# Seeing and Knowing the Earth as a System – Tracing the History of the Earth System Science Partnership

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## Abstract

In this paper we trace the institutional history and rationale of the Earth System Science Partnership by studying the practical and epistemic contributions of the International Geosphere-Biosphere Programme and the International Human Dimensions Programme respectively. While the main aim of our study is to offer an empirical understanding of how this new partnership for the integrated study of the Earth System has come about, the paper also conceptualises the scientific practices and modes of thought represented by the ESSP as a central form of agency in Earth System governance. In order to understand the formation of governance practices in the Earth System, we argue that it is necessary to critically scrutinise the diverse set of knowledges and practices that have constituted the Earth System as a thinkable and governable domain.

## Introduction

In July 2001 four global change research programmes – the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP) and the International Biodiversity Programme DIVERSITAS – jointly formed the Earth System

Science Partnership (ESSP). The ESSP represents a formalised and yet loose network of global environmental change scholars joined together in a global effort to study the Earth as an integrated system. At the centre of the academic endeavour is a general concern that human activities are modifying the planetary life support system as never before. In the wake of the new millennium Crutzen and Stoermer (2000) coined the concept ‘the Anthropocene’ to capture this image of humankind as a new geological force that is influencing the dynamics and very functioning of Earth itself. The ESSP draws upon this daunting image. In order to come to terms with the human-driven changes to the Earth’s inter-linked terrestrial, aquatic, and atmospheric systems, this new research network seeks to offer the knowledge base necessary for effective and science-based solutions (Leemans et al. 2009).

In this paper we trace the institutional history and rationale of the ESSP by studying the practical and epistemic contributions of the IGBP and IHDP respectively. While the main aim of our study is to offer an empirical understanding of how this new partnership for the integrated study of the Earth System has come about, the paper also conceptualises the scientific knowledges and practices manifested by the ESSP as a central form of agency in Earth System governance. In order to understand the formation of governance practices in the Earth System, we argue that it is necessary to critically scrutinise the diverse set of projects, theories, methods, experimentations and technical devices that have constituted the Earth System as a thinkable domain and problem for government. Hence, although this paper draws attention to the institutional dimensions of the ESSP, we are equally interested in the constitutive forms of knowledge that they (re)produce. Miller and Rose (2008) remind us that governing a sphere requires that it is represented in such a manner that it can enter conscious political calculation. Although the scientific know-how manifested by the ESSP may seem disparate and loosely connected, we argue that there are close links between the knowledge practices of this international science network and the exercise of political authority. By rendering the Earth System thinkable, diagnosable and debatable, the ESSP has opened the door for government intervention.

After a brief introduction to the paper’s theoretical framework, we begin our analysis by placing the ESSP in a historical context. In the first section we offer a short historical account of how global environmental change research evolved into an integrated study of the Earth’s biogeochemical cycles from the 1950s and onwards. Against this background, the second section traces the institutional history of the IGBP and the IHDP respectively. We here approach these two international science programmes as two central epistemic and technical arrangements that have produced and carried the idea of the Earth and human society as an integrated system into the new millennium. We end our historical account with the formation of the Earth System Science Partnership in 2001. Our analysis is based upon historical records and newsletters produced by the IGBP and IHDP respectively, as well as semi-structured interviews with four programme directors.

**Tracing the history of the present**

In this paper we draw upon the governmentality framework proposed by Lövbrand et al. (2009) in order to trace the history of the Earth System Science Partnership. Rather than taking this partnership granted, we ask where it comes from and what forms of knowledge it rests upon. Since Michel Foucault offered almost no written accounts of his thinking on government and governmentality, Foucault-inspired governmentality studies do not represent a unified theory. Nevertheless, the publication of Foucault's lectures and interviews on the theme in the late 1970s has fuelled a wide range of studies in sociology, geography and cultural studies during the past decades. Rose-Redwood (2006 p. 469) notes that these studies share a common concern for critically examining the role that knowledge production has played in the formation of modern governmental practices. For Foucault, knowledge was central to the activities of government and the very function of its objects. Every government programme either articulates or presupposes knowledge of the field of reality upon which it is to intervene (Gordon 1980, p. 248). Hence, most governmentality scholars assume that there are intrinsic links between ways of representing and knowing a phenomenon, on the one hand, and the ways in which it is acted upon as to transform it, on the other (Rose and Miller 2008, p. 15). Drawing upon Foucault's brief writings on the theme, Miller and Rose (2008) have called the former 'rationalities of government' and the latter 'technologies of government'.

Rationalities of government refer to the styles of thinking or mentalities that represent, order and, indeed, constitute the objects of politics. This epistemic dimension of government is always morally coloured and grounded in knowledge. Adler and Bernstein (2005, p. 296) have defined episteme as "the 'bubble' within which people happen to live, the way people construe their reality, their basic understanding of the cause of things, their normative beliefs, and their identity, the understanding of self in terms of others." By establishing limits to what can be thought and done, epistemes are more than mere social imagining. According to Adler and Bernstein (2005), they both enable and delimit agency and thus represent a fundamental building block of governance. Governmentality scholars often draw attention to the discursive characteristics of epistemes or rationalities of government. As suggested by Miller and Rose (2008, p. 31), the government of a population, a family or the national economy becomes possible only through discursive mechanisms that represent the domain to be governed as an intelligible field with its own limits and characteristics. When studying rationalities of government, we therefore need to draw attention to the linguistic or conceptual conditions under which it is possible to represent a domain of reality such as the Earth System as something that is knowable and amendable to government intervention.

