity*. (To some extent, it followed the example of the Intergovernmental Panel on Climate Change; however, the latter started operating before the climate change convention was elaborated, and its first report in 1990 preceded and substantially motivated the negotiations of that convention.) The IPBES cooperated closely with other organizations concerning comprehensive assessments in parallel with the work of the scientific advisory body established by the biodiversity convention – of course, to achieve the same general objectives. The Platform's *Global Assessment Report on Biodiversity and Ecosystem Services* [IPBES, 2019] was not only an essential reference for the above-mentioned 2020 'outlook'

[168] GBO-1 Executive Summary: "The Conference of the Parties will consider a strategic plan for the Convention, comprising visionary but realistic goals for each of the three objectives of the Convention. […] The Global Biodiversity Outlook shows that the condition of biodiversity in the world's major ecosystems continues to deteriorate, almost without exception and often at an accelerating rate. Biological diversity provides the goods and services that make life on earth possible and satisfy the needs of human societies." (p. 9)

[169] GBO-5 Summary for policymakers: "Each of the measures necessary to achieve the 2050 Vision for Biodiversity requires a significant shift away from 'business as usual' across a broad range of human activities. […] Each of these transition areas involves recognizing the value of biodiversity, and enhancing or restoring the functionality of the ecosystems on which all aspects of human activity depend, and at the same time recognizing and reducing the negative impacts of human activity on biodiversity; thus enabling a virtuous cycle – reducing the loss and degradation of biodiversity and enhancing human well-being." (p. 14)

(CBD/GBO-5), but its findings and conclusions guided the design of the new implementation strategy.

International cooperation in research about the global climate system began in the 1970s, focusing on the climate impacts of those human activities which played a considerable role during the intensification of economic globalization (i.e., in the period of the 'Great Acceleration'). Studies on the large-scale atmospheric processes have also been extended to other hazards (e.g., ozone layer depletion, 'acid rains').

- As part of the Global Atmospheric Research Programme (GARP, 1967–1982), a climate research sub-program was initiated in 1974 to improve scientific methods and models for studying the climate system [WMO-ICSU-UNEP, 1975[170]].
- Based on the initial experiences with this sub-program, it was agreed at the 1979 World Climate Conference that "There is a serious concern that the continued expansion of man's activities on earth may cause significant extended regional and even global changes of climate." In order to obtain better insight into the functioning of the climate system and discover ('diagnose') its potentially human-induced changes, a decision was made to inaugurate the World Climate Programme (WCP), with particular emphasis on strengthening international scientific cooperation [WMO, 1979[171]; Faragó, 1981]. In order to achieve this, the World Climate Research Programme (WCRP, 1980-) was also formulated (as one of the key components or 'subprograms' of WCP). Over time, this greatly contributed to understanding the drivers, causal relationships, and the process of climate change. Moreover, the outcomes of this program were intended to be taken into account in the development of the more recent

[170] "The conference unanimously recommended that the cooperative research programme outlined in the present report be used as the basis for a programme on the climate of the earth and that such a programme be given high priority. The programme should be part of GARP under the auspices of WMO, ICSU and […] developed in close contact with the UNEP." (p. 3)

[171] "Research into climate in order to clarify the relative roles of natural and anthropogenic influences. The overall purposes of the Programme are thus to provide the means to foresee the possible future changes of climate and to aid nations in the application of climatic data and knowledge to the planning and management of all aspects of man's activities. This will require an inter-disciplinary effort of unprecedented scope of the national and international levels." (pp. 3–4)

international climate and environmental policies [ICSU/ISC-WMO-UNESCO/IOC, 2018[172]].

- In this subject area, it is primarily two multidisciplinary institutions that have undertaken to foster science-policy 'dialogue' – namely, the above-mentioned Intergovernmental Panel on Climate Change [IPCC, 1988[173]] and the scientific advisory body of the Conference of the Parties to the *UN Framework Convention on Climate Change* (COP-SBSTA[174], 1992–). (The *Convention on Biological Diversity*, also adopted in 1992, introduced broadly similar institutional arrangements with the establishment of its advisory body, as referred to above.) Both the IPCC and the SBSTA were formally set up as frameworks for intergovernmental cooperation, albeit their activities were based in practice on the findings and involvement of researchers from around the world and a wide range of disciplines. This was particularly evident in the preparation of the assessment reports of the IPCC and their summaries (for policymakers). The first report was published in 1990, and its findings had a major influence on the negotiations of the climate change convention (1991/92), as did the fifth report, finalized in 2014, on the political negotiations leading to the agreement endorsed in Paris in 2015.[175] (Since the entry into force of the said Convention, a joint

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[172] "[T]he core, underpinning climate science which WCRP delivers is needed more than ever, as society seeks solutions to climate change (Paris Agreement), to resilience to disasters (Sendai Agreement), and to sustainable development for the planet (UN Sustainable Development Goals). Without a strong foundation in climate science and prediction none of these challenges can be addressed in a robust, cost-effective and durable way. […] international coordination enables scientific advances that would not happen otherwise." (p. 48)

[173] Objectives: "(i) Assessing the scientific information that is related to the various components of the climate change issue, such as emissions of major greenhouse gases and modification of the Earth's radiation balance resulting therefrom, and that needed to enable the environmental and socio-economic consequences of climate change to be evaluated; (ii) Formulating realistic response strategies for the management of the climate change issue." (p. 4)

[174] Subsidiary Body for Scientific and Technological Advice (SBSTA) shall: "(a) Provide assessments of the state of scientific knowledge relating to climate change and its effects; (b) Prepare scientific assessments on the effects of measures taken in the implementation of the Convention; …".

[175] The author of this book was elected the first chair of the SBSTA, where one of his tasks was to facilitate cooperation with the IPCC together with its chair and to establish a proper form and method of collaboration between the bureaus of these two organizations (UNFCCC/COP and IPCC).

working group of representatives of the IPCC and the COP has promoted cooperation between the two organizations on scientific matters, and the science-based recommendations to be taken into account in the course of setting new policy goals and commitments by the parties.)

The beginnings of institutionalized international cooperation in water science date back to the first half of the last century. Below, we mainly refer to the development of cooperation concerning surface water and groundwater (terrestrial water) issues. The respective researchers collaborate within a variety of organizations and programs, elaborating and publishing their assessments and proposals, which have become especially relevant due to escalating water-related problems and the situation that several scientists call a 'global water crisis.'

- The International Association of Hydrological Sciences (IAHS, 1930–)[176] and the WMO's Commission for Hydrology (1961–) effectively contributed to expanding research cooperation in this field. Both organizations actively supported the goals of the International Hydrological Decade (IHD, 1965–1974) coordinated by UNESCO [Nace, 1965[177]; Rosbjerg & Rodda, 2019]. During this decade-long program, the scientific community achieved such fundamental results that, according to András Szöllősi-Nagy, hydrology actually became a scientific discipline at that time [Szöllősi-Nagy, 2015[178]].

[176] The International Association of Scientific Hydrology (1930–) 'grew out' of a research group (Section d'Hydrologie Scientifique) established in 1922 within the framework of the IUGG; in 1971, it was renamed the International Association of Hydrological Sciences (IAHS). For several years the president of IAHS was György Kovács, then president of VITUKI, the hydrological research institute in Hungary.

[177] "Projects designated as contributions to the IHD will be those which have special international significance for a wide audience in many countries. […] The future success of failure of man may well depend on his ability to make effective use of a fresh-water supply that varies in amount from time to time but is effectively constant. […] The success in the endeavor is adequate hydrologic knowledge properly coupled with intelligent water management." (pp. 822–823)

[178] "The Decade made fundamental contributions in establishing the first authoritative water balance of the world, a catalogue of discharges of the major rivers of the world and most importantly, through a world-wide set of experimental and representative catchments, contributed to some major breakthroughs in understanding the hydrological cycle. It may sound an overstatement but IHD indeed pushed hydrology into becoming a science." (p. 33)

- Besides being covered by the broad research 'repertoire' of the above-mentioned organizations, cooperation on water quality problems also progressed within specialized institutional formats such as the International Association on Water Quality (IAWQ, 1965–) and the International Commission on Water Quality.[179]
- The International Hydrological Programme (IHP, 1975–) was developed on the basis of the positive experiences of the above-mentioned 'hydrological decade' to evaluate the global situation of water resources, including increasing human impacts [UNESCO, 2015[180]]. In parallel, WMO launched its own Hydrology and Water Resources Programme (HWRP, 1975–).
- The first major United Nations water conference (Mar del Plata, 1977) proved to be a milestone in the international collaborative process. According to the *Action Plan* adopted there, proper water management and access to safe drinking water and sanitation for all are fundamental for socio-economic development, but for the realization of these goals, more knowledge, scientific research, and effective interventions were needed [UN, 1977[181]]. An inter-agency mechanism (UN-Water) was set up in 1977 to promote the implementation of the recommendations contained in the *Action Plan* and coordinate the activities of the specialized UN agencies and other international organizations in this regard. (The effectiveness of this mechanism was significantly

[179] The International Association on Water Quality (1965–) became a member organization of the ICSU/ISC; it continued its activities as the International Water Association (IWA) from 1999 after merging with the International Water Services Association. László Somlyódy was elected president of the successor of the IWA in 2004. The ICWQ is acting under the umbrella of the aforementioned IAHS. Géza Jolánkai and Zsolt Jolánkai are among the members of the ICWQ.

[180] "The general guidelines adopted by the IHP Council were: a) to provide a scientific framework for the general development of hydrological activities; b) to improve the study of the hydrological cycle and the scientific methodology for the assessment of water resources throughout the world, thus contributing to their rational use; c) to evaluate the influence of man's activities on the water cycle, considered in relation to environmental conditions as a whole …". (p. 57)

[181] "Realising that the accelerated development and orderly administration of water resources constitute a key factor in efforts to improve the economic and social conditions of mankind, especially in the developing countries, and that it will not be possible to ensure a better quality of life and promote human dignity and happiness unless specific and concerted action is taken to find solutions and to apply them at the national, regional and international levels. […] A.2: to improve the management of water resources, greater knowledge about their quantity and quality is needed."

strengthened from 2003 with the extension of its mandate by taking into account the relevant provisions of the 2002 World Summit on Sustainable Development.)

- A global water program was initiated a few years after the 'birth' of the UNEP (UNEP/Water, 1978–). Later, a more specific research project was set up on international watercourses and lakes (UNEP/GIWA[182]). Actually, system-wide collaboration could only be achieved much later within the framework of the *World Water Assessment Programme* (UN/WWAP, 2000–). Its main goals were to regularly prepare assessment reports on global freshwater resources, their use and management, and to strengthen sustainable water policies and their implementation worldwide (UN/WWDR).[183]
- In addition to the mainly intergovernmental bodies dealing with water affairs, new international non-governmental organizations were formed after the 1992 UN Conference (UNCED), such as the World Water Council (1996–) and the Global Water Partnership (1996–). Assessments and declarations endorsed at their international forums and the respective congresses convened by the International Water Resources Association (IWRA, 1971–) demonstrated that because of continuing population growth, unsustainable water use, climate change, and other factors, there was a need for more effective research, integrated water management and water policy cooperation than ever before [WWC, 2018; GWP, 2019[184]]. The same conclusion was formulated at the 2019 Budapest Water Summit (BWS), whose final document highlighted, among other things, that "The crisis of too little, too much, or too dirty water is here, exacerbated by climate change. [...] Facilitate knowledge sharing about water (science, technology and management, socio-economic impacts, agreements) within and across geographic, administrative, sectoral, and national boundaries. [...] Without good water management, all investments in fighting poverty, improving health, education, ensuring economic development and prosperity, protecting our planet and its ecosystems will be in vain." [BWS, 2019].[185] The activities of the above-mentioned organizations had a significant impact insofar as water policy goals and tasks were given increased emphasis in the

[182] Global International Waters Assessment (1999–2008).

[183] WWAP was established by the UNESCO in 2000 and then it became a UN system-wide cooperative program.

[184] "The global water crisis urgently needs more attention and coordinated action. Sound and integrated water resources management is needed more than ever." (p. 5)

[185] The first Budapest Water Summit was held in 2012.

course of the elaboration of international environmental assessment reports and the determination of the goals and measures associated with a number of environmental and nature conservation conventions,[186] as well as the UN's *2030 Agenda for Sustainable Development*.

International scientific cooperation on chemical safety started to develop when accelerating globalization processes in the second half of the last century were reflected not only in the production and use of large quantities of diverse chemical substances but also in the growing awareness of their adverse ('side') effects on human health and the environment. For similar reasons, there was growing concern about the escalating amounts of hazardous waste, a significant proportion of which contains toxic chemicals. Research organizations and programs were set up to study these dangerous processes and assist in formulating (interrelated) international environmental, health, and economic policy objectives and interventions.

- Several recommendations of the 1972 UN Conference (UNCHE) addressed the increasing problems in relation to various chemical substances and waste components, together with the proposed international activities. The latter included, on the one hand, the assessment of hazards associated with the toxic chemicals (for which inventory and monitoring mechanisms were later created by the UNEP) and, on the other, the call for the further implementation of the few programs that then existed, in particular, the reduction of harmful effects of agricultural wastes and agro-chemicals [UN, 1972[187]].

[186] E.g., the conventions on biodiversity, climate change, desertification [CBD, 1992; UNFCCC, 1992; UNCCD, 1994].

[187] "Recommendation 21. It is recommended that Governments, the FAO and the WHO, in co-operation with the UNESCO and the IAEA, strengthen and co-ordinate international programmes for integrated pest control and reduction of the harmful effects of agro-chemicals […]. Recommendation 22. It is recommended that the Food and Agriculture Organization of the United Nations, under its 'War on Waste' programme, place increased emphasis on control and recycling of wastes in agriculture […]. Recommendation 74. (e) Develop plans for an International Registry of Data on Chemicals in the Environment based on a collection of available scientific data on the environmental behaviour of the most important man-made chemicals and containing production figures of the potentially most harmful chemicals, together with their pathways from factory via utilization to ultimate disposal or recirculation."

- Scientific cooperation on chemicals and chemical safety was primarily promoted under the auspices of the ICSU.[188] A notable turning point was the approval of the *International Programme on Chemical Safety* (IPCS) in 1980. One of its main objectives was the reduction of risks to human health and the environment caused by the chemicals throughout their entire 'life cycle' (production, transport, use, and disposal).
- Even greater emphasis was given to the toxic chemicals and hazardous waste in the UN program *Agenda 21* [UN, 1992]. This led to the foundation of the Intergovernmental Forum on Chemical Safety [IFCS, 1994[189]], which primarily focused on the 'environmentally sound' management of chemicals and establishing a joint program by the relevant UN agencies (IOMC, 1995–).[190]
- The improved cooperation and the more precise observations and analyses since the 1980s have led to the development of global conventions on hazardous waste, international trade in various chemicals, safe handling and gradual phase-out of persistent organic pollutants and mercury compounds, and programs on the sustainable management of chemicals. The latter included the *Strategic Approach to International Chemicals Management* (SAICM, 2006–), whose overall objective reiterated the commitment agreed upon at the 2002 World Summit to achieve the sound management of chemicals and wastes by 2020 (and to minimize their significant adverse effects on human health and the environment) [UN, 2002].
- Since the recent status of the above institutions, policy programs, and conventions will be presented in detail in the next chapter, we only mention a more recent institutional initiative here. According to the most summative conclusion of the 2019 global assessment report [UNEP/GCO, 2019]: "The global goal of minimizing the adverse impacts of chemicals and wastes will not be achieved by 2020. Solutions exist, but they require urgent and determined action by all stakeholders worldwide." With this in mind, the establishment of a new

[188] ICSU / IUPAC: International Union of Pure and Applied Chemistry; ICSU / IUTOX: International Union of Toxicology; ICSU-WHO / SGOMSEC: Scientific Group on Methodologies for the Safety Evaluation of Chemicals.

[189] "1.1 The Intergovernmental Forum on Chemical Safety […] to consider and to provide advice and, where appropriate, make recommendations to governments, international organizations, intergovernmental bodies and nongovernmental organizations involved in chemical safety on aspects of chemical risk assessment and environmentally sound management of chemicals."

[190] IOMC: Inter-Organization Programme for the Sound Management of Chemicals (UNEP, ILO, FAO, WHO, UNIDO, UNITAR; OECD).

intergovernmental body on 'chemical pollution' has been proposed [IPCP, 2019] (similarly to organizations dedicated to climate change and biodiversity, i.e., IPCC and IPBES) that could also assist in the preparation of the new program for sustainable chemical management [UNEP/SAICM, 2020].

Abiotic natural resources. The 'unsustainable' international consequences of the increasing exploitation and use of these resources as a result of the growing demand for raw materials for economic activities and the growth in their international trade have been dealt with in more depth since the 1970s. In this case, as with many other global-level affairs, the different situations and changing relations between developed and developing countries have become a key element of international relations. The Brundtland Report clearly articulated this problem's background [WCED, 1987[191]]; in essence, it is much more costly and difficult for those who started the process of industrialization later to access specific mineral resources, thus for developing countries. At the same time, improving resource use efficiency has become a common interest.

- Shortly after the foundation of the UNEP, this issue was raised, first, in relation to raw materials [UNEP, 1975[192]; UNEP, 1982[193]], and then in its full complexity in the global environmental reports published since 1997 [e.g., UNEP/GEO, 2019]. The International Resource Panel

[191] "24. The search for common interest would be less difficult if all development and environment problems had solutions that would leave everyone better off. This is seldom the case, and there are usually winners and losers. Many problems arise from inequalities in access to resources. […] 25. As a system approaches ecological limits, inequalities sharpen. […] When mineral resources become depleted, late-comers to the industrialization process lose the benefits of low-cost supplies."

[192] "48. Total resource requirements are increasing rapidly over the entire world. In developed countries, although population is increasing slowly, per capita use is increasing rapidly, while the opposite is happening in developing countries. […] 51. A fundamental shift towards less resource-intensive patterns of growth is important, especially in the industrialized world. Such a shift could improve the distribution of the world's economic activity and industrial capacity, bringing increased opportunities for employment and economic and social development to the developing world and having a generally salutary effect on the environment …".

[193] "54. The definition of mineral resources and reserves and their classification were advanced during the decade, emphasizing the tentative nature of many estimates and the fact that at any one time such estimates are strongly influenced by investment factors. Much argument took place during the 1970s over the increase in mineral consumption and the possibility of depleting mineral resources […] 105. The changed perceptions during the decade led people to question how supplies of non-renewable fossil fuels would be available at acceptable prices, and how such resources would last."

(IRP), established in Budapest in 2007, has produced and published a series of reports devoted explicitly to this multifaceted theme. These reports showed that over the last half-century, resource use, including that of non-metallic minerals and metal ore extraction, has increased substantially, and fossil fuel use has also grown significantly but at a slightly slower pace. The IRP made it clear that "In the absence of urgent and concerted action, rapid growth and inefficient use of natural resources will continue to create unsustainable pressures on the environment" [UNEP/IRP, 2019: p. 27].

- The International Union of Geological Sciences (IUGS) has long been concerned with the geological aspects of these resources. However, due to the growing demand for them, the last decade has not only seen a 'revival' of scientific studies about this topic [Brezsnyánszky, 2012[194]] but also an initiative by the IUGS to launch a new research program to discover how these demands may be satisfied in the coming decades [Lambert et al., 2013[195]].
- Other international organizations, such as EEA, OECD, SEI, WEC, and WRI,[196] have also carried out global and regional level analyses, in which, as above, environmental problems associated with the exploitation, transport, and use of natural resources have been highlighted, besides the international conflicts arising from the growing demand for oil and natural gas, critical raw materials, and rare earths.
- In addition to evaluating the environmental performance of its member states, the OECD has published reports on global resource demand, material flows, and international trade in various resources. These have shown that claims on and the use of natural resources are growing

[194] "Although the objectives of the IUGS have not fundamentally changed, the focus of the supported activity has changed several times over the course of fifty years. Today, due to the foreseeable scarcity of raw materials and energy, initiating new research on this issue and responsible management of natural resources are in the first place." (p. 517)

[195] "Finding the massive amounts of natural resources to satisfy the needs of society in the long-term will be challenging and it is important to establish what should be done in the next 10 to 20 years to help. That is the objective of the proposed international collaborative program which IUGS is referring to as Resourcing Future Generations (RFG). […] It is proposed that Earth science research driven by the RFG initiative be fully incorporated into Earth System Science programs. […] Discovery and production of new mineral resources to satisfy the needs of future generations is a challenging priority." (pp. 82–83)

[196] EEA: European Environment Agency; SEI: Stockholm Environment Institute; WEC: World Energy Council; WRI: World Resource Institute

rapidly and that it is necessary to improve resource productivity for both economic and environmental reasons [OECD, 2008[197]; OECD, 2015]. It is estimated that, based on current trends, the extraction and use of the abiotic resources referred to above will continue to increase globally, which will not be offset by improvements in the efficiency of their use (i.e., by reducing the 'material intensity' of the world economy), and this will lead to severe environmental impacts [OECD, 2019[198]].

International science and policy cooperation on specific environmental elements, processes, and resources has progressed considerably over the last half-century. But it can also be seen from the above that the increase in the dangerous impacts of human activities in these areas could only be somewhat mitigated. One reason is that the interactions between the various processes and emerging problems have often not been sufficiently considered. This situation has become more than evident with issues such as global biodiversity loss, anthropogenic climate change, the unsustainable use of water resources, environmental releases of toxic chemicals, ubiquitous waste streams, and unsustainable resource management. While it is therefore essential to study and address each of these hazards in depth, it is also necessary to take a 'systems approach,' whether this involves theoretical research, modeling, assessments, or creating the scientific foundation for complex policy responses to these problems (strategies, programs or agreements).

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[197] "Over the past two decades, worldwide use of virtually every significant material has been rising. Growing economic and trade integration among countries has enlarged the size of markets, allowed greater specialisation and mobility in production, increased the role of multinational enterprises, and led to an overall increase in international flows in raw materials and manufactured goods (OECD, 2007a). In consequence, the scale of many policy issues has widened from the local and national to the global. In recent years, prices for energy and other material resources have risen significantly amid growing demands from OECD and other countries, notably from fast-growing economies. Rising prices affect the manner in which natural resources are supplied to and used in the economy. They also influence decisions about technological development and innovation. Hence, natural resource consumption and the economic efficiency of materials use have become important issues …". (p. 12)

[198] "Global primary materials use is projected to almost double from 89 Gt in 2017 to 167 Gt in 2060. Non-metallic minerals – such as sand, gravel and limestone – represent the largest share of total materials use. […] Metal use is smaller when measured in weight, but is projected to grow more rapidly and metal extraction and processing is associated with large environmental impacts. […] decline in material intensity reflects a relative decoupling: global materials use increases, but not as fast as GDP." (pp. 15–16)

2.2.3. International scientific cooperation on global environment and sustainability

In addition to the creation of 'umbrella' scientific organizations, initiatives aimed at investigating the global environmental system and the cause-effect relationships associated with its changes have also led to the design and implementation of multidisciplinary programs and the elaboration of multifaceted (holistic) assessments and reports. The results and recommendations stemming from these research activities have to some extent catalyzed and influenced the development of new international environment-related policy strategies and action plans and, later, evaluations of the effectiveness of their implementation.

Global scientific fora. The recognition of the need for comprehensive collaboration in environmental science to study the environmental system as a whole from the late 1960s onwards was influenced by the increase in observational data and scientific investigations on the potentially dangerous, large-scale environmental impacts of human activities. In view of this, a UN resolution was adopted in 1968 concerning the urgency of dealing with the "problems of the human environment," and a global conference to be convened in 1972 on the matter [UN, 1968]. As the evidence of globalizing environmental processes strengthened, the UN, its specialized agencies, and interested international non-governmental organizations became even more determined to promote scientific cooperation to improve the understanding of those problems and formulate appropriate international goals and activities.

- The scientific conference organized by UNESCO in September 1968 not only laid the foundations for the above-mentioned 'Man and Biosphere' (MAB) program but also reviewed human activities in general that increasingly affect the environment, its quality, and resources. Furthermore, participants called for a multidisciplinary approach and international efforts to control these activities and mitigate their damaging consequences, including further environmental

degradation [UNESCO, 1970[199]]. (It was also in light of the conference's outcomes that the UN General Assembly passed the above-mentioned resolution in December 1968.) One of the conclusions of the UNESCO conference was particularly forward-looking since it even then defined the basic premise of the concept that several decades later emerged in its entirety entitled the 'Anthropocene'; let us quote here that statement: "[M]an now has the capability and responsibility to determine and guide the future course of his environment, and to the beginnings of national and international corrective actions."

- The formation of the Scientific Committee on Problems of the Environment (SCOPE) was decided by the ICSU in 1969. The committee also served as a link among those associations of experts dealing with environmental themes and representing a wide range of disciplines that had joined the ICSU. (The Hungarian scientist Károly Szesztay was involved in planning SCOPE's terms of reference.) The decision was motivated by concerns about the deteriorating state of the environment. According to its mandate, this scientific body was to promote and coordinate interdisciplinary research primarily on global environmental problems [White, 1987[200]].
- In the case of UNEP, the importance of creating its own multi-disciplinary scientific (advisory) body and seeking close cooperation with research institutions were not among the priorities for quite a long period following the establishment of the UNEP in 1972. Its first

[199] "114. The Conference, Drawing the attention of Member States to the importance of multidisciplinary centres for research and training on the environment and its resources at both the national and local levels". (p. 229) "Until this point in history the nations of the world have lacked considered, comprehensive policies for managing the environment. […] Although many of these changes have been taking place for a long time, they seem to have reached a threshold recently that has made the public aware of them. This awareness is leading to concern, to the recognition that to a large degree, man now has the capability and responsibility to determine and guide the future course of his environment, and to the beginnings of national and international corrective actions." (p. 235)

[200] "The explorations of modes of international scientific cooperation which led to the creation of SCOPE grew out of the widely-held public concern for environmental quality that took shape during the late 1960s." (p. 7) "SCOPE seeks to deal with scientific problems that have major significance on the world environmental scene. […] We stress those activities which are genuinely international, nongovernmental, and interdisciplinary." (p. 10)

concise global environmental assessment reports were compiled without such an institutional background (e.g., in 1975, 1977, and 1982), and there was at least implicit reference to the significance of researchers' contributions a few years later: "The scientific community should continue to play an important role in environmental research and risk assessment and international scientific co-operation." [UNEP, 1987: para. 119] The determination to play a substantially greater role in assessing the state and changes of the environmental system with the involvement of representatives of scientific institutes from all over the world arose in 1997. The first *Global Environmental Outlook* [UNEP/GEO, 1997] covered all regions of the world (albeit did little to address truly global trends), but at long last, the difficulties encountered during its preparatory process highlighted the lack and necessity of a stable organizational framework for global-level cooperation in environmental science (also serving as a science-policy interface). Even after that, it took several more years to agree on the institutional form of such cooperation (obviously, by considering the example of the IPCC that had already been effectively operating for a decade and a half) [UNEP, 2003[201]]. Unfortunately, that panel on global environmental change was not established either then or since. But at least under the leadership of UNEP, the 'GEO process' not only survived but involved many more scientists, who also became focused on creating the scientific basis for policies and measures that address the global environmental problems defined in the more recent GEO reports.

- The InterAcademy Panel (IAP) was set up in 1993, and since then (and after its agreement to collaborate with two other academic networks in 2016[202]) has provided a platform for the exchange of views and setting of joint positions by the members of national academies on global issues. The themes of the IAP reports and statements have included, among others, the implications of population growth on natural resource use and environmental pressures, energy supply/demand and

[201] "[…] proposals for strengthening the scientific base of UNEP by improving its ability to monitor and assess global environmental change including the establishment of an intergovernmental panel on global environmental change." (p. 9)

[202] The joint network was established in 2016 and entitled the InterAcademy Partnership.

the environment, forests and sustainable forest management, climate change, and the state of the oceans.

- The World Conference on Science was held in Budapest in 1999. This major event, jointly initiated and organized by UNESCO and ICSU, was followed by the biennial World Science Forum (WSF).[203] The participants' deliberations and adoption of declarations about global processes became integral parts of the programs of these events. The themes included critical environmental issues, about which the shared positions and further research tasks were clearly reflected in the reports of the meetings held in 1999 and 2003 [WCS, 1999[204]; WSF, 2003[205]]. Similarly, global environmental and social interlinkages and directions for strengthening cooperation in this field were emphasized at several subsequent fora and in the agreed

[203] The author of this book has participated in all these events held in Budapest (WCS, WSF) since 1999 and was on some occasions invited to assist in the preparations and conducting of several sections (as co-organizer, speaker, and/or rapporteur), as well as the compilation and presentation of those sections' summaries/conclusions.

[204] Declaration: (27.) "a new relationship between science and society is necessary to cope with such pressing global problems as poverty, environmental degradation, inadequate public health, and food and water security, in particular associated with population growth"; Science Agenda: (29.) "The goals of the existing international global environmental research programmes should be vigorously pursued within the framework of Agenda 21 and the action plans of the global conferences …".

[205] Conclusions: "Improving knowledge on environment, on interrelation of environmental processes and societies is of utmost importance for our further development. […] science assisted us to realise that our economic activities, their resource needs and environmental pressures gradually reached a level, when we already interfere with the global environment of our planet. […] Science has double challenge: on the one hand to identify, analyse and understand the complex processes of environment and societies, on the other hand to develop the solutions to the various problems. […] science should be holistic especially in light of emerging global environmental problems and the proposed responses …".

conclusions [WSF, 2005, 2009, 2011, 2019[206]]. From these, we highlight here only the essence of one of general relevance, according to which science has an exceptional role in improving our understanding of the Earth's vast and complex environmental system – its processes, feedback mechanisms, and interactions – and based on that, deriving increasingly accurate assessments about the probable future behavior of this global system [WSF, 2005].

