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Planetary Boundaries and Governance Mechanisms in the transition to the Anthropocene

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Editorial

Planetary Boundaries and Governance Mechanisms in the Transition to the Anthropocene – a special issue of REPATS.

Compelling evidences are leading to the conclusion that anthropogenic action is playing a key role in triggering changes of great magnitude in the environment we live in and whose consequences entail significant rearrangements in the Earth's stability or, in other words, in the adequate functioning of some essential system processes upon which we depend on to survive and thrive in this communal space, such as the biospheric, atmospheric, geologic and hydrologic ones.

As a corollary of this scenario, global community is increasingly agreeing with scientific-based inferences that point out to the fact that humankind has entered into a new geologic time period, the Anthropocene, an epoch precisely defined by the recognition of anthropic influence as a driving force capable of jeopardizing the planet resilience as never seen before, a turning point that puts all humanity in a brand-new context of challenges, uncertainties and unpredictable consequences.

Amongst the priorities to be dealt with in the Anthropocene, related to human-induced changes to the environment, there are the so-called Planetary Boundaries, limits that, if exceeded from a certain point, have the potential to put at risk the human existence. This conceptual framework presents a set of nine processes/systems intrinsically connected to the stability and resilience of the Earth System, namely: 1) Stratospheric ozone depletion; 2) Loss of biosphere integrity (biodiversity loss and extinctions); 3) Chemical pollution and the release of novel entities; 4) Climate Change; 5) Ocean acidification; 6) Freshwater consumption and the global hydrological cycle; 7) Land system change; 8) Nitrogen and phosphorus flows to the biosphere and oceans and; 9) Atmospheric aerosol loading. In this regard, it is worth mentioning that four of them, including the "core boundaries" - climate change and biosphere integrity - have already been dangerously crossed.[1]

Therefore, the efforts undertaken to foster collaborative actions through mechanisms of governance - here understood as a multi-layered and multi-scale process of accommodation of consensus and, also, of conflicts and divergences by a combination of participatory dynamics based on a culture of dialogue - within the community of scientists and policymakers are more than necessary. These endeavors are also an overwhelming warning about the risks of generating large-scale or irreversible changes by crossing these boundaries since the resulting externalities

[1] Source: http://www.anthropocene.info/planetary-boundaries.php

could seriously imperil the conditions needed for achieving a viable and sustainable future for the generations to come.

Aimed at contributing to the emerging debate of such a paradigmatic issue, the Journal of Studies and Advanced Researches on Third Sector (REPATS) is pleased to bring this peer-reviewed special issue on **Planetary Boundaries and Governance Mechanisms in the Transition to the Anthropocene.** By gathering distinguished scholars from all over the world, we hope that the resulting innovative, informative and provoking set of high-level contributions, stemming from several epistemological perspectives, be a welcome invitation for an inclusive and collaborative dialogue over the broad-ranging impacts of the anthropic actions in our planet, in our lives, in the future we want.

Last but not least, we are immensely grateful to all the contributing authors for accepting the challenge of being part of this project, for their passionate dedication and enthusiastic cooperation in making this very special issue possible.

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Original Paper

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The Anthropocene as Process: Why We Should View the State of the World through a Deep Historical Lens

Todd J. Braje*

Abstract

The geological community and the Anthropocene Working Group (AWG) are moving ever closer to formalizing a new geologic epoch, the Anthropocene. First proposed to raise awareness for planetary stewardship, the Anthropocene will likely be defined, according to the AWG, based on patterns of near-synchronous anthropogenic change that place its boundary marker in the mid-twentieth century during the Great Acceleration. While a number of anthropologists, archaeologists, sociologists, and other social scientists have argued against such a designation, the International Commission on Stratigraphy (ICS) mandates the process and criteria for evaluating potential formal units of the geological timescale; and, the Anthropocene, with a recent boundary maker, likely will be ratified by the Executive Committee of the Internal Union of Geological Sciences. In light of this, I review biotic, atmospheric, and stratigraphic evidence offered by the AWG for a mid-twentieth century Anthropocene and demonstrate how failing to consider deeper historical processes may result in resource management policies and environmental science actions that exacerbate, rather than alleviate, future anthropogenic impacts.

Keywords: Ecodynamics, Historical Ecology, Archaeology

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Introduction

The proposed new geological epoch in earth history, the Anthropocene, has been a lighting rod for discussions centered on the nature of human-environmental interactions. In a geological blink of the eye, human activities have profoundly impacted earth systems, resulting in, for example, accelerated extinction rates (Barnosky et al. 2011), alterations to atmospheric records (Crutzen and Steffen 2003), and land surface transformations (Ellis 2011; Ellis et al. 2013). First proposed by the geological sciences community as recognition that human action has, in many cases, destabilized planetary systems and as a call for greater environmental stewardship (e.g., Crutzen 2002; Crutzen and Stoermer 2000; Steffen et al. 2007; Zalasiewicz et al. 2008), the Anthropocene has been discussed extensively in a variety of disciplines including the natural sciences (e.g., Ellis and Haff 2009; Waters et al. 2015; Zalasiewicz et al. 2015), the humanities and social sciences (e.g., Latour 2015; Lövbrand et al. 2015; Malm and Hornborg 2014; Solli et al. 2011; Visconti 2014), and the historical sciences (e.g., Braje 2015; Braje and Erlandson 2013; Erlandson and Braje 2013; Lewis and Maslin 2015; Ruddiman 2013; Smith and Zeder 2013), among others. The Anthropocene Working Group (AWG) was formed and tasked with determining whether the Anthropocene stratigraphic record meets the requirements for formal definition of a new epoch and, if so, when the Anthropocene began (Steffen et al. 2016; Zalasiewicz et al. 2015). On August 29, 2016, the AWG recommended to the International Geological Congress to formally design the Anthropocene as a new geological time unit added as a subdivision of the Geological Time Scale (GTS), with a boundary date of 1950 linked to the spread of radioactive elements across the planet resulting from nuclear bomb testing.

To define a geological time unit, formal geological criteria must be satisfied (Finney 2014). The AWG had to determine if global-scale changes have been recorded and can be identified in geological stratigraphic materials, such as glacial ice, rock, or sediments. If it can be, the new geological unit is defined by its lower boundary marker or inception, and boundaries typically are indicated by Global Stratigraphic Section and Points (GSSPs) or “golden spikes” (Simon and Maslin 2015:172; Zalasiewicz et al. 2008:4). GSSPs are reference points with well-preserved geologic sections, many of which historically have been based on paleontological changes. When an appropriate GSSP cannot be defined, a Global Standard Stratigraphic Age (GSSA) is designated. GSSAs have been used to designate boundaries prior to 630 million years ago due to challenges associated with finding well-preserved sections for very ancient intervals.