Technologies of government, in turn, draw attention to the practical aspects of knowing and intervening. According to Dean (1996, p. 50), there is a pattern of linkages between organised thought and knowledge about a domain, and the many practices, techniques and mechanisms that seek to shape the conduct within such domains. Governmentality scholars therefore tend to approach the representation of that which is to be governed as an active, technical process. By means of inscription aspects of reality are made stable, comparable and diagnosable. Information is in this sense not the outcome of a neutral recording function. It is itself a way of acting upon the real and making it susceptible to government intervention (Rose and Miller 1992, p. 185). When speaking of technologies of government, governmentality scholars typically refer to the wide range of techniques of notation, statistics, accounting and computation that render a domain of knowledge operational. Although these various practices may seem disparate, loosely connected and dispersed, they become technological when assembled in a manner that structures the field of possible actions within a domain and hereby direct the conduct of individuals (Dean 1996, p. 59). Barry (2001, p. 9) has made a useful distinction between a ‘technical device’, conceived of as a material or immaterial artefact, and a ‘technology’, which refers not only to a device in isolation but also to the forms of knowledge, skill, diagrams, calculations and energy which make its use possible.

In this paper we trace both the epistemic and technological history of the Earth System Science Partnership (ESSP) in order to raise questions about its political effects. What forms of knowledge does the ESSP rest upon? And what ways of seeing, problematising and acting upon nature and society do these forms of knowledge produce? Following a Foucauldian analytics of government, our analysis draws upon a positive or productive account of power. Rather than viewing power as a right which can be possessed (typically by a sovereign) and used to dominate or repress others, productive power works through mechanisms of knowledge production and the constitution of subjectivities. While a Foucualdian interpretation of government is about ways of conducting conduct, ways of acting upon the actions of others, studies of governmentality assume that such exercise of power is 'intentional but non-subjective' (1996, p. 60). A government programme is not the result of a specific individual or group that has consciously created a certain strategic situation. A strategic situation is instead seen as the unintended outcome of millions of intentional actions by subjects who themselves are enabled and constrained by that situation (Oels 2005, p. 187). Hence, the unplanned conjunction of techniques and conditions arising from very different aspirations may allow something to work without an explicit rationale (Rose, Miller 1992, p. 190-91).

This approach to the arts of governing means that we can study the ESSP without searching for a master plan or grand political strategy. To trace the history of the present suggests a mode of examination that does not ask why certain things happened, but rather *how* they happened and how contemporary ways of thinking and doing differ from what has been going on before (Rose and Redwood 2006, Gordon 1980, p. 242). As suggested by Barry et al. (1996, p. 5), present time is not presumed to be the culmination of some grand historical process, it has no inevitability, no essence, no underlying cause. The present, in Foucualt's work, is more an array of questions. By focusing on the multitude of contingent practices that mediate contemporary ways of doing global environmental change research, our governmentality approach seeks to show that taken-for-granted ways of perceiving nature-society relations are far from self-evident or necessary. Hence, we reject any *a priori* understanding of the governed reality. To analyse mentalities of government is to analyse political knowledge; i.e. how thought produces the governed reality and hereby directs the ways we act upon it.

**The Amsterdam Declaration - manifesting the Earth System idea**

The institutional history of the Earth System Science Partnership (ESSP) may at first glance seem rather short. The partnership was created through the signing of Amsterdam Declaration on Global Change by four global environmental change programmes in year 2001. Through the declaration, the chairs of the IGBP, IHDP, WCRP and DIVERSITAS respectively call for a new kind of global environmental science that can account for the complex, multi-scale and dynamic feedbacks between natural and social processes that characterize the Earth System (ESSP 2009). By combining the expertise built up over many years by respective programme, the declaration sets out to develop the integrated knowledge base necessary to respond effectively and quickly to the great challenges of global change.

As indicated by the title of the IGBP's 2001 open science meeting - 'Challenges of a Changing Earth: Global Change' - the Amsterdam conference manifested a growing concern about the human modifications of the global environment. The declaration reminds us about the state of emergency of human induced global change:

> 'Human activities are significantly influencing Earth's environment in many ways in addition to greenhouse gas emissions and climate change. Anthropogenic changes to Earth's land surface, oceans, coasts and atmosphere and to biological diversity, the water cycle and biogeochemical cycles are clearly identifiable beyond natural variability. They are equal to some of the great forces of nature in their extent and impact. Many are accelerating. Global change is real and is happening *now*' (Amsterdam Declaration 2001, emphasis in original).

This image of a changing Earth is epitomised by 'the Anthropocene' concept, launched by Crutzen and Stoermer (2000) in an IGBP newsletter one year before the Amsterdam conference. Here the Anthropocene denotes a new geological époque when humans are influencing the very functioning and dynamics of the Earth itself. It is a period in the Earth's history, claimed Crutzen and Stoermer (2000, p. 17), when the human population has increased tenfold, when we are in the process of exhausting the fossil fuels that were generated over several hundred million years, when emissions of sulphur, nitrogen and greenhouse gases are disrupting the Earth's biogeochemical cycles, when 30-50 percent of the land surface has been transformed by human activity, when species extinction rate has increased by thousand to ten thousand fold in the tropical region, and when more than half of all accessible fresh water is used by humans. Drawing upon these and many other major and still growing impacts of human activity on Earth and the atmosphere, the Amsterdam declaration states that the Earth System has moved well outside the range of the natural variability exhibited over the last half million years at least. 'The Earth is currently operating in a no-analogue state' (Amsterdam Declaration 2001).

Apart from presenting a diagnosis of the planet, the declaration also establishes the Earth System as a new ontological category. As specified in the text, the Earth System behaves as a single, self-regulating system comprised of physical, chemical, biological and human components. The interactions and feedbacks between the component parts are not only seen as complex with multi-scale temporal and spatial variability. Earth System dynamics are also characterised by critical thresholds and abrupt changes (Amsterdam Declaration 2001). In the declaration, human activities are both represented as an integral part of the system and as a severe disturbance to the Earth's environment. Since human-driven changes cause multiple effects that cascade through the Earth System in complex ways, and have the potential to switch the Earth System to alternative modes of operation that may prove irreversible, natural and human systems have to be understood and studied as an integrated whole (Amsterdam Declaration 2001). This understanding of how natural and human systems interact was not invented at the Amsterdam meeting. As spelled out in the declaration, it draws upon advancements in global change research over many years. In fact, as we will argue in this paper, the very imagining of the Earth System cannot be separated from the long series of investigations into the Earth's biogeochemical processes that began many decades before the Amsterdam meeting.