- A broad international coalition of scientists, entitled the Alliance of World Scientists (AWS), was created in 2017 to assess the enhancing human influence on the global environment and call for urgent measures for their strict control (abandonment or at least mitigation). This initiative by researchers at Oregon State University followed their publication of a paper on global environmental processes [Ripple et al., 2017]. Since then, many experts from all over the world have joined this call and refer to this Alliance as an international virtual institution and collaborative network that promotes new analyses and disseminates their results about hazardous global issues.[207]

Global environmental change: international science programs and assessment reports. The most influential outcomes of environmental science cooperation for the 'outside world,' including especially the policymaking community, are the summary reports that highlight only the most essential monitoring and assessment results and include the key conclusions. The detailed background documents and their concise summaries are drawn up and agreed upon jointly by the participating researchers under the auspices of relevant international organizations and/or at international meetings. Most commonly, these research

[206] (2005:) "The Earth's environment is a huge, complex system. All of us need to more fully understand this global system – including processes, feedback mechanisms and interconnections – so a better assessment of the system's future behavior can be made, reflecting internal processes, external factors and especially, our planned and inadvertent influences on it." (2009:) "The importance of integrating social and natural sciences was highlighted as was the need to seriously consider changing our lifestyles to lessen our pressure on ecosystems and unsustainable use of natural resources." (2011:) "The advancements in science have also shed light on new and previously unforeseen concerns. Climate change, the large-scale and irreversible impact of human civilization on the world's fauna and flora, an overconsumption of natural resources, and their respective consequences require stronger involvement from both scientists and society." (2019:) "Environmental and social challenges including demography, climate change, pollution and water security have raised new expectations for science."

[207] The author of this book joined AWS in 2017.

communications cover not only the essence of new/updated scientific knowledge on the global environmental system and related socio-economic findings but also science-based policy recommendations.

- The International Geophysical Year (1957/58) can be considered the first global-scale and multidisciplinary scientific program for monitoring and studying a wide range of environmental phenomena and processes, including their interrelationships [Odishaw, 1958[208]]. This program was organized and coordinated by the ICSU, its several scientific federations, and the WMO.
- The preparation of the report entitled *Only One Earth* (with the subtitle 'The Care and Maintenance of a Small Planet') on the growing interactions between societies and the environment worldwide was based on extensive research cooperation [Ward & Dubos, 1972]. Eminent experts from some fifty countries (including Imre V. Nagy and Bruno F. Straub from Hungary) contributed with their opinions and suggestions to this comprehensive assessment. The authors of this book went into great detail concerning hazardous anthropogenic environmental problems[209] and called for more effective international research cooperation on this matter. We have already pointed out that this report actually set the 'tone' for the 1972 UN Conference held in Stockholm (UNCHE).
- The importance of science in better understanding emerging environmental hazards was also stressed at the 1975 pan-European conference convened in Helsinki [CSCE, 1975[210]]. Afterward, although the implementation of some environment-related and other world

[208] "[F]ields include meteorology, ionospheric physics, geomagnetism, aurora and airglow, and cosmic rays […] studies of the sun were also necessary. […] The IGY program also included oceanographic and glaciological studies. […] a significant human venture has been realized. This venture has represented a major scientific inquiry into the nature of man's physical environment. […] results at hand suggest that IGY has opened new doors for man in relation to his environment. Some of these are purely research doors, for as new insight is gained into nature …". (pp. 48, 54)

[209] "Human interference with the natural order has, over the last 200 years – and at an enormously accelerated pace in the last 25 years – assumed proportions that mark the dawn of a revolutionary new era in human history …". (p. 35)

[210] "[T]o study, with a view to their solution, those environmental problems which, by their nature, are of a multilateral, bilateral, regional or sub-regional dimension; as well as to encourage the development of an interdisciplinary approach to environmental problems." (p. 27)

programs continued at a variable intensity (e.g., UNESCO/MAB), international scientific contacts were considerably set back by the Cold War's political atmosphere. The situation gradually improved from the early 1980s onwards, first by addressing some environmental research topics that were not in the limelight of 'high politics' – that is, were not closely related to the sensitive international political confrontations of the time. Such rather few cooperative opportunities included broad-based research activities on the biosphere and the atmosphere (e.g., ICSU-UNEP-WWF: *World Conservation Strategy*, 1980; WMO-ICSU-IOC: World Climate Research Programme, 1980–), as well as those in connection with global environment-related assessments. As concerns the latter, the UNEP undertook the (above-mentioned) evaluation of the state of Earth's environment [UNEP, 1982].[211] Moreover, its Governing Council decided in 1983 to compile a conceptual document about the long-term 'environmental perspective' (including strategies for achieving sustainable development) and establish a commission to elaborate on it. The World Commission on Environment and Development (WCED) also began its activities in 1983 (with a more general mandate and stronger support).[212]

- The UNEP's Governing Council adopted the *Environmental Perspective to the Year 2000 and Beyond* in 1987 and then submitted it to the UN General Assembly. The global threats and the need for comprehensive actions were very clearly emphasized: "(1.) […] environmental degradation has continued unabated, threatening human well-being and, in some instances, the very survival of life on our planet" and "(4.) […] Environmental problems cut across a range of policy issues and are mostly rooted in inappropriate development patterns. Consequently, environmental issues, goals, and actions cannot be framed in isolation from the development and policy sectors from which they emanate. [...] Throughout the Environmental Perspective, an attempt has been made to reflect consistently the interdependent and integrated nature of environmental issues" [UNEP, 1987]. In addition to describing a number of specific hazardous processes, the document

[211] Actually, this was preceded by even more concise reports on the state of the environment in 1975 and 1977.

[212] The chairman of the World Commission on Environment and Development was Gro Harlem Brundtland, Prime Minister of Norway; István Láng, Secretary-General of the Hungarian Academy of Sciences was among the members of the Commission.

presented those environment-related actions which implementation seemed to be the most important in the relevant sectors and areas. The same year, the World Commission on Environment and Development finalized its report under the title *Our Common Future*. Its scope was much broader than that of the above-mentioned UNEP document. In line with its mandate, the Commission provided a wide-ranging assessment of the interrelated social, economic, and environmental processes and proposed multifaceted activities for promoting sustainable development [WCED, 1987]. Based on these documents (and the UN resolutions that 'welcomed' them), preparations for the 1992 UN Conference on Environment and Development (UNCED) and the global sustainable development strategy to be approved by the conference were launched. The said perspective published by the UNEP laid the foundations for the further development of environmental assessments and policy-oriented efforts supported by other UN specialized agencies besides the UNEP.[213]

- The International Geosphere-Biosphere Programme (IGBP) started in 1987 with the objective, as stated in the ICSU's General Assembly Resolution, "to describe and understand the interactive physical, chemical, and biological processes that regulate the total Earth system, the unique environment that it provides for life, the changes that are occurring in this system, and how they are influenced by human actions. [...] Priority in the IGBP will therefore fall on those areas of each of the fields involved that deal with key interactions and significant change on time scales of decades to centuries" [ICSU, 1987]. According to the initiators of this program, human activities have become the main drivers of that change. Therefore, a much broader research agenda is needed to explore the functioning of the complex environmental system.[214] To complement this cooperation in the natural sciences, in 1990, the International Social Science Council (ISSC) initiated a 'human dimension' research program on the social aspects of global change, which planning was completed together with

[213] Concerning the environment-related issues and recommendations, the two reports turned out to be mutually coherent since the Governing Council of the UNEP and the WCED were in close contact and before finalizing the UNEP's strategic document the relevant preliminary recommendations of the WCED were taken into account.

[214] Hungarian representatives were also involved in preparing and implementing this program. Academician József Tigyi became the chairman of the Hungarian IGBP committee.

the ICSU (IHDP, 1996). Their first synthesis report on *Global Change and the Earth System* was issued in 2004, and then the summary of the main results and conclusions were published in a document entitled *State of the Planet* at the end of the program [Steffen et al., 2004; ICSU, 2012]. In the latter, the critical global situation ("pressures on the environment that may cause fundamental changes in the Earth system") and the substantial role of science "in exploring these processes and […] providing the basis for societal and policy responses" were articulated.[215]

- Building on the experience of the IGBP, the international research program Future Earth was designed to take forward, deepen, and broaden integrated studies with the involvement of natural and social scientists. The scientific community was determined to explore more thoroughly the causes and effects of global environmental changes and estimate their further evolution, moreover, to identify more precisely the possibilities for solving the problems arising from these changes [ICSU, 2013[216]]. Several international organizations[217] took part in designing this program, whose implementation started in 2015.
- The UN agencies primarily concerned with environmental hazards (UNEP, UNESCO/IOC, and WMO) have been involved not only in the above-mentioned broad undertakings but also launched and/or expanded their 'own' and supported other environment-related activities from the late 1980s onwards. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 upon UNEP and

[215] "(2) In one lifetime our increasingly interconnected and interdependent economic, social, cultural and political systems have come to place pressures on the environment that may cause fundamental changes in the Earth system and move us beyond safe natural boundaries […] (6) Researchers observe unsafe levels of pollution, ecological change and resource demand, with potentially catastrophic consequences for our global civilisation. […] (10) Research plays a significant role in monitoring change, determining thresholds, developing new technologies and processes, and providing solutions. The international global-change research community proposes a new contract between science and society in recognition that science must inform policy to make more wise and timely decisions […]. The challenges facing a planet under pressure demand a new approach to research that is more integrative, international and solutions-oriented."

[216] "Future Earth will answer fundamental questions such as how and why the global environment is changing. What are likely future changes? What are the risks and implications for human development and for the diversity of life on earth? It will define opportunities to reduce risks and vulnerabilities, to enhance resilience and innovation, and show ways to implement transformations to prosperous and equitable futures." (p. 10)

[217] ICSU, ISSC, UNESCO, UNEP, UNU, WMO.

WMO's joint initiative. The UNEP, IUCN, and WWF jointly assisted and promoted the elaboration of a study on factors endangering the biosphere (as mentioned in the previous section) [IUCN-UNEP-WWF, 1991: Caring for the Earth] with the intent of facilitating the ongoing negotiations of a convention on biological diversity. In this context, the UNEP's first Global Environment Outlook (GEO) on the state and future of the Earth's environment, referred to above, can also be mentioned [UNEP/GEO, 1997]. The latter and the resulting 'GEO process' partly solved the problem of the failure to set up an international scientific advisory body that could contribute to improving the completeness and quality of the former environmental reports and their international recognition (as well as the reputation of the UNEP in general). The subsequent assessment reports were prepared through extensive scientific collaboration, including the most recent sixth report [UNEP/GEO, 2019]. The latter provided a very detailed picture of the environmental consequences of global socio-economic processes and their adverse feedback (repercussions) and assessed as insufficient the mitigation measures taken so far at the international and national levels.[218]

Cooperation aiming at establishing and deepening sustainability science. In addition to actively dealing with their 'own' more or less specific fields of expertise, environmental researchers, together with representatives of other disciplines, have contributed to the 'birth' and development of sustainability science, which subject is also sometimes seen as a generalization and extension of environmental sustainability (as outlined in Section 2.1.3.). Instead of taking into account to some extent the 'external' socio-economic *or* environmental factors (driving forces and effects) in the assessments, models, concepts, strategies, and programs focusing on either environmental *or* social and economic processes, respectively, within this new comprehensive scientific framework, the 'ensemble' of all these processes (together with their interactions) and the conditions of its sustainability were examined using a multidisciplinary approach.

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[218] "Projected population growth, urbanization trends and economic development will significantly increase demand for natural resources, such as food, energy and water, towards 2050. Under a business-as-usual scenario, resource efficiency in production and consumption, agricultural yields and nutrient use, water and energy efficiency are projected to increase, thereby partially offsetting demand for key environmental resources. However, such improvements will be inadequate to reduce the pressure on already-stressed environmental systems." (GEO-SPM, p. 19)

- The essence of sustainability in this broader sense and the importance of its holistic research were referred to in some documents adopted by international organizations as early as the 1980s. The *World Conservation Strategy* published by the IUCN in 1980 in collaboration with UNEP and WWF, in addition to highlighting the vital importance of maintaining ecological processes, conserving genetic diversity, and the sustainable use of living resources, emphasized that all these could only be achieved on the basis of a development concept that also takes into consideration social and economic objectives [IUCN-UNEP-WWF, 1980[219]]. Likewise, the *World Charter for Nature* endorsed by the UN General Assembly underlined not only the significance of nature and natural resources in general but emphasized the harmony between 'man and nature'; that is, the need to consider nature conservation an integral part of socio-economic development concepts and activities [UN, 1982[220]].
- The report published by the World Commission on Environment and Development went far beyond the earlier primarily 'environment-centered' assessments and objectives, which were only more or less concerned with the socio-economic context. According to this report, world problems, and above all, those that had already reached some critical level, could no longer be examined and solved in a fragmented way, either at the national and sectoral level or within the framework of particular research disciplines associated with environmental,

[219] (1.3.) "Development is defined here as: the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life. For development to be sustainable it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base …". (1.12.) "[…] there is a close relationship between failure to achieve the objectives of conservation and failure to achieve the social and economic objectives of development – or, having achieved them, to sustain that achievement. Hence the goal of the World Conservation Strategy is the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and wellbeing of all people."

[220] "(b) Civilization is rooted in nature, which has shaped human culture and influenced all artistic and scientific achievement, and living in harmony with nature gives man the best opportunities for the development of his creativity, and for rest and recreation …". (p. 1) "In the planning and implementation of social and economic development activities, due account shall be taken of the fact that the conservation of nature is an integral part of those activities." (II.7.)

economic *or* social issues [WCED, 1987[221]]. In this regard, it is symbolic that while the background assessment report for the 1972 UN meeting (UNCHE) was entitled *Only One Earth*, the 1987 assessment report (catalyzing the preparations for the 1992 Earth Summit) was given the full title *Our Common Future, From One Earth to One World*. In latter report, the members of the WCED formulated the sustainability requirements not only in regional, sectoral, or disciplinary dimensions but also in their 'wholeness,' thereby having a significant impact on the (political) negotiations which eventually resulted in the completion of the global agenda and its approval at the 1992 UN Conference (UNCED). The in-depth analysis and the recommendations included in that report had also a considerable effect on further international cooperation on the interpretation and clarification of sustainable development and sustainability. We refer here to two such examples. The new strategic document of IUCN, UNEP, and WWF presented the sustainability principles and conditions for social and natural systems together and with their interlinkages in a much clearer way than in their 1980 report [IUCN-UNEP-WWF, 1991[222]]. Although the InterAcademy Panel (IAP), in its 1994 statement, dealt primarily with the consequences of rapid population growth, its findings were also generally

[221] "11. Until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade), and within broad areas of concern (environment, economics, social). These compartments have begun to dissolve. This applies in particular to the various global 'crises' that have seized public concern, particularly over the past decade. These are not separate crises: an environmental crisis, a development crisis, an energy crisis. They are all one."

[222] "This is a strategy for a kind of development that provides real improvements in the quality of life and at the same time conserves the vitality and diversity of the Earth. The goal is development that meets these needs in a sustainable way. […] We need development that is both people-centered, concentrating on improving the human condition, and conservation-based, maintaining the variety and productivity of nature […]. Living sustainably depends on accepting a duty to seek harmony with other people and with nature." (p. 8)

valid concerning the environmental, social, and economic aspects of development [IAP, 1994[223]].

- At the turn of the millennium, sustainability science cooperation strengthened due to the increase in high-level political interest in the development path based on this approach. The World Conference on Science (Budapest, 1999), organized by UNESCO and ICSU with the participation of the IAP and the subsequent IAP conference (Tokyo, 2000), can be considered turning points in the research cooperation along the lines of the holistic concept. The declarations of these conferences emphasized the role of science in interpreting sustainability, exploring its interlinked social and environmental context, and developing scientifically sound proposals for appropriate policy decisions [WCS, 1999[224]; IAP, 2000[225]]. This was more-or-less reflected in the Millennium Declaration, the global plan endorsed at the 2002 World Summit and Sustainable Development, and the *2030 Agenda for Sustainable Development* (and its sustainable development goals) adopted in 2015 [UN, 2000; UN, 2002; UN, 2015].

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[223] "Our common goal is the improvement of the quality of life for all, both now and for succeeding generations. By this we mean social, economic and personal wellbeing while preserving fundamental human rights and the ability to live harmoniously in a protected environment. […] Natural and social scientists, engineers and health professionals have their part to play in developing better understanding of the problems, options and solutions, especially regarding: […] 2. impediments to human development, especially social inequalities, ethnic, class and gender biases; 3. global and local environmental change, its causes (social, industrial, demographic and political) and policies for its mitigation …". (pp. 1–2)

[224] (1.) "The sciences should be at the service of humanity as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations." (4.) "Today, whilst unprecedented advances in the sciences are foreseen, there is need for a vigorous and informed democratic debate on the production and use of scientific knowledge. The scientific community and decision-makers should seek the strengthening of public trust and support for science through such a debate. Greater interdisciplinary efforts, involving both natural and social sciences, are a prerequisite for dealing with ethical, social, cultural, environmental, gender, economic and health issues …".

[225] (I.) "Even with the many positive achievements in using science for human benefit, the future challenges will be enormous and rapidly evolving. […] These multiple factors have mobilized us, the world's scientific academies, to focus on how to promote the worldwide transition to sustainability more effectively." (II.2.) "The current store of knowledge, while it can and must be much more broadly applied, will not be adequate to meet projected and as-yet-unforeseen challenges to sustainability. The successful production and application of new knowledge is necessary."

- Since then, a number of international scientific organizations have been working together to broaden the scope of sustainability science to address more thoroughly the interactions between environmental and socio-economic processes, and issues concerning technology development and, within this broad sustainability framework, to explore the possibilities for more effective science-policy collaboration [Clark & Dickson, 2003]. The primary outcomes of these research activities were summarized in a separate publication and jointly represented by these organizations[226] at the 2002 World Summit on Sustainable Development [ICSU, 2002a; 2002b]. In turn, the crucial role of science and science-based decision-making was acknowledged in the final document approved at the summit [UN, 2002: paras. 107–113]. This research cooperation continued at varying intensity, e.g., in the context of the above-mentioned global programs (IGBP, IHDP).
- The relevance of global sustainability was re-emphasized in 2012 both in the *State of the Planet* declaration endorsed by the representatives of four international organizations[227] and among the objectives of the forthcoming ICSU research program (Future Earth). The essence of these conceptual directions introduced in these documents was presented at the 2012 UN Conference on Sustainable Development, partly with the aim of improving the science-policy interface [ICSU, 2012[228]; UN, 2012a]. At the same time, the Sustainable Development Solutions Network was set up [UN/SDSN, 2012], and the theme of global sustainability also received great attention at the World Science Forum,

[226] ICSU, WFEO, TWAS, IAP, ISSC.

[227] IGBP, Diversitas, IHDP, WCRP.

[228] "B2. The challenges facing a planet under pressure demand a new approach to research that is more integrative, international and solutions-oriented. We need to link high-quality focused scientific research to new policy-relevant interdisciplinary efforts for global sustainability. This research must integrate across existing research programmes and disciplines, across all domains of research […]. As part of this new collaboration, at this conference the global-environmental-change programmes support a major research initiative, Future Earth: research for global sustainability."

especially after 2012 [WSF, 2013, 2015, 2019[229]]. The Future Earth program, the planning of which was finalized in 2015, was definitely based on sustainability science, with the objective and strategy of accelerating the transition to sustainability at a global level [ICSU-ISSC, 2015[230]]. The recognition of the importance of interdisciplinary, or already rather 'trans-disciplinary' cooperation, was clearly demonstrated when the International Science Council (ISC) was created in 2018 by the merger of two organizations (ICSU and ISSC), which had been engaged and cooperated in global environmental, social, and sustainability programs for a long time. It is worth noting that UNESCO also joined this endeavor with a program supporting the further development and application of sustainability science [UNESCO, 2016[231]].

[229] WSF-2013: "In the complex global system of environmental, economic and social interdependencies, sustainable development can only be addressed when global and national efforts are coordinated. International coordination and common principles are required to harmonize national science policy actions and research projects focusing on global sustainability issues. […] Global challenges offer a unique opportunity for collaborative research on an equitable basis". WSF-2015: "Shift for new, sustainable development paths […]. We seek an integrated approach in addressing the environmental, social and economic dimensions of sustainable development based upon the 17 Sustainable Development Goals (SDGs), prepared using best available knowledge and defined by the broad and comprehensive involvement of our fellow scientists." WSF-2019: "Science for global well-being […] The value of science cannot be measured solely by its contribution to economic prosperity. Science is a global public good with the ability to contribute to sustainable development and global well-being."

[230] Mission: "Future Earth's mission is to accelerate transformations to global sustainability through research and innovation." Strategy: "Future Earth develops the knowledge and tools that government, communities, and companies need to meet the United Nations' 17 Sustainable Development Goals. By understanding connections among environmental, social and economic systems, Future Earth works to facilitate research and innovation, build and mobilize networks and shape the narrative, turning knowledge into action."

[231] "Science is a human endeavor, which takes place in given cultural contexts; therefore, the Sustainability Science Project is sensitive to the current debate on the role and responsibility of science in different social, economic, environmental and cultural contexts." (p. 15)

3. HAZARDS OF ENVIRONMENTAL GLOBALIZATION: THEIR POLITICAL ACKNOWLEDGMENT AND RESPONSES

> "To understand adequately the significance of international environmental policy in the present and the probable future, its origins and evolution need to be understood."
>
> *Caldwell & Weiland, 1996*[232]

3.1. International environmental conflicts

In addition to the scientific analysis of extensive environmental processes and interrelationships, the international conflicts arising and lessons learned from the transboundary adverse effects of pollution and the exploitation and/or degradation of natural resources in 'international areas' have ultimately catalyzed the adoption of principles, programs, and international agreements aimed at preventing such problems and mitigating the related harmful consequences if they occur. Such conflicts involving two or more countries may arise, for instance, from the emission and transmission of air pollutants, 'improper' use of transboundary watercourses (with harmful impacts on other riparian countries), illegal transport of hazardous wastes, and extraction of natural resources in areas beyond national jurisdiction. We present below some historical and more recent cases that illustrate the diversity of such conflicts and their indirect role as catalysts in enhancing environmental cooperation. In general, compared to the transboundary or even global-scale deleterious effects of emissions of various pollutants, bilateral and multilateral conflicts associated with the exploitation/utilization of specific natural resources remain more difficult to resolve through the elaboration, and implementation of universally accepted and respected international agreements.

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[232] Caldwell, L.K. & P.S. Weiland, 1996: International Environmental Policy: From the Twentieth to the Twenty-first Century. Duke Univ. Press

3.1.1. Continuous and extraordinary environmental damages

'Chronic' transboundary environmental pollution and subsequent environmental and health damage caused to other country/countries has occasionally led to prolonged international political tension. ('Chronic' here stands for situations when the harmful effects stem from some continuous/regular or repeated industrial or residential activity.) Many such cases have been (fully or partially) resolved through dispute settlement or other means, and eventually contributed to the development of relevant international environmental policies and legal instruments.

- Air pollution from a smelter in the Canadian town of Trail had adverse effects on nearby US territory from the early 1920s onwards. This conflict between factory managers and the community on the other side of the border was finally settled at the level of the two governments in 1941 [UN, 2006]. Rather than going into the details of the arbitration, it is important to note here that the final decision was based on the general obligation to prevent transboundary damage by harmful emissions.[233] To comply with the agreement between the two governments, the smelter operator reduced those emissions (by removing sulfur content from the flue gas).[234] A similar but much more protracted problem arose in relation to a smelter in the Russian settlement of Nikel (!), a few kilometers from the Norwegian border [Rowe, 2013]. There are many other examples of such bilateral conflicts; here we mention only one more, when chlorine gas from a chemical plant in the Romanian border town of Giurgiu (Gyurgyevó) in the 1980s caused significant health effects on the inhabitants of the neighboring Bulgarian town of Ruse.
- Some air pollutants can be transported over long distances and deposited far away from their source. This occurred when acidifying compounds emitted in Western European countries reached areas in Northern Europe, and such pollutants of Canadian origin 'arrived' in some locations in the USA. For quite a long time, the possibility of that long-range transmission, together with the responsibility for such

[233] The substance of this argument was adopted a few decades later, namely at the 1972 UN Conference on Human Environment, as a universally applicable principle of international environmental cooperation.

[234] In the words of the Tribunal: "abeyance of harmful sulphur dioxide fumigations" (UN, 2006; p. 1980).

transboundary pollution, was rejected by the representatives of the 'source countries' until finally, those 'teleconnections' were demonstrated by a multiannual monitoring program promoted by the OECD [Ottar, 1977[235]; OECD, 1977]. Based on the outcomes of this program, it was also decided to set up a permanent pan-European monitoring network (EMEP) and to draw up an international convention to regulate these emissions [CLRTAP, 1979].[236]

- When the invading Iraqi army blew up about seven hundred Kuwaiti oil wells during its retreat in 1991, the situation was in some ways the reverse of the above (regarding the sequence of events). At that time, one of the consequences of the two countries' dispute over oil production was the severe and far-ranging air pollution caused by burning oil wells [Small, 1991].
- There are also numerous examples of intermittent or continuous water pollution due to effluents entering international watercourses from industrial plants located in an upstream country. Here, we refer to just one, namely the dispute between Austria and Hungary (which escalated in the early 2000s) over continuous pollution discharge from Austrian leather factories operating along the upper sections of the river Rába (Raab). To resolve this conflict, the Hungarian side cited in its appeal, for example, the provisions of the pan-European convention on transboundary watercourses.[237]
- The incineration and dumping of hazardous waste have also often caused cross-border air or water pollution. Moreover, there are numerous precedents concerning such waste being transported to

[235] "(OECD) LRTAP program, as well as studies in Canada and the USA, have shown that large amounts of pollutants are transported over long distances and have resulted in a general pollution of areas which were previously considered unaffected. […] What is needed is an international agreement to reduce emissions." (p. 269)

[236] EMEP: European Monitoring and Evaluation Programme (1977–); CLRTAP: Convention on Long-Range Transboundary Air Pollution (1979).

[237] The official title of this international agreement is as follows: Convention on the Protection and Use of Transboundary Watercourses and International Lakes [CTWC, 1992]. The author of this book participated in the negotiations between the official representatives of the two countries. The Hungarian side requested the abandonment of the technological process used in the leather factories that was the cause of the severe water pollution ('foaming') of the river. The Austrian officials promised to eradicate this problem and the necessary investments were made, and the situation improved. However, the harmful effects of this pollution have reappeared from time to time.

another country, either ‘disguised’ as legal or as a clearly illegal shipment. In 1986, a ship left a US port with a large quantity of hazardous waste, part of which was dumped on a beach in Haiti, and afterward, the rest was sunk somewhere at sea. The disclosure of several such notable incidents reinforced the necessity of introducing international regulations for controlling and/or restricting such ‘waste trade’ activities [Vu, 1994; Faragó, 2013b].

Industrial and transport-related accidents and their harmful environmental effects have already been mentioned in the context of globalization (in the first chapter). Below, a few concrete examples of such accidents that caused extreme and ‘acute’ damages are highlighted, the follow-up analysis and lessons of which were directly utilized in developing the relevant international agreements and strengthening environmental security.

- The oil tanker Torrey Canyon ran aground near Wales in 1967. The oil spill and the chemicals used to dispose of it caused enormous damage along the coastline and soon also reached the French coast [Walsh, 1968]. The dispute over the high levels of pollution between the US company (owner of the tanker) on the one hand and the British and French governments on the other eventually resulted in a record compensation settlement.
- In 1986, a fire at the Sandoz chemical plant in Switzerland and its extinguishing contaminated the Rhine with toxic chemicals, with significant adverse effects on German, French, and Dutch territories. This incident was compounded by the lack of international legal instruments for enforcing compensation claims at that time [Schwabach, 1989]. During the reconciliation process between these governments, they also addressed the need to establish international procedures to prevent such environmental damages and make redress if such a severe incident were to occur. Several relevant legal instruments already existed when the Tisza River was damaged by cyanide and heavy metal pollution from a Romanian tailings pond in 2000 [Faragó & Kocsis-Kupper, 2000]; however, the failure to enforce the respective international regulations was mainly related to their limited scope and effectiveness in terms of clarity and applicability.
- The assumed large-scale or even global environmental consequences of a potential international nuclear conflict began to be dealt with as early as when the two ‘nuclear superpowers’ had accumulated substantial

nuclear arsenals. Testing of such weapons caused extensive damage to the natural environment [UN, 1980]. From the 1970s onwards, quite a few studies were published on the potential 'nuclear winter' that would occur because of the tremendous amounts of pollutants (aerosol particles) that would be released into the atmosphere from nuclear explosions 'blocking' (decreasing) solar radiation from reaching the Earth's surface for a prolonged period [Kondratyev, 1986; ICSU/SCOPE, 1986; Martin, 1988]. International nuclear safety cooperation accelerated after the 1986 Chernobyl nuclear power plant accident. In that case, partially because of the considerable delay in notifying the relevant international and national agencies of the reactor explosion, it only became clear much later how far the radioactive pollution had spread due to air currents. First of all, the obligation to provide early notification about a nuclear accident was established [CENNA, 1986], and shortly after that, the elaboration of a comprehensive nuclear safety convention was proposed [IAEA, 1991[238]], which was finalized and adopted within a few years (1995).

3.1.2. Resource conflicts

The utilization of some natural resources or the specific nature of the related activities have occasionally triggered international conflicts in the past and even recently. Sometimes this occurred merely due to a unilateral declaration of the intent to appropriate valuable resources located in 'international areas'. The latter problematic includes both the exclusive claim to some resources in areas which are beyond national jurisdiction or the use of these resources to the detriment of the interests of other nations.

To prevent and/or manage all such international tensions, a number of legal instruments and guidelines have been developed, albeit with very different degrees of effectiveness.