The Holocene boundary is the only geological unit less than 542 million years old defined by a GSSA. The ICS has plans to designate a GSSP for the Holocene and bring it in line with other boundary divisions within the current geologic eon, and the golden spike likely will be placed in the North Greenland Ice Core Project ice core at the “beginning of an interval at which deuterium values (a proxy for local air temperature) rise, an event rapidly followed by a marked decrease in dust levels and an increase in ice layer thickness” (Zalasiewicz et al. 2008:4). Zalasiewicz et al. (2008:4) argue it is important “that the [Holocene’s] GSSP is a tangible horizon within a stratigraphic sequence, a ‘time plane’ marking an elapsed, distinctive, and correlatable geological event rather than an arbitrary or ‘abstract’ numerical.” Zalasiewicz et al. (2008:7) argue that the

same logic need not be followed for the subdivision or elimination of the Holocene and designation of the Anthropocene, and a GSSA may be appropriate for its lower boundary marker. For years, the AWG has been building towards a recommendation that the Anthropocene be added to the GTA with a mid-twentieth century starting date (Zalasiewicz et al. 2015), sometime during the "Great Acceleration" (Steffen et al. 2007). Zalasiewicz et al. (2015) argue that the a Great Acceleration, characterized by exploding human populations, massive increases in carbon dioxide, intensification of agriculture, rapid globalization, and associated anthropogenic environmental transformations, boundary maker would offer a globally synchronous and commonly understood GSSA or golden spike.

The Anthropocene proposal and complications regarding its designation have spurred considerable interdisciplinary debate over what markers should take precedence, when the age of humans began, and whether or not we even need an Anthropocene. Unlike other geological time units, the Anthropocene designation has implications far beyond geology. An early start date may give climate change deniers a platform to argue that humans have been altering climatic systems for centuries to millennia, so modern atmospheric and other changes are nothing to worry about. A late start date may suggest that the thousands of years of human impacts on the earth are simply part of natural variation and we need only worry about more recent, post-Industrial Revolution impacts. The political and social implications of scientific nomenclature rarely have been so explicit.

One of the major issues with a strictly defined, mid-twentieth century boundary maker is that it neglects the anthropogenic elements that created the Anthropocene – deep human histories and socio-cultural processes (Braje 2015, 2016; Malm and Hornborg 2014) , along with a variety of other critiques levied at the Anthropocene narrative (e.g., Bonneuil 2015; Clark and Gunaratnam 2017; Crist 2007, 2013; Malm 2015; O'Brien 2010; Solli et al. 2014; Visconti 2014). Most concerning, however, is that a recent Anthropocene may communicate to scientists and the public that human influence began sometime in the last 100 years. We risk overlooking the deep historical processes and long-term human-environmental dynamics that created the present and making environmental management and stewardship decisions that neglect deep history, a stumbling block that scientists and resource managers have only recently recognized (e.g., Braje and Rick 2013; Foster et al. 2003; Rockham 1998; Rhemtulla and Mladenoff 2007; Rick and Lockwood 2013; Swetnam and Allen 1999). We now have countless examples of how ancient human influences have helped shape the present in surprising ways, ignoring these lessons or relegating them to a pre-anthropocene (Steffen et al. 2007) or a paleoanthropocene (Foley et al. 2013) potentially undermines their importance for shaping modern environmental management policy.

While an exhaustive review of the proposed criteria for designating a recent Anthropocene Epoch by the AWG is beyond the scope of this manuscript, I provide examples using the three major lines of evidence, biotic, atmospheric, and stratigraphic (soil), for determining GSSPs or golden spikes that suggest an Anthropocene began long ago. These examples demonstrate how human action has resulted in globally recognizable earth system changes over centuries to millennia in complicated and discontinuous ways. I also present

scenarios under which modern conservation management policy can be negatively impacted by ignoring these long-term anthropogenic processes in favor of more recent, post-Industrial Revolution human impacts. I believe these examples demonstrate why it is important to forgo debates over stratotypes, golden spikes, and boundary markers and focus on the deep historical processes that created the anthropogenic world and how to address the challenges of our Anthropocene future.

Biotic Markers of the Anthropocene

Applying biotic markers to define the Anthropocene makes inherent sense; paleontological criteria have been the most common method for defining boundary markers of geological eras, periods, epochs, and ages (Figure 1). The extinction or appearance of species or classes of animals has been critical in making geological ages and stages in many cases, especially for deep geological time periods. Every epoch and every stage of the Cambrian (dating approximately 485 to 541 million years ago), for example, has been defined using palaeontological criteria. The same can be said for the Silurian, Devonian, Carboniferous, Permian, and Jurassic.

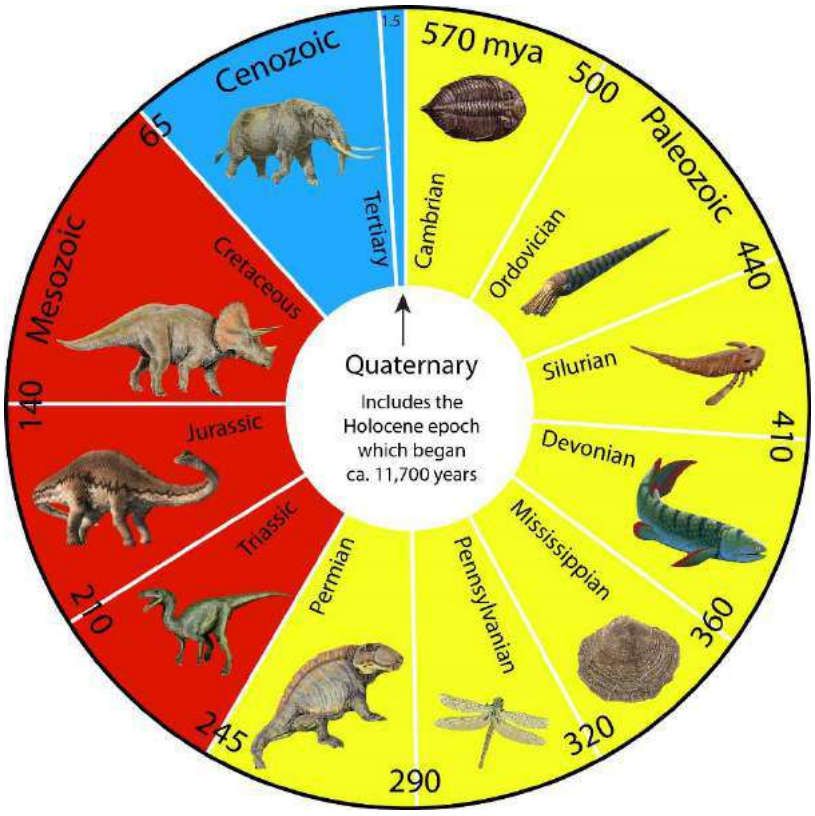

Figure 1. Figure depicting geological time periods from 570 million years ago to the present (moving clockwise). The three geological eras are labeled along the border, the twelve periods along the interior, and pictures represent major paleontological markers of each period (save the Quaternary). Ages for geological periods are labeled with their boundary dates as millions of years ago (mya).