Similarly, the declaration's call for a new kind of global and interdisciplinary environmental science rests upon a knowledge infrastructure that has gone through huge transformations from information stored on paper to internet based databases with information collected by satellites (IGBP 1994, IGBP 1986). Moreover, the very notion of the Earth as a complex and integrated system owes much to the development of computer models that allowed global environmental change scholars to link their process understandings of the separate elements of the atmosphere, geosphere and biosphere into one comprehensive system (Sahagian 2000, Schellnhuber 2000, Alcamo, Leemans and Kreileman 1998). Only by tracing the history of these technical arrangements is it possible, we argue, to understand how the Earth System has become established as a natural object for scientific analysis. In line with Braun (2000, p. 18), we note that the construction of nature is historically contingent and therefore must be understood in terms of mundane historical and spatial practices that have given rise to particular ways of 'seeing' and 'knowing'. While the Amsterdam declaration manifests a certain way of 'seeing' nature-society relations, the resulting Earth System Science Partnership was designed to provide the practical and institutional support necessary for 'knowing' more about this relationship in order to improve it.

In the following section we seek to historicise these particular ways of seeing and knowing the Earth by drawing attention to the complex set of knowledges, methods and techniques that paved the way for the Amsterdam declaration and the establishment of the ESSP. While these knowledge practices have drawn together people, instruments and theories at a variety of sites over several decades, and hereby allowed an ordered system of knowledge to emerge, we should not overestimate their unity or inevitability. Rather than searching for an underlying cause, our historical tracing is focused on the more or less rationalised set of techniques and instruments that have brought the Earth System into being as a thinkable and knowable ontological category open for government intervention.

**Towards a global and interdisciplinary outlook**

Many political scientists make a clear distinction between the social world of politics and the material world of engineering and the natural sciences. Yet, as noted by Barry (2001, p. 10), to analyse the conduct of political and economic life without considering the importance of the material devices and artefacts produced in these domains is simply to miss half the picture. Such material devices are not merely passive objects of human manipulation. Depending on the forms and circumstances of their use, they produce effects and may hereby open up new sites and objects of politics (Barry 2001). In the period after the Second World War, we saw the birth of satellites, the fax machine, networks of computers and civil aviation. These new means of recording, storing, communicating, transporting and organising the flow of objects, information and persons did not only open up the world as a new arena for political and civic activity. They also allowed the scientific community to extend the scope of research into new domains. The International Geophysical Year (IGY) 1957-58 is an important passage in this development.

In 1952 the International Council of Scientific Unions (ICSU) decided to arrange a third International Polar Year, following the two previously held in 1882-33 and 1932-33 respectively. Such an event held great promise for a diverse set of actors within the geophysical sciences. While radio scientists saw an opportunity to explore the Ionosphere and the reflection of radio waves, the International Meteorological Association wanted to use the Polar Year to better examine the magnetism of the Earth. As a result of these diverse scientific agendas, the event changed name to the International Geophysical Year signalling a broader scope and perspective (Greenaway 1996). The IGY turned into a significant event in the history of science that engaged researchers from 67 countries and more than 4000 research stations in a world-wide study of the Earth's geophysical systems (NOAA 2007). Due to technical innovations from the previous decade, such as rockets, radar, and computers, the IGY resulted in the collection of a vast amount of data about geomagnetism, gravity, solar activity, oceanography and Polar ice sheets and more.

The storage and distribution of the IGY data was handled through the establishment of three World Data Centres that would make scientific information freely available across national borders. The first one was started in 1957 by the World Meteorological Organisation (WMO) specialising in meteorological data. Centres specialised on different topics started in the following years (Greenaway 1996, p. 162). Storage and distribution was not enough. The huge amounts of accumulated geophysical data did, however, call for a new and more long-term organisation of data. To meet this new situation, and at the same time make data accessible across disciplines, the Committee on Data for Science and Technology (CODATA) was established by the General Assembly of ICSU in 1966. The aim of this new committee was to promote and encourage, on a world-wide basis, the compilation, evaluation and dissemination of reliable numerical data of importance to science and technology. The interdisciplinary work of CODATA made scientific data accessible to a wider range of research fields and enhanced the ability to analyse linkages between findings in different disciplines and areas. Of course this set a new scene for interdisciplinary research. This exploratory way of working with data was evolving closely with the use of computers. At the turn of the decade CODATA were pioneers in the use of computers (Greenaway 1996, p. 164). This was a practice unthinkable or at least undoable at this scale only a decade earlier. Together these two pieces of information infrastructure supplied a basic framework for further global and interdisciplinary cooperation within the scientific community.

Apart from initiating new ways of storing and distributing scientific data, the IGY also paved the way for a wide array of international science programmes using new instruments and techniques for studying the Earth's geophysical processes. In a speech to the UN General Assembly in 1961, the US president J. F. Kennedy underlined the promise of satellites, to bring peace, better weather prediction and possibly weather control. The latter called for better understandings of the physical foundations of the climate. In 1967 the WMO and the ICSU responded to this call by launching the Global Atmosphere Research Program (GARP) as the first research programme built on data gathered by Earth Observation satellites. The aim of GARP was primarily to provide better weather predictions and, as a method of doing so, develop a better understanding of the climate system (Bolin 2007). These efforts paved the way for the World Climate Research Programme (WCRP) that since 1979 has engaged climate scientists from different disciplinary backgrounds in a coordinated study of the climate as an interconnected global system (WCRP 2006). The global outlook and technical legacy of the IGY also inspired biologists to coordinate and redirect their research efforts.