- ***Water resources***. (i) One of the early resource-related disputes (often cited in the literature) arose between Mexico (U.S.M.) and the USA over the use of the water from the Rio Grande for irrigation purposes in

[238] According to the German environmental minister, Klaus Töpfer who chaired that IAEA-conference: "Member States have been able to create important legal requirements. Examples include: The Convention on Early Notification of a Nuclear Accident; The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; […] We should now set a process in motion to create a similar convention in the area of nuclear safety as well." (p. 13)

the agricultural regions on both sides of the border. This confrontation was settled in 1906 through the conclusion of an agreement on the "equitable distribution" of that natural asset between the two parties. (ii) In comparison, the use of water from the Nile for agricultural and, more recently, electricity production, has long been a source of serious and unresolved conflict between upstream and downstream countries. This illustrates how past events (i.e., arrangements that do not take into account the situations/interests of all nations concerned), even under significantly changed political and socio-economic circumstances, can still have major repercussions for multilateral relations.[239]

- ***The exploitation of biological resources*** in various areas may lead to detrimental consequences, particularly for endangered species, and also catalyze international conflicts of interest. A few examples provided below demonstrate how these (and many other more or less similar) cases either led to unilateral declarations/decisions or the development of international cooperation and regulations on nature conservation. (i) The Icelandic–British maritime fisheries dispute has taken several sharp turns since the eighteenth century, especially since the 1950s when Iceland first defined the limits of its 'exclusive fishing zone' as four nautical miles (nm), extending this a few years later to twelve nm. This 'Cod War' became even harsher when Iceland unilaterally declared a 200 nm boundary for its 'exclusive economic zone' (EEZ), arguing that this would also guarantee the maintenance of 'sustainable fisheries' in that area. (ii) Control over the Falkland Islands (Islas Malvinas) and the surrounding 'territorial sea' is another well-known example of serious historical international discord. These islands are part of the overseas territories of the U.K. After Argentina failed to assert its claim over these islands even with military force (1982), the U.K. unilaterally defined an EEZ of 850 nm (!) around the islands. In doing so, reference was also made to the importance of protecting the habitat of the sea squid population (however, historical and geopolitical reasons were obviously the prime factors in the 'recapture' of the islands and extending that zone). On both of the latter occasions, the

[239] The Nile Waters Agreements signed by Egypt and Sudan in 1929 and 1959, did not take into account the interests of the upstream states, including Ethiopia. About a decade ago, Ethiopia began the construction of a huge dam associated with a hydroelectric power plant, the operation of which will severely reduce the quantity of Nile water reaching Sudan and Egypt, whose agriculture is highly dependent on that water source.

real or alleged danger of 'overfishing,' i.e., the overexploitation of some marine biological resources, was also raised to justify the unilateral measures. Actually, such threats, in more general terms, were referred to as "the tragedy of the commons" by Garret Hardin in a famous article [Hardin, 1968]. (iii) Let us add one example of when tensions related to hunting rights ended up in a reasonable compromise. The fur seal population in the Barents Sea was drastically depleted by overhunting from the end of the nineteenth century onwards. Controversy over the demands for further massive sealing [Bailey, 1935[240]] and concern about the risk of this species' extinction forced the representatives of the respective countries to negotiate and eventually approve an international convention on controlling seal hunting in 1911.[241] (iv) In the case of whaling, partly analogues reasons led to an agreement in 1946.[242]

- ***Mineral and other resources***. (i) The British flag was hoisted on the uninhabited Christmas Island in the Indian Ocean in 1888. When it was discovered that the island's depths contained valuable material, phosphate mining began. This continued, but to the benefit of the Japanese after they occupied the island during the Second World War until the island came under Australian jurisdiction in 1958. (Later, a new confrontation broke out between those who wanted to expand phosphate mining and those who opposed it and thought ecosystem protection on and around the island was much more important.) (ii) The exploration and acquisition of other geological resources have led to international clashes, especially in relation to natural gas and crude oil reserves located in disputed offshore areas [Csatlós, 2012; Faragó, 2018a]. One recent example is the conflict between some Mediterranean countries that escalated after Turkish hydrocarbon exploration and drilling in the Eastern Mediterranean. (iii) As mentioned above, one of the difficult tasks in such resource-related matters is establishing at least a basic institutional and/or legal framework for cooperation involving all interested parties, of which the

[240] "Pelagic sealing was not only frightfully destructive of wildlife but it was also a danger spot in the relations of the United States with both Great Britain and Japan. […] With the decline of the Canadian fleet and the increase in the number of the Japanese pelagic sealers the danger of serious trouble with Japan became increasingly imminent." (pp. 4–5)

[241] North Pacific Fur Seal Convention (1911).

[242] International Convention for the Regulation of Whaling (1946).

1991 Protocol on Environmental Protection to the Antarctic Treaty is one example.

- ***Growing resource demands***. Continuing globalization has increased the risk of widespread international tension over natural resources. No longer does more-or-less peaceful competition for resources occur in particular regions, but, according to Michael T. Klare, 'resource wars' are qualitatively more characteristic of our world than ever before [Klare, 2001; 2008[243]]. We highlighted this situation in the context of the present 'rush' for the hydrocarbon resources in areas beyond national jurisdiction and in analyzing the great powers' interest and positions concerning global environmental problems [Faragó, 2018a; 2018b].

While scientific studies about the increasing exploitation of natural resources, human impacts on ecosystems, and the harmful emissions can promote better understanding and consideration by policymakers of pre-existing and prospective hazards stemming from these human activities, environment-related conflicts directly indicate their serious international consequences worldwide. Together, the theory (science) and the experience (facts) could better catalyze the political recognition of the severity of these globalizing processes, their driving factors and harmful consequences, and the need to develop international policy cooperation, programs, and agreements for addressing them.

3.2. International environmental policy cooperation: turning points, and fluctuations in its development

Since the first half of the last century, environmental subjects directly or indirectly, have become part of multilateral policy cooperation. In the last few decades, globalizing environmental problems have also been addressed in the context of sustainable development by considering the complex interlinkages between socio-economic and environmental matters. The main factors driving this process are scientific knowledge about multiplying environmental hazards and their causes, the extreme and widespread environmental events, and moreover, the environment-related

[243] "One can argue, then, that the re-emergence of resource conflict in the current period is nothing more than a return to the status quo ante: to the long stretch of time in which resource competition was a dominant force in world affairs. But it is the contention of this chapter that the situation we face today is not just more of the same: it is, instead, a qualitatively different situation, in which resource competition has assumed a more decisive and central role in armed conflict than has been the case in the past." (p. 293)

international conflicts and rapidly changing international political circumstances. The latter are a significant cause of the substantial fluctuation in the intensity of environmental and sustainable development cooperation over time and the fact that this has sometimes been more pronounced and sometimes less so. These ups and downs are reflected, for instance, in the concreteness of goals and commitments and the 'ambition level' of the resolutions, declarations, programs, and agreements thus adopted. The main stages of this process are reviewed and assessed below. It should be pointed out that while the main historical turning points between these stages can be rather unambiguously identified, the intermediate (sub)periods cannot be so clearly demarcated. Nevertheless, on the one hand, there are some tangible motives and signs of the favorable transitional (sub)periods, and on the other, specific causes of the 'low points' or stagnation in this multilateral cooperation.

3.2.1. The beginning of multilateral relations associated with environmental matters

The League of Nations (LoN) was established in 1920, to which a non-governmental organization turned with an initiative to extend the LoN mandate to deal with environmental hazards of international importance. The submission also included the idea of setting up a commission for nature protection and first of all, elaborating an international convention to curb marine oil pollution as soon as possible. However, none of these proposals were accepted: obviously, compared to other critical global problems, environmental matters were perceived as marginal [Wöbse, 2008[244]]. Yet a few multilateral nature conservation conventions were concluded a few years later (in 1933 and 1940),[245] and there were several such legal instruments even in the early part of the century that were primarily guided by the economic interests of the contracting parties.[246] Environmental cooperation efforts revived after the Second World War.

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[244] "Compared with pressing problems on the list of international issues such as migration, slave labor, health, and impending political and military conflicts, the care for flora and fauna turned marginal, however. In the end, the plan to establish a clearinghouse for environmental matters under the auspices of the League eventually failed to gain support." (p. 524)

[245] Convention Relative to the Preservation of Fauna and Flora in the Natural State, 1933; Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, 1940.

[246] Convention for the Preservation of Wild Animals, Birds and Fish in Africa, 1900; Convention for the Protection of Birds Useful to Agriculture, 1902; Convention for the Preservation and Protection of Fur Seals, 1911; Migratory Bird Treaty, 1916.

Learning from earlier international confrontations over natural resources, the rapidly changing global political situation and the expanding body of environmental science led the UN, its specialized agencies, and other organizations to show growing interest in the environmental dimension of the accelerating globalization processes.

In the new political situation after 1945, it seemed that there was an opportunity to address the environmental aspects of the global and regional socio-economic activities in line with the general objectives of the UN.[247] Until the late 1960s, however, due to the tense global political situation, such cooperation remained very limited in scope and effectiveness, except for two brief (sub)periods when consensus was reached at least on some environmental topics, as indicated below.

- ***The period 1945–1948***. For the developing countries, the right to self-determination also needed to be considered in terms of the right of national sovereignty over their natural resources. This was clearly reflected in the UN Charter (Articles 1.2 and 55) as a fundamental condition of the cooperation of UN member states [Dietrich, 2018]. This became a crucial requirement for further international regulation of the use of and trade in natural resources, which played a significant role, especially in the changing relations between developed and developing countries. Besides this, the common interest in the careful utilization of these resources (especially potentially exhaustible ones) was another fundamental criterion that was taken into account. The latter general aspect and the intention to avoid the 'overexploitation' of natural resources guided the elaboration of the convention on whaling [ICRW, 1946][248] and the establishment of the International Union for

[247] "Article 55: With a view to the creation of conditions of stability and well-being which are necessary for peaceful and friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, the United Nations shall promote: […] b. solutions of international economic, social, health, and related problems" [UN Charter, 1945].

[248] "Considering that the history of whaling has seen overfishing of one area after another and of one species of whale after another to such a degree that it is essential to protect all species of whales from further overfishing".

the Conservation of Nature[249] [IUCN, 1948].[250] Afterward, global-level cooperation, for instance, on environmental matters was almost 'frozen' due to the outbreak and deepening of the Cold War.

- ***The period 1957–1959***. The short-term improvement in the 'political climate' made it possible to organize the International Geophysical Year (1957/58) at the initiative of ICSU (together with WMO and UNESCO). During these few years, the basic components of the international *Law of the Sea* (1958) were finalized and approved, as well as the general rules for cooperation in the Antarctic region, including the conservation of its wildlife [ATS, 1959[251]]. The former included the *Convention on Fishing and Conservation of the Living Resources of the High Seas* [CFCLR, 1958] and the *Convention on the High Seas*, which laid down rules for preventing pollution in those areas, in particular, pollution caused by oil spills and radioactive substances [CHS, 1958]. Following these essential outcomes of the late 1950s, with the resurgence of Cold War tensions, environmental collaboration at the global level was 'put on ice' for about a decade.

Over this period of almost a quarter of a century (until the late 1960s), cooperation – apart from the two above-mentioned short subperiods – evolved mainly in line with the differing interests of major groups of countries concerning the increasing demand for various natural resources for their economic development. Correspondingly, this essentially meant the escalating enforcement of resource-related interests and attempts at the reconciliation of these interests within and between the various country groups.

- An important achievement for the 'Third World' (the group of developing countries) was the fact that two UN resolutions in 1952

[249] The International Union for the Protection of Nature (IUPN), established in 1948, was renamed the International Union for Conservation of Nature and Natural Resources (IUCN) in 1956.

[250] "[T]he time has come when human standards of living are being depressed because natural resources are becoming inadequate for their maintenance; […] this trend may be reversed if people are awakened in time to a full realization of their dependence upon exhaustible natural resources and recognize the need for their protection and restoration as well as for their wise and informed administration".

[251] Article IX. 1. "(f) preservation and conservation of living resources in Antarctica."

confirmed the sovereignty over their natural resources [UN, 1952a[252]; UN, 1952b[253]]. A decade later, a declaration was adopted that was even more emphatic about this issue, as the developing countries became much more aware of the importance of freely determining the utilization of their natural resources and in relation to their participation in international economic cooperation [UN, 1962[254]]. There was no indication in these documents that the accelerating exploitation of some resources might sooner or later lead to their unsustainable use and depletion.

- The first United Nations Development Decade began in 1960. It aimed at assisting developing countries to fulfill their development aspirations, including the improvement of the economic, technical, and commercial conditions associated with extracting and using their natural resources. The United Nations Development Programme (UNDP), established in 1965, also focused on supporting the economic progress of those countries [UN, 1965[255]]. In 1964, the developing countries institutionalized their cooperation within the 'Group of 77' (G77) to better coordinate and represent their positions, particularly in international trade affairs involving their raw materials.[256] One of the

[252] The General Assembly: "Considering that the underdeveloped countries have the right to determine freely the use of their natural resources […] to further the realization of their plans of economic development in accordance with their national interests, and to further the expansion of the world economy".

[253] "[T]he right of peoples freely to use and exploit their natural wealth and resources is inherent in their sovereignty and in accordance with the Purposes and Principles of the Charter of the United Nations". The General Assembly: "1. Recommends all Member States, in the exercise of their right freely to use and exploit their natural wealth and resources […] to have due regard […] to the need for maintaining the flow of capital in conditions of security, mutual confidence and economic co-operation among nations".

[254] "Desiring that there should be further consideration by the United Nations of the subject of permanent sovereignty over natural resources in the spirit of international co-operation in the field of economic development, particularly that of the developing countries".

[255] "The General Assembly, […] Being convinced that the United Nations assistance programmes are designed to support and supplement the national efforts of developing countries in solving the most important problems of their economic development, including industrial development".

[256] This group has gradually expanded and currently includes more than 130 countries. As formally, the People's Republic of China is not a member, when they communicate their common statements, it is made "on behalf of Group 77 and China."

first results of these joint efforts was clearly reflected in the human rights covenants, which reconfirmed the right of all peoples to freely dispose and utilize their natural resources [ICCPR, 1966; ICESCR, 1966[257]].

- Coal and iron for a long time, then crude oil and some later natural gas, various minerals, metal ores, various other natural resources, and more recently, 'critical raw materials' became of key economic importance worldwide. The growing demand for some of these resources has also been at the root of past and more recent severe international conflicts. Lessons learned from these clashes and the need to reconcile interests related to such resources motivated the creation of the European Coal and Steel Community (ECSC) [CECA, 1951[258]] and the Organization of the Petroleum Exporting Countries (OPEC) in 1960. The division of labor between the member states of the Council for Mutual Economic Assistance (CMEA/Comecon) established in 1949 (by the countries of the 'Eastern bloc') also included the 'rational exploitation,' – i.e., the processing, trade, and utilization – of specific natural resources. As a matter of fact, more comprehensive environmental considerations concerning the potential adverse impacts of improper resource transport and use and various forms of industrial pollution were only taken into account much later within these three organizations. Oddly enough, one of the first international agreements governing the already evolving 'space race' in the 1960s also referred to the exploitation of resources of other celestial bodies in the future [OST, 1967[259]].
- In this period, a few environmental programs were launched under the aegis of some international organizations, the themes of which were (or appeared to be) more distant from the tense 'high politics' of the Cold War. These included the programs cited above, namely, the biological and hydrological programs of UNESCO (IBP, 1964–; IHD, 1965–) and

[257] "Article 1: 2. All peoples may, for their own ends, freely dispose of their natural wealth and resources".

[258] "Article 3. Les institutions de la Communauté doivent, dans le cadre de leurs attributions respectives et dans l'intérêt commun: […] d) veiller au maintien de conditions incitant les entreprises à développer et à améliorer leur potentiel de production et à promouvoir une politique d'exploitation rationnelle des ressources naturelles évitant leur épuisement inconsidéré".

[259] "Bearing in mind the benefits which may be derived from the exploitation of the natural resources of the Moon and other celestial bodies".

the Global Atmospheric Research Programme promoted by WMO, ICSU, and the UNEP (GARP, 1967–).

As demonstrated above (and in Section 3.1.), until the late 1960s, the development of multilateral environmental relations was basically characterized by the conflict and reconciliation of interests concerning natural resources, but not yet with the long-range transmission and transboundary impacts of hazardous pollutants. This is largely because the widespread and accumulating effects of such increasing emissions became clearly detectable and identifiable only after about one and a half to two decades when they reached some critical levels (thresholds).

3.2.2. Acceptance of the need for global environmental cooperation and agreeing on its basic principles and directions

A new period of cooperation started in the late 1960s and lasted nearly two decades. This was triggered by further strengthening international tension due to accelerating demands for natural resources and more recent scientific indications of the potentially extensive and harmful implications of the emissions of various pollutants. As regards key resources, the two oil crises of the 1970s generated very serious lessons. The first phase of the said period was the so-called 'détente' (thawing of East–West confrontation), followed by the return to the Cold War 'political climate' for a while and the economic recession from the early 1980s onwards (with the especially worsening economic situation in Eastern European countries in the second half of that decade). The latter developments set back again – albeit not entirely – international efforts to address large-scale environmental problems.

The UN General Assembly resolutions in 1968 and 1983 indicated the turning points of the beginning of the above-mentioned period of slowly improving global-level environmental policy cooperation and the subsequent one, which eventually led to the landmark UN conferences in 1972 and 1992. The former started with a proposal by Sweden to convene an international conference on the human environment.[260] The UN Secretary-General agreed with this initiative and published a report for the forthcoming debate about this topic by the General Assembly that included

[260] E/4466/Add.1 (22 May 1968).

a summary of the ongoing environment-related programs implemented and/or supported by the UN specialized agencies [UN, 1968a[261]].

- One of the key reasons for the Swedish proposal was the sharp disagreement concerning long-range air pollution and its effects that had evolved since the early 1960s between the European countries that were the 'major emitters' and those considered to be the most severely affected by the respective pollutants.[262] The primary intention was to hold a global intergovernmental forum to discuss this issue besides other emerging large-scale environmental problems and to agree on further potential common actions in relation to them.
- The developing countries' environmental priorities were very different. These were in line with concerns about national sovereignty over their natural resources and the establishment of equitable international conditions for the exploitation, use, and international trade of these resources.
- Eventually, the UN resolution approved in 1968 referred to both components of concern (pollutants and resources) and made arrangements for a UN conference on the interactions between societies and the environment [UN, 1968b[263]]. This was the first time there had been general political recognition that economic activities may cause transboundary or even global-level environment-related damages and of the common interest in establishing an international framework for dealing with this problematic.

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[261] "Generally, emphasis has been put on work programmes concerned with pollution of the human environment, this being an aspect of the subject-matter outlined in the Swedish memorandum which has up to the present time concerned United Nations organizations and programmes more than others." (para. 3)

[262] At that time, the subject of disagreement was primarily the emission of 'acidifying air pollutants' such as the sulfur-dioxide from fossil fuel combustion and the long-range transmission of these pollutants causing harmful environmental effects far away from their emission sources. We refer to this problem and the relevant scientific study written by Svante Odén in the second chapter of this book.

[263] "Noting, in particular, the continuing and accelerating impairment of the quality of the human environment caused by such factors as air and water pollution, erosion and other forms of soil deterioration, waste, noise and the secondary effects of biocides, […] Bearing in mind the recommendations of the Intergovernmental Conference of Experts on the Scientific Basis for Rational Use and Conservation of the Resources of the Biosphere, […] Decides, in furtherance of the objectives set out above, to convene in 1972 a United Nations Conference on the Human Environment".

The UN Conference on the Human Environment (1972) and the Conference on Security and Co-operation in Europe (1975). The volatile Cold War circumstances of the East–West confrontation and changing North–South relations (the growing divergence of interests between developed and developing countries) made a strong imprint, inter alia on cooperation in dealing with rapidly increasing environmental threats.

- Although the 1968 UN resolution called for holding a global conference in 1972, several Eastern European countries boycotted the event,[264] and only India was represented at the highest political level (by Prime Minister Indira Gandhi) from the large group of developing countries. There were varying reasons for this. According to the developing world, the emergence and solution of globalizing environmental problems were primarily the (historical) responsibility of the developed countries. The cancellation of the participation of Eastern European delegations was not directly related to the conference's agenda and objectives but to the admission of both German states to the UN [Engfeldt, 2009[265]]. In any case, from a historical perspective, the outcomes of this UN Conference on Human Environment (UNCHE) proved to be of outstanding importance. These included the Stockholm Declaration, which laid down the basic principles of international environmental cooperation, and the Action Plan, which consisted of recommendations on all environmental matters considered substantial at that time. The urgency of actions was firmly emphasized in the declaration [UN, 1972a]: "A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference, we can do massive and irreversible harm to the earthly

[264] Hungarian experts were involved in the preparations for the conference, but eventually, Hungary was not represented at the Stockholm meeting, nor were some other countries of the 'Eastern bloc.' Academician István Láng has highlighted the significance of the outcomes of the conference and explained the political reasons for the boycott [e.g., Láng, 2001].

[265] "Relations with developing countries became the most contentious issue in the spring of 1971. […] Yugoslavia reported a deep dissatisfaction among developing countries […]. They felt it (i.e., the preparatory process) was too oriented towards the interests of industrialized countries" (p. 56); "The issue was hostage to East–West negotiations on the German question, particularly concerning the international status of the GDR. […] Uncertainty prevailed until a few days before the Conference but, in the end, the question could not be resolved. The Soviet Union and its allies did not participate in the Conference." (pp. 60–61)

environment on which our life and wellbeing depend. [...] 7. A growing class of environmental problems, because they are regional or global in extent or because they affect the common international realm, will require extensive cooperation among nations and action by international organizations in the common interest." According to the resolutions, a new institution, the Governing Council of the United Nations Environment Programme (UNEP), was established inter alia for the promotion of cooperation in and coordination of environmental activities within the UN system [UN, 1972a; UN, 1972b].

- The easing of East–West relations[266] again from 1973 allowed for the launch of the 'Helsinki Process,' the environmental policy themes of which were greatly influenced by the outcomes of the Stockholm conference. The final act adopted at the 1975 Helsinki summit, that is, by the Conference on Security and Cooperation in Europe, included a section about the main environmental areas of action at the pan-European level [CSCE, 1975[267]].

International organizations active in different fields continued or even extended their environment-related programs in line with the said Action Plan for the Human Environment. Moreover, due to the continuing relatively favorable global political situation by the late 1970s, environmental policy cooperation unfolded through new multilateral organizations, programs, and agreements, which were partly inspired by the 1968 UN resolution and the recommendations approved at the 1972 and 1975 international conferences.

- The programs commenced at that time comprised those on the rational use and conservation of the resources of the biosphere [UNESCO, 1971, 1972], environmental education [UNESCO-UNEP, 1975], water management [UN, 1977], global climate change [WMO, 1979], etc. The environmental activities of the UN's specialized agencies were to be 'interlinked' and harmonized by the newly created UN Environment

[266] The representatives of the USA and USSR approved a program of cooperation in environmental matters in September 1972 and the same month both German states became members of the UN.

[267] "The participating States declare that problems relating to the protection and improvement of the environment will be solved on both a bilateral and a multilateral, including regional and sub-regional, basis, making full use of existing pattern and forms of co-operation. They will develop co-operation in the field of the environment in particular by taking into consideration the Stockholm Declaration on the Human Environment, relevant resolutions of the United Nations General Assembly". (p. 32)

Programme, which also became responsible for facilitating the operation of the Earthwatch environmental monitoring system. Furthermore, these years proved to be productive in terms of passing a series of nature conservation and environment protection conventions, such as on wetlands of international importance (1971), world heritage encompassing inter alia various universally valuable natural sites (1972), the regulation of international trade in endangered species of wild fauna and flora (1972), the protection of seas against dumping of waste and pollution from ships (1972, 1973), the general regulation of transboundary air pollution (1979) and on the protection of wild fauna and flora (1979).

- The institutional developments during this period were also noteworthy, including the establishment of the UNECE's Committee on Environmental Policy (1971), the fact that the Council of Europe also began to pay attention to the environmental problematic [CdE, 1971], and the establishment of the OECD's Environment Policy Committee (1972). The first oil crisis was a determining factor leading to the creation of the International Energy Agency (1974). We should also recall that the Stockholm conference had a considerable effect on both the Western and the Eastern European 'blocs' of countries in this regard. The importance of environmental protection was underlined by the 1972 Paris Summit of the European Communities, which was followed by the adoption of the first environmental program [EEC, 1973]. The leaders of the member states of the Eastern European economic organization (COMECON/CMEA) took a decision in 1973 to establish an Environmental Protection Commission.

With the return of Cold War tensions after the 1970s, the world's interest in environmental politics became more subdued for a while despite the rapid expansion of observational data and scientific knowledge on hazardous processes. Nevertheless, environmental cooperation continued, at least on a few critical matters.

- UNEP published a comprehensive environmental assessment, and seeing the adverse tendencies, Mostafa K. Tolba, UNEP's executive director, made it clear that much more decisive action was needed to

halt the deterioration in environmental quality caused by human activities [UNEP, 1982a; Tolba, 1982[268]].

- In view of some these negative tendencies, the achievements during those years included the International Programme on Chemical Safety (IPCS, 1980–), the resolution calling for a 'responsible' approach to environmental dangers stemming from nuclear weapons testing and the arms race in general [UN, 1980], the *World Conservation Strategy* and the *World Charter for Nature* [IUCN-UNEP-WWF, 1980; UN, 1982], the *Convention on the Law of the Sea* [UNCLOS, 1982] and the convention on the threat to the ozone layer (resulting or likely resulting from human activities) [VCPO, 1985].

The increasing overall recognition of the multiplying and growing environmental consequences of globalization and the need to address these hazards led to the development of international environmental cooperation and policies from the late 1960s onwards. This process was facilitated by the moderation of international political confrontations, especially in regard to East–West relations. The most important first turning points and results of this period were the UN resolution of 1968, together with the basic principles and global environmental program endorsed at the 1972 Stockholm conference (UNCHE) and the environmental provisions contained within the final act of the Helsinki conference in 1975 (CSCE). The general political and economic situation temporarily set back this cooperation again in the early years of the 1980s. It could not be foreseen that the start of a new progressive phase in this history would be marked by the adoption of a resolution by the UN General

[268] "A subtle change in emphasis has taken place during the decade, from worrying about changes in the state of the physical environment to concern over the causes and impacts of such changes. Throughout the decade our perceptions and our understanding have continuously evolved. […] Unhappily, governments have not matched this developing environmental knowledge with deeds. The concepts for ecologically sound management have been imperfectly or too slowly applied. In some cases they have been ignored entirely. The inevitable consequence is that the fundamental objective of Stockholm, to protect and enhance our environment for future generations, has not been fulfilled. On virtually every front there has been a marked deterioration in the quality of our shared environment."

Assembly and its implementation [UN, 1983[269]]. This led to the preparation and publication in 1987 of two particularly important documents that presented the most severe environmental and related socio-economic challenges and identified the main directions for further international action. These were the UNEP assessment of the state and the perspectives of the global environmental system and the report by the World Commission on Environment and Development on unsustainable global processes and the actions recommended to promote sustainable development.

3.2.3. Global environmental policies and their sustainable development framework

The demand for multilateral cooperation has revived since the mid-1980s thanks to the growing scientific knowledge about the large-scale environmental processes triggered, modified and/or amplified by human activities and their potential/actual dangerous consequences. These efforts were further facilitated by the easing of Cold War confrontation. The push for such cooperation was also strengthened by a few industrial calamities, such as the Chernobyl nuclear disaster (1986) and the chemical accident in Basel in the same year, along with the explosion at the Bhopal pesticide plant (1984),[270] because of their shockingly severe effects and international implications. Other 'symptoms' of globalization and catalysts for stringent international regulations were conflicts caused by the transboundary movement of hazardous wastes and their 'disposal.' Such well-known cases include the incidents mentioned already (delivery of a large volume of waste from a port in the USA to a coastal area of Haiti and its dumping there in 1986, and a toxic waste shipment from Italy to a Nigerian site in 1987). In parallel with recognizing a diversity of environmental problems, international environmental policy organizations and instruments have become just as diverse (and fragmented). The need for more holistic approaches and policies arose. Cooperation accelerated from the end of the

[269] "The General Assembly […] 8. Suggests that the special commission, when established, should focus mainly on the following terms of reference for its work: (a) To propose long-term environmental strategies for achieving sustainable development to the year 2000 and beyond; (b) To recommend ways in which concern for the environment may be translated into greater co-operation among developing countries and between countries at different stages of economic and social development and lead to the achievement of common and mutually supportive objectives, which take account of the interrelationships between people, resources, environment and development".

[270] The US-based company Union Carbide was the majority owner of the pesticide-producing industrial plant in Bhopal (India).

1980s and early 1990s onwards, resulting in the elaboration of programs and agreements of great significance. This process, particularly in terms of the implementation of commitments, was not uninterrupted but rather fluctuated. Several strands of collaboration evolved at a global level, largely in parallel but referring to each other, with foci such as environmental sustainability, international development, development-financing cooperation (also covering environmental issues), sustainable development including its environmental dimension, and the environmental conditions and impacts of social and economic development. The main stages and components of this multifaceted process are summarized below.

The more effective coordination and cohesion of the wide range of environmental policy activities conducted under the aegis of the UN was the fundamental objective of a decision by the UNEP Governing Council in 1983, which was endorsed by the United Nations General Assembly [UN, 1983]. In order to realize the said objective, it was also proposed to formulate a system-wide, comprehensive environmental strategy. As a matter of fact, such a framework strategy was approved three decades later (!) after a long process of preparation with the participation of all the institutions concerned (including the relevant specialized agencies of the UN). An especially important factor in this endeavor was that the same 1983 UN resolution led to the launch of wide-ranging collaboration on sustainable development with a much broader scope of goals and policies.

- The UNEP document *Environmental Perspective to the Year 2000 and Beyond*, finalized in 1987, included an assessment of the state of the global environment and the main tasks considered integral to the attainment of 'environmentally sustainable development.' It was submitted to and adopted by the UN General Assembly [UN, 1987a]. Realizing that UNEP had not been able to play an effective coordinating role within the UN system since its inception in 1972, this time, its 'perspective' document outlined the strong link between environmental matters and socio-economic development with the expectation that such a broader method of analysis would better strengthen cooperation with all UN organizations and bodies

concerned.[271] In full consistency with this concept, the sustainable development agenda finalized at the 1992 global summit also referred to the environment-development nexus and the prominent role of UNEP [UN, 1992a[272]].

- Nevertheless, a majority of the widespread environmental hazards have not been alleviated in spite of 'promises' associated with international reports, programs, and agreements since the mid-1980s. This worrying situation was highlighted in a dramatic statement by the participants of the ministerial meeting held in Malmö [UNEP, 2000[273]]. At the 2002 and 2012 UN conferences on sustainable development, it was reiterated that while some progress has been achieved in a few areas to halt the deterioration of the environmental system, a new strategy and more decisive measures would be necessary, together with the more efficient coordination of the relevant activities through the whole institutional

[271] The General Assembly "2. Adopts the Environmental Perspective to the Year 2000 and Beyond, contained in the annex to the present resolution, as a broad framework to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound development, and specifically as a guide to the preparation of further system-wide medium-term environment programmes and the medium-term programmes of the organizations and bodies of the United Nations system". Annex: "3. (e) Environmental issues are closely intertwined with development policies and practices; consequently, environmental goals and actions need to be defined in relation to development objectives and policies; […] 114. The governing bodies of all United Nations organizations should report regularly to the General Assembly on the progress made in achieving the objectives of sustainable development. Such reports should also be submitted to the Governing Council of the United Nations Environment Programme".