The University of California, Berkeley, palaeontologist Anthony Barnosky (2013) has been a leading advocate for defining the Anthropocene using palaeontological criteria following common biostratigraphic practices in geology. Enhanced rates of change in the biosphere across strata, rather than simply observed differences, have been effective in defining biotic boundary makers for other geological time divisions. This is clearly illustrated with extinction events. Extinctions are a natural and constant part of earth evolution. When extinction rates rise to at least ten times above background rates, however, geologists have designated mass extinction events and linked them to geologic boundaries. Extinction rates today are at least ten times above background rates (perhaps even 1000 times background rates) and a number of palaeontologists argue that we are in the midst of the sixth mass extinction event (Barnosky et al. 2011, 2012; Ceballos et al. 2015, 2017; McCallum 2015; Pimm et al. 2014). Projections suggest that the problem might only worsen and that humans could drive one of every three species on the planet to extinction within the next 200 years (Cafaro 2015), a rate that outpaces the last mass extinction event at the end of the Cretaceous Period 65 million years ago. (Raven et al. 2011).

Anthropogenic climate change has forced the movements of plants and animals and shifted their biogeographic ranges, in many cases exceeding similar shifts documented at the beginning or the end of the Pleistocene (Diffenbaugh and Field 2013). Future climate projections suggest that future shifts will be even more dramatic, “an order-of-magnitude faster” than those that occurred during the last glacial-interglacial shift (Steffen et al. 2016:335). Adding to the impacts, the translocation of plant and animals species around the globe due to massive increases in intercontinental shipping and air travel have mixed native and non-native flora and fauna, creating novel marine and terrestrial ecosystems and new biostratigraphic zones (Barnosky 2013; McNeeley 2001; Williams et al. 2015). Based on this evidence, Barnosky (2013) proposed an AD 1950 boundary marker for the Anthropocene, in line with the larger AWG.

While a mid-twentieth century Anthropocene may seem appropriate based on biotic evidence, the sixth mass extinction event, in fact, has grown from a longer trajectory, beginning at least with an initial wave of megafaunal extinctions during the terminal Pleistocene and accelerating into the Great Acceleration (Braje and Erlandson 2013). In addition, declines in plant and animal biodiversity became a global pattern long before the twentieth century. European colonialism from about AD 1400 to the early 1800s transformed floral and faunal communities as transoceanic trade, commercial agrarian systems, fur trading, hunting, and whaling enterprises, and the movements of commodities and people around the globe resulted in the spread of non-native species and the concurrent disruption of ecosystems (Lightfoot et al. 2013).

At more local or regional scales, this was happening well before the Columbian Exchange. Prehistoric humans have long transported plants and animals, creating novel communities of mixed native and non-native species. Agriculturalists were doing so at least 10,000 years ago, but hunter-gatherers did much the same (albeit at a smaller scale) long before this. The global human colonization of islands is an excellent means of understanding these processes and their effects, and archaeological research demonstrates that, in many cases, human colonization of islands and island groups hundreds to thousands of years ago resulted in the introduction of a variety of

plants and animals and, often, sudden reorganizations of marine and terrestrial ecosystems (see Braje et al. 2017; Rick et al. 2013).

A recent Anthropocene suggests to conservation managers, policy makers, and the public that the most important impacts of humans on the biosphere occurred recently. This would, in many ways, be business as usual. Environmental conservation and restoration policy traditionally have focused on recent datasets and overlooked the longer, coupled human-environmental histories of plants and animals. On California's Channel Islands, for example, sea mammal biologists and the National Park System have worked diligently to protect and increase seal and sea lion populations since their near extinction from the 18th and 19th century fur and oil trade. Most biologists view their recovery as a wildly successful one, as tens of thousands of these animals have repopulated island beaches and rocky shores in recent years. Zooarchaeological data suggest, however, that their recovery has not followed a "natural" trajectory. At least 1500 years ago, Guadalupe fur seals (*Arctocephalus townsendi*) were the focus of prehistoric hunting and widely abundant in coastal California (Rick et al. 2009). Elephant seals (*Mirounga angustirostris*), on the other hand, are rare in archaeological sites and likely were not abundant prehistorically (Rick et al. 2011). Today, the situation is reversed. Recovery of these animals, then, resulted in a biogeographic reversal and their present distributions are a byproduct of modern management and conservation. The lesson is that our management efforts must continue and we need to better understand why Guadalupe fur seal recovery has lagged behind other species, a perspective that would be lost if not for understanding the deeper human-environmental history of these animals.

Atmospheric Markers of the Anthropocene

Following criteria that defining a new geological epoch requires a synchronous, global marker, the AWG has proposed a number of atmospheric indicators that meet criteria for a mid-twentieth century boundary date. The two most commonly cited are the burning of fossil fuels since the Industrial Revolution, which has produced an ~120 parts per million (ppm) increase in atmospheric carbon dioxide levels (Waters et al. 2016; Zalasiewicz et al. 2015) and the detonation of atomic weapons over the last 70 years, which has spread artificial radionuclides (Hancock et al. 2014; Wolff 2014; Zalasiewicz et al. 2008). The AWG has explored other potential atmospheric markers such as the eruption of Mount Tambora in 1815, which resulted in the "year without summer" in the Northern Hemisphere (Zalasiewicz et al. 2008). Although an aerosol sulfate spike is visible in both Greenland and Antarctic ice cores and a distinct signal has been identified in dendrochronological records, this natural maker seems to have fallen out of favor with the AWG for more anthropogenic ones (e.g., Waters et al. 2016; Zalasiewicz et al. 2011, 2015).

Ruddiman (2003; Ruddiman and Thomson 2001; Ruddiman et al. 2008; see also Fuller et al. 2011) has argued that increases in atmospheric greenhouse gas accumulations began long before the Industrial Revolution. His paleoclimatological research identified significant increases in atmospheric methane beginning 5000 years ago, likely the combined result of increases in human and animal waste, breeding of domesticated livestock, and landscape burning to clear agricultural fields. Ice cores dating between 6000 and 4000 years ago contain a ten-fold increase

in methane levels compared against previous millennia. Ruddiman (2013) contends that a post-Industrial Revolution boundary marker for the Anthropocene, based on atmospheric criteria, makes little sense as his data suggest that preindustrial anthropogenically-driven temperature increases were at least twice those of the industrial era and, instead, proposed a two-phase Anthropocene with an early period that began thousands of years ago.

Beyond these complications, some scholars argue that atmospheric criteria may not be the best Anthropocene marker for two primary reasons. First, air bubbles in ice cores, the means by which atmospheric accumulations of greenhouse gasses and other such indicators are measured, are transitory. The long-term viability of ice cores is particularly vulnerable as anthropogenic warming threatens their continued existence (Certini and Scalenghe 2011:1270-1273). In addition, atmospheric gasses or radionuclide accumulations fail to capture the range of human activities that has resulted in human domination of the earth, including domesticated animal grazing, deforestation, agricultural production, road and harbor construction, and a variety of other anthropogenic activities, which began millennia ago.