In 1964 the International Biology Programme (IBP) was set up to bring the biological and physical sciences together in an integrated study of the Earth's biosphere (Greenaway 1996). In practice the IBP took several steps on the path towards global scientific cooperation and policy relevance. The programme was spurred by the concern that humans are consuming renewable resources faster that they are restored. As stated by the member of the U.S national committee on IBP Sargent II (1965, p. 101), '(m)an must make some fundamental decisions within the next decade. The nature of the decisions he makes will be crucial for the future of subsequent generations of men.' In order to manage the Earth's ecosystems, the IBP assumed that it was necessary to first understand the functioning of the biosphere. The programme thus set out to develop standardised methods among the participating biologists (Sargent II 1965). The importance of IBP was manifested in 1971 when UNESCO decided to launch their Man and the Biosphere Programme to bring the question about ecosystem management closer to policy making (Rosswall 2009). Through SCOPE and UNESCO IBP also provided a foundation for DIVERSITAS (DIVERSITAS 2008).

In 1969 the Scientific Committee on Problems of the Environment (SCOPE) was also set up by ICSU to offer reviews of the state of the art in environmental research. Whereas GARP and the IBP had embarked on scientific studies of the atmosphere and biosphere respectively, SCOPE sought to offer integrated assessments of key environmental issues at the interface of science and decision-making. To fully understand the role and structure of SCOPE it is important to notice how it co-evolved with the United Nations Environment Programme (UNEP), co-operating but careful to maintain its scientific integrity (Greenaway 1996). In order to balance the close contact with the intergovernmental arena, ICSU set up independent science committees that were responsible for the strategic plans of new research projects (Rosswall 2009). Among the first reviews to be published by SCOPE in the mid and late 1970s focused on the Earth's biogeochemical cycles of nitrogen, phosphorus, sulphur and carbon (Svensson and Söderlund 1976). Following the global and interdisciplinary legacy of the IGY, these reviews offered integrated assessments by scientists in atmospheric research, chemical oceanography, ecology and geology (Bolin et al. 1979). This combination of perspectives allowed SCOPE to take an important step towards the integrated Earth System outlook of today. This was taken even further in the review of the climate issue where also social sciences were included (Kates, Ausubel and Berberian 1985). The SCOPE assessments also offered an epistemic platform for a diagnosis of the Earth as a whole.

**The IGBP – the whole Earth as the object of analysis**

When tracing the history of the ESSP, it is difficult to overestimate the importance of technological advancements during the second half of the 20th Century. The rise of satellite observation systems, the growing network of Earth-bound measurement stations, the emerging capabilities in data handling and numerical modelling gave scientists the ability to map the planet in ways that was practically impossible at the end of the Second World War. Schellnhuber (1999) talks about this new way of seeing the Earth as a second Copernican revolution. By the mid 1980s the newly won technical capabilities had not only enabled a worldwide information exchange within the scientific community. It had also given rise to a global change research agenda that approached the Earth as a complex and integrated system in need of rational management (Schellnhuber 1999). The launch of the International Geosphere-Biosphere Programme (IGBP) epitomises this new way of seeing and knowing the Earth.

As spelled out in the first IGBP newsletter, prepared for ICSU's 21st General Assembly in Berne in September 1986, progress in knowledge about the Earth has reached the point where steps toward integration are not only possible, but also needed (IGBP 1986). Whereas the international science programmes from the previous decades had advanced the understanding of the Earth's subsystems such as the atmosphere, the biosphere and the hydrosphere, the IGBP was here given the mandate to offer a fuller understanding of the Earth as an integrated whole. Hence, according to ICSU's Ad Hoc Planning Group on Global Change the appropriate focus for the IGBP would be:

> '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 to this system, and the manner in which they are influenced by human actions' (IGBP 1986, p. 3, emphasis added).

Although this may not be the first time in the history of science that the Earth System metaphor was used, the creation of the IGBP marks an important discursive shift. The objective of the scientific enterprise was no longer to understand the Earth's biogeophysical processes in isolation. In the first of IGBPs Global Change Reports (IGBP 1986, p 2), the scope of this enterprise is extended to 'the Earth as a whole' and the many ways in which humans are affecting the interactive biogeochemical processes that control the global life support system. The recognition that human energy consumption and land use are influencing the chemistry of the air, the diversity of plant and animal species, and the balance of the global ecosystems did not only give the concept global change a new meaning. According to the Ad Hoc Planning Group, it also called for new ways of organising international scientific cooperation. Scientific disciplines and programmes that in the past had operated alone now had to collaborate in order to advance the understanding of how humans are influencing the Earth as a whole.

At the ICSU General Assembly in 1986, a Special Committee was given the mandate to develop scientific themes that would guide the future work of the IGBP. A secretariat was also established in Stockholm, Sweden. At the first meeting of the IGBP Special Committee a year later, four specific areas of research were agreed upon; 1) terrestrial biosphere-atmospheric chemistry interactions, 2) marine-biosphere interactions, 3) biospheric aspects of the hydrological cycle, and 4) effects of climate change on terrestrial ecosystems. Over time these research areas were broken down into a number of core projects (see Fig. 1).