[272] "38.22. Priority areas on which UNEP should concentrate include the following: a) Strengthening its catalytic role in stimulating and promoting environmental activities and considerations throughout the United Nations system; b) Promoting international cooperation in the field of environment and recommending, as appropriate, policies to this end".

[273] "1. The year 2000 marks a defining moment in the efforts of the international community to ensure that the growing trends of environmental degradation that threaten the sustainability of the planet are arrested and reversed. Hence, there is an urgent need for reinvigorated international cooperation based on common concerns and a spirit of international partnership and solidarity. 2. There is an alarming discrepancy between commitments and action. […] 9. The trends of globalization in the world economy, with its attendant environmental risks and opportunities, require that international institutions adopt new approaches and engage the major actors involved in globalization in new ways."

system of the United Nations [UN, 2002; UN, 2012a[274]; Faragó & Láng, 2012]. As a step in that direction, the decision-making level of the UN Environment Programme was raised by replacing its Governing Council with the UN Environment Assembly (UNEA). Nonetheless, promoting environment-related cooperation among the UN agencies and formulating a coherent UN-wide strategy was expected not from the 'reformed' UNEP but instead from the UN Environment Management Group (EMG). This entity started operating in 2001 with the participation of some fifty UN specialized agencies and other bodies (consequently, it was not one of those organizational units that worked in parallel with each other in the environmental area).

- The *System-wide Framework of Strategies on the Environment for the UN System* was approved in 2016, finally creating common ground for system-wide collaboration about environmental sustainability, as well as promoting the coherence and regular comprehensive assessment of the implementation of all the environmental goals and policies formulated under the aegis of the United Nations [UN, 2016].[275] This strategy framework was also closely linked to the global sustainable development agenda's environmental objectives, goals, and targets endorsed at the 2015 UN summit.

The repertoire of international instruments dedicated to particular environmental problems has also expanded rapidly as a result of more accurate monitoring data and scientific knowledge about global-scale processes. In other words, in parallel with the aspiration to formulate a broad-based environmental strategy, an increasing number of thematic programs and agreements have been concluded.

- The first few years of this period saw the formulation of recommendations, guidelines, and other soft law instruments by various UN organizations, which were the 'precursors' to the legally binding international agreements drawn up subsequently. These included the conference statements calling for the reduction of (anthropogenic)

[274] C. Environmental pillar in the context of sustainable development: 88.(c) "formulate United Nations system-wide strategies on the environment".

[275] Goal: "Ensuring environmental sustainability is a shared responsibility. […] In this way, the UN can provide support more effectively to Member States through the design and delivery of coherent, impactful, and cost-effective solutions that integrate the environmental dimension into their efforts to implement and achieve the 2030 Agenda". (p. 6)

greenhouse gas emissions (1985[276], 1987[277]), the first assessment report of the Intergovernmental Panel on Climate Change (IPCC, 1990), the international guidelines for the environmentally sound management of pesticides and hazardous waste [FAO, 1985; UNEP, 1987a] and the resolution recommending the preparation of a general convention on biodiversity [UNEP, 1987b[278]]. At the same time, agreements on some environmental matters of global concern were also accepted, which cause-effect relationships were already more or less precisely identified together with the increased readiness of policymakers to take more concrete action. These legal instruments contained preventive and/or precautionary policies, measures, and commitments by the parties, which primarily aimed at mitigating the environmental burden of the human activities enhancing those harmful processes. Such agreements inter alia were directed at reducing the emissions of ozone-depleting substances (1987), decreasing the atmospheric release of acidifying pollutants (sulfur dioxide, 1985; nitrogen oxides, 1988), and restricting the international movement of hazardous waste (1989). The convention on the early international notification of nuclear accidents (1986)[279] was initiated and concluded immediately after the Chernobyl nuclear disaster and was especially relevant in light of the dangerous transboundary radiological consequences, including health and environmental effects.

- In the following years, thanks to further improvement in the political atmosphere, openness to international cooperation, and findings communicated in new scientific reports about the globalizing

[276] Statement adopted at the UNEP-WMO-ICSU conference on climate change (Villach, 9–15 Oct. 1985): "establish a small task force on greenhouse gases, or take other measures, to: […] initiate, if deemed necessary, consideration of a global convention."

[277] Statement adopted at the WMO conference on changing atmosphere (Toronto, 27–30 June 1988): "reduce CO_2 emissions by approximately 20% of 1988 levels by the year 2005 as an initial global goal".

[278] "Recognizing the need for adequate protection and preservation of biological diversity […] investigate in close collaboration with the Ecosystems Conservation Group and other international organizations the desirability and possible form of an umbrella convention".

[279] Convention on Early Notification of a Nuclear Accident (CENNA, 1986): Article 5 (1.) "(e) information on current and forecast meteorological and hydrological conditions, necessary for forecasting the transboundary release of the radioactive materials; (f) the results of environmental monitoring relevant to the transboundary release of the radioactive materials".

environmental hazards, further global environmental legal and political instruments of outstanding importance were approved (albeit with rather variable concreteness and strictness of goals and provisions). Some of these achievements included[280] the Convention on Biological Diversity (1992) and the UN Framework Convention on Climate Change (1992), their subsequent protocols, agreements and/or amendments and implementation strategies; the Rotterdam and Copenhagen Conventions for regulating the international trade, production and use of hazardous chemicals (1998, 2001); the global strategy for sustainable chemicals management (2006–2020); the Minamata Convention on the gradual phase-out of mercury mining and use (2013); a global cooperation framework for the reduction of environmental and industrial disasters (1990–)[281] and the global program to protect the seas from the adverse effects of land-based activities (1995–).

In the early stage of international development cooperation (from the 1960s onwards), the potential disadvantageous environmental consequences of the development programs and projects were taken into consideration only sporadically. For a long time, the programs of the UN 'Development Decades' were based on the priority of promoting economic growth in developing countries and, through this, improving the living standards of their societies. When it turned out that this approach did little to alleviate social problems and contribute to the betterment of human life and its environmental conditions in the supported countries, the priorities were radically changed [Jolly, 2005[282]; Boda, 2007[283]; Faragó, 2013a]. These changing standpoints on and expectations of development assistance also characterized the common positions of the developing countries from the 1980s onwards, as expressed at all forums on international development, global environmental, and sustainable development

[280] We return to and present the substance of these international agreements and programs at the end of this chapter.

[281] The International Decade for Natural Disaster Reduction (IDNDR, 1990–) was followed by the elaboration of comprehensive strategies on this matter.

[282] "One of the greatest dangers in development policy lies in the tendency to give the more material aspects of growth an overriding and disproportionate emphasis. The end may be forgotten in preoccupation with the means."

[283] Boda also refers to what he considers to be a 'naive' but misleading argument, according to which "although the growth of welfare is actually only a tool, it must be promoted in order to create other opportunities for the achievement of political, cultural, social, environmental and other goals".

cooperation. One of the key elements of this position was the accentuation of the principle of 'common but differentiated responsibility,' particularly regarding all the global environment-related problems and their solutions that were addressed at those meetings [UN, 1992a[284]].

- ***Development cooperation***, in its essence and general objectives, was initially aimed at supporting decent living conditions and a better quality of life in developing countries, especially in the least developed ones. The institutional framework for these efforts was established in the mid-twentieth century, one of the prominent institutions of which became the United Nations Development Programme (UNDP, 1965–). The UN resolution (1968) about the preparation of the conference on the human environment made it clear that the hitherto economic development-oriented way to tackling social issues (poverty, malnutrition, lack of basic health care, etc.) must be interlinked with environmental considerations [UN, 1968b[285]]. The institutional settings for international development and environmental cooperation were at least symbolically balanced when the United Nations Environment Programme (UNEP) was formed in 1972 following the 'UNDP model.' Yet, it was only from the 1980s onwards that environmental concerns and tasks were better reflected in the development policies, including the strategies behind the more recent UN Development Decades, but

[284] (Principle 7) "[…] In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command."

[285] The General Assembly "Convinced that increased attention to the problems of the human environment is essential for sound economic and social development, Expressing the strong hope that the developing countries will, through appropriate international co-operation, derive particular benefit from the mobilization of knowledge and experience about the problems of the human environment, enabling them, inter alia, to forestall the occurrence of many such problems".

still only supplementing economic growth priorities [UN/DD, 1980[286]; UN/DD, 1990[287]].

- ***In the declaration endorsed at the Millennium Summit***, the increasing globalization-driven interdependence of societies was unequivocally recognized along with the need for joint and coordinated action, particularly in the face of the threat of emerging environmental hazards [UN, 2000]: "We believe that the central challenge we face today is to ensure that globalization becomes a positive force for all the world's people. [...] 21. We must spare no effort to free all of humanity [...] from the threat of living on a planet irredeemably spoiled by human activities, and whose resources would no longer be sufficient for their needs." This declaration led to the definition of the Millennium Development Goals (MDGs) to be achieved by 2015, one of which was explicitly devoted to the environmental dimension of development ("Ensure environmental sustainability"). In addition, an international development finance program was also set up to facilitate the accomplishment of these goals and their concrete targets [UN/FfD, 2002[288]]. The participants of the summit held on the occasion of the 60th anniversary of the foundation of the UN further clarified the MDGs. They reaffirmed their dedication to realizing these goals,

[286] (41.) "Accelerated development in the developing countries could enhance their capacity to improve their environment. The environmental implications of poverty and under-development and the interrelationships between development, environment, population and resources must be taken into account in the process of development." (156.) "Because health, nutrition and general well-being depend upon the integrity and productivity of the environment and resources, measures should continue to be developed and carried out to promote the environmental and ecological soundness of developmental activities."

[287] (78.) "[E]conomic growth by itself does not ensure that its benefits will be equitably distributed or that the physical environment will be protected and improved. […] The Strategy must therefore give special attention to the policies and measures needed in the areas of poverty alleviation, human resource development and the environment." (96.) "The economic growth and development of the developing countries are essential in order to address problems of the degradation and protection of the environment."

[288] "3. Mobilizing and increasing the effective use of financial resources and achieving the national and international economic conditions needed to fulfil internationally agreed development goals, including those contained in the Millennium Declaration, to eliminate poverty, improve social conditions and raise living standards, and protect our environment, will be our first step to ensuring that the twenty-first century becomes the century of development for all."

including effectively implementing the related environmental tasks [UN, 2005a[289]].

- ***Linking development and sustainable development cooperation***. The state of play regarding the MDGs was discussed again at a high-level meeting in 2010, where not only was the commitment to meet all the MDGs reiterated, but it was also decided to start planning the post-2015 development agenda [UN, 2010[290]]. Afterwards, the determination of the goals for international development cooperation and the goals of sustainable development progressed in parallel for many years, though with some 'inter-referencing.' At long last, all these general goals, together with some concrete targets of these two cooperative mechanisms, were combined in the global sustainable development agenda finalized in 2015 [UN, 2015; Faragó, 2016], albeit a renewed separate international program on financing for development was also adopted in the same year [UN/FfD, 2015]. The latter was in line with the 'usual' general objectives of international development cooperation; however, at long last, it also underlined the importance of promoting the achievement of the universal sustainable development goals (SDGs) that were the core components of the above-mentioned new sustainable development program.

The comprehensive sustainable and environmentally sound development framework presented in detail in the report of the World Commission on Environment and Development [WCED, 1987] was endorsed by the UN General Assembly as the conceptual basis for further

[289] "17. We strongly reiterate our determination to ensure the timely and full realization of the development goals and objectives agreed at the major United Nations conferences and summits, including those agreed at the Millennium Summit that are described as the Millennium Development Goals […] 169. We support stronger system-wide coherence by implementing the following measures: Recognizing the need for more efficient environmental activities in the United Nations system, with enhanced coordination, improved policy advice and guidance, strengthened scientific knowledge, assessment and cooperation".

[290] "81. We request the Secretary-General to report annually on progress in the implementation of the Millennium Development Goals until 2015 and to make recommendations in his annual reports, as appropriate, for further steps to advance the United Nations development agenda beyond 2015."

policy cooperation in this broad area [UN, 1987b[291]]. To this end, it was also decided to convene a global conference to assess the environmental and related socio-economic problems and formulate recommendations for international response policies and actions [UN, 1988[292]]. The said report and these resolutions marked the beginning of a new phase of multilateral cooperation, which was manifested by a general acknowledgment of the urgent need to find adequate and more effective policy responses to the worsening global environmental challenges and to use for this purpose the much wider sustainable development approach to address, in a comprehensive manner, interlinked unsustainable environmental, social, and economic processes. This also means dealing with the 'root causes,' that is, the socio-economic drivers and repercussions of these globalizing issues, instead of closely focusing on particular hazardous phenomena without their broader context and interrelations with other factors, and identifying the complex response policies for them (i.e., using a 'synergistic' approach).

- The 1992 UN Conference on Environment and Development (UNCED) approved a global program for sustainable development comprising fundamental social and economic objectives (poverty eradication, a decrease in disparities in standards of living, the reduction/elimination of unsustainable patterns of production and consumption, etc.). Together with these, environmental protection was made an integral part of this agenda, including the sustainable use of natural resources, halting environmental degradation, and reducing environmental

[291] The General Assembly: "Concerned about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development, […] Recognizing, in view of the global character of major environmental problems, the common interest of all countries to pursue policies aimed at sustainable and environmentally sound development, […] Agrees with the Commission that while seeking to remedy existing environmental problems, it is imperative to influence the sources of those problems in human activity, and economic activity in particular, and thus to provide for sustainable development".

[292] The General Assembly: "Believing it highly desirable that a United Nations conference on environment and development be convened no later than 1992, […] Considering in this context that the conference could, inter alia: (a) Review trends in policies and action taken by all countries and international organizations to protect and enhance the environment and to examine how environmental concerns have been incorporated in economic and social policies and planning since the United Nations Conference on the Human Environment in 1972, (b) Assess major environmental problems, risks and opportunities associated with economic activities in all countries, (c) Make recommendations for further strengthened international co-operative action within a set of priorities to be established by the conference".

releases of hazardous substances. As articulated in a concise form in the Rio Declaration: "Human beings are at the centre of concerns for sustainable development. […] In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. […] States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem." The planning of this comprehensive program, entitled *Agenda 21*, and the above-mentioned declaration lasted two years. Finally, these were adopted during the 'Earth Summit' (the high-level segment of the conference) held in Rio de Janeiro [UN, 1992a; Bulla, Faragó & Nathon, 1992]. This historical event and its outcomes can be seen as a milestone in global-level international cooperation on tackling the prevailing 'unsustainable' and hazardous issues and acting for 'our common future' (referring here to the title of the 1987 WCED report) – that is, on clarifying the common but differentiated responsibilities and interests of all societies concerning human development, defining sustainability goals on interrelated social, economic, and environmental matters, and facilitating and monitoring their implementation.[293]

- Sustainable development cooperation unfolded and underwent several notable turning points after 1992. In the years after the approval of the global program, the very slow progress of its implementation was realized. That is why, in 1997, another summit was convened, formally as a high-level special session of the UN General Assembly (UNGASS), where the delegations reaffirmed their commitment to *Agenda 21* and agreed on the acceleration of its fulfillment [UN, 1997]. In 2002, at the World Summit on Sustainable Development (WSSD, Johannesburg), the significance of the sustainable development agenda for the twenty-first century was not only emphasized again, but it was also substantially complemented with a series of more concrete targets and means of implementation [UN, 2002]. Following a lengthy debate between developed and developing countries, according to a compromise solution, another conference was organized to mark the twentieth anniversary of the 1992 summit, but it was mainly devoted only to the theme of the "green economy in the context of sustainable

[293] The author of this volume was given the opportunity to participate as a member of the official Hungarian delegation in this historical 1992 UN conference and to document its arrangements, negotiations, and outcomes [Bulla, Faragó & Nathon, 1992].

development and poverty eradication." The selection of this theme was preferred by many developed countries in spite of the rather divergent views, interests, and priorities of other country groups and different stakeholders concerning the importance and substance of this issue [UN, 2012a]. This 'greening' was primarily aimed at mitigating the adverse environmental and social impacts of 'sustained economic growth' and various economic activities, in general,[294] similarly to the objectives of the program framework on 'sustainable consumption and production' accepted at the same meeting [UN, 2012b]. As it soon turned out, the most influential provisions of the outcome document of this conference proved to be those (para. 246–249) on the basis of which the international deliberations on 'sustainable development goals' (SDGs) began the following year.

- Eventually, a new overarching program, *Transforming our World: the 2030 Agenda for Sustainable Development* (also embedding the SDGs), was finalized and approved at the 2015 summit [UN, 2015].[295] This overarching program was indeed (and effectively) based on the holistic concept of sustainable development and dealt with all its essential components. New institutional arrangements for the monitoring and facilitation of the implementation of this agenda have also been settled for the accomplishment of its goals and targets.[296] Of course, within this broad framework, much attention was paid to environmental aspects and relevant provisions since it was evident that without the latter, other sustainable development goals could not be attained [UN, 2015: para. 14]: "Natural resource depletion and adverse impacts of environmental degradation, including desertification, drought, land degradation, freshwater scarcity and loss of biodiversity, add to and exacerbate the list of challenges which humanity faces. Climate change is one of the

[294] "60. We acknowledge that green economy in the context of sustainable development and poverty eradication will enhance our ability to manage natural resources sustainably and with lower negative environmental impacts, increase resource efficiency and reduce waste."

[295] The essence and outcomes thereof and their evaluations were documented and published by us in order to raise public awareness of the importance of these international developments and the relevant national tasks [Faragó et al., 1997; 2002; Faragó & Láng 2012; Faragó, 2013a; 2016]. The author of this book also participated in the 1997 'Rio+5' conference and was appointed the delegation's chief negotiator for the 2002 World Summit on Sustainable Development.

[296] A new organization was created to facilitate the implementation of this new program and to 'replace' the UN Commission on Sustainable Development with the High-Level Political Forum on Sustainable Development (UN CSD, 1993–2013; HLPF, 2013–).

greatest challenges of our time and its adverse impacts undermine the ability of all countries to achieve sustainable development." Consequently, the course of environmental actions was also clearly stated under the primarily social- and economic-centered sustainable development goals within this agenda.[297] Moreover, care for the environment was highlighted in general in the preamble of the program amidst all the key interdependent objectives: "We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations."

Global meetings on social, economic, and other key components of sustainable development were initiated and convened during the 1990s, obviously also inspired by the successful arrangements and the accomplishments of the 1992 UN Conference on Environment and Development. Those environmental factors were also raised (albeit to a very different extent and depth) that were closely related to the main subject areas discussed during these events and addressed in their outcomes. After the turn of the millennium, cooperation along these topics and programs continued and was even more closely aligned with the general sustainable development context and its environmental dimension, especially after the Millennium Summit and 2002 World Summit on Sustainable Development (WSSD).

- At the World Conference on Human Rights (Vienna, 1993), the general environmental criteria for the realization of the right to development were emphasized by reiterating the relevant principle from the 1992 Rio Declaration [UN, 1993[298]]. With the establishment of the UN Human Rights Council in 2006, cooperation for promoting human rights went well beyond referring only to the principles of and requiring compliance with universal human rights. The scope of the Council's activities was substantially extended by, among other elements, putting onto its agenda the adverse implications on the enjoyment of human rights

[297] For instance, 1.5, 3.9: reduction of adverse effects of various shocks, including environmental disasters and those stemming from pollution; 6.3: improvement of water quality by reducing pollution and release of hazardous chemicals and materials; 8.4: increase of global resource efficiency; 12.5: reduction of waste generation; 14.2, 15.1: protection of marine and terrestrial ecosystems.

[298] Vienna Declaration: "11. The right to development should be fulfilled so as to meet equitably the developmental and environmental needs of present and future generations."

stemming from environmental releases of toxic chemicals, climate change, and environmental damages in general [UNHRC, 2011[299]].

- The International Conference on Population and Development (Cairo, 1994) also discussed the environmental factors of poverty, gender equality, and health situations worldwide. It was emphasized that all population-related problems should be seen in the context of sustainable development and that their solution is inherently dependent on tackling hazardous environmental processes and, specifically, the adverse impacts of climate change [UNFPA, 1994[300]]. On the one-and-a-half-decade anniversary of this event, the link between the fulfillment of the *Cairo Plan of Action* and the achievement of environmental sustainability was again underlined [UN/CPD, 2009[301]].
- The World Summit for Social Development (Copenhagen, 1995) was organized following the example of and recalling the outcomes of the 1992 'Earth Summit.' In the declaration and action program adopted in 1995, the objectives of social development (poverty eradication, social justice, better quality of life, etc.) were considered realizable only within the broad framework of sustainable development (interdependent with economic development and environmental protection) [UN, 1995[302]]. On the tenth anniversary of this summit, the

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[299] "Noting that sustainable development and the protection of the environment can contribute to human well-being and the enjoyment of human rights. Noting, conversely, that environmental damage can have negative implications, both direct and indirect, for the effective enjoyment of human rights".

[300] Cairo Declaration: (3.) "International Conference on Population and Development, which comes at a pivotal time in the development of partnerships for global strategies identified in the series of United Nations conferences on environment, human rights, social development, and the role of women." (4.) "We believe that the population issue should be seen not in isolation, but within the larger context of sustainable development of the planet for the betterment of humankind".

[301] "11. Requests the United Nations funds, programmes and specialized agencies, within their respective mandates, to continue to support countries in implementing the Programme of Action of the International Conference on Population and Development and thus contribute to eradicating poverty, promoting gender equality, improving adolescent, maternal and neonatal health, preventing HIV/AIDS and ensuring environmental sustainability, including to address the negative impacts of climate change".

[302] Copenhagen Declaration: "6. We are deeply convinced that economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development, which is the framework for our efforts to achieve a higher quality of life for all people. Equitable social development that recognizes empowering the poor to utilize environmental resources sustainably is a necessary foundation for sustainable development."

state of implementation of the action program was assessed, and the participants reiterated the importance of taking into account the requirements of both 'social and environmental sustainability' when they formulated the new policy framework [UN, 2005b[303]].

- International environmental cooperation reached a stage in the 1990s also in relation to several socio-economic areas, concerning which the linkages between their specific sectoral and environmental policy objectives were highlighted in greater detail than ever before. These important developments included the international energy conference (Lisbon, 1994) and the approval of the Energy Charter Treaty [ECT, 1994], the World Food Summit held in Rome [FAO, 1996], the UN Conference on Human Settlements in Istanbul [UN/CHS, 1996] and the World Health Assembly convened in Geneva [WHO, 1998]. The discussion of all these issues and the renewal of previously agreed goals and tasks continued in the framework of similar forums after the turn of the millennium.

A high degree of variation in the strength of the environmental policies characterized this period of multilateral cooperation from the early 1990s onwards, i.e., the extent to which emerging hazardous environmental processes were taken into consideration within the international policy strategies, programs, and agreements. We have described above how this cooperation, in terms of its general tendency, strengthened and became multifaceted. However, taking a closer look, we see that the process has not developed steadily over the last few decades. It could no longer be hindered by sharp global political tensions comparable to those of the Cold War or, only to a much-limited extent, due to the global financial crisis and economic recession of 2007–2009. Nevertheless, international environmental policymaking experienced remarkable ups and downs in these decades for other reasons. The latter include the repeatedly escalating and heated debates about the differing historical responsibilities of the developed and developing countries for global (environmental and many other) problems and the much stronger prioritization of social and economic development objectives together with neglecting (or at least downplaying) their environmental preconditions and worsening implications, along with postponing more stringent environmental policy responses.

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[303] A comprehensive policy framework for social development: "Subscribing to the notion that human beings are at the centre of development requires a multifaceted approach to development. For example, the approach should be socially sustainable in reducing poverty and inequality and in promoting social justice. […] Finally, the approach should be environmentally sustainable, taking into account access to and use of natural resources and preserving biodiversity."

- After 1992, renewed conflicts of interest hampered the start of the effective implementation of global agreements and programs approved not long before. Perhaps the only exception to this was the reduction of the use and atmospheric release of ozone-depleting substances. (By that time, not only the developed countries but the majority of the developing countries, including the 'big emitters,' had joined the parties to the 1987 ozone layer protection protocol, including the People's Republic of China in 1991 and India and Indonesia in 1992.) In contrast, most of the world's countries delayed acceding to the 1989 Basel Convention on the international trade in hazardous waste, which was designed to restrict the shipment of the latter, especially to developing countries. At the 1996 Geneva session of the parties to the 1992 climate change convention, the conflict between the representatives of the developed and some developing countries became more acute concerning how the different country groups ought to contribute to curbing the still rapidly growing global emissions of greenhouse gases. We include here a quote from the critical evaluation of the very slow progress in the implementation of *Agenda 21*, according to which, besides the persistence/continuation of all the social issues addressed within that global program, "[f]ive years after the United Nations Conference on Environment and Development, the state of the global environment has continued to deteriorate [...]. Acid rain and transboundary air pollution, once considered a problem only in the industrialized countries, are increasingly becoming a problem in many developing regions. [...] Conditions in natural habitats and fragile ecosystems, including mountain ecosystems, are still deteriorating in all regions of the world, resulting in diminishing biological diversity." [UN, 1997: para. 9]
- This collaborative process was 'revitalized' a few years later. At the 'Rio+5 summit' (New York, 1997), the participants endorsed *Agenda 21* and reiterated their intention to fulfill its provisions [UN, 1997[304]]. Moreover, the *Kyoto Protocol* to the climate change convention was accepted at the end of the same year, which included quantified greenhouse gas emission control/reduction commitments by the developed countries and the obligation for all parties to formulate

[304] UN Special Session of the General Assembly (June 1997, New York): (5.) "Time is of the essence in meeting the challenges of sustainable development as set out in the Rio Declaration and Agenda 21. To this end, we recommit ourselves to the global partnership established at the United Nations Conference on Environment and Development and to the continuous dialogue and action inspired by the need to achieve a more efficient and equitable world economy, as a means to provide a supportive international climate for achieving environment and development goals."

and implement national programs with "measures to mitigate climate change and measures to facilitate adequate adaptation to climate change" [UNFCCC/KP, 1997]. In 1995, the *Basel Convention* was amended [BC/BBA, 1995] by admitting the high risk associated with hazardous wastes and prohibiting their transboundary movement to developing countries. Other developments have also proved the 'resurgence' in multilateral relations involving environmental topics, notably the above-mentioned summits in 2000 and 2002 and their outcomes.[305]

- After 2005, there were again indications of a slowdown in the implementation of a number of international undertakings, such as the Millennium Development Goals and those approved under the biodiversity and climate change conventions (with deadlines of 2010 and 2012, respectively), and the commitments made at the 2002 World Summit on Sustainable Development. A report presented by UNEP pinpointed, on the one hand, the continuing adverse environmental trends and the human activities giving rise to them at global and regional levels, and on the other, the inadequacy of progress towards the goals/targets agreed upon over the previous two decades [UNEP/GEO, 2007]. The 2010 UN Summit assessed the efforts to reach the MDGs as insufficient, including those directly or indirectly related to environmental sustainability [UN, 2010[306]]. The goal of reducing the rate of biodiversity loss by 2010 was not met [CBD/GBO, 2010]. It also seemed that efforts made since 1997 by the developed countries would not be sufficient to meet the most essential emissions reduction goal defined in the *Kyoto Protocol*, and this 'implementation gap' could not be overcome at the Copenhagen climate summit [IPCC, 2007; UNFCCC, 2009[307]].
- Cooperation was again reinvigorated from 2010 onwards. At the global summit dedicated to the critical appraisal of the implementation of the MDGs (2010) and the UN Conference on Sustainable Development

[305] As a member of the Hungarian delegation, the author of this book took part in the 1997 and 2002 UN summits, the 1996 session of the parties to the climate change convention and its 1997 session when the Kyoto Protocol was finalized and adopted.

[306] "20. We acknowledge that much more needs to be done in achieving the Millennium Development Goals as progress has been uneven among regions and between and within countries. […] There has been slow progress in reaching full and productive employment and decent work for all, advancing gender equality and the empowerment of women, achieving environmental sustainability and providing basic sanitation".

[307] At the 2009 session of the Parties, the final document entitled the Copenhagen Accord could not be adopted by consensus. This contained the main directions and global climate policy goals for further negotiations.

(2012), the previously agreed international development and sustainable development commitments were again reconfirmed. Moreover, it was decided to start planning a new development agenda for the post-2015 period and to define more concrete goals to promote sustainable development [UN, 2010; UN, 2012a]. Decisions were also passed, among others on biodiversity, climate change, and environmental disasters, to strengthen the international policies, taking into account the latest assessments at that time [CBD/GBO, 2014; IPCC, 2014; UNDDR/GAR, 2013]. Another important achievement was the joint meeting of the decision-making bodies of the three conventions on chemicals and hazardous waste in 2010, closely linked to each other regarding their health, environmental, and general sustainability objectives and provisions. It was decided to continue to address these interrelated subjects further in a coherent manner [UNEP-FAO, 2010].

International environmental policy cooperation has proceeded at varying pace and along various strands for the past several decades. It has involved elaborating specific environmental agreements, strategies, and action plans and paying attention to environmental criteria as core components of comprehensive development, sustainable development, and socio-economic programs. The year 2015 marked the beginning of a (hopefully) new progressive stage, as the international community adopted more concrete and ambitious goals than ever within the framework of the new sustainable development program that covered all crucial global-level social problems, together with the key environment and economy-related issues.

3.3. Shapers, outcomes, and the effectiveness of environmental cooperation

An overview of the long history of international environmental policy development can provide a generally complete picture of this cooperative process and an opportunity for its comprehensive evaluation. For this and to assess the effectiveness of the particular components of global environmental governance, such as the respective multilateral institutions, programs, and agreements, a number of aspects need to be taken into account. In making an appropriate assessment, inter alia, the issues of responsibility, vulnerability, and capability should be clarified. These refer to what extent the ‘actors’ (primarily political representatives/delegates of the intergovernmental deliberations) admit the share of responsibility of their countries for the emergence/existence of the environmental hazards in question, the vulnerability of their societies to the arising impacts and the capability to undertake and fulfil respective commitments to handle

those problems. Judgments about the role and significance of different factors have not only varied over time but have also depended on which environmental components, drivers of those changes and/or adverse implications are the subject of such analysis. At the outset, let us advance the general observation that, despite the widespread efforts of a multitude of international organizations and the plethora of legal and policy instruments so far approved, the state of the global environment is, on the whole, worsening due to the steadily increasing anthropogenic influence.