A recent Anthropocene, when considering atmospheric criteria, may seem to offer few conservation or policy management concerns. Atmospheric climate scientists nearly always present long-term records of greenhouse gas accumulations to contextualize post-Industrial Revolution spikes in atmospheric carbon dioxide, methane, and other indicators (see Waters et al. 2016). Modern spikes are readily identifiable and dramatic when compared against earlier fluctuations. Atmospheric carbon dioxide is now at 400 ppm, for example, and accumulation rates were 100 times faster in the first decade of the twenty-first century than at any time during the Holocene (Wolff 2011). Modern carbon emissions are at their highest rates ever recorded in the last 65 million years (the Cenozoic era; Rubino et al. 2013; Waters et al. 2016). If the goal of designating an Anthropocene epoch is to guide effective environmental stewardship (Crutzen 2002:23), however, we need to carefully consider earlier human impacts that drove fluctuations in atmospheric gasses. Understanding the causes of human-driven pre-Industrial changes in carbon dioxide and methane, even if they were at significantly lower rates than post-Industrial Revolution increases, can help us plan and predict modern and future actions to address anthropogenic climate change.

Ruddiman (2003), for example, identified a 20 to 25 ppm increase of carbon dioxide 8000 years ago. Similar to Dull et al. (2010), Ruddiman (2003) argued that this signaled wide scale clearance of tropical forests by anthropogenic burning for agricultural fields – demographic pressure that increased through the Holocene until its peak in the late-fifteenth century, coinciding with the spread of European colonialism. The introduction of Old World diseases, indigenous population crashes, and the regrowth of tropical forests all resulted from the Columbian encounter and are linked to significant decreases in atmospheric carbon dioxide from about AD 1500 to 1750 resulting from terrestrial biospheric carbon sequestration. Although controversial (Elsig et al. 2009), understanding these patterns can provide insights into what outcomes we might expect and target from modern strategies to reduce greenhouse gas emissions. In particular, when properly scaled and modeled, careful consideration of deep historical patterning can help us envisage the impacts of forest management strategies around

the world. A recent Anthropocene, one that overlooks the longer-term human-climate interface, may lose sight of these important lessons and baselines.

Stratigraphic Markers of the Anthropocene

Anthropogenic soil makers have been the most widely discussed potential golden spike for the Anthropocene, and AWG members have proposed a wide variety of candidates. Nearly all fall within the Great Acceleration. Some of the proposed signals are globally synchronous, while others rely on a rapid, global spread of technologies, pollutants, or other signals from multiple points of origin. The invention and global dispersal of modern artifacts (so called technofossils such as cell phones, ballpoint pens, and other artifacts of modernity) in the environment has been particularly popular (Ford et al. 2014; Haff 2014; Zalasiewicz et al. 2014). Others include discarded plastic (Corcoran et al. 2014; Zalasiewicz et al. 2016), environmental waste and deposition of new forms of human-created metals and materials such as aluminum, concrete, and synthetic fibers (Waters et al. 2016; Zalasiewicz et al. 2013), dispersal of carbonaceous particles from the anthropogenic burning of fossil fuels, plastics, and other materials (Zalasiewicz et al. 2016), and massive increases in surface nitrogen from fertilizer runoff (Wolfe et al. 2013). Potential markers also include human activities that are currently shaping landforms such as artificial deposits associated with urbanization (Ford et al. 2014), anthropogenic alternations to fluvial deposition from large dams (Zalasiewicz et al. 2014), and oil and deep-sea drilling that have altered natural stratigraphic sequences (Zalasiewicz et al. 2014).

Scholars have challenged many of these markers as only considering very recent human activities that have altered global soils and stratigraphy. Modern technologies and post-Industrial human impacts are given precedence over similar, more ancient ones. Soil scientists Certini and Scalenghe (2011), for example, argue that repeated human activities dating back thousands of years have created anthrosols. The outcomes of regular and millennia-long plowing, fertilizing, terracing, contamination, and artifact deposition are distinctive geological boundaries that, in many cases, have spanned the Holocene. Edgeworth (2013) contends that tells, plaggen soils, sedimentation behind dams, earthworks, and occupation debris date back thousands of years in many places around the globe and constitute anthropogenic pedosheres. Erlandson (2013) references shell midden soils as distinctive makers of human activity in worldwide coastal and aquatic regions beginning at least 8000 to 10,000 years ago.

Rather than a significant, global impact only felt during the later half of the twentieth century, humans have been altering land surfaces for thousands of years in profound ways, both as part of hunter-gatherer activities but, more significantly, as part of agrarian systems. These alterations have resulted in ecosystem fluctuations, along with human demographic regime and socio-political system shifts. One of the best examples of a conservation pitfall we might stumble into with a recent Anthropocene comes from the Amazon Basin.

Greater Amazonia contains nearly one half of the world's tropical forests, includes nearly a quarter of the world's fresh water, produces about one-third of the world's oxygen, shelters over one-third of the known species on earth, and is one of the world's most important biodiversity hotspots (Heckenberger et al. 2003, 2007). As such, the area has become a lighting

rod in sustainability debates as an important "tipping point" for the future of earth's climate and ecology (Laurance et al. 2001). For millennia ecologists, conservationists, and other scholars and activists have viewed the Amazon as a pristine forest sparely populated by small and dispersed indigenous communities until the arrival of Europeans in the fifteenth century.

The construction of the Amazon Basin as virgin tropical rainforest treaded only lightly upon by primitive peoples, however, turns out to be an ahistorical fallacy. Archaeological and ethnohistorical research over the last twenty years have demonstrated that numerous regions along the Amazon River and throughout Greater Amazonia supported large pre-European occupations; and ancient forest and wetland environments were transformed by human activities (Heckenberger et al. 2007). The most dramatic and enduring ancient human imprint is the creation of extensive black-stained anthropic paleosols (e.g., Eden et al. 1984; Smith 1980). Dubbed terra preta (black soil in Portuguese), these deeply stratified anthropogenic soil horizons were created through indigenous soil management practices that included low-temperature burning as part of a slash-and-burn agricultural system and the mixing of charcoal, organics, and manure to enhance relatively infertile Amazonian soil. Over thousands of years, these activities created Amazonian dark earth soils, which bind and retain minerals and nutrients and supported large pre-Columbian population centers (Glaser and Birk 2011; Roosevelt 2013; Smith 1980).

Often associated with Amazonian dark earth soils are cultural or oligarchic forests, dominated by only one or two tree species that are important sources of fruits, seeds, or oils (Balée 2013; Peters et al. 1989). Tropical forests typically are very taxonomically diverse, but Amazonian anthropic forests are dominated by tree species that tend to be highly valued and activity managed by Amazonian people today. While not true domesticates, the proliferation of these tree species is encouraged by human planting, clearing, protection, and fertilization, that has been ongoing for thousands of years (Roosevelt 2013). Many of these oligarchic forests persist with few to no signs of depletion, even under heavy human exploitation pressure (Peter et al. 1989).

Roughly 40% of the remaining tropical forest in the world is found in the Brazilian Amazon. These forests exist under critical threat due to the expansion of agro-pastoralism and other development (Goulding et al. 2003). Efforts to save and protect this critical resource often employ predictive models and conservation interventions based on post-1950s data, and especially post-1990s data when satellite imagery became widely available – data from the AWG's Anthropocene (Heckenberger et al. 2007). These efforts would be greatly improved by understanding the long-term human-environmental ecodynamics that created the soils, biomes, and biodiversity of Greater Amazonia. As Heckenberger et al. (2007:205) argue, we need to be "looking at the way certain cultural and biological patters are mutually constituted" and how this process unfolds over deep time.