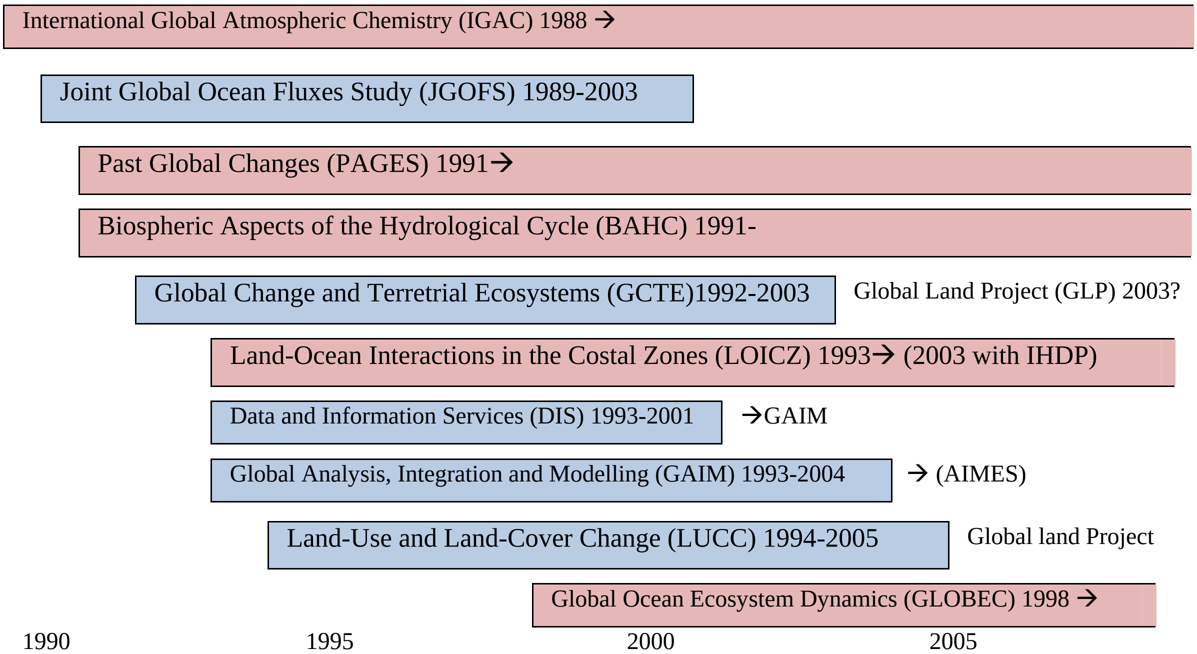


Fig. 1 The core projects of the IGBP

Already in the Ad Hoc Working Group's initial report from 1986, the research agenda of the IGBP was presented as '*a* study of global change' (IGBP 1986). In order to advance the capability to predict changes in the global environment, the programme was asked to take full advantage of the modern ability to study the Earth's surface, oceans and biota from space, from ground-based observation stations and via high-speed computers. It was understood within the IGBP that better data systems were needed in order to be effective in this endeavour. The collection and organisation of data was provided by IGBP-DIS (Data Information System), founded in 1993. The establishment of this data unit facilitated the development of methods to integrate remote sensing data with land based observations, allowing a spatial resolution of $1km^2$. This effort is comparable with older Global Circulation Models using a resolution up to 250000 $km^2$ (IGBP 1989, IGBP 1992a). Numeric, dynamic models also played a central role for data integration within the IGBP. In order to 'incorporate the appropriate level of understanding of relevant global biological, geological and chemical processes into physical models of the Earth system' (IGBP 1988), close cooperation with system modellers was necessary.

In 1993 the IGBP set up the Global Analysis, Interpretation and Modelling Task Force (GAIM) with the clear aim to produce predictive models of the Earth System. Even if the Earth System was perceived as a set of coupled systems, the modellers had to decouple them in order to build their models. This inconsistency between the integrated Earth System outlook of the IGBP and its efforts to model the same highlights the often disorganised and unpredictable character of technical work. As argued by Barry (2001, p. 20), technologies may both be catalysts in processes of change and sources of inertia working against change. Although technologies of government may open up new ways of seeing and knowing a problem, there will always be connections yet to be made visible, and curbs on what is possible. During its first years GAIM had a range of assignments. Apart from providing a link between the different core projects of the IGBP, the integrated perspective of GAIM also helped to develop these projects further. By comparing results from different global change models, new questions about the Earth System were raised (Sahagian 2000). In 2000 Schellnhuber, the chair of GAIM, clarified the central role of GAIM in the effort to build a solid base for the Earth System analysis. According to Schellnhuber (2000, p. 3) the modelling exercises of GAIM have offered a sophisticated integration methodology that has helped the scientific community to 'describe the make-up of the ecosphere machinery as well as its susceptibility to erratic or judicious human interventions.'

Although GAIM enhanced the IGBP's capacity to integrate multiple environmental and social processes (Sahagian 2000, Alcamo, Leemans and Kreileman 1998), the IGBP modellers faced great challenges. One such challenge was to 'predict the past' (Goldewijk 2001). In order to offer credible scenarios of future change, global models had to be tested against dynamic historic data such as global ice volume, surface ocean temperature, atmospheric CO2 content, vegetation zones. To recover the past history through quantifiable environmental indicators was thus central in order to understand 'the natural background' against which human changes now are imposed (IGBP 1986, p. 10), In order to trace social processes, the models required the sanction of history. In the short time perspective this seemed doable using environmental data. But to understand the more long-term connections between nature and society, help from the social sciences was required (Goldewijk 2001).

## The IHDP - including society in the Earth System

Although human impacts on the Earth System played a central role in the research agenda of the IGBP, the social sciences were not included in this international science effort. Integrating the natural sciences was perceived as a challenge great enough (Rosswall 2009). As a consequence, the International Social Science Council (ISSC) began to prepare an international social science programme in 1986. The rationale behind this program was that human activity had to be included as a driver in order to understand global change (HDP 1990), the aim of the programme was to address the social aspects of global environmental change and hereby complement the work of the IGBP. The proposed research agenda included seven topics; 1) social dimensions of resource use, 2) perception and assessment of global environmental conditions and change, 3) impacts of local, national, and international social, economic, and political structures and institutions, 4) land use, 5) energy production and consumption, 6) industrial growth, and, 7) environmental security and sustainable development (HDP 1990). The ISSC planning process took several years and eventually led to the establishment of the Human Dimensions on Global Environmental Change Programme (HDP) in 1992. Four years later the HDP was relaunched as the International Human Dimensions Programme on Global Environmental Change (IHDP), now also with the support of ICSU (IHDP 2007).

Following the model of the IGBP, the HDP was organised around a secretariat in Bonn and a Scientific Committee that was given the task to guide the science agenda of the programme. Also the research within the HDP was divided into a set of core projects, each with their own international project office. Figure 2 offers an overview of the IHDP core projects launched until the establishment of the ESSP in 2001. In order to link the research conducted within these projects with national research agendas and capacities, the IHDP also set up a network of national committees and contact points around the world.