It is especially important to clarify what is meant by effectiveness in this context, what the obstacles to improvement are, and what methods, policies, and measures can be used to overcome the latter. These problematics have been discussed at a number of international forums, including at the 2005 UN Summit, where the need to better integrate environmental subjects into the sustainable development framework and to improve the coordination and harmonization of the relevant activities of various institutions were highlighted [UN, 2005a[308]]. Since then, not too much has been achieved in this respect, but at least the new sustainable development agenda adopted in 2015 has created a common platform for action by all international organizations, governments, and non-governmental organizations, in particular, in environment-related areas [UN, 2015].

3.3.1. Actors on the global environmental scene: their groups, interests, and positions

International cooperation on global affairs is shaped by a wide range of actors and occurs in many forms. In the following, the general interests and positions of the key participants of those intergovernmental meetings are presented and assessed at which environmental agreements, programs, or action plans were initiated, discussed, elaborated, approved, and/or whose implementation was reviewed. Obviously, these interests and positions varied over time and across thematic areas.

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[308] "Recognising the need for more efficient environmental activities in the UN system, with enhanced coordination, improved policy advice and guidance, strengthened scientific knowledge, assessment and cooperation […] as well as better integration of environmental activities in the broader sustainable development framework at the operational level, including through capacity-building, we agree to explore the possibility of a more coherent institutional framework to address this need, including a more integrated structure, building on existing institutions, and internationally agreed instruments, as well as the treaty bodies and the specialised agencies."

These participants are delegates accredited by their governments. Accordingly, the programs, agreements, decisions, or other outcomes contain jointly approved objectives and goals acceptable by all of them. Moreover, these international legal or policy instruments can define the specific commitments for the parties (countries or groups of countries) and the tasks of relevant intergovernmental organizations. This does not mean that other international entities do not have an essential role in this cooperation and its further strengthening. The related activities of the scientific community and its international institutions in this area are described in detail in the previous chapter. In addition, representatives of other stakeholder groups ('major groups') recognized by the UN regularly express their views and take action regarding the critical themes on the agendas of the intergovernmental and other multilateral meetings. The basic legal provisions for their contribution were settled as early as in the UN Charter (and likewise, specified much earlier by the League of Nations) [UN, 1945[309]]. Decades later, the importance of involvement and collaboration with these groups became much better recognized in the global program on environment and development [UN, 1992a[310]].

Developed and developing countries. The extent to which the socio-economic, trade, and environmental situations, problems, and interests of these two country groups diverged (but were also interdependent) has been much more clearly articulated since the late 1960s in the context of international development and environmental cooperation [G77, 1967[311];

[309] Article 71: "The Economic and Social Council may make suitable arrangements for consultation with non-governmental organizations which are concerned with matters within its competence. Such arrangements may be made with international organizations and, where appropriate, with national organizations after consultation with the Member of the United Nations concerned."

[310] Chapter 23: Strengthening the role of major groups. "23.1. Critical to the effective implementation of the objectives, policies and mechanisms agreed to by Governments in all programme areas of Agenda 21 will be the commitment and genuine involvement of all social groups."

[311] (Part One, III.) "The international community has an obligation to rectify these unfavourable trends and to create conditions under which all nations can enjoy economic and social well-being, and have the means to develop their respective resources to enable their peoples to lead a life free from want and fear. In a world of increasing interdependence, peace, progress and freedom are common and indivisible. Consequently the development of developing countries will benefit the developed countries as well. […] The gravity of the problem calls for the urgent adoption of a global strategy for development requiring convergent measures on the part of both developed and developing countries."

UN, 1972a[312]]. Their differentiated (historical) responsibilities for the emerging global environment-related problems and their capabilities to respond to them were reflected in differences in their commitments within subsequent general and more specific environmental strategies, agreements, international development and sustainable development programs. While this distinction was and remains reasonable, the 'shares of responsibility' for the globalizing hazardous processes have gradually changed.

- ***The need for action by all parties*** to combat environmental hazards of common concern was firmly expressed in the respective conventions, including those on the ozone layer (1985), biological diversity (1992), global climate change (1992), etc. In each of these international deals, the positions of the developed and developing countries were clearly distinguished, and likewise their obligations and the conditions for meeting those. As to the ozone-depleting substances, these two country groups were not subject to the same requirements [VCPO, 1985; VCPO/MP, 1987[313]]. The developing countries' specific priorities and needs have been emphasized in relation to the conservation of biodiversity [CBD, 1992[314]]. The differentiated responsibilities for "combating climate change and the adverse effects thereof" were also unambiguously stated in the convention dealing with this dangerous global process [UNFCCC, 1992[315]]. In all such cases, the provision of

[312] Stockholm Declaration: "4. In the developing countries most of the environmental problems are caused by under-development. […] Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should make efforts to reduce the gap between themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development."

[313] Vienna Convention, Preamble: "Taking into account the circumstances and particular requirements of developing countries"; Montreal Protocol: "Article 5. Special situation of developing countries".

[314] Preamble: "Recognizing that economic and social development and poverty eradication are the first and overriding priorities of developing countries".

[315] Preamble: "Noting that the largest share of historical and current global emissions of greenhouse gases has originated in developed countries, that per capita emissions in developing countries are still relatively low […]. Acknowledging that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions".

financial and technological support for developing countries has become a precondition for undertaking and fulfilling their commitments. Indeed, most of these countries acceded to the convention and its protocol (1987) on ozone layer protection only after the establishment of a financial fund for the said purpose in 1990 (Multilateral Fund, MF). The circumstances were similar for the conventions on biodiversity and climate change, for which specific financial mechanisms and another fund (Global Environment Facility, GEF) were also set up. Subsequently, other global environmental agreements, social development, sustainable development, and some further programs have addressed the specific situation of the developing countries and/or some of their subgroups – for instance, the more recent *Minamata Convention on Mercury*, *the 2030 Agenda for Sustainable Development*, and the *Paris Agreement* on climate change [MCM, 2013; UN, 2015; UNFCCC/PA, 2015].

- ***The developing countries*** established in 1964 a formal group (G77) to harmonize and assert their interests in the substantive modification of international trade rules that were unfavorable to them. Since then, this group has nearly doubled its membership and commonly communicates its positions about major international affairs, including environmental ones. Over the past decades, the 'Third World' has become much more heterogeneous in political, social, and economic terms, as well as regarding environmental matters (such as access to and use of their natural resources and concern about harmful environmental processes). We refer here only to three organizations of some developing countries whose members have taken up strong positions on forests and climate change in international forums. (i) The elaboration of a global convention for promoting forest protection was repeatedly proposed by the International Tropical Timber Organization (ITTO) [ITTA, 1983, 1994, 2006] and also during the preparatory meetings of the 1992 UN conference (UNCED). Its necessity was firmly supported at that time by the most developed countries [G7, 1990[316]]. In contrast, it was vehemently opposed by the developing country members of the ITTO, obviously because of the proposed trade-related provisions that could

[316] "67. We are ready to begin negotiations, in the appropriate fora, as expeditiously as possible on a global forest convention or agreement, which is needed to curb deforestation, protect biodiversity, stimulate positive forestry actions, and address threats to the world's forests. The convention or agreement should be completed as soon as possible, but no later than 1992."

have interfered with their strong interest in exporting tropical timber products. Other developing countries joined them on sovereignty and economic grounds [Humphreys, 1996; Dimitrov, 2005[317]]. Eventually, as a compromise, only the general principles of sustainable forest management were agreed upon [UN, 1992b]. (ii) The standpoints of two other developing country groups were particularly noteworthy in the course of the finalization of the climate change convention. On the one hand, the small island developing states[318] urged a halt to anthropogenic interference with the climate system, primarily because of the gradual sea-level rise resulting from global warming. On the other, the oil-exporting countries[319] raised their strong concern because of the expected economic and trading consequences of limiting the use of fossil fuels [UNFCCC, 1992[320]].

- ***The attitudes of different developed country groups*** towards environmental problems and policies have also been characterized by considerable variability over time. The several examples below refer only to occasions when such groups' members recognized their common environmental interests, which was followed by formulating relevant programs that complemented and reinforced their pre-existing collaboration in economics, trade, and other areas. (i) As mentioned before, the first environmental action program of the EEC[321] was drawn up in 1973 under the influence of the 1972 UN conference held in Stockholm [EEC, 1973]. (ii) The Nordic Council's *Environmental Protection Convention* was adopted in 1974. Later, both organizations

[317] "The plan to include negotiations on a forest convention on the agenda for the 1992 UNCED was abandoned at the preparatory stage due to sharp disagreements among governments on the need for such a treaty. […] developing countries stressed sovereign rights to utilize natural resources. They viewed proposed international regulations as methods of raising trade barriers: a treaty would put limitations on their timber exports and/or oblige them to engage in sustainable forest management that makes harvesting more expensive."

[318] SIDS/AOSIS: Small Island Developing States, Alliance of Small Island States.

[319] OPEC: Organization of the Petroleum Exporting Countries.

[320] "8. In the implementation of the commitments […] the Parties shall give full consideration to what actions are necessary under the Convention […] to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures, especially on: (a) Small island countries; […] (h) Countries whose economies are highly dependent on income generated from the production, processing and export".

[321] EEC: European Economic Community.

further strengthened their own environmental policies and standards and became active players and shapers of international cooperation in this field. (iii) EFTA[322] was set up to promote trade relations among its member countries, but the scope of this organization was considerably widened when its political leaders agreed at their 1977 Vienna summit to foster economic cooperation, especially with the EEC, and also to pay attention to environmental issues.[323] (iv) Much later, also inspired by the 1992 UN conference (Earth Summit) outcomes, NAFTA[324] was supplemented with an environmental agreement, too [NAFTA, 1993]. (v) In addition to these institutionalized intergovernmental forms of cooperation, there are less formal ad hoc settings based on the similar interests of participants, one of which is the 'Umbrella Group' launched by five developed countries in the course of global climate policy negotiations.[325]

- ***The 'Second World'***. From the 1990s onwards, many Central and Eastern European countries (CEE countries) required concessions and support for the implementation of their commitments under more recent environmental agreements. (These countries formerly belonged to the 'Eastern Bloc' and collaborated within the Comecon/CMEA[326] during the Cold War; then many of them were named as 'countries with economies in transition' or 'countries undergoing the process of transition to a market economy.') One of the main reasons for those requirements was the severe downturn of their economies at that time, but there were other factors and motivations for the changes in their approach, in particular, to international environmental policy cooperation [Tóth & Hizsnyik, 2001; Karsai, 2006; Popov, 2007]. The

[322] EFTA: European Free Trade Association.

[323] EFTA Vienna Summit (13 May 1977), Declaration: "4. The development of trade and economic co-operation with the European Community. […] Other fields of interest for wider economic co-operation include transport policy, research, and the protection of the environment. […] 8. East–West trade and economic relations. […] Full use should be made of the international fora available for co-operation, particularly the ECE, which is playing an increasingly important role in promoting European economic co-operation, including extended co-operation in the field of environment."

[324] NAFTA: North American Free Trade Agreement between Canada, Mexico and the USA (1994; this was replaced by a new agreement in 2020).

[325] JUSCANZ (Japan, USA, Canada, Australia, New Zealand), or the 'Umbrella Group' that was set up after the adoption of the Kyoto Protocol during the climate change negotiations in Bonn (on a rainy day). It was later expanded and regularly expressed its positions and proposals on climate-related policy issues.

[326] Comecon: Council for Mutual Economic Assistance.

acknowledgment of this situation and acceptance of the claim for some flexibility and even financial assistance for these countries (to increase their capacity to fulfill their commitments) turned out to be a rather sensitive point, especially for developing countries.[327] Nevertheless, the 'transitional' economic problems of this country group were taken into account for instance, in the two global conventions approved in 1992; in particular, in terms of financing (this meant that they did not commit themselves to providing such resources to the developing countries, while they themselves claimed them) [CBD, 1992; UNFCCC, 1992].[328] In turn, the Global Environment Facility (GEF) made available some financial assistance to these countries for the implementation of their commitments stemming from these two conventions, as well as their obligations for the protection of the ozone layer [GEF, 1995; Pató & Faragó, 2004; VCPO/MP, 1987].[329] There were also differentiated provisions for this group of countries concerning the limitation/reduction of their greenhouse gas emissions; moreover, under the convention to combat desertification and mitigate the harmful

[327] UNCTAD, 1992: "how to meet the large and growing financial needs of the transition countries without diverting development resources, particularly flows, away from traditional recipients, i.e. developing countries" [UNCTAD, 2006]. UNCED, 1992: "(1.5) In the implementation of the relevant programme areas identified in Agenda 21, special attention should be given to the particular circumstances facing the economies in transition. It must also be recognized that these countries are facing unprecedented challenges in transforming their economies, in some cases in the midst of considerable social and political tension" [UN, 1992a].

[328] Details of both conventions, their background and essence, and the relevant national tasks for Hungary have been published in detail in two volumes [Nechay & Faragó, 1992; Faragó et al., 1992].

[329] Hungary became a member of the Global Environment Facility (GEF) and was awarded funding for several national projects. Between 1993 and 2010, the author of this book was responsible for the cooperation of Hungary with this international organization, as well as for participation in the decision-making process of the GEF (including its Council meetings and sessions of the General Assembly).

effects of droughts [UNFCCC, 1992[330]; UNFCCC/KP, 1997[331]; UNCCD, 1994[332]]. Such claims for specific requirements ('derogations') within the more recent international environmental agreements were not announced, at least by those CEE countries that acceded to the European Union. (We have reviewed and analyzed this 'transition' process in detail in several publications [Láng et al., 2003; Faragó, 2002, 2012]).

The Great Powers, the EU, and international environmental affairs. The actual state of East–West relations has been of decisive importance for a long time in terms of determining whether common ground could be created, at least regarding basic objectives and courses of action, in relation to the global and/or pan-European level environmental problems discovered by the scientific community. In this respect, the US–SU (i.e., the U.S.–Soviet) relationship played an essential role from the 1950s onwards for four decades. Depending on the volatile stage of the 'bipolar world order,' environmental policy cooperation was either hindered by these great powers' rivalry or promoted due to their mutual willingness to proceed with formulating and implementing international programs and agreements. According to Lars-G. Engfeldt, scientific or technological advancement was one of the catalysts that eased the Cold War confrontation ad interim, leading to collaboration in such areas in which, at that time, there were no significantly conflicting interests, such as the peaceful use of outer space and the exploitation of marine resources in areas beyond national jurisdiction [Engfeldt, 2009[333]]. This situation

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[330] 4(6) "In the implementation of their commitments under paragraph 2 above, a certain degree of flexibility shall be allowed by the Conference of the Parties to the Parties included in annex I undergoing the process of transition to a market economy, in order to enhance the ability of these Parties to address climate change, including with regard to the historical level of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol chosen as a reference."

[331] 3(6) "Taking into account Article 4, paragraph 6, of the Convention, in the implementation of their commitments under this Protocol other than those under this Article, a certain degree of flexibility shall be allowed by the Conference of the Parties serving as the meeting of the Parties to this Protocol to the Parties included in Annex I undergoing the process of transition to a market economy."

[332] Annex V. Regional implementation annex for Central and Eastern Europe. "2(a) specific problems and challenges related to the current process of economic transition, including macroeconomic and financial problems and the need for strengthening the social and political framework for economic and market reforms".

[333] "The possibility of using scientific discourse to promote détente, in spite of the Cold War, was being explored both in the US and the Soviet Union. […] The environment was seen then as a largely scientific and technological issue". (p. 31)

greatly transformed after the late 1980s, along with the changing 'weight' of these two countries in world politics and the increasing influence of other actors, namely, the major 'emerging economies' of the developing world and the European Union. These changes had severe impacts on global environmental cooperation.

- The temporary thawing of Cold War tensions made it possible to organize the program of the (first) International Geophysical Year (1957/58) and to adopt the UN resolution (1968) on the preparation of a global environmental conference to be held in 1972. In both cases, the two great powers at that time were among the strong supporters. However, just before convening that conference, the two sides clashed over the admission of both German states to membership in the United Nations. As the Western countries were ready to endorse only the membership of West Germany (FRG), the Soviet and some other Eastern European delegations stayed away from (i.e., boycotted) the conference held in Stockholm. Once this political problem was resolved in 1973, the 'Helsinki Process' could be launched, eventually leading to the approval of the *Helsinki Final Act* (1975) at the high-level 'Conference on Security and Cooperation in Europe.' The environmental chapter of this historical document referred to the *Stockholm Declaration* and highlighted those environmental themes that all signatories considered as being of "major importance to the well-being of peoples and the economic development of all countries and […] can be solved effectively only through close international cooperation" [CSCE, 1975].
- From the late 1980s onwards, rapid geopolitical changes occurred. This marked the end of the long period of the 'bipolar world order' and the beginning of newly accelerated globalization. This went together with the substantially modified position of the USA and the Russian Federation inter alia, on global environmental affairs in line with their changing political and economic interests. This became apparent regarding the global agreements adopted in 1992. The USA became a party to the climate convention (UNFCCC), but neither to its Kyoto Protocol (1997) nor the convention on biodiversity either then or since. Russia ratified the climate convention and its 1997 protocol only on condition that it would receive substantial 'concessions' (apparently due to its prolonged and deep economic recession). The attitude of these two countries towards the newer environmental agreements has remained highly variable, of course, depending partly on their domestic and foreign political interests and the extent to which they have been concerned about the environmental hazard in question and its assumed effects on their

countries. In this respect, one of the rather illustrative recent examples is the global convention on mercury [MCM, 2013], to which the USA became the first party but has not yet been ratified by Russia.[334]

- Representatives of the Western and Northern European countries effectively participated in shaping international environmental policies from the 1970s onwards, but they were much less able to assert their environmental and sustainability visions from the 1990s onwards due to the rapidly changing world order. In the case of the European Union, Mihály Simai saw the reason for this in the fact that "although the EU is indeed the largest and most efficient economic grouping in the world in the 21st century … [and the] educational level of its developed member states, the technical development and research base, capital strength, logistical network and global connectivity of its large companies could, in principle, be favorable conditions in most areas for the EU to face the major global challenges of the 21st century. However, its power in world politics is ultimately determined by the relations of its member states of different sizes and with particular interests. The EU does not represent a uniform, homogeneous bloc in the global political and military power structure like the USA, Russia, China, or other centers of power in a multipolar world." [Simai, 2016: p. 45] Nevertheless, in the international arena, the EEC, then its 'successor' the European Community, and more recently the enlarged European Union and its Member States not only actively supported international environmental cooperation but also aligned the community's (internal) environmental legislation and programs with the goals and commitments agreed at global and pan-European levels. This occurred with the agreements and the global agenda adopted in 1992, the most essential goals of which were integrated into the EC's *Fifth Environmental Action Programme* [EC, 1993] and similarly, when the key provisions of the outcome documents of the 2002 and 2005 UN summits were reflected in the renewed sustainable development strategy [EU, 2006].
- After the 1990s, both East–West and North–South relationships underwent major changes, and the People's Republic of China gradually caught up with the United States of America and the Russian Federation in terms of global political engagement and influence on global affairs [Szőke, 2018], which is also identifiable in environmental

[334] The Minamata Convention on Mercury was adopted on 10 October 2013. The Russian Federation signed it on 24 September 2014 but has not ratified it since. On 6 November 2013 (!), the USA not only signed but also accepted it, becoming the first Party to this convention.

matters [Faragó, 2018b]. Nowadays, these great powers have a major role in shaping these international processes not only by themselves but also through the country groups of which they are members. The latter include the G7 (the forum of seven major industrialized countries) and the OECD (whose predecessor was established upon the initiative of the USA and now acts as an organization of more than thirty countries with market-based economies). Russia and China are active members of the G20, a group of the largest economies, and the five-member BRICS.[335] All these groups usually define and deliver their joint positions on global environmental issues as well. In addition to recurrently evaluating the environmental performance of its member countries, the OECD is engaged in global environmental assessment and strategy development [e.g., OECD, 2001]. The BASIC, a coalition of four major developing countries, was formed in 2009 on the margins of the Climate Summit held in Copenhagen (where they represented and insisted on a very tough position); since then, they have regularly formulated and communicated their views on climate change and other global problems [BASIC, 2019].[336]

3.3.2. International environmental instruments: principles, agreements, programs

The increasing interdependence of societies partially due to transboundary environmental impacts and the recognition of the need for concerted action to solve them have led to the development of multilateral environmental instruments. These include the determination of common principles, general objectives, specific goals, tasks, and their means of implementation. This process is a crucial part of environmental globalization, and its outcomes are the basic components of global environmental governance that were achieved in the course of shorter or longer-term deliberations/negotiations and through a series of compromises. The concreteness of the content of these documents approved by the international community and the 'ambition level' of the agreed goals and commitments have varied substantially by time and according to the specific issue being addressed and largely depended on the degree of scientific certainty about the environmental problem in question, its cause-effect relationships and the preparedness of the decision-making representatives of the negotiating parties to act amidst a multitude of interests and priorities. On the whole, all these internationally endorsed legal and policy instruments are aimed at regulating activities that

[335] BRICS: Brazil, Russia, India, China, South Africa.
[336] BASIC: Brazil, South Africa, India, China.

trigger dangerous environmental processes, moderating their harmful effects, and preventing any further such potential hazards. We summarize below (without claiming completeness) some of the key non-binding ('soft') and binding legal instruments and policy frameworks that form the basis of international environmental policy cooperation.

Basic principles. For a long time, the environmental dimension of peoples' rights only concerned the disposal/exploitation of a territory's natural resources. As concerns the quality of the environment, the main sources of guiding principles interrelated with healthy/clean environmental and human health conditions have been the declarations and programs approved at global environmental forums since the 1970s. More specifically, such environmental-quality-related aspects in the context of human rights principles did not appear or were raised only in a very limited (or indirect) way in human rights instruments (declarations, covenants) until the 1990s [e.g., Boyle, 2012[337]].

- Both human rights covenants accepted in 1966, namely, the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights, emphasized the right of all peoples to freely dispose of their natural resources [ICCPR, 1966; ICESCR, 1966[338]]. Two decades later, the Declaration on the Right to Development did not simply reaffirm that right (together with other provisions of the above-mentioned covenants) but determined it to be the right of full sovereignty over all their natural resources [UN/DRD, 1986[339]]. This principle was reconfirmed in the Vienna Declaration of the World Conference on Human Rights [UN/VDPA, 1993: para. 10]; moreover, during the finalization of its text, attention was also paid to the outcomes of the

[337] "It is self-evident that insofar as we are concerned with the environmental dimensions of rights found in avowedly human rights treaties […], then we are necessarily talking about a 'greening' of existing human rights law rather than the addition of new rights to existing treaties. […] Some of the main human rights treaties also have specifically environmental provisions, usually phrased in relatively narrow terms focused on human health". (p. 614)

[338] "Article 1. 2. All peoples may, for their own ends, freely dispose of their natural wealth and resources without prejudice to any obligations arising out of international economic co-operation, based upon the principle of mutual benefit, and international law. In no case may a people be deprived of its own means of subsistence."

[339] Article 1. "2. The human right to development also implies the full realization of the right of peoples to self-determination, which includes […] the exercise of their inalienable right to full sovereignty over all their natural wealth and resources."

1992 UN Conference on Environment and Development as regards the implications for human rights stemming from some activities hazardous to the environment and human health.[340]

- The declarations of the 1972 and 1992 UN conferences included a long list of fundamental principles of international environmental cooperation. Among the most frequently quoted of the former are the principles of the responsibility to avoid transboundary environmental damage and to protect/improve the environment for present and future generations [UN, 1972a: Principles 21, 22; Principles 1, 2 and para. 6]. The declaration by the 1992 UN conference largely reiterated and clarified the principles formulated twenty years earlier. Furthermore, they were complemented by the precautionary principle and the principle of common but differentiated responsibilities of the developed and developing states for global environmental degradation. These principles became the cornerstones of the determination of measures and differing commitments by those country groups within quite a few environmental agreements and programs [UN, 1992a: Principles 15, 7].[341]
- The extension of the scope of 'classic' human rights principles by taking into account their environmental aspects was foreshadowed by the above-mentioned 1993 Vienna Conference. Similarly, the concepts of environmental sustainability and sustainable development outlined in the outcome documents of the 1992 and 2002 global conferences considerably influenced other summits dedicated to development-related issues, viz., the 1995 Copenhagen Summit on Social Development [UN, 1995[342]] and the Millennium Summit [UN,

[340] "11. The right to development should be fulfilled so as to meet equitably the developmental and environmental needs of present and future generations. The World Conference on Human Rights recognizes that illicit dumping of toxic and dangerous substances and waste potentially constitutes a serious threat to the human rights to life and health of everyone."

[341] The responsibility-related principles mentioned here, in other terms, emphasize the importance of *inter*generational and *intra*generational responsibilities for protecting and improving the environment.

[342] (8.) "We acknowledge that people are at the centre of our concerns for sustainable development and that they are entitled to a healthy and productive life in harmony with the environment."

2000[343]]. The UN Commission on Human Rights also paid attention to these new facets [UN/CHR, 2003]. A decade and a half later, draft framework principles on human rights and the environment (i.e., on their interdependence) were presented to and discussed by the UN Human Rights Council [UNHRC, 2018[344]], which eventually were endorsed three years later by the Council in a resolution on the human right to a clean, healthy and sustainable environment [UNHRC, 2021].

International agreements. Since the beginning of the twentieth century, a plethora of multilateral legal instruments on the environment have been developed. Even if we limit ourselves to the truly global agreements in force today, there are still many of them. A comprehensive database of these is maintained by the United Nations Environment Programme (UNEP). The UN and its specialized and regional organizations are also keeping track of such agreements that were designed and approved under their aegis. (These databases are regularly supplemented with newer instruments and updated with the changes in the lists of the parties.) We refer below to three 'clusters' of these agreements: first, those primarily dealing with the physical, abiotic components of the environmental system (their state and protection); second, those on nature conservation in the broad sense (biosphere, ecosystems, species, and their habitats); and third, those focusing on the hazardous environmental impacts of human activities. This does not and cannot imply the strict demarcation of the multitude of multilateral environmental agreements (MEAs) since the problems they treat are interlinked, as are the policies and measures (and their effects) adopted by the parties to tackle them. We have followed this

[343] (6.) "Respect for nature. Prudence must be shown in the management of all living species and natural resources, in accordance with the precepts of sustainable development. Only in this way can the immeasurable riches provided to us by nature be preserved and passed on to our descendants." (21.) "We must spare no effort to free all of humanity, and above all our children and grandchildren, from the threat of living on a planet irredeemably spoilt by human activities, and whose resources would no longer be sufficient for their needs."

[344] Framework principle 1. "States should ensure a safe, clean, healthy and sustainable environment in order to respect, protect and fulfil human rights." Framework principle 2. "States should respect, protect and fulfil human rights in order to ensure a safe, clean, healthy and sustainable environment." Framework principle 13. "States should cooperate with each other to establish, maintain and enforce effective international legal frameworks in order to prevent, reduce and remedy transboundary and global environmental harm that interferes with the full enjoyment of human rights." Framework principle 16. "States should respect, protect and fulfil human rights in the actions they take to address environmental challenges and pursue sustainable development."

rationale in previous publications that presented a number of such legal instruments using this conditional structure [Bándi et al., 1994b; Faragó, 2006]. Other groupings are also possible, for instance, by dividing the agreements into two large clusters, namely those dedicated to (environmental) 'conservation' and all others that deal with some kind of pollution [Escobar-Pemberthy & Ivanova, 2020]. Our aim is not to provide here a comprehensive overview of the MEAs but, in line with the general objective of this book, to demonstrate and to assess at the end of this chapter how and to what extent the diversity of these agreements contributes to solving the environmental problems arising from globalization.

- ***Agreements intended to protect the physical (abiotic) components of the environment***. (i) Framework-type conventions were elaborated to address the harmful effects of pollutants emitted to and transmitted by the atmosphere over long distances, such as the convention on transboundary air pollution (1979), the convention on the ozone layer (1985), and the climate change convention (1992). In light of the increasing scientific knowledge about the sources and influences of (anthropogenic) atmospheric emissions dealt by these international agreements and the development of the ways and means of coping with these matters, the internationally agreed goals and commitments were strengthened and/or extended within the protocols to these conventions or in other legally binding forms (such as amendments and additions).[345] (ii) The protection of international rivers against pollution and the rational and equitable use of their water were covered by pan-European and global conventions on transboundary watercourses (1992, 1997).[346] (In addition to these, specific legal instruments were formulated, e.g., for the protection of the Danube, Rhine, and Mekong rivers with the participation of their riparian countries). (iii) We recall

[345] These conventions and some of their 'supplementary' instruments include the Convention on Long-range Transboundary Air Pollution and its first protocol on reducing sulfur emissions [CLRTAP, 1979; CLRTAP/SP, 1985] and other protocols on reducing/controlling sulfur, nitrogen oxides, VOC, and heavy metals emissions; the Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol [VCPO, 1985, VCPO/MP, 1987]; the UN Framework Convention on Climate Change, its Kyoto Protocol and Paris Agreement [UNFCCC, 1992; UNFCCC/KP, 1997; UNFCCC/PA, 2015].

[346] Convention on the Protection and Use of Transboundary Watercourses and International Lakes (a global convention since 2013) [CTWC, 1992]; Convention on the Law of the Non-navigational Uses of International Watercourses [CLNUIW, 1997].

here only two international agreements devoted to the protection of the marine environment from pollution: the 1972 convention on the prevention of deliberate disposal (dumping) of wastes or other matter at sea (which was replaced by its 1996 protocol) and the 1973 convention on the prevention of marine pollution from ships (later 'complemented' by its 1978 protocol).[347] (The protection of the rivers and seas from pollution, of course, involves the conservation of their aquatic ecosystems as well.) (iv) In addition to the high seas, the protection of two other vast 'international areas' of the global environment[348] – the sixth continent (Antarctica) and outer space – became urgent due to the potentially harmful effects of human activities in the course of rapidly increasing demand for various natural resources and accelerating space exploration from the late 1950s onwards.[349]

- ***There are numerous nature conservation agreements*** directed at the protection of endangered species, habitats, and the conservation of wildlife in general. These include, among others, the conventions on wetlands (1971), world cultural and natural heritage (1972), migratory species of wild animals (1979), biological diversity (1992), and preceding all these, the agreement on the regulation of whaling (actually, on its limitation; 1946).[350] The general objectives and provisions of all these are the clearest – one could say, the most sublime – expressions of why it is so essential and of common interest to conserve the natural environment and the significance of international cooperation to this end. Some highlights in this regard are: "Recognizing the interdependence of Man and his environment …"

[347] London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and the London Protocol [LC, 1972, 1996]; International Convention for the Prevention of Pollution from Ships and its protocol [MARPOL, 1973, 1978].