Conclusions

Now that the AWG made their recommendation to formally designate a mid-twentieth century Anthropocene, they will spend the next several years determining what indicators best signal the age of humans and selecting a location for a golden spike. It seems inevitable now that

the GTS will be amended in record speed (usually such alternations take decades to centuries). The Holocene will be subdivided, and we will be officially living in the Anthropocene. Given the current state of the world and unchecked human population growth, rampant pollution, accelerating anthropogenic warming, and the serial collapse of resources and ecosystems, this probably comes as little surprise. The most important next step, I believe, is for scientists across disciplines to consider carefully how we discuss the Anthropocene with the public. Now, more than ever, we need to focus on the Anthropocene as process. Significant human impacts that resonate in the modern world did not begin in 1950, a fact not lost on the AWG (e.g., Steffen et al. 2016; Waters et al. 2016; Zalasiewicz et al. 2015).

I maintain the belief that scientific and public discourse would best be served by combining the Anthropocene with the Holocene, as a combined Anthropocene/Holocene Epoch (Braje 2015, 2016; Braje and Erlandson 2013). The Holocene Epoch, Greek for "entirely recent" and marked as beginning 11,650 years before present, was designated out of practicality rather than following strict geological taxonomy (Zalasiewicz et al. 2011:837). What makes the Holocene different from previous Pleistocene interglacials is the influence of Anatomically Modern Humans, who for the first time occupied every continent on earth (save Antarctica), had begun to domesticate plants and animals, and were making the transition to agrarian systems in several regions. It makes logical sense to connect the Anthropocene with the Holocene, as human influence is already connected to the Holocene's designation (Gibbard and Walker 2014). Subdividing the Holocene Epoch into a smaller geological time unit to make room for the Anthropocene undermines the Holocene of its most tangible feature – humans. A Holocene/Anthropocene Epoch would recognize the growing influence and impacts of humans on earth systems, which accelerated after the widespread domestication of plants and animals and the transition to agricultural systems (Figure 2).

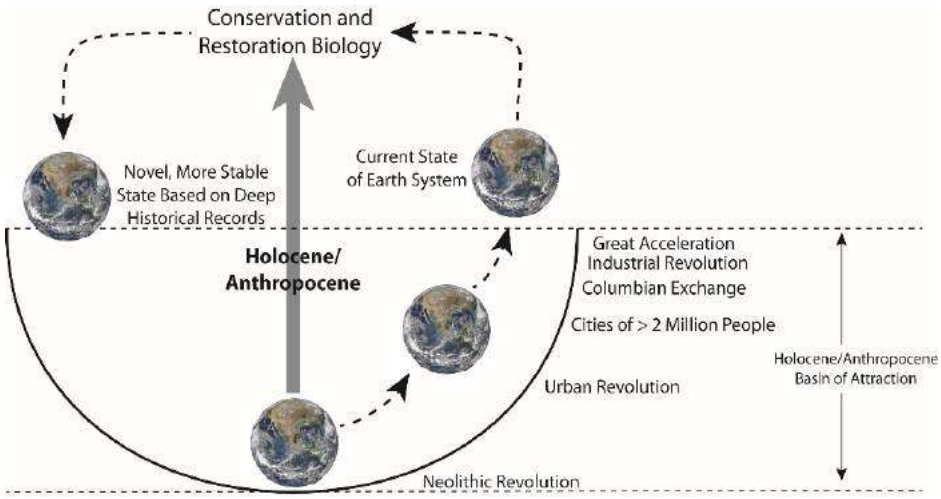

Figure 2. A ball-and-cup model of the current state of the earth depicting the importance of viewing the Anthropocene as process. The Holocene/Anthropocene basin of attraction is represented as a signal unit, demonstrating the linkages of ancient, historical, and modern human actions that have created the current state of the world. Restoration and conservation biology efforts must consider deep historical processes to build a more stable, sustainable earth system (after Steffen et al. 2016:Figure 4).

It would also frame critical scientific inquiry to understand and long, complex, and dynamic role humans played in shaping earth's biosphere (Smith and Zeder 2013). The way forward, to me at least, is clear. We must embrace the Anthropocene as a valuable public communication tool to combat anthropogenic climate change and effectively communicate, explain, and package the modern environmental crisis. The Anthropocene needs to be more than simply a new temporal subdivision of geological time. The reason to designate an Anthropocene, an age of humans that is still taking shape and likely will look very different in a million years from now, should be to demonstrate the importance of building sustainable systems, reducing our footprint on earth, and rallying a global scientific and public community to the cause. Lost on many who study climate and the state of the world is that our most effective tool for confronting and meeting environmental challenges is with sustainability science.

Studying and documenting the impacts of humans on earth and the anthropogenic climate change is only a starting point for a movement towards environmental sustainability. At its core, sustainability science attempts to understand and characterize the complex interactions between nature and society (Kates et al. 2001). Data regarding climate change is useless until it is coupled with human action. Scientists, resource managers, and activists must work together to build a better world, and we must not shy away from connecting sustainability science with a political agenda for future sustainable development. The Anthropocene, and particularly the Anthropocene as deep historical process, is poised to take center stage in rallying the world to this clarion call.

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Planetary Boundaries and the Challenge to Governance in the Anthropocene

David Chandler*

Abstract

This article considers the challenge to governance posed by new Anthropocene discourses of planetary boundaries. The first section introduces the problematic of the Anthropocene as a new geological epoch and also as symptomatic of the end of modernist ontological and epistemological assumptions of the divide between culture and nature. The Anthropocene is thus seen to fundamentally decentre the human as subject and the temporal linearity of Enlightenment progress. The second section analyses the implications of this closure for critical approaches to governance, which increasingly accept and reproduce these ontopolitical assumptions. The tasks of governance thus become transformed, no longer seeking to imagine alternative futures but rather drawing out alternative possibilities that already exist in the present. Governance becomes increasingly an act of affirmation rather than a discourse of change and transformation. The third section expands on this point to consider how contemporary governance approaches articulate the status quo in increasingly radical and enabling ways.