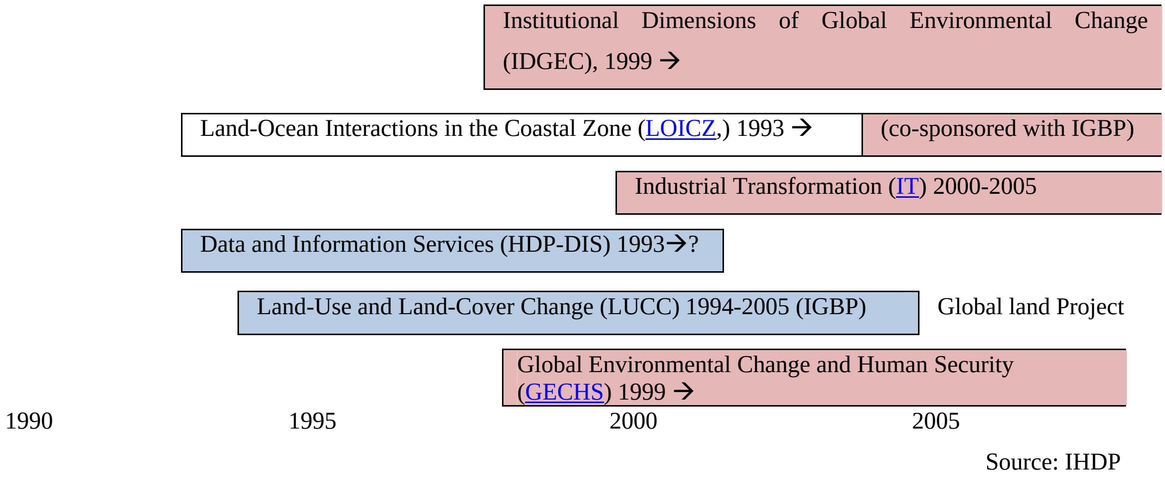


Figure 2 The IHDP core projects launched before 2001

The establishment of a human dimensions programme was welcomed by the IGBP, and already in 1994 the jointly sponsored Land-Use and Land-Cover Change project (LUCC) was launched. The LUCC project set out to enhance the understanding of how changes in land use will develop in the coming 50-100 years based on past trends projected into the future using predictive models integrating human activities and biochemical circulation (IGBP-IHDP 1999). However, the lack of usable societal data was a problem. From the start of the LUCC project, it was clear that national and regional statistics were too coarse to fit into the global models of the IGBP. In order to provide data for each $km^2$ on Earth, the grid had to be improved and advanced satellite measurements of human land use change were required (IGBP-HDP 1993, IGBP-HDP 1995, HDP 1992). This data inconsistency between the IGBP and the HDP called for organised data support. Hence, in 1993 the HDP gave the Consortium for International Earth Science Information Network (CIESIN) the task to develop and run a new information system called HDP/DIS. One effect of this new data infrastructure was a significant change in the ways in which knowledge about society was represented. Rather than organising demographic and economic data according to the conventional political grammar such as state or municipal boarders, the participating social scientists had to adjust to the modelling squares or equivalents of the IGBP (IGBP-HDP 1995).

Barry (2001, p. 19) reminds us that the deployment of technical devices may reconfigure political space. Forms of political action may emerge which do not correspond to spaces and territorial regions defined in geopolitical terms, but to zones confined by technology. Rose-

Redwood (2006, p. 470) refers to this production of technological spaces as ‘geo-coding’. Through geo-computational techniques new spatial regimes are written on the surface of the Earth itself. The collaboration between the IGBP and HDP can indeed be interpreted as an exercise in such spatial ordering. By establishing connections between diverse sets of knowledges and methods from the natural and social sciences, these two programmes affirmed the spatial grammar of the Earth System. However, these epistemic and technical arrangements were by no means smooth or straightforward. In 1992, at latest, HDP was understood to participate in the IGBP project Global Change Terrestrial Ecosystem (GCTE) (IGBP 1992b). Since the aim of GCTE was to study the effects of global change on agriculture and forestry (IGBP 1990), the role of human activity was central. However, from the outset the project had primarily integrated natural science perspectives in its modelling efforts. Although the IGBP scientists recognised that ‘human dimension of global change will have more profound influence on the fate of the terrestrial ecosystems than will climate change’ (IGBP 1992b), demographic and economic data were not included as drivers in the modelling exercise. Human activities were rather treated as an external stressor than an integrated dimension of the Earth System itself.

The LUCC project, by contrast, addressed human activity as the very driving force of land use change. While this change in perspectives brought new challenges to the modelling community, it allowed social scientists to contribute to the understanding of how societal factors such as economic growth, access to capital and consumption trends are connected to the planetary life-support system as a whole (Alcamo, Leemans and Kreileman 1998). The HDP could hereby bring society into the Earth System and thus extend the scope of the previous IGBP research. More importantly, however, the HDP scientists hereby reconfigured the way that nature-society relations were perceived and thus opened up an epistemic and technological space for the Anthropocene imagery articulated by Crutzen and Stoermer a decade later. In contrast to the global change concept, the Earth System idea that emerged from the interactions between the IGBP and the HDP reflects a more integrated and systemic understanding of the interrelations between human and natural processes on planetary scales (Jäger 2009). By including humans as driving forces in the global change models, a new ontological object (i.e. the Earth System) was born.

**The Earth System Science Partnership**

When writing the history of the present, it may be tempting to approach our time as the culmination of some grand historical process. In an interview from the late 1980s (quoted in Barry et al. 1994, p. 4), Foucault himself saw this temptation to view the present as the break, the climax, or the fulfilment as one of the 'most destructive habits of modern thought'. Hence, in governmentality studies the aim is not so much to stabilise, but to destabilise, the present. To illustrate how it has been 'put together contingently out of heterogeneous elements each having their own conditions of possibility' (Barry, Osborne and Rose 1996, p. 5). When tracing the historical junctures that led to the establishment of the Earth System Science Partnership in 2001, we have in this paper come across a diverse set of techniques, methods and conceptual devices employed and advanced by a number of more or less loosely connected actors and international science programmes. Although these epistemic and technological arrangements may seem to point in one direction (see Fig 3), several of the actors who participated in the journey towards the ESSP suggest that it was less organised and more fragmented than what contemporary writings typically convey. One example of this is that the right persons in the right positions are pointed out as main drivers (Canadell 2009, Ingram 2009).