[348] 'International' means that these areas fall outside national jurisdiction.

[349] The Antarctic Treaty and Protocol on Environmental Protection (Antarctic Treaty System) [ATS, 1959, 1991]; Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty); Agreement on Control of the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty) [OST, 1967; Moon, 1979].

[350] International Convention for the Regulation of Whaling [ICRW, 1946]; Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) [RCW, 1971]; Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention) [WHC, 1972]; Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) [CMS, 1979]; Convention on Biological Diversity [CBD, 1992].

[RCW, 1971]; "Considering that deterioration or disappearance of any item of the cultural or natural heritage constitutes a harmful impoverishment of the heritage of all the nations of the world …" [WHC, 1972]; "Affirming that the conservation of biological diversity is a common concern of humankind …" [CBD, 1992].

- ***Human activities endangering the environment*** and the measures controlling, restricting, or abandoning them are the focus of other international agreements. In general, these aim at mitigating/minimizing or avoiding further harmful impacts on the environment and human health. (i) In this respect, we first refer to legal instruments, the initial versions of which originated many decades ago. These include the agreements regulating the transboundary carriage/transport of dangerous goods (by air, sea, road, river, and rail)[351] and those concerning weapons of mass destruction and military interventions which are also extremely harmful to the natural environment (especially those deliberately designed to modify and/or deteriorate the environment).[352] (ii) Other global conventions and their subsequent 'supplementary' instruments (protocols and/or amendments) about the management of hazardous chemicals and wastes – that is, their (sound/unsound) production, use, and disposal, international trade, and the handling of occasionally arising harmful environmental effects – are important achievements of the last three decades. Their finalization and adoption have been the result of difficult negotiations, particularly because of the large differences in the positions and interests of developed and developing countries. In this relation, the most essential global agreements are those on the transboundary movement of hazardous wastes (1989), international trade in hazardous chemicals (1998), the minimization/elimination of the production and use of persistent organic pollutants, and the reduction/elimination of the mining of mercury and the use of it and its compounds in products and manufacturing processes (2001, 2013).[353] (iii) Compared to these, the treaties regulating the international trade in

[351] E.g., Dangerous Goods Regulations (IATA, 1956); International Convention for the Safety of Life at Sea (SOLAS), Ch. VII Carriage of Dangerous Goods (IMO, 1974).

[352] This Convention was specifically designed to prohibit such military interventions [ENMOD, 1976].

[353] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal [BC, 1989]; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade [RC, 1998]; Stockholm Convention on Persistent Organic Pollutants [SC, 2001]; Minamata Convention on Mercury [MCM, 2013].

endangered species of wild flora and fauna, and sustainable tropical forest management date back to earlier times (1973, 1983).[354] (iv) A number of pan-European agreements under the aegis of the UNECE have also been developed to prevent and mitigate the adverse environmental consequences of human activities, such as the 1992 *Convention on the Transboundary Effects of Industrial Accidents*.

- ***Interlinkages of environmental agreements***. Once a human-induced environmental problem has been scientifically recognized and its causal links identified, then the determination of the relevant policy responses can begin in parallel with the development of international and intergovernmental cooperation, programs, and/or agreements in the case of a large/global-scale hazardous process. In general, this scientific and political collaboration has evolved separately for each environmental issue with the participation of different professionals from the scientific community and representatives of the respective national organizations/authorities; furthermore, rather often under the umbrella of different international institutional frameworks. A consequence of this 'disjunct' process has occasionally been the overlooking or inadequate consideration of the relationships between the respective problems (concerning their causes and effects) and the inadvertent side-effects of policies/measures (as specified in an agreement but affecting other ones). This occurred when the initial responses to tackling ozone layer depletion consisted of the introduction of 'ozone-friendly' but significantly not 'climate-friendly' compounds to replace the former ozone-depleting substances (e.g., as cooling agents in refrigerators) that were initially considered for phase-out. Thus, while the process of eliminating the threat to the ozone layer was underway, human interference with the global climate system intensified. Finally, the decision to avoid this adverse 'side-effect' was made in the form of the 2016 amendment to the *Montreal Protocol* [VCPO/KA, 2016; Faragó, 2017]. Considering such interrelationships and interactions and identifying the proper ('win-win') solutions for avoiding similar contradictory situations is important, at least during the further development (strengthening and complementing) and implementation of environmental agreements. This approach could increase the aggregate effectiveness of the interventions intended to simultaneously cope with various large-scale environmental issues

[354] Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES, 1973]; (the first) International Tropical Timber Agreement [ITTA, 1983].

[UNU, 1999[355]; Chambers, 2008[356]]. However, achieving this synergy is hampered by several factors (e.g., the autonomy of the coordinating and decision-making institutions of each environmental convention). Nevertheless, there are good examples, such as the close collaboration of the relevant organizations associated with the three 'chemical conventions' and the substantive cooperation among the representatives of the nature conservation agreements [McInerney, 2017[357]]. To these promising cases, we can add the regular liaison and coordination between the secretariats of the three 'Rio conventions.'[358]

Global environmental strategies, programs, and plans (hereafter referred to as programs) are usually designed to cover a shorter or longer period (a few decades or rarely even a century). Usually, they are renewed (or supplemented/extended) afterward, or sometimes even before they expire, which is preceded by an assessment of their implementation. The progress of such comprehensive program development is summarized below; then, some thematic programs are also presented. The original or renewed versions of quite a few of these programs are still in force and remain the core documents of international environmental cooperation.

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[355] "States have tended to consent to new laws and institutions, such as MEAs, in an ad hoc manner, and only when growing awareness, and political momentum, force a response to a new problem. This momentum can be channeled through a variety of existing institutions and may lead to the creation of new institutions. The result is fragmentation."

[356] "Without first understanding how treaty performance can be improved through treaty-to-treaty cooperation it is unlikely that treaty bodies and contracting parties will be motivated to work more cooperatively together. Moreover, without knowing what types of interventions work more than others or how interlinkages can improve treaty effectiveness it is difficult to direct policy interventions at the right target." (p. 10)

[357] "[P]athbreaking efforts have been made among the parties to MEAs to rationalize and develop synergies among all aspects of treaty activities, most notably in the chemicals and biodiversity domains. These efforts are important developments because the legal autonomy of MEA Conferences of the Parties has led to situations in which decisions taken by these Conferences of the Parties have on occasion contradicted those taken by UNEA due to lack of prior coordination and communication." (p. 8)

[358] The conventions on biodiversity and climate change are 'Rio conventions' only in the sense that both were opened for signature at the high-level segment of the 1992 UN Conference in Rio de Janeiro. (As a member of the Hungarian delegation, the author of this book was granted the opportunity not only to participate in this summit, but also to be present at the signing ceremony of the indicated agreements on the Hungarian side.) At the same meeting, the decision was taken to draw up a 'desertification convention,' negotiations for which were finalized in Paris in 1994 (UNCCD).

- For the first time, a wide-ranging program entitled *Action Plan for the Human Environment* covering all the major environmental problems (as known at the time) and the relevant tasks was approved at the 1972 UN conference (UNCHE) [UN, 1972a]. A decade later, the implementation of this plan was reviewed and, on that basis and in accordance with a 1983 resolution of the UN General Assembly, a strategic document on the key long-term international environmental policy directions was prepared, submitted to, and endorsed by the General Assembly in 1987 [UNEP, 1982; UN, 1983; UN, 1987a].
- The above-mentioned UNEP document and the report of the World Commission on Environment and Development [UN, 1987b] formed the basis for the elaboration of the new comprehensive program *Agenda for the 21st Century* that was finalized in 1992 during the UN Conference on Environment and Development (UNCED) and afterward adopted by the UN General Assembly [UN, 1992a]. It was reviewed a decade later, then reinforced and supplemented by more concrete goals and provisions by the *Johannesburg Plan of Implementation* [UN, 2002]. These documents extensively dealt with environmental issues within the broad framework of sustainable development.
- At the 'Rio+20 conference' a consensus was reached to 'elevate' the decision-making level of the UNEP by establishing the UN Environment Assembly (UNEA) and strengthening the coordination of environmental activities within the UN system [UN, 2012a[359]]; yet, the preparation of the *System-wide Framework of Strategies on the Environment* was led not by the UNEP but by the UN Environment Management Group [UN, 2016]. Nevertheless, this strategic framework might further ensure better coherence among the UN institutional family's highly diverse activities in the environmental field.
- Following another recommendation made at the 2012 UN conference, a new comprehensive sustainable development program, *Transforming our World: the 2030 Agenda for Sustainable Development* was drawn

[359] "88. We are committed to strengthening the role of the United Nations Environment Programme (UNEP) as the leading global environmental authority that sets the global environmental agenda […]. In this regard, we invite the General Assembly, at its sixty-seventh session, to adopt a resolution strengthening and upgrading UNEP in the following manner: (c) Enhance the voice of UNEP and its ability to fulfil its coordination mandate within the United Nations system by strengthening UNEP engagement in key United Nations coordination bodies and empowering UNEP to lead efforts to formulate United Nations system-wide strategies on the environment".

up with a broad scope and more ambitious goals/targets than ever before [UN, 2015].

Many thematic or specific environmental programs have also been elaborated during the last few decades. Some of these have directly 'served' the implementation of one or more international agreements in the respective problem areas and were endorsed by the parties to those legal instruments. We cite here only a few examples.

- A Strategic Plan was formulated to achieve the objectives of the 1992 *Convention on Biological Diversity* (CBD) for the 2002–2010 period. It was renewed for 2011–2020 and included the *Aichi Biodiversity Targets* [UNEP/CBD, 2010].[360]
- The *Strategic Approach to International Chemicals Management* (SAICM) for the period 2006–2020 was intended to facilitate compliance with the provisions of the global chemicals conventions (the Rotterdam, Stockholm, and Basel Conventions) as part of its general goals of promoting the sustainable management of chemicals [UNEP/SAICM, 2006; UN, 2015[361]].[362]
- As regards the environmental protection of 'international areas' (i.e., those beyond national jurisdiction), we refer to two significant documents. Obviously, the *Global Programme of Action for the Protection of the Marine Environment from Land-based Activities* is aimed at preventing the degradation of the marine environment in general (that is, its scope includes not only the 'high seas' but all maritime areas/zones) [UNEP/GPA-LbA, 1995]. In the case of the rapidly intensifying space debris hazard, due to a lack of consensus among the 'space nations,' there are only *Space Debris Mitigation Guidelines* for voluntary measures for minimizing the probability of the accidental collision of and damage to any spacecraft by space debris [UN/COPUOS, 2010].
- Special programs have been elaborated to tackle natural and industrial disasters. The first was worked up for the UN International Decade for Natural Disaster Reduction (launched in 1990), followed by renewed

[360] The subsequent biodiversity framework program under the CBD was adopted in 2022.

[361] The global agenda on sustainable development that was approved in 2015 included SAICM's general objective of achieving the environmentally sound management of chemicals by 2020 as one of the specific SDGs.

[362] The subsequent chemicals framework program was adopted in 2023 by the International Conference on Chemicals Management (ICCM).

ones, including the most recent *Sendai Framework for Disaster Risk Reduction* [UNDRR/SFDRR, 2015].[363]

The developments above demonstrate gradual progress concerning global-level environmental policy cooperation and its achievements, at least in terms of the preparation and adoption of a large diversity of multilateral legal and policy instruments. (But it is one thing to agree on a common program or convention – after this, the focus will be on its adequacy and effective implementation. These issues will be discussed in the following subsection.)

3.3.3. The evaluation of environmental and sustainable development governance

So many initiatives associated with holding conferences/forums, establishing organizations, elaborating programs, and agreements have been woven through the century-long history of global environmental cooperation.[364] Many of those international organizations are currently still active (at most, their mandate has been changed/widened), some of the programs are ongoing now and/or have been renewed, and numerous such agreements have remained in force (but in many cases, with an expanded scope, more stringent goals and additional means of implementation). However, their simple existence (either when they were 'born' or later prolonged/strengthened) does not mean that they are sufficient, that is, that their current mandate, scope, concrete goals, and provisions are adequate to address the respective environmental hazards as known by the science of the time or to contribute better to their resolution as scientific awareness

[363] International Decade for Natural Disaster Reduction (IDNDR, 1990–); Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action (1994–); Hyogo Framework for Action (2005–2015); Sendai Framework for Disaster Risk Reduction (2015–2030). In this regard, there is a legally binding instrument but only at a pan-European level – the Convention on the Transboundary Effects of Industrial Accidents [CTEIA, 1992].

[364] Because of the relatively slow evolution of large-scale environmental problems and their identification until the mid-twentieth-century, as well as militant international political relations in the period during and between the two World Wars, it is understandable that the first few decades of this century-long period were not overly rich in more or less significant developments in multilateral environmental cooperation. We have referred to some of the latter in the previous sections, such as the initiatives for dealing with environmental issues within the framework of the League of Nations (in the early 1920s), the program of the second International Polar Year (1932–1933), the establishment of international scientific organizations (IUBS, 1919; IAHS, 1930) and the elaboration of several regional nature conservation agreements (1933, 1940).

increases.[365] Therefore, an evaluation of the current state of environmental governance – based on the effectiveness of its main components and actual 'performance' – can help with judging what the international community should do more of to mitigate increasingly adverse widespread environmental impacts and avoid potential new ones in due time.

International institutions have proliferated, particularly since the middle of the last century, contributing significantly to the identification of globalizing environmental problems and developing relevant response policies and measures.

- The necessity of convening an international council of scientists from different countries was probably first raised by U.S. President Lyndon B. Johnson in 1968 to promote cooperation in environmental science.[366] Since then, numerous organizational frameworks have been created to support science-policy links in a number of subject areas, including the loss of biodiversity, climate change, ozone layer depletion, and challenges of natural resource management.[367] The scientific partnership launched with the support of the ICSU embodied a much more comprehensive partnership of scientists dealing with complex Earth system processes using a holistic approach (Earth System Science Partnership, 2001–2012), which cooperation continued from 2012 as the 'Future Earth' network of researchers. But despite repeated initiatives by the UNEP, a multidisciplinary organization has not been created to serve as a global science-policy interface to provide science-based policy-relevant knowledge about the environmental system as a whole (although such panels have been inaugurated for specific thematic areas, like the IPCC and IPBES). Regardless of the lack of

[365] Adequacy in this context was referred to, e.g., in the 'climate convention' [UNFCCC, 1992: Art. 4, para. 2(d)]: "review the adequacy of [the policies and measures] shall be carried out in the light of the best available scientific information and assessment on climate change and its impacts, as well as relevant technical, social and economic information."

[366] "Scientists from this country and the Soviet Union – and from 50 other countries – have already begun an international biological program to enrich our understanding of man and his environment. I propose that we make this effort a permanent concern of our nations. I propose that the United States scientists join with the scientists of the Soviet Union and other nations to form an international council on the human environment." (Commencement Address at Glassboro State College; June 04, 1968)

[367] We include here some examples. Biodiversity: CBD/SBSTTA (1992–), IPBES (2012–). Climate change: IPCC (1990–), UNFCCC/SBSTA (1992–). Ozone layer: MP/TEAP (1990–). Natural resources: UNEP/IRP (2007–).

such a 'holistic' international body, at least (and at long last) a global system for environmental observations was set up (GEOSS, 2005–)[368]; moreover, reports on the state of the global environment and the status of sustainable development in the world (including issues associated with environmentally sustainable development) have been regularly compiled and published (Global Environmental Outlook, UNEP/GEO, 1997–; Global Sustainable Development Report, GSDR, 2013–). Nevertheless, it remains essential to improve the collaboration of the scientific and policymaking communities concerning global environmental affairs especially under the aegis of the UN because only this would ensure the definition of truly appropriate, comprehensive, and consistent goals and policies for coping with the increasing number of globalizing harmful environmental and related processes.

- The development of the international institutional framework for broad-based environmental policymaking has been described in detail above, starting with the United Nations Environment Programme (UNEP) established in 1972 (with a relatively limited mandate) and continuing with initiatives to achieve more effective policy cooperation. Four decades on, the UNEP's own decision-making body has become 'universal'; that is, its former Governing Council (composed of the representatives of 58 elected member countries on a rotational basis) was replaced in 2012 by the United Nations Environment Assembly (UNEA) with universal membership, while (f)actual UN-wide environmental policy coordination remained the responsibility of the UN Environment Management Group that was entrusted to it by a resolution of the UN General Assembly (EMG, 2001–). As mentioned before, the latter arrangement has finally made it possible to produce a strategic framework [UN, 2016] that, in the future, will hopefully create somewhat greater coherence among the multitude of different environment-related programs of the specialized UN agencies. In the field of sustainable development cooperation and its environmental dimension, a more-or-less similar change has occurred: the UN Commission on Sustainable Development (set up to facilitate the implementation of the global agenda adopted in 1992) was replaced by the High-level Political Forum on Sustainable Development (HLPF,

[368] The intention to create the Global Environmental Monitoring System (GEMS) was repeatedly discussed from 1972 onwards. However, the UNEP did not succeed with this endeavor, merely creating some of its basic components, such as GEMS/Water.

2013–), which inter alia recurrently assesses and supports the execution of the most recent comprehensive global program, that is the *2030 Agenda* [UN, 2015]. All in all, in light of so many environmental issues, the global governance situation in this context remains very inadequate and, unfortunately, the UN reform process launched at the end of the 1990s has left this problematic almost untouched except for some not too substantial changes (such as the updates or 'upgrades' indicated above). A recent analysis also argues that current global environmental challenges make it entirely justified for UN member states to finally address them at an appropriate institutional level "to ensure the protection of the global ecological heritage and the survival of the human race in the age of the Anthropocene" [Desai, 2019[369]].

- This inadequacy was so evident to some prominent, high-ranking persons that they devised proposals for overcoming this gap that involved some options for the more effective 'institutionalization' of global environmental policy coordination. In 1997, UN Secretary-General Kofi Annan published his ideas for reforming the UN: one of the elements was empowering the Trusteeship Council with the new function of exercising collective trusteeship for the integrity of the global environment [UNSG, 1997[370]; Redgwell, 2005]. (In the absence of a consensus concerning the acceptance of that proposal, the UN General Assembly dissolved that council not long after.) At the 2002 UN summit, the President of the French Republic, Jacques Chirac, suggested that in view of the serious global environmental situation, UNEP should continue its activities not as a 'program' with a narrow mandate but as a specialized agency of the UN entitled the 'World Environment Organization' (WEO), with much greater

[369] "The global environmental challenges warrant institutional responses that are timely, pragmatic, and adequate to ensure the protection of the global ecological heritage and the survival of the human race in the age of the Anthropocene. These states – members of the UN – will need to rise above their narrow partisan considerations and muster enough political courage to appropriately carve out a new mandate for the TC as a supervisory authority for the environment and the global commons." (p. 340)

[370] "85. Member States appears to have decided to retain the Trusteeship Council. The Secretary-General proposes, therefore, that it be reconstituted as the forum through which Member States exercise their collective trusteeship for the integrity of the global environment and common areas such as oceans, atmospheres and outer space."

empowerment.[371] The outcome document endorsed by that summit also highlighted the role of UNEP in fulfilling the global tasks that had been decided upon, but with its 'status' essentially unchanged within the UN system [UN, 2002: 140(d)]. Similarly, another proposal to extend the mandate of the Security Council to include the critical issues of 'environmental security' remained only a theoretical option [Elliott, 2005[372]].

The effectiveness of global environment-related agreements and programs can be evaluated at different levels and 'stages.' Effectiveness, as envisaged at the time of their adoption, can be measured by the extent to which the (presumed) fulfillment of their goals brings the international community closer to solving the environmental problems they cover. Sometimes, this is considered the 'degree of efficacy' of the agreement or program – i.e., to what extent its ultimate objective and more concrete goals can be achieved through its provisions and their complete and thorough implementation.[373] Another stage of evaluation is scrutinizing the existence or lack of consistency between science and policy, that is, the extent to which the provisions of the agreement/program reflect the scientific knowledge available at the time of its development, including the science-based advice for policy options. (The divergence between the two is usually called the 'science-policy gap'). Therefore, we can distinguish

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[371] "Pour mieux gérer l'environnement, pour faire respecter les principes de Rio, nous avons besoin d'une Organisation mondiale de l'environnement." (Discours de Président de la République devant l'assemblée plénière du Sommet Mondial du Développement Durable, Johannesburg, 2 sept. 2002)

[372] "The developing norm of human security, again by analogy with humanitarian intervention, offers scope for invoking Security Council action or expanding its mandate with respect to environmental degradation. […] It is less clear, however, whether the Security Council has or should have a mandate to act against more general environmental threats to peace and security". (p. 209)

[373] Some examples of these objectives/goals are as follows: [CBD, 1992] Art.1 "The objectives of this Convention […] are the conservation of biological diversity, the sustainable use of its components"; [UNFCCC, 1992] Art.2 "The ultimate objective of this Convention […] is to achieve […] stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."; [UNEP/SAICM, 2006] Para.13 "The overall objective of the Strategic Approach is to achieve the sound management of chemicals throughout their life-cycle .."; [UNFCCC/PA, 2015] Art.2 "(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C" Art.4 "1. In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible".

between two fundamental levels of effectiveness of an international legal or policy instrument: (i) its intended contribution to the solution of the respective hazardous process according to the then-existing level of scientific evidence about it [Escobar-Pemberthy & Ivanova, 2020[374]] and (ii) the actual accomplishments of that agreement or program. Of these two types of evaluation, the former is also referred to as the designed 'environmental effectiveness' (or 'ecological effectiveness'), while the latter is described as the 'institutional effectiveness' – or specifically in the case of legal instruments as the 'legal effectiveness' – derived from the evaluation of the implementation of the tasks/commitments defined in the adopted document. Concerning the latter, the accent is on the 'implementation', that is, the extent of the compliance of the parties with the provisions of the legal or policy instrument in question [Jackson & Bührs, 2015; Sand, 2016[375]].

- How can one analyze the science-policy concordance or gap (the consistency or divergence) between the science-based recommendations and the policy responses/commitments included in an agreement or program (more generally, that of an environmental 'policy regime')? A theoretically possible starting point for this is consideration of the significance of the fact that such a legal or policy instrument exists at all or the appraisal of what would happen to the environmental problem in question without such an instrument [Helm

[374] "Effectiveness means fulfilling the goals of the agreement and resolving the environmental problem in question […]. Particularly, in the context of increasing environmental challenges, the successful implementation of global environmental conventions through goal setting, metrics development, data collection, and resource mobilization is fundamental to coordinating, integrating, and systematizing efforts to protect the environment and promote sustainability."

[375] Legal effectiveness: "how and to what extent do States actually meet their international commitments under an environmental treaty to which they have become parties? […] ecological effectiveness: how successfully have the environmental problems targeted by a treaty been solved or mitigated as a result of cooperative action by the contracting States?" (p. 3)

& Sprinz, 2000[376]]. A more concrete approach would involve comparing the approved goals, policies, and measures to the science-based recommendations. Significant science-policy gaps may stem from differences in judgment about the severity of the problem concerned, different perceptions/awareness of its causes, and/or preferences among diverse options for acting. As a consequence of compromises, the goals, the overall effect of the concrete commitments, or other provisions of an agreement/program approved for a specified period may fall far short of the level of intervention proposed by a relevant scientific body for the mitigation/solution of that problem. To some extent, such discrepancy characterized the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* that provided the possibility to deviate from the general restrictive/prohibitive trading rules "in exceptional circumstances," and of course, could not cover the protection of the same endangered species from illegal trading activities and in areas under national jurisdiction [CITES, 1973[377]; Weiss, 1998[378]]. The situation is somehow analogous to the *Minamata Convention on Mercury* because although the hazardous effects of mercury on human health and the environment were generally recognized, the text of the convention could only be finalized and adopted with many options for applying

[376] "Most authors have used relatively simple indicators as the object of evaluation. An obvious candidate is the degree of problem solving, the actual impacts of a regime. […] especially, for environmental problems, there is sometimes a long time lag between the action triggered by a regime and the impacts that follow from this action […] (as for stratospheric ozone depletion)." "Having decided on the object of evaluation, the next question is against which standard this object should be evaluated. The first candidate is the no-regime counterfactual […]. The no-regime counterfactual does not suffice as the only evaluative criteria because it gives only a very vague indication of how well a regime serves the purpose it has been designed for." (pp. 632–634)

[377] "The Contracting States, Recognizing that wild fauna and flora in their many beautiful and varied forms are an irreplaceable part of the natural systems of the earth which must be protected for this and the generations to come; […] Article II. 1. Appendix I shall include all species threatened with extinction which are or may be affected by trade. Trade in specimens of these species must be subject to particularly strict regulation in order not to endanger further their survival and must only be authorized in exceptional circumstances."

[378] "The CITES has been criticized for its effectiveness in controlling international trade in endangered species. […] a country could be in compliance with trade controls under the CITES but promote the elimination of the species by actions within the country." (p. 1565)

exemptions [MCM, 2013[379]; Faragó, 2015[380]]. For similar reasons, there has been a considerable gap between the level of scientific evidence about the hazardous phenomenon to be dealt with and the 'ambition level' of the commitments in the majority of the environmental agreements at the time of their conclusion. A somewhat exceptional and rare example is the *Montreal Protocol* for the protection of the ozone layer (including its systematic 'tightening' by means of amendments), as well as the first 'sulfur protocol' to the pan-European *Convention on Long-Range Transboundary Air Pollution* [VCPO/MP, 1987; CLRTAP/SP, 1985]. Both of these were drawn up shortly after the unambiguous identification of the cause of the relevant environmental damage (ozone layer 'thinning' and acidification, respectively) and the acceptance of the urgency of reducing the emissions of the relevant pollutants (ozone-depleting substances and sulfur compounds).

- When the legal effectiveness of an agreement is evaluated, it should be assessed how the States Parties to that agreement deal with it and its provisions, especially those that cover the commitments and tasks to be implemented by them individually or jointly with other parties. The first and most trivial determinant of that effectiveness arises from the fact that once a multilateral legal instrument is finalized, not all the States concerned will necessarily accede to it (i.e., become parties), which may, even at this early stage, cast doubt on the achievement of the objectives/goals it pursues. For instance, according to the *Basel Ban* (the 1995 amendment to the *Basel Convention*), the developed countries were prohibited from moving any hazardous waste to another country, but this amendment entered into force in 2019 (!) without the participation of several key developed countries (members of the

[379] "The Parties to this Convention, Recognizing that mercury is a chemical of global concern owing to […] its significant negative effects on human health and the environment …" Art. 1 "The objective of this Convention is to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds." Art. 6 "Exemptions available to a Party upon request."

[380] "It will no longer be allowed to manufacture, export or import products containing mercury from 2020, with many exceptions. [...] One specific compromise relates to dental amalgam, which gives parties a great deal of freedom on how to gradually restrain from this use of mercury. [...] concerning the PVC manufacturing compound (VCM), the negotiators could so far only agree on limiting this mercury technology".

OECD) [BC/BBA, 1995].[381] Other rather exceptional examples are the 1992 *Convention on Biological Diversity*, to which all but one UN member state (the USA) became parties, and the 'withdrawal' of Canada in 2011 from the 1997 *Kyoto Protocol* (obviously because it turned out that it would not meet its emission reduction commitment by the 2012 deadline).[382] Patrick Széll argues that the number of parties to a multilateral environmental agreement is not the appropriate measure of its 'success,' but rather, whether all parties are meeting their obligations [Széll, 2007[383]]; however, from the point of view of achieving the agreement's objective/goals, it is not at all irrelevant how many parties participate in its execution.

- It is evident that one cannot expect 'non-parties' to comply with the obligations of an international legal instrument. Furthermore, some parties to such agreements occasionally fail to comply with one or more (substantial) requirements contained therein. Actually, compliance would mean that the parties adhere to the provisions of the agreement and fulfill their obligations, which are typically based on many compromises [UNEP, 2006[384]]. This situation is also valid for international programs (agendas, action plans, etc.) in the sense that members of the international community (governments and various stakeholders, regardless of whether they participated in their development) acknowledge not only the importance and validity of the respective programs but also that they apply to them so that they are ready to actively contribute to their completion. In the case of some agreements, specific instruments and institutional arrangements promote compliance and/or address non-compliance [Goeteyn & Maes,

[381] Australia, Canada, Japan, Russia, New Zealand, and the USA did not become Parties to the 1995 'Basel Ban'.

[382] "The Government of Canada notified the Secretary-General that it had decided to withdraw from the Kyoto Protocol" (15 Dec 2011).

[383] "The number of ratifying states is, of course, not an appropriate way to measure an MEA's success. A successful treaty is one of whose obligations are fulfilled by all it Parties". (p. 79)

[384] "Compliance means the fulfilment by the contracting parties of their obligations under a multilateral environmental agreement and any amendments to the multilateral environmental agreement". (p. 59)

2011[385]]. Such a procedure exists in relation to the 1972 *World Heritage Convention*, according to which its Committee can inscribe a World Heritage Site on the *List of World Heritage in Danger* and delete it from that list only if the values of that site are properly restored [WHC, 1972; Guèvremont, 2019[386]]. This happened to natural heritage sites in Indonesia, Madagascar, and the USA.[387] The international 'emissions trading' mechanism was introduced by the *Kyoto Protocol* as a supplementary instrument for the developed country parties to facilitate the fulfillment of their emission reduction commitments [UNFCCC/KP, 1997; Faragó, 2011]; however, its applicability could be temporarily suspended for such parties that failed to meet some other obligations.

- Ultimately, the overall effectiveness of an international legal or policy instrument depends, as mentioned before, on whether and to what extent its completion contributes to the solution of the environmental problem – in other words, to achieving its ultimate objective or goal [Jackson & Bührs, 2015[388]; Sand, 2016[389]]. It should also be noted that the dangerousness of that environmental issue (and/or the appraisal of this danger) does not necessarily remain unchanged in the light of newer, more accurate observations and scientific analyses. Consequently, this problem can be seen as a 'moving target' that may sometimes require strengthening of goals, and/or the response policies

[385] (44.) "Compliance mechanisms are structures created to enhance the effectiveness, good working and implementation of the international convention that establishes them."; (45.) "They are considered a necessary part of any MEA in terms of effectiveness of the conventions. […] they contribute to the effective implementation of international obligations by states."