Keywords: Anthropocene, Governance, Planetary Boundaries, Nature/Culture divide, Modernity

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A New Epoch

The Anthropocene - a concept coined by Eugene Stormer in the 1980s and popularised by Paul Crutzen in the 2000s (Crutzen and Stoermer, 2000; also Crutzen, 2002; Crutzen and Steffen, 2003) - is a disputed term, which refers to a new geological epoch,[1] in which human activity is seen to have profound and irreparable effects on the environment.[2] This attention to a new epoch in which humanity appears to have impacted the earth in ways which mean that natural processes can no longer be separated from historical, social, economic and political effects has powerfully challenged the modernist understanding of the nature/culture divide, separating social and natural science, destabilising the assumptions of both. Nature can no longer be understood as operating on fixed or natural laws, while politics and culture can no longer be understood as operating in a separate sphere of autonomy and freedom. These assumptions, in both spheres, were central to modernist constructions of governance shaped upon a telos of progress, which is now seen to no longer exist or to have always been problematic (Latour, 2014; Clark, 2010; Haraway, 2015; Proctor, 2013; Swyngedouw, 2011; Macfarlane, 2016; Bonneuil and Fressoz, 2016). Jeremy Davies argues that: 'The idea of the Anthropocene makes this state of being in between epochs the starting point for political thinking.' (Davies, 2016: 5) As Bruno Latour, one of the most prolific and widely influential theorists articulating the Anthropocene as a break with modernist conceptions of governance, highlights: the fact that it is science itself that appears to lead the questioning of modernist constructions of the world is highly significant, considering the impact this has for ways in which we can imagine politics and governance:

> But what is even more extraordinary is that it's the brainchild of stern, earnest and sun-tanned geologists who, until recently, had been wholly unconcerned by the tours and detours of the humanities. No postmodern philosopher, no reflexive anthropologist, no liberal theologian, no political thinker would have dared to weigh the influence of humans on the same historical scale as rivers, floods, erosion and biochemistry (Latour, 2013b: 77).

[1] The previous understanding was that earth was in the epoch of the Holocene, which began at the end of the last Ice Age, 12,000 years ago. The Holocene is understood to be an epoch of relative temperature stability, which enabled the flourishing of human progress: the naming of the Anthropocene as a new epoch calls attention to how human impacts on the earth have brought this period of stability to an end. At the time of writing the International Commission on Stratigraphy had not reached a formal decision on the naming or dating of the Anthropocene as a new epoch.

[2] Working Group on the 'Anthropocene', 2017. These impacts include the emissions of 'greenhouse' gases leading to global warming, the collapse of biodiversity including debate about whether we can speak of a 'sixth extinction', the acidification of the oceans and changes in biogeochemical cycles of water, nitrogen and phosphate. The earth system scientists of the Resilience Centre in Stockholm list nine planetary boundaries: stratospheric ozone depletion; loss of biosphere integrity (biodiversity loss and extinctions); chemical pollution and the release of novel entities; climate change; ocean acidification; freshwater consumption and the global hydrological cycle; land system change; nitrogen and phosphorus flows to the biosphere and oceans; and atmospheric aerosol loading. Four of these are currently operating beyond the safe operating space and two are not yet quantified (Stockholm Resilience Centre, 2017).

For the consideration of governance in the Anthropocene, it makes very little difference when the geological era is believed to have started:[3] whether in 1492 with Columbus and the European holocaust in the Americas (Lewis and Maslin, 2015); in 1784 with the invention of the steam engine by James Watt, that ushered in the industrial revolution; with the explosion of the atom bomb in 1945; or with the 'Great Acceleration', the spread of industrialization across the world since (see Bonneuil and Fressoz, 2016: 14-18). The conclusion of the discussion, regardless of dating, is a shared one: that today human history cannot be understood as separate to geological history:

> The Anthropocene, as the reunion of human (historical) time and Earth (geological) time, between human agency and non-human agency, gives the lie to this – temporal, ontological, epistemological and institutional – great divide between nature and society… It signals the return of the *Earth* into a *world* that Western industrial modernity on the whole represented to itself as above the earthly foundation. (emphasis in original) (Bonneuil and Fressoz, 2016: 32-33).

Natural time is no longer somehow slow in comparison to the speed of human or cultural time. 'What is sure is that glaciers appear to slide quicker, ice to melt faster, species to disappear at a greater speed, than the slow, gigantic, majestic, inertial pace of politics, consciousness and sensibilities.' (Latour, 2013b: 1219) Nature or the 'environment' is no longer to be seen as merely the 'background', but is itself a 'protagonist' (Ghosh, 2016: 6). Thus, the division between agential 'man' and passive 'nature' is fundamentally challenged, with catastrophic events which seemed to be exceptional or highly improbable in the past, becoming increasingly regular, even in the advanced West: '…in the era of global warming, nothing is really far away; there is no place where the orderly expectations of bourgeois life hold unchallenged sway.' (Ibid: 26) As Amitav Ghosh powerfully notes, expectations of normality, balance and order that defined the modern world view, appear from today's vantage point to be a terrible error or hubris: as carried to the point of 'great derangement' (Ibid: 36). There is a contemporary consensus that: 'There can be no more talk of a linear and inexorable progress' (Bonneuil and Fressoz, 2016: 21).

For Timothy Morton: 'In an age of global warming, there is no background, and thus there is no foreground. It is the end of the world, since worlds depend on backgrounds and foregrounds.' (Morton, 2013: 99) What was taken for granted is now revealed to be much more contingent, fragile and unpredictable; for Morton, the world is no longer an object, fixed, passive and external to us, thus there can be no such thing as a human 'lifeworld' shaped within this (Morton, 2013: 104). As Latour states, the positions are reversed, the background becomes foreground: 'what was until now a mere décor for human history is becoming the principal actor' (Latour, 2013b: 4; 63; 100). So much so that it could be said that the Anthropocene does not just overcome the culture/nature divide, 'it bypasses it entirely' (Ibid: 78):

[3] Any attempt to quantify an onto political shift in understandings via geological markings or historical events is inevitably going to be unsatisfactory as it is impossible to demarcate a change empirically, when the key aspect is the changing interpretation of the facts rather than the facts themselves.

> …everything that was part of the background has now melted into the foreground. There is no environment any more, and thus no longer a need for environmentalism. We are post-natural for good. With the end of the political epistemology of the past that insured the presence of an indisputable outside arbiter – namely, Nature known by Science – we are left without a land and without a body politic (Latour, 2013b: 125).

How we understand the causal drivers of the Anthropocene also makes little difference to the new approaches to governance: whether responsibility lies with the Enlightenment, with capitalism (Moore, 2015), with modernity, with mass consumerism, with the organisation, industrialization and commercialization of agriculture, with colonialism and imperialism, with economic theory, with the extraction of and dependency upon fossil fuels, with the rise of the military-industrial complex etc (Bonneuil and Fressoz, 2016, provide seven, in depth, historical narratives). It fact it is often argued that the more narratives there are, 'from many voices and many places, rather than a single narrative from nowhere, from space or from the species' the more the 'black boxes of the Anthropocene discourse' can be opened and repoliticized (Bonneuil, 2015: 29). Regardless of where authors stand on the allocation of blame or responsibility for the contemporary condition - or whether it is named Anthropocene, Capitalocene (Moore, 2016) or by some other concept, such as Donna Haraway's 'Chthulucene' - the descriptive and analytical conclusions fall into a similar set of ontological framings. Whatever the driving forces, the conclusion is common across them, that there is no longer a separation between culture and nature: there is no longer an 'outside' or an 'away'. What happens 'sticks' with us, like Styfroam cups or plastic bags that stay in the environment and do not degrade in a human lifetime (Morton, 2013: 1; 60).[4]