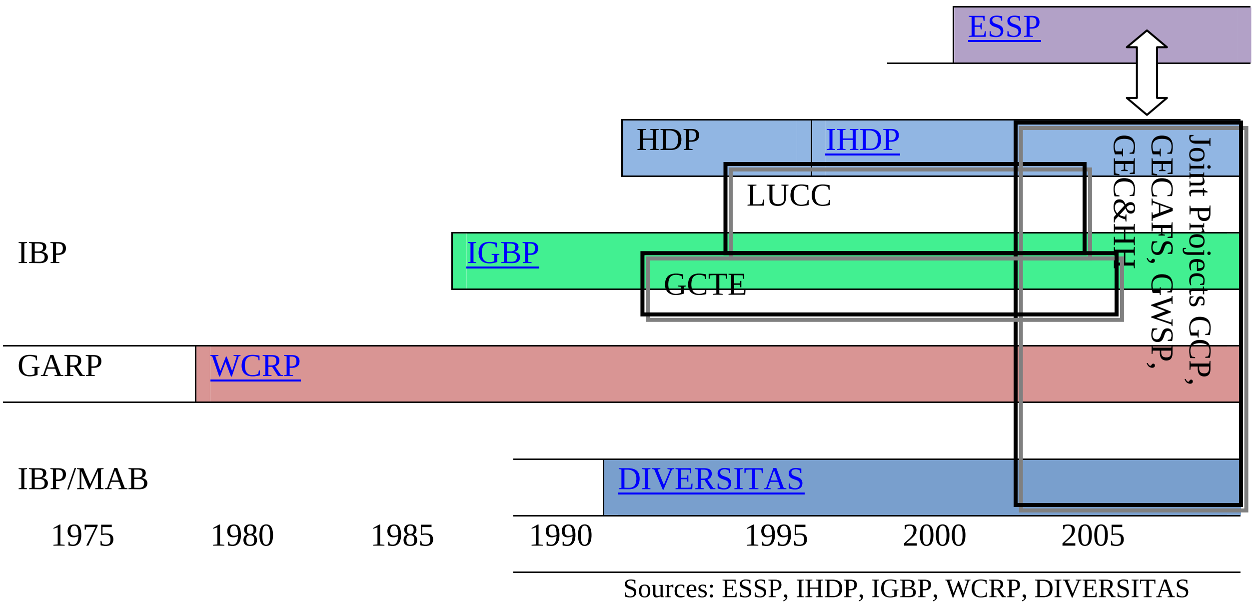


Figure 3 The institutional history of the ESSP

In a reflection paper from 2007, Ingram et al. describe two important events that helped the ESSP to come about. One in 2000 was the widening of the IGBP's open science conference to include the IHDP and the WRCP. Secondly, in 1996 the IGBP decided to synthesise its first ten years of research in a book project (Steffen et al. 2004). Since collaboration already had been established with the IHDP and the WRCP, the scope of this book was widened to include the experiences of these two other programmes. Jill Jäger, who was the director of the IHPD at the time, was invited to act as co-author. She describes the writing process as an important forum where the mutual benefit of further cooperation became clear (Jäger 2009). Hence, at the time of the Amsterdam conference in 2001, the idea to strengthen the co-operation between the IGBP, IHDP and WCRP was not new. The making of an Earth System Science Partnership had already been discussed for some time (Moore III 2000). So had the planning of two joint projects that were launched already in connection to the Amsterdam conference. The Global Carbon Project (GCP) is one of the projects. It sets out to develop a complete picture of the global carbon cycle, including both its physical and human dimensions. The aim of the second Global Environmental Change and Food Systems project (GECAFS) is in turn to determine strategies to cope with the impacts of global environmental change on food systems and food security.

The scientific plans of these two joint projects clearly reflect the ambitions laid out in the Amsterdam declaration (GCP 2003, GECAFS 2005). As described by Ingram et al. (2007), the aim of the joint projects was to build on the results of the core projects in respective parent programme but more explicitly address questions of societal concern. The notion that the ESSP research hereby would be closely linked to policy making is highlighted in the goals of the two joint projects (GCP 2003, GECAFS 2005). In the years after 2001, two additional joint projects were launched on different topics but with a similar policy agenda. First was the Global Water System Project (GWSP) aiming to understand how the coupled natural/human global water system works and what impacts of changes in this system will influence society (GWSP 2005). Global Environmental Change and Human Health (GECHH) is the fourth of the joint projects. It aims at enhancing the knowledge about how global environmental change affects the wellbeing of humans (GECHH 2007). Figure 4 illustrates how these four joint projects are linked to the ESSP.