[386] (32.) "List of World Heritage in Danger is a crucial tool for safeguarding the outstanding universal value of a property and several examples support such conclusion. Over the years, several properties have been deleted from this list, thanks to the effort of States Parties, and in some cases International Assistance, that allow the adoption of an appropriate management plan and/or the elimination of the threat."

[387] Tropical Rainforest Heritage of Sumatra, Rainforests of the Atsinanana, Everglades National Park.

[388] "It is not enough to understand how regimes are functioning at an institutional level: we also must have a firm grasp of their actual impacts on our world. […] Given that international regimes are the main tools used to address global environmental issues, it is imperative that we increase our understanding of how their institutional and ecological effectiveness can be enhanced." (p. 83)

[389] "In a broader view of effectiveness, therefore, legal compliance with a treaty commitment should be distinguished from the extent to which the commitment has actually influenced the behavior of States so as to advance the goals that inspired the treaty". (p. 5)

and measures formerly adopted may need to be complemented, or a new, more stringent international instrument elaborated [Weiss, 1998[390]; Sand, 2016[391]]. Such 'adjustments' occurred inter alia in the case of emission reduction targets for ozone-depleting substances and greenhouse gases.

- Some international agreements/programs are mentioned below as examples, with some evaluations of whether they have been adequately implemented. (i) Reductions in the production, use, and environmental concentrations of chemicals controlled by the *Stockholm Convention on Persistent Organic Pollutants*,[392] hitherto were not detectable in all regions [UNEP/POPS, 2017; UNEP/GEO, 2019[393]]. (ii) The sustainable chemicals management strategy planned for the 2006–2020 period has ended 'unfinished,' so this will be taken into consideration in its 'renewal' process [UNEP/SAICM, 2006; UNEP/SAICM, 2020]. (iii) The 2020 targets accepted in line with the *Convention on Biological Diversity* have not been met; moreover, the situation has become even more critical, so it was agreed that more robust interventions are necessary, especially in relation to agricultural land use changes [CBD/GBO, 2020[394]; IPBES, 2019[395]; WWF, 2020]. (iv) Unfortunately, as regards other more recent global-level environmental issues, there have been, at best, only partial results but

[390] "Effectiveness refers to whether the purposes of the agreement are being achieved, and more generally, whether the agreement as designed is effective in addressing the problem for which it was negotiated." (p. 1564)

[391] "Ultimately, though, the success or failure of a treaty – its "problem-solving capacity" or "functional effectiveness" – will have to be ascertained by its impact not only on the subsequent behavior of member States, but on the physical or biological conditions of the environment which the treaty was intended to protect or improve." (p. 6)

[392] "The Parties to this Convention, Recognizing that persistent organic pollutants possess toxic properties […]. Determined to protect human health and the environment from the harmful impacts of persistent organic pollutants". [SC, 2001]

[393] "Concentrations of POPs that are regulated and monitored under the Stockholm Convention have been reduced in Europe, North America, and Asia and the Pacific". (p. 121)

[394] "On our current trajectory, biodiversity, and the services it provides, will continue to decline, jeopardizing the achievement of the Sustainable Development Goals. In 'business as usual' scenarios, this trend is projected to continue until 2050 and beyond, due to the increasing impacts of land and sea use change, overexploitation, climate change, pollution and invasive alien species." (p. 12)

[395] "Past and ongoing rapid declines in biodiversity, ecosystem functions and many of nature's contributions to people mean that most international societal and environmental goals, such as those embodied in the Aichi Biodiversity Targets and the 2030 Agenda for Sustainable Development, will not be achieved based on current trajectories." (p. 14)

no global improvements. Atmospheric concentrations of the gases covered by the *Paris Agreement* (2015) adopted under the climate change convention (UNFCCC) are growing (the rise in their global emissions was only temporarily and slightly moderated in 2020 for well-known reasons) [UNEP/EGR, 2020[396], UNEP/EGR, 2021]. (v) To achieve the objectives of the quarter-century-old program for the protection of the marine environment especially from land-based activities, a more concrete time-bound target was set as part of the Sustainable Development Goals agreed in 2015 [UNEP/GPA-LbA, 1995; UN, 2015: 14.1[397]]; but so far, according to recent assessments, that waste stream is growing, primarily due to the "rapidly increasing levels of marine litter, including plastic litter and microplastics" [UNEP, 2019[398]; UNEP/AHEG, 2020[399]]. (vi) As we have already pointed out, the effectiveness of the *Montreal Protocol* on the protection of the ozone layer may be one of the rare exceptions in terms of the effectiveness of its provisions (including their gradual strengthening) and the effectiveness of the implementation. (At the same time, it is an important lesson that it may take until the middle of this century for the ozone layer to 'heal' [UNEP/MP, 2020[400]].)

- Besides focusing on the content and effectiveness of particular agreements/programs dedicated to environmental hazards, it is essential to direct attention to the dangerous changes in the global environmental system (as a whole) because of the interlinkages of the factors triggering those processes, their environmental and socio-economic impacts, as well as the effects of the interventions for their 'regulation.' Recent comprehensive assessments of environmental sustainability and sustainable development have highlighted, in

[396] "Although 2020 emissions will be lower than in 2019 due to the COVID-19 crisis and associated responses, GHG concentrations in the atmosphere continue to rise, with the immediate reduction in emissions expected to have a negligible long-term impact on climate change." (p. iv)

[397] "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution".

[398] "Noting with concern that the high and rapidly increasing levels of marine litter, including plastic litter and microplastics, represent a serious environmental problem at a global scale, negatively affecting marine biodiversity, ecosystems, animal well-being, societies, livelihoods, fisheries, maritime transport, recreation, tourism and economies".

[399] (20.) "[P]lastics were the largest, most harmful and most persistent fraction of marine litter, with growing volumes recorded in all marine and coastal environments."

[400] (80.) "Thanks to the Montreal Protocol, the ozone layer was healing and was expected to return to pre-1980 levels by mid-century."

general, the importance of this 'systems approach' (system-based perspective). Both the recent UN report on sustainable development and the report presented by an expert group showed that there are severe problems with progress towards the previously agreed global goals and targets, including those that are directly related to environmental issues [UN, 2020a[401]; UN/SDSN, 2020[402]]. In this context, the declaration adopted on the occasion of the 70th anniversary of the founding of the United Nations also stressed the need "to take more determined action" to promote sustainable development and address global environmental challenges [UN, 2020b[403]]. The urgency of acting more synergistically

[401] "The world continues to use natural resources unsustainably. […] Global community shies away from commitments required to reverse the climate crisis. COVID-19 may result in a 6% drop in greenhouse gas emissions for 2020, still short of 7.6% annual reduction required to limit global warming to 1.5°C. […] Ocean acidification continues to threaten marine environments and ecosystem services. […] The world is falling short on 2020 targets to halt biodiversity loss. Forest areas continue to decline at an alarming rate, driven mainly by agricultural expansion." (pp. 17-20) Whilst the deadline for the majority of the goals/targets is approaching, in general, this situation is remained unchanged [UN, 2021, p. 56]: "Ending environmental decline and restoring our planet is fundamental to sustainable development. Nevertheless, forests are being cut down, biological diversity is declining, and terrestrial ecosystems are being degraded at alarming rates […]. Land degradation now affects one fifth of the Earth's land area."

[402] "Covid-19 will have severe negative impacts on most SDGs. The world is facing the worst public health and economic crisis in a century […]. The only bright spot in this foreboding picture is the reduction in environmental impacts resulting from declines in economic activity: a key objective will be to restore economic activity without simply restoring old patterns of environmental degradation. However, all long-term consequences of the pandemic remain highly uncertain at this point." (p. vi)

[403] "5. Our challenges are interconnected and can only be addressed through reinvigorated multilateralism. […] 7. We will leave no one behind. The next 10 years, which have been designated as the decade of action and delivery for sustainable development, will be the most critical of our generation. […] 8. We will protect our planet. Without more determined action we will continue to impoverish our planet with less biodiversity and fewer natural resources. We will see more environmental threats and climate-related challenges, including natural disasters, drought, desertification, food shortages, water scarcity, wildfires, sea level rise and depletion of the oceans. The time to act is now."

and effectively was also strongly emphasized by the UN Environment Programme [UNEP, 2021[404]].

[404] "Human well-being critically depends on the Earth's natural systems. Yet the economic, technological and social advances have also led to a reduction of the Earth's capacity to sustain current and future human well-being. […] Society is failing to meet most of its commitments to limit environmental damage. […] None of the agreed global goals for the protection of life on Earth and for halting the degradation of land and oceans have been fully met." (p. 14) "Humanity's environmental challenges have grown in number and severity ever since the Stockholm Conference in 1972 and now represent a planetary emergency. […] Earth's environmental emergencies and human well-being need to be addressed together to achieve sustainability. The development of the goals, targets, commitments and mechanisms under the key environmental conventions and their implementation need to be aligned to become more synergistic and effective." (p. 13)

4. CONCLUSIONS AND LESSONS LEARNED

4.1. Environmental globalization and environmental science

Scientific investigations and international science cooperation devoted to the exploration of the causes, effects, and interconnections among environmental problems of global concern

> "Global environmental problems demand a multilateral approach […], effective commitments need to be formulated, agreed and implemented in the context of agreed international legal frameworks […]. Such agreements can only be effective if they are properly based on the results of systematic observations and multidisciplinary research. Science policy should take into account the complexity of environmental problems, along with identified gaps and the need for transdisciplinary research."
>
> [WSF, 2005][405]

International scientific cooperation concerning global environmental hazards and the options for the mitigation of their dangerous ecological and social impacts has progressed, especially since the middle of the last century. Numerous organizations have been established and research programs launched or renewed for studying generally the changes in the state of the environmental system and its specific components, the interacting natural and anthropogenic factors ('drivers') of these changes, as well as their potential shorter and longer-term consequences. The main findings of these studies have been regularly communicated, inter alia, in the forms of assessment reports or outlooks. This was done not only to share this knowledge with the broader scientific community but also to raise public awareness of the harmful processes and to alert decision-makers to the need to cogitate on taking appropriate steps to tackle them,

[405] World Science Forum (Nov. 2015), Session V: The future of the environment, Conclusions (p. 2)

including the elaboration of relevant international programs, action plans and/or agreements. Concerning the evolution of environmental research activities and science cooperation in this complex subject area, a number of conclusions and lessons can be identified that highlight the difficulties of exploring globalizing environmental problems, formulating science-based (theoretical and methodological) options for addressing them, and confirming the importance of a comprehensive, inter- and multidisciplinary scientific approach and appropriate scientific communication.

The signs of the expanding environmental effects of globalization were not clearly discernible for many decades. Therefore, they were not recognized or 'simply' were misinterpreted for a long while. The beginnings of 'economic globalization' have been dated by some authors to the early nineteenth century and by others to later decades [O'Rourke & Williamson, 2002; Nayyar, 2006]. When some of the adverse environmental influences were first noticed, they were considered insignificant or negligible compared to the hoped-for benefits of the gradually unfolding socio-economic development.

- The potential global-level influence of increasing environmental releases of hazardous substances, primarily the atmospheric emissions of pollutants, was first raised as early as the end of the nineteenth century [Högbom, 1894].[406] Compared to this, the potentially extensive problems stemming from the rapidly rising demand for and exploitation of natural resources were recognized much later, namely, from the first decades of the twentieth century onwards. These were associated with the growing intent and concrete efforts to access and utilize resources from areas under the jurisdiction of other nations or beyond national jurisdiction. This led not only to bi- and multilateral conflicts, such as the proliferation of international maritime fisheries disputes and those that catalyzed the 'oil crises' of the 1970s, but to much more severe regional and even global-level 'resource wars.'
- The identification of the globalizing harmful environmental consequences of human activities has resulted from rapidly developing environmental observations and intensifying research activities. The relatively long duration needed for the comprehension of these inadvertent impacts was owing to the gradual increase in these environmental pressures, the long-range transport and accumulation of the pollutants, the 'delay' in the build-up of their adverse implications,

[406] Högbom referred to the large volume of carbon dioxide emissions from coal combustion and their possible climatic implications [Arrhenius, 1896].

and the time lags in the clearly noticeable (identifiable) degradation of the environment [UNESCO, 1970[407]; Young et al., 2006]. The perception of the significance of these hazards may have been hampered if, according to initial assessments, the occurrence of such serious effects was either unlikely (i.e., underestimated) or expected 'only' in the long term [Carson, 1962[408]].

- Another factor that can further complicate the detection of globalizing anthropogenic environmental issues is the high degree of natural variability of the phenomena under study (both in time and space), which may overlap with or mask the alarming trends (e.g., regarding the slowly rising concentration of airborne pollutants or toxic substances in the environment). A similar situation is encountered due to the considerable inertia of the environmental system (or components thereof) that may defer the emergence and detectability of the hazardous changes in its state. In other terms, these difficulties, on the one hand, stem from overlapping slow and fast environmental processes (i.e., those with shorter and much longer time scales) and, on the other, can also be interpreted in the context of relatively 'weak signals' or low environmental 'signal-to-noise' ratios [Czelnai, 1980; Faragó, 2016[409]; UNEP, 2021[410]].

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[407] "The environment is degraded by combinations of physical, chemical and biological materials, acting in general in concert, but of eternally varying character. […] The combinations of wastes, normally confronting us, all have significant health implications. Some are obvious and direct. Others are subtle, indirect and of long time lag in appearance. Still others are less well understood and perhaps less important. In any event one must view the environment and its degradation as a totality, regardless of the fact that the 'carriers of deterioration' may be liquid, gas or solid." (p. 156)

[408] "Responsible public health officials have pointed out that the biological effects of chemicals are cumulative over long periods of time, and that the hazard to the individual may depend on the sum of the exposures received throughout his lifetime. For these very reasons the danger is easily ignored. It is human nature to shrug off what may seem to us a vague threat of future disaster." (pp. 188–189)

[409] "[T]he detection of the present climate change signal and its attribution to different drivers (forcing factors) is rather problematic because of the relatively low climate change signal-to-noise ratio (where the "noise" is the climatic variability in this context) and because of the diverse interactions and characteristic timescales of natural and human-induced contributions to the GHG cycles and to the impacts of the changing climatic conditions." (p. 34)

[410] "Almost all of the Earth system and human system processes involved in the dramatic changes observed over the past century contain time lags of years to centuries. This imparts an inertia to the changes observed and reinforces the urgency with which people must act." (p. 67)

- The multifaceted and in-depth scientific research of environmental globalization started in the middle of the last century in parallel with the acceleration of human impacts on the natural environment, including the rapidly increasing utilization of its resources and deterioration of its quality. Sometime later, the substantial social and economic repercussions of the worsening environmental conditions also had to be realized. Concerns about the diversity and dangerousness of the latter reinforced the understanding of the need for 'environment-friendly' development paths [Holdgate, 1990[411]; Rakonczai, 2018[412]]. This led to a broadening of international environmental policymaking collaboration and the creation of a large number of institutions and instruments, albeit with very different levels of effectiveness. Overall, this 'fragmented' environmental governance system has proved inadequate for sufficiently addressing the globalization and diversification of the environmental problems [Esty & Ivanova, 2003[413]].

In order to study thoroughly the global environmental system and understand its functioning, it has become indispensable to strengthen the cooperation of representatives of different scientific disciplines and to examine the system as a whole in a holistic manner.

- For a long time, the components and potentially dangerous processes of the environmental system have been analyzed in general within the framework of the different branches of natural science. Such research activities for advancing meteorological, hydrological, ecological,

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411 "All the ingredients of a system to bring humanity into harmony with nature exist. The problem is that they are not being used – or not with a sufficient urgency, on a sufficient scale." (p. 17)

412 "A vital new element of the change is that the representatives of the still dominant economy have had to realize that the relationship between the global economy and global ecology has changed direction. While some decades ago, after becoming cognisant of environmental problems, we worried about the environmental consequences of economic development, we now need to find solutions for the socio-economic effects of ecological stress. Similarly, while in the past the commercial dependence of countries used to be a decisive factor, present-day environmental interdependency can contribute to problems through global warming or regional pollution, for example." (p. 19)

413 "Collective action is necessary and urgent, yet in the environmental domain it has fallen short as a result of the deep-seated weakness of the institutional architecture and decision-making processes of the existing international environmental regime. Fragmentation, gaps in issue coverage, and even contradictions among different treaties, organizations, and agencies with environmental responsibilities have undermined effective, results-oriented action". (p. 13)

biological, geo- and oceanographic, geological and other environment-related scientific knowledge were and remain essential; however, without 'systems thinking,' it would not have been possible to explore the complex interrelations among the various environmental pollution and/or degradation phenomena.

- Likewise, it is essential to take into account all those environmental effects that are induced by the same human activities. The sulfur dioxide and carbon dioxide emissions from fossil fuel combustion are well-known examples of this situation, although some essential means of lessening these emissions were common (e.g., using non-fossil fuel energy sources), whilst pollutant removal techniques sometimes differed (viz., the harmful acidification caused by the former problem was avoided by the desulphurization of fossil fuels). The recommendation, choice, and implementation of response measures should also be revised if it turns out that they unintentionally generate or reinforce other hazards (as occurred at the early stages of ozone layer protection).
- Consequently, human-induced adverse environmental issues should be studied not only independently but also together as a whole. This comprehensive approach is covered by the complex scientific 'multidiscipline' that Johan Rockström called Earth System Science [Rockström, 2016].
- Without recognizing, exploring, and taking into consideration the aforementioned relationships/interactions, the scientific hypotheses about one or another environmental hazard may be misleading, and the proposals for their management may inadvertently lead to or enhance other problems. In more general terms, this means the need for the above-mentioned systems or holistic thinking that was emphasized by János Selye (Hans Selye), whose thoughts regarding biological research on stress are obviously valid in other scientific fields: "No matter how much we shall learn about the most intimate mechanisms of biological phenomena, we will always need the old-fashioned holistic approach." [Selye, 1967]

Establishing global environmental observing systems and the availability of information from their databases have been crucial for thorough and rigorous scientific research into large-scale environmental processes.

- The ability to carry out sufficiently detailed and accurate environmental observations and make accessible the large amounts of information from these for scientific analysis and modeling was achieved due to the rapid development of the necessary technical means from the 1970s

onward (measuring and data-transmitting instruments, satellites, computers, etc.).

- It is a peculiar (but understandable) coincidence that thanks to fast technological progress, (i) multitudes of new methods and techniques have been invented and applied that have contributed to the propagation of production and consumption patterns associated with increasing pressure on the environment and at the same time, (ii) more and more powerful and precise procedures and equipment have been developed by means of which those pressures and the subsequently changing environmental conditions could be much better monitored.
- The most notable achievement in this context was the agreement in 2005 among the organizations operating 'thematic' environmental observational systems about their close collaboration in the future. The objective of coordinating these activities to provide coherent environmental data was accentuated in the 'founding document' as follows: "Understanding the Earth system […] is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, reducing disaster losses, and achieving sustainable development. Observations of the Earth system constitute critical input for advancing this understanding." [GEOSS, 2005].

The new generations of theoretical models that better capture the complexity of the global environmental system and the numerical assessments derived by their means have reflected much more accurately the functioning, processes, and changes of this system.[414] Moreover, it has become feasible through such model simulations to derive conditional scenarios of the system's future behavior.

- In general, the same applies to global environmental research as was stated in the 1970s in connection with the examination of the climate system – namely, that there is no suitable alternative to the construction of (and numerical simulations using appropriately comprehensive) models for studying such complex systems [WMO-ICSU-UNEP, 1975[415]]. In this case, too, technological developments (above all, the increase in the capacity of computers) have made it possible to carry

[414] An expanding amount of and higher-resolution information from environmental and relevant socio-economic data sources (for model initialization) was also essential for making more realistic assessments.

[415] "The construction of climate models that simulate the real climate system is an enormous task […]. There seems to be no clear alternative to the modelling approach for understanding climate sensitivity." (p. 17)

out numerical analyses using advanced models that process enormous amounts of data.

- Of course, those analyses have been based on models of different types and structures deployed in climatic, ecological, hydrological, and other environmental examinations. However, overall, the reliability of the outcomes of such calculations depends not only on the models' quality but, to a large extent, continues to be a function of the technical development level of the monitoring networks that provide data for the input and verification of the numerical simulations.

The justification or rejection of scientific hypotheses about the cause-effect relationships of potentially dangerous globalizing environmental issues has often been a lengthy process. The history of the scientific recognition of such hazards has been characterized by sharp debate about their existence, causality, and/or 'only' their severity. These disputes have sometimes manifested in clashes of arguments 'for and against' (pros and cons), followed by 'turning points' leading to conclusions about the urgency of the further/deeper scientific exploration of the threats concerned and (at least) taking some 'preliminary' measures in accordance with the precautionary approach.

- There are well-known examples from the past century of how difficult it was to unambiguously identify the natural and human factors that were triggering substantial changes in the state and quality of the environment and to conceive of appropriate interventions for preventing or at least mitigating the adverse effects. This occurred, for example, with the search for the causes of changes in atmospheric greenhouse concentrations, the depletion of the stratospheric ozone layer, and increasing environmental acidification. In relation to all these and several other historically notable cases, the significance of the reliance on 'facts' and scientific arguments backed up by reliable environmental observations, measurements, and assessments was demonstrated to be a decisive factor in the evidence-based proceedings (reasoning) that established and confirmed the cause-effect relationships [Faragó, 2018].[416]
- Thoughtful science communication, including clear indications of the degree of scientific certainty that has been achieved concerning the findings of studies about large-scale hazardous environmental processes,

[416] In that study, we summarized the essence of five such historical scientific debates (e.g., disputes about the possible harmful side effects of DDT, ozone-depleting freons, and lead additives in gasoline). We called it 'eppur argumentation' when experts/scientists referred to concrete facts (factual evidence) to argue for the existence of those harmful effects.

has become essential for maintaining scientific credibility (especially in terms of the soundness of the recommended actions). Although it is not easy to judge the level of the sufficiency of the evidence, in "lack of full scientific certainty," it often seemed to be appropriate to rely on the precautionary principle when "there are threats of serious or irreversible damage," as approved in the *Rio Declaration* [UN, 1992]. For the same reasons, the first activities promoted by international conventions on climate change, biodiversity loss, and other adverse environmental problems were guided, inter alia, by this principle.[417]

- A key criterion for selecting and implementing precautionary measures is their cost-effectiveness, the interpretation of which is somewhat unclear (or rather contradictory). This can result in different estimates and decisions also dependent on (i) the potential severity of the damage to be prevented or (ii) the comparison of the effectiveness and costs of such measures with the consequences if no measures are taken at all. That is why invoking this principle (formulated and adopted in 1992), may lead to controversial outcomes or even inaction [Driesen, 2013[418]; Pinto-Bazurco, 2020[419]].

The global collaboration of researchers turned out to be absolutely reasonable because of the worldwide scale of the environmental system and its changes studied by them and because these changes affect all regions in one way or another. Moreover, this collaboration is also

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[417] "The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures …"; [UNFCCC, 1992: Art.3.3]. "Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat …" [CBD, 1992: Preamble]; Stockholm Convention on Persistent Organic Pollutants [SC, 2001: Art. 1].

[418] "With respect to environmental policy generally, we need to recognize that CBA does not provide a means of mechanically calibrating appropriate standards. This is not to say that CBA is meaningless. But its meaning stems more from the underlying normative commitments reflected in the approach and its practitioners' attitudes than from mechanical calculation of costs and benefits. We also need to understand the precautionary principle in a more precise way, as indicating an attitude to uncertainty, not necessarily as a complete guide to setting abatement levels." (p. 774)

[419] "[I]ts opponents have decried the potential the principle has for overregulating or limiting human activity, as we see in the criticism about the establishment of moratoriums on genetically modified organisms (GMOs) in some countries. The disagreement boils down to: does the principle dictate that uncertainty demands action […] or does uncertainty justify inaction?" (p. 3)

particularly expedient in light of the necessity of developing international programs and agreements based on scientifically sound recommendations for relevant policies and measures to tackle dangerous environmental changes with the participation of policymakers from all regions.

- These aspects were taken into account in the founding of the IUCN and when Earthwatch was renewed in 1992 (twenty years after its establishment), and in the declaration by the World Conference on Science on the mission of the international scientific community [IUCN, 1948; Fritz, 1997; WCS, 1999[420]].
- The recognition of the importance of strengthening the science-policy interface associated with global environmental matters has also led to the creation of new forms of scientific communication. Besides the compilation of very detailed 'academic-style' reports by international groups/panels of scientists who have been invited to take stock of and assess the available knowledge about critical environmental problems, they also understood the significance of compiling and publishing the policy-relevant essence of such findings and conclusions (under the titles 'summary for policymakers' or 'executive summary'). Typically, such procedures have been followed by the intergovernmental/international panels dealing with global climate change, ozone layer depletion, biodiversity loss, and the degradation of natural resources (IPCC, MP/SAP, IPBES, IRP[421]).

The concepts of environmental sustainability and sustainability science have represented the broadening and enhancement of environmental research, in particular, (i) by taking into account environmental carrying capacity (as the limiting factor of socio-economic development's effects on the environment) and (ii) identifying the interrelated 'unsustainable' environmental and social processes and exploring the options for preventing or curbing them.

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[420] "62. Scientific advice is an increasingly necessary factor for informed policy-making in a complex world. Therefore, scientists and scientific bodies should consider it an important responsibility to provide independent advice to the best of their knowledge. […] 64. Governments, in cooperation with the agencies of the United Nations system and international scientific organizations, should strengthen international scientific advisory processes as a necessary contribution to intergovernmental policy consensus-building at regional and global levels".

[421] IPCC: Intergovernmental Panel on Climate Change; MP/SAP: Scientific Assessment Panel of the Montreal Protocol; IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services; IRP: International Resource Panel.

- Representatives of various scientific disciplines and fields of expertise have studied the above issues somewhat differently, depending on their professional background, views, and priorities regarding the nature-society relationship, and have reached partially similar or completely contradictory conclusions. This means that in parallel to the further elaboration of the concept of environmental sustainability (primarily its 'strong sustainability' version), human- and economy-centered approaches to sustainable development (sustainable human development, sustainable economic development, sustainable economic growth) have continued to gain ground, albeit with references to environmental challenges and some criteria associated with these development paths (e.g., G20, 2019).[422]
- While it was at least implicitly evident that the 'sustainability' promoted in the latter conceptions could not exist without the 'sustainability of the natural environment' (i.e., provided that ecosystem services are maintained and natural resources are sustainably used), those human- and economy-centered development ideas were still generally awarded precedence over the sustainability concepts that inherently were also based on environmental criteria. This focus was perhaps most clearly expressed by a few principles adopted in 1992 (that emphasized 'people-centered' sustainable development and economic growth),[423] which were to some extent balanced by others (e.g., those that referred to environmental protection as an integral part of development)[424] [UN, 1992]. In contrast, the close interdependence of nature and society was highlighted as the key to sustainable development throughout the Earth Charter (the compilation of which was initiated in 1992 but could only be finalized and adopted later) [Earth Charter, 2001[425]; Faragó, 2003].

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[422] Declaration adopted at the G20 meeting (Osaka, 29 June 2019): (1.) "We will work together to foster global economic growth" (34.) "A paradigm shift is needed where the virtuous cycle of environment and growth is accelerated through innovations".

[423] "1. Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature. .." "12. States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation."

[424] "3. The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations." "4. In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it."

[425] Earth, Our Home: "The resilience of the community of life and the well-being of humanity depend upon preserving a healthy biosphere with all its ecological systems, a rich variety of plants and animals, fertile soils, pure waters, and clean air. The global environment with its finite resources is a common concern of all peoples." (p. 1)

- Eventually, the ‘sustainability science’ led to the introduction of a truly comprehensive, global-level, and ‘large-scale system’ framework alongside the more specific disciplinary approaches for studying complex nature-society interactions [Clark & Dickson, 2003[426]]. The role and responsibility of science in discovering, understanding, and resolving ‘unsustainability’ problems have increased further in the face of still rapidly globalizing and interacting environmental, social, and economic processes and the multiplication of conflicts arising from them.[427]

[426] “In seeking to help meet this sustainability challenge, the multiple movements to harness science and technology for sustainability focus on the dynamic interactions between nature and society, with equal attention to how social change shapes the environment and how environmental change shapes society. These movements seek to address the essential complexity of those interactions, recognizing that understanding the individual components of nature–society systems provides insufficient understanding about the behavior of the systems themselves.” (p. 8059)

[427] We have also referred to this responsibility in a former study: “Scientists have to promote the interdisciplinary approach that is indispensable for research on global environmental change. Scientists must balance on a fine line between professional credibility and admitting the remaining scientific uncertainties. The responsibility of the groups of experts and scientific bodies that present the future global environmental picture to policy and economic decision-makers is enormous. The responsibility of the expert groups and scientific panels that present different scenarios about the future state of the global environment to political and economic decision-makers is enormous.” [Pálvölgyi & Faragó, 1995: p. 87]

4.2. The development of international environmental policy cooperation

Lessons learned and the future of policy cooperation on environmental problems of global significance

> "Noting, in particular, the continuing and accelerating impairment of the quality of the human environment […], Convinced of the need for intensified action at the national, regional and international level in order to limit and, where possible, eliminate the impairment of the human environment". "Believing it desirable to provide a framework for comprehensive consideration within the United Nations of the problems of the human environment in order […] to identify those aspects of it that can only or best be solved through international co-operation and agreement …"
>
> [UN, 1968]

In the long history of international relations, cooperative efforts and bi- and multilateral conflicts have frequently been driven by environmental factors, foremost, natural resource-related interests (the annexation of land and claims on territories beyond national jurisdiction, the access to and utilization of the natural resources of such areas, the use of international watercourses, etc.). Later, multilateralism also became affected by increasing environmental pollution (including the release of various hazardous substances) with adverse transboundary or even continental- and global-scale consequences. Multifaceted research about these environmental matters has preceded and underpinned discussions about the need and options for their 'treatment,' i.e., the relevant policy responses. With all these issues, the application of many written and unwritten rules and procedures of 'classic' diplomacy aimed at finding reasonable compromises has become essential. However, besides these generally used and customary methods, multilateral 'environmental diplomacy' has sometimes arrived at specific solutions for bridging the wide-ranging interests encountered during complicated environmental policy negotiations over past decades. Eventually, all these formal and informal

conciliation mechanisms contributed to the formulation and adoption of many international environmental programs and agreements.

The evolution of multilateral environmental policy cooperation has a century-long history in terms of the development of its institutional framework and the instruments thereby elaborated.