The end of the nature/culture divide is the 'end of the world' (Ibid: 7) as it was conceived in modernity, or by the 'moderns' (as Latour often describes those still clinging to these understandings, Latour 1993; 2010; 2013a). Thus, the debate, as much as there is one about the Anthropocene, could be seen to be shifting away from a discussion about the existence of the Anthropocene itself, and more about whether 'modernity' as a framework of knowing and governing ever actually existed. Bruno Latour has famously argued that 'We Have Never Been Modern', whereas for other theorists modernity as a rational and successful framework of reasoning is specifically challenged by the appearance of the Anthropocene or the 'intrusion of Gaia' (Morton, 2013: 19; Stengers, 2015; Ghosh, 2016). Latour has, however, been criticized on the basis that, in his view, the Anthropocene, or the entanglement of humanity and nature, is only a recent discovery: plenty of non-consensual pro-environmental voices have been raised in the West (Bonneuil and Fressoz, 2016: 72-79) and this position also seems to dismiss the

[4] As Myra Hird and Alexander Zahara note (2017: 123) 'waste constitutes perhaps the most abundant and enduring trace of the human for epochs to come'.

existence of a rich non-Western tradition of thought which was never 'modern' in terms of the centrality of the culture/nature divide (Danowski and Viveiros de Castro, 2017).

For the new formulations of governance in the Anthropocene, the key point is that the Anthropocene is understood to pose fundamentally different questions about how we can know and act in the world. In this sense, the declaration of the Anthropocene marks a very different moment to the Club of Rome's report that launched concerns of environmentalism and over the exhaustion of natural resources in 1974.[5] As Stoner and Melanthopoulos state, it would be difficult to read back contemporary receptions of the Anthropocene into the past century, when the sense of human capacity to regulate environment impacts was much stronger (Stoner and Melanthopoulos, 2015: 20). The power of the Anthropocene lies not merely in the attention to the importance of acting on climate change, but also in the context of responding to climate change without the twentieth century's confidence in modernity. As Rory Rowan notes: 'The Anthropocene is therefore not simply a disputed designation in geological periodization but a philosophical event that has struck like an earthquake, unsettling the tectonic plates of conceptual convention.' (Rowan, 2014: 447) Bruno Latour argues:

> What makes the Anthropocene a clearly detectable golden spike way beyond the boundary of stratigraphy is that it is the most decisive philosophical, religious, anthropological and… political concept yet produced as an alternative to the very notions of 'Modern' and 'modernity' (Latour, 2013b: 77).

Isabelle Stengers captures well the shift at stake, in her argument that it is 'as if we were suspended between two histories' both of which describe the world in global and interconnected terms (Stengers, 2015: 17). In one history, governance frameworks are clear, based on clear evidence and with straightforward goals of economic growth and social progress. The other seems much less clear with regard to what governance requires or how to respond to ongoing processes of change. In this sense, as Haraway argues, it makes more sense to see the Anthropocene as a 'boundary event' rather than an epoch: 'The Anthropocene marks severe discontinuities; what comes after will not be like what came before.' (Haraway, 2016: 100) Latour eloquently describes what is at stake in this shift beyond the boundary, in the recognition of the Anthropocene:

> What is so depressing in reading the documents of the sub-commission on stratigraphy, is that it runs through exactly the same items you could have read in any 20th century listing of all the glorious things that humans have done in 'mastering nature,' except that today the glory is gone, and both the master and the slave – that is, humans as well as nature – have been melted together and

[5] In 1972, hardly any voices challenged the modernist view that the crisis could be managed through predictive modeling and improvements in global governance, enabling a new 'global equilibrium', 'a condition of ecological and economic stability that is sustainable far into the future' (Club of Rome, 1972: 24); Friedrich Hayek and C S Holling were two of the very few dissenting theorists who contested what they saw to be the 'hubris' at play in imagining that a stable equilibrium was possible (Walker and Cooper, 2011: 149).

> morphed into strange new geological – I mean geostorical – forces. (Latour, 2013b: 76-77).

This is echoed by Nigel Clark's view that 'the Anthropocene – viewed in all its disastrousness – confronts "the political" with forces and events that have the capacity to undo the political, along with every other human achievement, by removing the very grounds on which we might convene and strategize' (Clark, 2014: 28).

As Bonneuil and Fressoz state, the Anthropocene is not a transitory crisis: 'the Anthropocene is a point of no return. It indicates a geological bifurcation with no foreseeable return to the normality of the Holocene.' (Bonneuil and Fressoz, 2016: 21) Clive Hamilton writes: 'it can no longer be maintained that humans make their own history' (Hamilton, 2015: 35). In this respect, the Anthropocene appears to confirm that we are living in an age of 'manufactured uncertainty' or 'manufactured risk'; in which societal threats can no longer be seen as external but rather are immanent to social processes (Giddens, 1994: 4; Beck, 2009) undermining the modernist separation between security referent and security threat (Baldwin, 1997; Chandler, 2010). It is held that modernity comes up against its own limits with the end of the culture/nature divide: the end of a 'nature' of laws and regularities somehow external to human interaction. The Anthropocene is an era of 'multiple entanglements' according to Stengers, between natural or 'non-human' forces and human (in)action, or, as Connolly describes this, of 'entangled humanism' (Connolly, 2017). In the face of this entanglement, continuing to rely on modernist epistemologies, leaving us 'armed only with the results of externalized and universal knowledge' would be, we are informed, the road to 'doom' (Latour, 2013b: 9).

In this more complex, contingent and inter-related world, the 'reductionist' causal connections, generalisations, and 'lessons learned', which shaped modernist understandings of governance and discourses of progress and development, are no longer seen to be tenable (Mitchell, 2009: ix-xiii; Prigogine and Stengers, 1985; Cilliers, 1998). Without the 'outside' of 'nature', counter positioned to the 'inside' of 'culture', modernist governance assumptions of there always being possible solutions and 'happy endings' no longer make sense, instead, if humanity is to survive in any recognizable form, new forms of political imagination need to be much more humble, 'reflexive' and 'adaptive' (Voss and Bornemann, 2011; Berkes *et al*, 2003). Isabelle Stengers calls the end of this division the 'intrusion of Gaia', the intrusion of natural forces into every aspect of social and political governance:

> The intrusion of… Gaia, makes a major unknown, which is here to stay, exist at the heart of our lives. This is perhaps what is most difficult to conceptualize: no future can be foreseen in which she will give back to us the liberty of ignoring her. It is not a matter of a "bad moment that will pass," followed by any kind of happy ending – in the shoddy sense of "problem solved." (Stengers, 2015: 47)

Thus, the lexicon of international political discourse is beginning to carry with it an asserted recognition of the Anthropocene as a fundamental challenge to previous epistemological and ontological assumptions about how we know and how we govern/secure in a world that is no longer perceived as open to linear temporalities of cause-and-effect (Fagan,

2017). As Latour argues, the system of the Anthropocene or Gaia 'is anything but unified or unifying'; it is 'not a cybernetic system designed by an engineer' but the product of multiple dispersed and interacting agencies, so there is no such thing as the 'balance of nature' or the 'wisdom of Gaia' (Latour, 2013b: 81). We have therefore 'permanently entered a post-natural period' where traditional science, based on stability, laws and regularities can no longer help negotiate the problem: 'Climate scientists have been dragged into a post-epistemological situation that is as surprising to them as it is to the general public – both finding themselves thrown "out of nature".' (Latour, 2013b: 81-2)