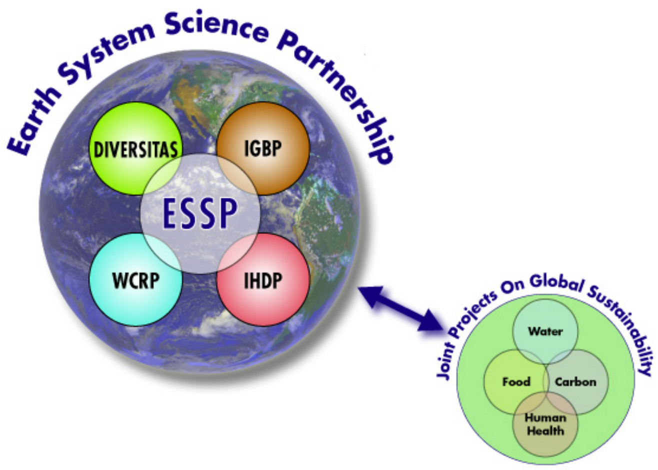


Fig 4. The Earth System Science Partnership. Source: www.essp.org

Although the Amsterdam conference set the scene for the ESSP, Jäger notes that the partnership best can be understood as a framework for collaboration than a new research programme in its own right (Jäger 2009). Since the four collaborating programmes did not want their positions to be threatened, the ESSP turned into a loose partnership with an unclear and vague mandate (Jäger 2009, Ingram, 2009, Rosswall 2009 and Canadell 2009). While governed by a Scientific Committee, the daily work of the ESSP has been organised around a secretariat with only one paid staff and a very small budget. As a result of this weak institutional arrangement the joint projects have been left to evolve by themselves without very distinct steering. When the progress of the ESSP was reviewed by ICSU in 2008, the partnership was criticised for making an unknown, marginal and unfocused contribution to the global change policy community (ICSU-IGFA 2008). While acting as a coordinating mechanism for the international science community, the review panel suggested that the ESSP has developed in an ad hoc manner and therefore not been effective in its efforts to influence governments to take action to reduce the impact of human activities on the global environment (ICSU-IGFA 2008, p. 16). While the limited policy resonance of the ESSP was presented as a failure by ICSU, this paper seeks to put the ESSP in a different light. When studying the constitutive forms of knowledge represented by this international science partnership, it appears far more powerful and effective any traditional policy analysis would convey.

Through its very formation, the ESS manifested a particular way of seeing and knowing the interactions between nature and society that have grown out of, more or less, coordinated collaborations between global environmental change scholars during many decades. As described by Leemans et al. (2009, p. 6) the ESSP was born out of the realisation that system-level questions, especially those related to energy (carbon), food, water and health, can no longer be addressed by conventional research programmes dealing with components of the Earth System. Following the epistemic and technical legacy of the IGY, the IGBP and the IHDP, a global and fully integrated science effort involving both the natural and social sciences was deemed necessary. In contrast to its predecessors in the global change research landscape, however, the ESSP has advanced an understanding of the Earth System where humans are fully integrated as drivers of global change. By recognising the stresses imposed by human activities on the planetary life-support systems, the ESSP has given itself a social mandate to produce research of relevance to decision-makers on both local and global scales. While the direct policy impact of these efforts is hard to judge, it is clear that the ESSP has established the Earth System as an intelligible field with its own limits and characteristics. By giving meaning to concepts such as the Anthropocene, the planetary life-support system (Steffen et al. 2004), safe corridors (Alcamo, Leemans and Kreileman 1998), ecological footprints (Rees 1992) the partnership has made the Earth System seem stable, comparable and diagnosable and hereby open for government intervention.

**Discussion and conclusions**

Metaphors are never neutral. When studying a metaphor we should examine what it does and does not reveal what effects it has on thought and practice (Barry 2001, p. 14). The Earth System metaphor is a particular powerful one. As outlined in this paper it does not only represent a particular way of seeing and knowing nature-society relations. Following Crutzen’s and Stoermer’s (2000) Anthropocene imagery, it also harbours a diagnosis for planet Earth that calls for immediate government intervention. Following Foucault’s understanding of government, Miller and Rose (2008) suggest that any effort to steer the conduct of individuals or collectives stems from a sense that such conduct is problematic. Hence, when studying government it makes sense to start asking how ‘this rending of things problematic occurred’ (Miller and Rose 2008, p. 14). We have in this paper set out to examine the technologies, knowledge practices and discursive devices that have turned the Earth System into a problem of government. By tracing the history of the ESSP from the Amsterdam conference in 2001 to the IGY of 1957-58 and back again, we have shown that the Earth System metaphor has evolved from a complex interplay between questions, development of information technology, modeling capacity, societal needs and institutional frames.

Our analysis suggests that the making of the Earth System into a problem of government has been far from straight forward. As argued by Miller and Rose (2008), to make issues and concerns appear problematic is a complex and slow process that occurs in different ways, in different sites, by different agents. However, once there is a certain level of agreement that a problem exists, it is usually framed within in a common language that makes dialogue possible between different groups. Knowledge plays a central role in this process. When articulated in terms of formalized knowledge, a problem becomes more or less stable and hereby susceptible to techniques that seek to remedy it (Miller and Rose 2008, p. 15). While the period after the IGY was characterized by the rise of a number of loosely connected science programmes seeking to understand how the Earth's biogeophysical processes interact, we have in this paper shown how the establishment of the IGBP in 1986 represents a central step towards contemporary ways of representing and knowing nature-society relations. Through the various research activities of the IGBP, an Earth System discourse developed that has conceptualized the Earth as an interactive system where biotic and non-biotic components are inextricably intertwined, and where human impacts are approximate the scale of the natural (IGBP 1986, p. 2). The IGBP collaboration with the IHDP in the mid 1990s affirmed this daunting image. However, by introducing new economic and demographic variables to the Earth System models, the social scientists involved in this collaborative effort gave humans an even more pronounced role in Earth System dynamics.

When analysing rationalities and technologies of government, governmentality scholars typically assume that there are intrinsic links between ways of representing and knowing a phenomenon, on the one hand, and ways of acting upon it as to transform it, on the other. 'Or, to put it differently, the activity of problematising is intrinsically linked to devising ways to seek to remedy it' (Miller and Rose 2008, p. 15). In this paper we have offered ample examples of how contemporary global environmental change scholars represent and talk about the challenges of the Earth System. However, which government programmes that follow such talk are less clear. How to best govern the Earth System remains an open question. Following ICSU's 2008 review, devising strategies to remedy the problems of the Earth System represents the next step of the ESSP:

> ‘For the ESSP to evolve into an excellent partnership, its activities should be based on the following principles: carrying out cutting-edge science guided by a strategic vision; adding value through innovative interdisciplinary approaches; developing new methodologies; and creating new partnerships with the policy and development communities. Ultimately, ESSP’s results should influence policy development’ (ICSU-IGFA 2008).

Where these efforts will take us remains to be seen. Although the scientists involved in the ESSP have embarked on an ambitious journey to identify strategies that may solve global problems of carbon, food security and water scarcity, Earth System science does not yet have a clear rationality of government. Nonetheless, by tracing the historical organization of data, theories and methods about the Earth System, we may get a sense of the spatial grammar within which such governmental action will take place. Hence, in order to understand how Earth System governance may evolve, we conclude that a good way to start is in the very practices that have constituted the Earth System as a problem for government.

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