- An early precedent of such initiatives was a proposal submitted to the League of Nations to establish a 'World Commission for Nature Protection' at the turn of the 1920s. More attention was devoted to emerging worldwide environmental problems only from 1945 onward under the aegis of the United Nations and its specialized agencies. Nevertheless, despite the acceleration of the exploitation of natural resources and the concomitant enhancement of environmental pollution, and the resulting and gradually globalizing adverse impacts, the international community's concern about these matters remained somewhat limited for almost four decades due to the volatile 'political climate' that followed the outbreak of the Cold War.
- At the same time, the developing countries began to manifest their interests and priorities regarding the disposal and utilization of their natural resources much more decisively. In parallel, meeting their economies' rapidly escalating natural resource demands was one of the key motivations for both the groups of Western and Eastern European countries to advance and institutionalize their economic collaboration (within their own 'blocks').
- The situation has fundamentally changed since the late 1980s as a growing number of international environmental challenges, their causes, and increasingly harmful effects were better revealed, and 'political actors' worldwide have acknowledged not only the existence and seriousness of these issues but also the common responsibility to address them.

The establishment of extensive international research cooperation in general and in all specific environmental problematic areas has become a 'prerequisite' for launching the preparation of the appropriate agreements and policy programs, defining their objectives, and reaching consent about the commitments and means of implementation.

- In-depth inter- and multidisciplinary research carried out by environmental scientists and representatives of other scientific branches has resulted in the identification of causal links to large-scale

environmental problems and their potential shorter- and/or longer-term consequences. This could be followed by the political realization of the existence of the risks and the requirement of concerted international action.

- In addition to considering the science-based indications and recommendations closely associated with such environmental issues, other socio-economic and political aspects and priorities motivated the deliberations/negotiations during the initiation and elaboration of the respective international programs and agreements. Because of the parties' contradictory approaches, differing circumstances, and positions, the final versions of those documents were usually comprised of a wide range of compromises.

Rapidly diversifying and strengthening transboundary environmental problems have been among the key factors in reinforcing the mutual interdependence of societies. In turn, this led to the promotion of international environmental relations. As this process progressed, the multilateral instruments gradually proliferated, and over time, so did positive and negative experiences with their implementation.

- The escalation of global political, economic, and trade-related international tensions from the 1950s onwards, also exacerbated by proliferating environmental challenges (conflicts over natural resources and the transboundary effects of pollution), gave rise to the recognition of the need for global cooperation on environmental matters [UN, 1972[428]]. The development of policy and technological options for preventing or at least mitigating harmful environmental impacts has also fostered the international community's willingness to formulate environmental programs/agreements with increasingly 'ambitious' goals and commitments.
- In the course of the evolution of environmental cooperation, some of its international institutions and mechanisms were formed based on earlier models and/or solutions (by applying these with appropriate modifications, as deemed necessary). Such precedents appeared to be re-applicable either because they had proved to be effective previously or at least could be accepted by consensus as 'hard-won' compromises

[428] Stockholm Declaration: "7. […] A growing class of environmental problems, because they are regional or global in extent or because they affect the common international realm, will require extensive cooperation among nations and action by international organizations in the common interest."

among parties representing substantially differing interests and positions. For instance, this was the case with some of the provisions of the *Vienna Convention for the Protection of the Ozone Layer* (1985) and its *Montreal Protocol* (1987) when their applicability was taken into account during the preparations of the *UN Framework Convention on Climate Change* (1992) and the *Kyoto Protocol* (1997).[429]

The progress of international environmental policy collaboration was highly dependent on growing scientific knowledge about environmental problems and, to a large extent, on the fluctuating world political situation (the 'global political climate'). This process stagnated between more or less favorable periods, but even during those periods, it was somewhat variable concerning its intensity and effectiveness.

- The 1972 UN Conference on Human Environment and the 1992 World Summit on Environment and Development may be considered the most significant milestones in the process of global environmental policy advancement [UN, 1972; UN, 1992]. (The decisions on holding these 'historical' events were adopted by the UN General Assembly [UN, 1968; UN, 1987 and UN, 1988].)
- Environmental policy aspects and 'environmental health' considerations may have been at odds with general political, economic, or other interests even during the preliminary determination of the expediency, modalities, and options for future international actions for responding to the globalizing environmental hazards. Eventually, the general adequacy and level of concreteness of the policy or legal instruments approved by the international/intergovernmental forums depended on the weights and 'matching' of the above-mentioned diverse factors. Accordingly, the outcomes of the sometimes lengthy preparatory processes (negotiations) could be, e.g., (i) general statements or declarations (merely) on the need for the better understanding of and further conciliation about the environmental problems raised; (ii) recommendations, framework strategies, programs or conventions including (only) the basic principles, general objectives and directions of further cooperation; or (iii) international action programs/plans or agreements containing specific time-bound goals and commitments. Basically, all these stages and outcomes have

[429] The author of this volume has detailed in a paper how the content of international agreements on the protection of the ozone layer and transboundary air pollutants has influenced the development of climate change agreements [Faragó, 2016].

characterized the history of deliberations/negotiations about the different hazardous problems unfolding in key components of the global environmental system, such as the atmosphere, the biosphere, the oceans, and outer space.

- Multilateral environmental relations and policies have alternately strengthened or stagnated; in other words, they have been characterized by ebb and flow over past decades. In this process of varying intensity and effectiveness, periods of greater prominence were marked by more or less ambitious goals, programs, and agreements, which then could be followed by periods when the implementation of the formerly approved instruments was neglected, weakened, or postponed due to the overriding importance of other political and/or economic matters.

Consensus could only be achieved during the elaboration, and finalization of the environmental programs/agreements (including the goals, commitments, and other provisions embedded in them) if and only if they properly reflected the different situations and interests of all the parties (countries) besides their responsibilities. Of these, the latter proved to be the most crucial: a principle adopted many decades ago referred only to the responsibility for damages caused to another country or other countries [UN, 1972].[430] More recently this notion has been extended to common but differentiated responsibilities because of "the different contributions to global environmental degradation" [UN, 1992].[431] While this principle provided a universal and general basis for deliberations about action to address common environmental hazards, its concrete application (through the differentiated attribution of responsibilities) encountered difficulties in particular when:

- the economic activities with adverse environmental impacts were 'outsourced' (typically from a developed country to a developing country having less stringent environmental regulations, so that the

[430] Principle 21: "States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

[431] Principle 7: "[…] In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command."

production-induced environmental degradation/pollution occurred in the latter, while the manufactured products were 'reimported' to the developed country);[432]

- the question was raised (and remained unresolved) concerning how and which country's 'environmental performance' ought to be taken into consideration with respect to the natural resources utilized in the production process of exported/imported goods (e.g., 'virtual water' or 'embodied energy' for food products[433]);[434]
- the policies and measures specified under an international environmental agreement might (indirectly) cause economic-, competitiveness-related, or other damages to some of the parties to that agreement.[435]

Representatives of different scientific disciplines and economic sectors often held diverging views and priorities (or could even follow contradictory or paradoxical approaches) when searching for solutions to emerging environmental problems. For this reason, their proposed environmental strategies and policies could be very dissimilar and turned out to be more or less effective (or even ineffective).

- Achieving the sustainable management of natural resources and keeping environmental pressures under control (i.e., limiting them or at least reducing/slowing their growth rate) seems impossible if maintaining economic growth is the primary goal. At the same time,

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[432] A typical case of this in relation to the implementation of climate change agreements is 'carbon leakage,' which means that, for example, an installation's activities covered by a stricter emissions regulation in an EU Member State are 'relocated' from that country to a country where there is no such regulation or where the regulation is much less stringent and therefore there is no or a lower cost to reducing emissions.

[433] "Significant shares of embodied energy and virtual water in food found to be imported" (Salmoral, G. & X. Yan, 2018: Food-energy-water nexus […]. Resources, Conservation and Recycling, 133:2, pp. 320–330).

[434] The 2013 Minamata Convention on mercury also provides for the import of certain products containing mercury, as well as products and substances manufactured using mercury and mercury compound technologies nevertheless, there is still significant international trade in these products involving exporting countries that have not acceded to the Convention or have requested a 'transitional' exemption for a longer period.

[435] Compliance or non-compliance with some of the provisions of the Basel Convention and the Basel Ban on hazardous waste still sometimes means that all hazardous waste is illegally shipped to another country's territory where it causes health and environmental harm.

some experts argue that it is feasible through 'relative decoupling.'[436] The acceptance of the overall primacy of economic development has led to a similar controversy, namely, the expectation that, first and foremost, facilitating economic prosperity will necessarily contribute to general social progress and the solution of environmental problems (inter alia, those arising from economic activities).[437]

- Even when it turned out that some consumption and production patterns are 'unsustainable,' that is, inadvertently harmful to the environment, these patterns often remained unchanged (at least for a long while). Some typical barriers may hamper the modification or abandonment of those 'obsolete' patterns and the switch to more straightforward, 'greener' consumption habits and production procedures. Such barriers include adherence to convenient means of consumption, the economic interest in continuing a 'proven' production procedure, lack of suitable alternatives, the higher costs of their introduction, etc. This kind of inertia in infrastructure, technology, production, or services is a so-called 'lock-in' effect [UNEP/IRP, 2019[438]].
- Improving natural resource efficiency can unexpectedly lead to greater resource use. According to this peculiar feedback or 'rebound' effect, also called the 'Jevons paradox,' efficiency gains can trigger and even be outweighed by a rise in demand for resources [Jevons, 1866[439]]. This idea has been widely discussed, and the main conclusion was that efficiency-enhancing efforts (e.g., relevant technological innovations) can be beneficial from both environmental and economic perspectives

[436] Concerning these two trends, we have referred to the concepts of 'weak and strong sustainability,' or using another conceptual approach, to the 'relative and absolute decoupling' of the economic growth rate from the increase in environmental damage and/or use of natural resources.

[437] This approach was taken, among others, during the first international 'development decades' of the United Nations and then abandoned due to its ineffectiveness.

[438] "While there have been improvements in fossil power plant emission standards throughout the world, there has also been a dramatic increase in fossil electricity generation capacity in recent years, which contributes to increased access to affordable energy but has environmental and health trade-offs. […] this poses the threat of a 'lock-in' to environmentally harmful technologies." (p. 86)

[439] "It is shown that the constant tendency of discovery is to render coal a more and more efficient agent, while there is no probability that when our coal is used up any more powerful substitute will be forthcoming. Nor will the economical use of coal reduce its consumption. On the contrary, economy renders the employment of coal more profitable, and thus the present demand for coal is increased". (p. 3)

but are insufficient to achieve sustainable resource management [Schettkat, 2009[440]].

- The rapid economic development (and other processes associated with the 'Great Acceleration') since the mid-twentieth century has not been accompanied by an adequate reduction in the vulnerability of societies to and strengthening their resilience against the threats of natural hazards and potential impacts of human-induced disasters. We have also referred to this development-vulnerability paradox (the 'development trap' and 'structural inertia') and its causes, which may become severe obstacles to further sustainable development [Hannan & Freeman, 1984; Faragó, 1981, 2011]. (The COVID-19 epidemic provided a recent example of the same phenomenon even in the most developed countries [UN, 2020[441]].)

Restraining from or at least substantially curbing human activities that trigger considerably adverse environmental problems should be considered a priority along with reducing their damaging environmental impacts (e.g., caused by hazardous waste disposal, pollution, or the environmental release of toxic chemicals) and preparing for already unavoidable adverse environmental consequences by improving the resilience or adaptive capacities of potentially affected societies. Therefore, there is no environmental 'mitigation or adaptation dilemma' (prevention or adjustment dilemma), and the two basic types of response policies should not be sharply separated.

- Mitigation and adaptation approaches are sometimes contrasted unjustifiably, either by focusing only on the former or considering the latter as more understandable and feasible under national/local circumstances (compared to participation in international mitigation efforts). In fact, if their potential interactions are taken into account,

[440] "Are efficiency improvements in the use of natural resources the key to sustainable development and are they the solution to environmental problems or will rebound effects compensate or even overcompensate potential savings, will they fire back?" (p. 5)

[441] "The economic impacts of the crisis are equally sobering: the world is now facing its worst recession in generations. Even the most advanced and developed countries are struggling to cope with the health, social and economic fallout of the pandemic, but the poorest and most disadvantaged countries will inevitably be hit the hardest." (p. 3)

they may reinforce each other [Ayers & Huq, 2008[442]; Faragó, 2011; Bulla, 2013].

- A few decades had to pass before the contrasts or synergism of these main policy directions (mitigation and/or adaptation) became better clarified in international environmental matters. For example, at an early stage of the debate on the causes of enhanced environmental acidification, Western European experts dismissed the possibility of the long-range, transboundary atmospheric transmission of acidifying pollutants from fossil fuel combustion. They recommended that Northern European countries apply 'local' procedures to counteract the acidification of their lakes [Hajer, 1993[443]]. It was only many years later that a consensus emerged, based on systematic environmental observations and scientific studies, about the main anthropogenic causes of that process and the urgency of reducing sulfur emissions from intensifying fossil fuel combustion (which pollutants were transported in the air and deposited far away from their sources). Regarding the international negotiations on global climate change and greenhouse gas emissions, it was accepted 'ab ovo' that both types of policies and measures were needed, but also that without significant emission reductions, adaptation could become much more difficult [UNFCCC, 1992: 1(b); UNFCCC/PA, 2015[444]].

In general, there has been a significant difference between the science-based recommendations on the one hand and the 'level of ambition' of the goals and commitments adopted within the framework of the international environmental instruments on the other. This means there is a substantial and sometimes even growing environmental 'science-policy gap' in relation to coping with many large-scale hazardous environmental processes.

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[442] "The distinction between mitigation and adaptation has resulted in policymakers and negotiators treating the two as policy alternatives or even in opposition […]. One way of overcoming the conceptual divide between mitigation and adaptation is to consider the synergies between them." (pp. 3, 5)

[443] "The British government emphasized that there was no firm evidence that its SO_2 emissions were responsible for fish deaths and acidification in the Swedish lakes […] it argued that tall stacks (to dilute and disperse pollution) and the liming of lakes (to counterbalance the acidification) were much cheaper and more effective means." (p. 52)

[444] "7.4. Parties recognize that the current need for adaptation is significant and that greater levels of mitigation can reduce the need for additional adaptation efforts, and that greater adaptation needs can involve greater adaptation costs."

- The adequacy of such agreements and programs can be assessed against the level of scientific knowledge that has been achieved about the adverse environmental phenomena they address. The consistency between the two depends largely on the science-policy 'dialogue' or interface, which relationship can be fostered by its 'institutionalization.' (Such 'bridges' were built between the representatives of the scientific and policymaking communities, for instance, in the case of the global biodiversity and climate change problematics, namely, by establishing relevant intergovernmental panels such as the IPBES and IPCC). Nevertheless, due to the changing priorities of international politics, environmental issues have often been relegated to a subordinate position and/or neglected in favor of other political or economic priorities.
- It is instructive to note how clearly these 'gaps' are revealed between science-based advice and actually approved goals/targets and commitments in many global programs and agreements.[445] These differences are also clearly traceable using indicators such as the 'ecological footprint' or those introduced by the theory of 'planetary boundaries.'
- Environmental programs/agreements could only be compiled and adopted at the cost of particularly serious compromises due to the diverse situations, interests, and positions of the parties involved (as mentioned above). But whatever the final deals covered, their effectiveness ultimately depended on their factual implementation in terms of achieving specific goals and fulfilling the associated commitments. For an international legal instrument, the first 'yardstick' of this evaluation is its entry into force and how complete or incomplete the list of parties ('States Parties') is that adhered to that agreement. But what matters much more is the actual implementation, including the fulfillment of all the approved commitments, even if this might 'only' mean the partial solution of the environmental problem covered by the agreement (as a consequence of the science-policy gaps and trade-offs mentioned above).

Why are changes in international environmental policymaking unavoidable? Since the early 1990s, in accordance with both the scientific

[445] These differences can be clearly identified in international conventions and programs on biodiversity, climate change, and chemicals, among others.

community's assessments and the joint statements approved at intergovernmental forums, it has become more than evident that more concerted and effective action is necessary to combat diverse unsustainable global tendencies, including environmental ones. Thanks to this recognition, over the last few decades, numerous initiatives, programs, and agreements have been created based on the realization of the "common future" of societies, increasing mutual interdependence, the common (but differentiated) responsibility for maintaining a "healthy planet" (viz., a 'healthy planetary environment') and addressing harmful processes.[446]

- Those profound changes can only be made until we reach 'tipping points,' beyond which it will be impossible to halt and reverse those processes.[447] As expressed by Will Steffen, Paul J. Crutzen, and John R. McNeill: "Enormous, immediate challenges confront humanity over the next few decades as it attempts to pass through a bottleneck of continued population growth, excessive resource use and environmental deterioration. [...] There is also evidence for radically different directions built around innovative, knowledge-based solutions." [Steffen et al., 2007: p. 620]
- These crucial questions were emphasized in the recent global sustainable development agenda, which, in addition to critical social issues, recalled the most serious and escalating environmental problems [UN, 2015]: "14. [...] Natural resource depletion and adverse impacts of environmental degradation [...] add to and exacerbate the list of challenges that humanity faces. Climate change is one of the greatest challenges of our time and its adverse impacts undermine the ability of all countries to achieve sustainable development. [...] The survival of many societies, and the biological support systems of the planet, is at risk."

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[446] Here we refer to the important notions from the titles of 'the Brundtland report' ("Our Common Future") and the UNEP's sixth environmental outlook ("Healthy Planet, Healthy People") [WCED, 1987; UNEP/GEO, 2019].

[447] We have already referred to this turning point in a study from 2001: "If these steps do not compensate for the growing environmental and related social problems on a global scale, the beginning of a real 'dramatic turnaround' due to diminishing access to resources and environmental space can be imagined at the earliest by the middle of the next century. There are two possible outcomes: (1) High-level international political agreements can be reached, taking into account ecological and equitable social conditions, and a genuine sharing of responsibilities and tasks, and a real transition to socially and environmentally sustainable development can begin; (2) Otherwise, the process could become irreversible." [Faragó, 2001: p. 21]

- While programs and/or agreements have been elaborated to somehow manage the widespread environmental hazards, so far, the international community has, with a few exceptions, only been able to moderate and/or slow their escalation. The main driving forces behind them have remained almost untouched. Global population growth has continued (albeit at a slower pace), and likewise, in general, has the unsustainable use of natural resources and environment-degrading activities. However, at least in a number of countries, serious steps have been taken to promote more resource-efficient and less polluting production and consumption patterns (in particular, formulating and implementing national action plans to facilitate the transition to environmental sustainability and a 'circular economy').
- It is also reasonable to assume that, as in the past, international environmental policy cooperation will continue at fluctuating intensity and effectiveness depending on the volatile global political and economic situation.
- We are now witnessing recurring and more recent conflicts over the acquisition and exploitation of crucial abiotic and biotic resources. Nonetheless, it has been less feasible and/or much more complicated to conclude or strengthen international agreements regarding such resources (in particular, concerning their international trade and utilization and acquisition from areas beyond national jurisdiction) than with transboundary/global pollution cases.
- Economic (particularly trade) globalization has resulted in a very high degree of interdependence of societies, accompanied by substantial 'unintended' harmful social and environmental consequences. Unfortunately, neither international development cooperation agendas and sustainable development programs nor the measures taken so far to regulate global economic relations and the world trading system (including the operation of multinational companies) have been able to moderate those global-level adverse effects substantially.

What does the future hold, and what should it be like? To cope with the increasingly unsustainable global-level trends, in addition to the effective implementation of existing programs and agreements, it seems necessary to define markedly stronger sustainability requirements and commitments, especially concerning the most critical and rapidly escalating environmental problems. The determination of the appropriate goals, policies, and measures can only be based on a more accurate and

comprehensive assessment of the causal links among these processes and more in-depth 'foreseeing' of the paths of development and their environmental and social 'imprints' (repercussions), including business-as-usual and other scenarios. (Obviously, the most purposeful way of deducing the necessary actions is based on 'backward planning' or 'backcasting,' that is, starting by defining the achievable ultimate objective or 'the future we want.'[448]) The abundant scientific literature on such foresight also focuses on environment-related changes, goals, and courses of action. Here, we refer to three analyses that have successively (one decade after another) outlined probable and desirable future global (interlinked) social, economic, and environmental states.

- More than three decades ago, faced with the fast changes in the world and the diverse social and environmental consequences of accelerated globalization, it was not only the Brundtland Commission that called attention to emerging risks and outlined a vision for sustainable development [WCED, 1987] but, among other notable researchers, Norman Myers reviewed and critically appraised the globalizing challenges facing humanity. In his view, we are finally beginning to understand that we are all part of the global economic and environmental system and responsible for the latter's crisis and that fundamental lifestyle changes are required to become much more environmentally conscious [Myers, 1990[449]].
- In a report published in 2002, a research team led by Paul Raskin (Stockholm Environment Institute) presented courses of action for further global social and economic development that could be taken to achieve the 'great transition' to sustainability in the broadest sense. They believed that it might be possible to pursue such a development path from 2025 onwards when conflicts between societies on the one hand and between societies and the environment on the other have subsided, and the 'environmental damages' to the planet have begun to heal (thanks also to the international communities' actions to promote

[448] This is an allusion to the title of declaration of the Rio+20 UN-conference held in 2012.

[449] Future Worlds, Planet: "We are starting to understand that just as we are all part of a single economic system worldwide, so we all share a single planetary ecosystem. […] In part, this surge of recognition is a reaction to environmental crises. But it also reflects a deeper and longer-standing shift in perceptions and lifestyles. For years there has been ever-widening interest in healthy living and in green consumerism. As a result, conservation is no longer seen as a weekend concern; it has become a central issue for the Monday-morning world." (p. 44)

the complete restoration of the health of the planetary environment) [Raskin et al., 2002[450]].

- On the fortieth anniversary of the publication of the influential book *The Limits to Growth* by the Club of Rome, one of its authors, Jørgen Randers, issued a global forecast for the next four decades. From this, we highlight two ideas that are especially relevant from an environmental perspective. In his view, in 40 years, much more will need to be done to substitute those natural resources that have become scarce, to reduce/eliminate dangerous environmental emissions, to replace ecological services that formerly seemed limitless (and at the same time there will be much greater emphasis on solving critical social and other problems) [Randers, 2012[451]].
- It follows from all this (in optimistic or somewhat gloomy terms according to different authors) that forced and/or purposefully planned attitudes and interventions will be needed to prepare for a new societal relationship with nature under rapidly and radically changing global environmental conditions.

* * *

[450] History of the Future: "Throughout the world, a cultural renaissance, rooted in pride in, and respect for, tradition, and an appreciation of local human and natural resources, unleashed a new sense of possibility and optimism. […] Poverty still survives in small pockets around the globe, but its eradication is in sight. Conflict and intolerance still flare, but effective tools for negotiation and resolution are in place. Our ailing planet has not yet healed from its environmental wounds, but the world is mobilized to restore it to health." (p. 89)

[451] "Over the next forty years global society will need extra investment money to: develop and implement substitutes for scarce resources like conventional oil and gas and phosphorus; develop and implement solutions for dangerous emissions like CFCs, SO_2, NO_X and climate gases; replace ecological services that formerly were free, such as water from glaciers, or underground water for agriculture, or fish protein […]" (p. 81); "But my story also includes the societal response that will emerge in an attempt to solve the emerging problems of depletion, pollution, an inequity through increased investments (in both prevention and adaptation). This social investment will reach major proportions after a while and solve parts of the problem. But not the full problem, and in the process increased investment will require reduced consumption. […] the stage will be set for major transformations in the way we organize our politics, our financial systems, and even our lives. And the first time, an emphasis on well-being over financial growth will begin to gain broader acceptance, for individuals and nations." (pp. 55–56)

The most important lesson and conclusion for the future is that 'social sustainability' (sustainable social development) cannot be achieved without 'environmental sustainability.'[452] As mentioned before, globalization, specifically its environmental components, has further strengthened the interdependence of societies and the risk of conflict over natural resources and adverse transboundary environmental effects. It is also more than evident that sustainability at the global level is only possible if its basic requirements are met in all regions, which in simple terms means not only 'living in harmony with nature' but also the harmonious coexistence and cooperation of societies. In meeting all these objectives, science, knowledge transfer, science-based policymaking, and adequate international programs and agreements (and their effective implementation) will all continue to play a key role.

[452] This close interconnection, especially in relation to the intra- and intergenerational equity demands of social development, was emphasized, for instance, in the Copenhagen Declaration adopted by the 1995 World Summit: 6. "Equitable social development that recognizes empowering the poor to utilize environmental resources sustainably is a necessary foundation for sustainable development." 26. "we will create a framework for action to: […] (b) Fulfil our responsibility for present and future generations by ensuring equity among generations and protecting the integrity and sustainable use of our environment".

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INTERNATIONAL AGREEMENTS

ATS 1959, 1991	The Antarctic Treaty; Protocol on Environmental Protection (Antarctic Treaty System)
BC 1989	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
BC/BBA 1995	Basel Ban Amendment (to the Basel Convention)
CBD 1992	Convention on Biological Diversity
CENNA 1986	Convention on Early Notification of a Nuclear Accident (IAEA)
CFCLR 1958	Convention on Fishing and Conservation of the Living Resources of the High Seas
CHS 1958	Convention on the High Seas
CITES 1973	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLNUIW 1997	Convention on the Law of the Non-navigational Uses of Transboundary Watercourses
CLRTAP 1979	Convention on Long-range Transboundary Air Pollution. (UNECE)
CLRTAP/SP 1985	Protocol on the Reduction of Sulphur Emissions or Their Transboundary Fluxes by at least 30 per cent (Sulphur Protocol)
CMS 1979	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
CTEIA 1992	Convention on the Transboundary Effects of Industrial Accidents (UNECE)
CTWC 1992	Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE)
ECT 1994	The Energy Charter Treaty (and Energy Charter Protocol on Energy Efficiency)
ENMOD 1976	Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques
ICCPR 1966	International Covenant on Civil and Political Rights
ICESCR 1966	International Covenant on Economic, Social and Cultural Rights
ICRW 1946	International Convention for the Regulation of Whaling
ITTA 1983, 1994, 2006	International Tropical Timber Agreement

LC 1972, 1996	London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (and London Protocol)
MARPOL 1973, 1978	International Convention for the Prevention of Pollution from Ships (and MARPOL Protocol)
MCM 2013	Minamata Convention on Mercury
Moon 1979	Agreement on Control of the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty)
OST 1967	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty)
RC 1998	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
RCW 1971	Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention)
SC 2001	Stockholm Convention on Persistent Organic Pollutants
UNCCD 1994	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa
UNCLOS 1982	United Nations Convention on the Law of the Sea
UNFCCC 1992	UN Framework Convention on Climate Change
UNFCCC/KP 1997	UNFCCC: Kyoto Protocol
UNFCCC/PA 2015	UNFCCC: Paris Agreement
VCPO 1985	Vienna Convention for the Protection of the Ozone Layer
VCPO/MP 1987	VCPO: Montreal Protocol on Substances that Deplete the Ozone Layer
WHC 1972	Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention; UNESCO)

ACRONYMS

AOSIS	Alliance of Small Island States
BAPMoN	Background Air Pollution Monitoring System
CBD	Convention on Biological Diversity
CBD/SBSTTA	CBD: Subsidiary Body on Scientific, Technical and Technological Advice
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CSCE	Conference on Security and Co-operation in Europe
ECSC	European Coal and Steel Community
EHC	Environmental Health Criteria
EMEP	European Monitoring and Evaluation Programme
GARP	Global Atmospheric Research Programme
GCO	Global Chemicals Outlook
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GEO	Global Environmental Outlook
GEOSS	Global Earth Observation System of Systems
GMA	Global Mercury Assessment
GSDR	Global Sustainable Development Report
GWP	Global Water Partnership
ICCM	International Conference on Chemical Management
ICSU	International Council for Science (International Council of Scientific Unions)
IDNDR	International Decade for Natural Disaster Reduction
IFCS	Intergovernmental Forum on Chemical Safety
IGBP	International Geosphere-Biosphere Programme
IGY	International Geophysical Year
IHDP	International Human Dimension Programme
ILO	International Labour Organisation
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPCS	International Programme on Chemical Safety
IRP	Intergovernmental Resource Panel (UNEP)
IRPTC	International Register of Potentially Toxic Chemicals
IUCN	World Conservation Union (International Union for Conservation of Nature)
MAB	Man and Biosphere
MDG	Millennium Development Goal(s)

MENA	Middle East and North Africa
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PIC	Prior Informed Consent
POP	Persistent Organic Pollutant
SAICM	Strategic Approach to International Chemicals Management
SCOPE	Scientific Committee on Problems of the Environment (ICSU)
SDG(s)	Sustainable Development Goal(s)
UNCED	UN Conference on Environment and Development
UNCHE	UN Conference on Human Environment
UN/CHS	UN Commission on Human Settlements
UNCHS	UN Centre for Human Settlements (Habitat)
UN/COPUOS	UN Committee on the Peaceful Uses of Outer Space
UN/CPD	UN Commission on Population and Development
UNCSD	UN Conference on Sustainable Development
UNCTAD	UN Conference on Trade and Development
UNDAC	UN Disaster Assessment and Coordination
UN/DD	United Nations Development Decade
UNDP	UN Development Programme
UNDRR	UN Office for Disaster Risk Reduction
UNECE	UN Economic Commission for Europe
UN/EMG	UN Environment Management Group
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Program
UNEP GC	UNEP Governing Council
UNEP/IRP	UNEP International Resource Panel
UNESCO	UN Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
UNFCCC/SBSTA	UNFCCC: Subsidiary Body for Scientific and Technological Advice
UN/FfD	UN Financing for Development
UNFPA	UN Population Fund (UN Fund for Population Activities)
UNGA	UN General Assembly
UNHRC	UN Human Rights Council
UNIDO	United Nations Industrial Development Organization
UN/OCHA	UN Office for the Coordination of Humanitarian Affairs
UN/SDSN	UN Sustainable Development Solutions Network
UNSG	UN Secretary-General
UN/WWAP	UN World Water Assessment Programme
VCPC	Vienna Convention for the Protection of the Ozone Layer
VCPO/MP	VCPO: Montreal Protocol
VCPO/MP: TEAP	VCPO/MP: Technology and Economic Assessment Panel
WCED	World Commission on Environment and Development
WCP	World Climate Programme

WFP	World Food Programme
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development
WWF	World Wide Fund for Nature (World Wildlife Fund)
WWI	Worldwatch Institute