The one thing that many Anthropocene theorists, advocating new approaches to governance, agree on is that there can be no technical fixes. The Anthropocene is not a problem to be solved but an opportunity to be grasped. This drive to affirm the Anthropocene is particularly clear in the field of international relations, where leading theoretical journals, such as the *European Journal of International Relations*, seem keen to flag up critical work that highlights that the Anthropocene should not understand the problems of ecology or of climate change as merely fitting into an extension of traditional modernist international security discourses. For example, Madeleine Fagan argues:

> Ecology offers a reordering of the world, a recreation of the world as a whole, a neutralizing of the threat to logic and sense posed by the anthropocene…. This matters for thinking about security because to give the modern subject a home is to secure it; it is to reproduce the claims about universality and particularity that constitute the modern subject (Fagan, 2017: 308).

The Anthropocene challenges international relations' governance discourses of security and strategic thinking at the most fundamental level of the subject of security itself. Modernist assumptions of securing the human against the world are held to be precisely the problem that needs to be overcome (Hamilton, 2017). It is precisely because the Anthropocene is ontopolitically constructed as a critique of modernist discourses of problem-solving that there can be no 'comic faith in technofixes, whether secular or religious' (Haraway, 2015: 3). No pretence of geoengineering solutions 'which will ensure that it is possible to continue to extract and burn, without the temperature rising' (Stengers, 2015: 8).[6] No possibility of fixed relations capable of regulation in the imaginary of 'spaceship Earth' (Latour, 2013b: 66). The idea of a humanist or modernist solution, positing the idea of a 'good Anthropocene' (Revkin, 2014) is often anathema to those who seek to affirm the Anthropocene as 'after the world of modernity'. As Claire Colebrook states: 'Any "good" Anthropocene would be possible only by way of countless injustices' (Colebrook, 2017: 18). The modernist perspective is seen as the 'managerial variant' of the Anthropocene, where the concept could potentially be captured and 'become the

[6] See also Stengers (2017: 384): 'whatever the geoengineering method, it would require that we keep extracting and mobilizing the massive necessary resources, to keep on feeding the climate manipulating machine…'

official philosophy of a new technocratic and market-oriented geopower (Bonneuil and Fressoz, 2016: xiii; 49):

> Whereas it should mean a call to humility, the Anthropocene is summoned in support of a planetary hubris… [exemplified by] the Breakthrough Institute, an eco-modernist think-tank that celebrates the death of nature and preaches a 'good anthropocene', one in which advanced technology will save the planet… sentiments characteristic of early infancy, lie at the basis of such 'post-nature' discourse, participating in the dream of total absorption of nature into the commercial technosphere of contemporary capitalism (Bonneuil and Fressoz, 2016: 86).

While for Bonneuil and Fressoz eco-modernism smacks of 'early infancy', Clive Hamilton argues that this view of welcoming the Anthropocene epoch with imaginaries of geoengineering is 'reminiscent of Brian's song on the cross at the end of *Monty Python's Life of Brian*' (Hamilton, 2015: 41; see also Hamilton, 2013). For others, such as Richard Grusin, the imaginary of the 'heroic agency of geoengineering' is merely another failed attempt to impose 'many of the same masculinist and human-centred solutions that have created the problems in the first place' (Grusin, 2017: ix). Simon Dalby asserts that any attempt to problem-solve in the manner of 'contemporary earth system science syntheses of the human transformation of the biosphere… [with its] assumption of separation as the starting point for governing a supposedly external realm is now simply untenable' (Dalby, 2017).

In response to this closure, new governance possibilities are held to be inherent in existing communal forms of living and socio-technological forms of interconnectivity and networked community, building on new ways of making connections and seeing relationships (for example, Gibson-Graham and Roelvink, 2010). It is this need for a fluid awareness of relations in their specific and momentary context that is beginning to enable new governance frameworks. For Anthropocene epistemologies and ontologies, the actual existing reality contains much more possibility and potential than has been traditionally recognised by policy makers and academics (Sharp, 2011; Grosz, 2011: 77; 183). Thus, the task is that of engaging more imaginatively with the constantly emerging present, alert to the fact that these relationships need to become a matter of care, attention and opportunity.[7]

'Welcome to the Anthropocene'[8]

To grasp the new governance discourses of the Anthropocene, they need to be placed in the context of a broad demand that we accept that the way we understand the world has to change along with the way in which we act within it. The Anthropocene, in this respect, symbolises more than the threat of global warming - rather global warming is seen as the

[7] In this regard, the implications of the Anthropocene accord closely with perspectives forwarded by a wide range of critical theorists associated with posthuman, new materialist and speculative realist approaches among others (for example, Braidotti, 2013; DeLanda, 2006; Coole and Frost, 2010; Barad, 2007; Bennett, 2010; Connolly, 2013; Harman, 2010).

[8] See *Economist*, 2011.

harbinger of a new awareness of our humbler position in the world: the end of the reassuring assumptions of governance in liberal modernity. To be more precise, it is held that modernity itself was never how we understood it to be. As Bruno Latour has pointed out, modernity was a paradoxical condition, in that the more that we imagined ourselves as subjects separated from the world, developing knowledge of how we could direct and control 'natural' processes, the more humanity grew entangled within these processes. Modernity itself was the midwife to processes that were no longer 'natural' nor amenable to external control or direction by human subjects seen to have all the powers of agency while the rest of the world - of nonhumans – was seen to be merely passive objects of our intentionality (Latour, 1993; 2004a). As Timothy Morton argues, the awareness of human-induced climate change and of our dependence upon nonhuman agency has 'done what two and a half decades of postmodernism failed to do, remove humans from the centre of [our] conceptual world' (Morton, 2013: 181).

The Anthropocene is thus seen to call forth new ways of thinking about governance. Ways that are less human-centred or anthropocentric. These challenge the epistemological and ontological framings of modernity, from a position of radical scepticism grounded upon a new set of metaphysical certainties. For authors, like Latour and Morton, it is held to be the advances of science itself, which has revealed the world to be much more entangled and complex than modernity imagined. Science has itself called a halt to modernity in its recognition of the Anthropocene condition. In this respect, according to Morton, global climate change could be seen as a 'saving power' or a candidate for Heidegger's 'last god', enabling humanity to come back to the world after realising the terrible errors of modernist assumptions (Morton, 2013: 21). This return to the world is not a happy but a humbling one, 'made precisely through our advanced technology and measuring instruments, not through worn peasant shoes and back-to-Nature festivals' (Morton, 2013: 36). For Ray Brassier it is science itself that has 'uncovered the objective void of being' (Brassier, 2007: 25). For Morton: '…our cognitive powers become self-defeating. The more we know about radiation, global warming, and the other massive objects that show up on our radar, the more enmeshed in them we realize we are… Increasing science is not increasing demystification.' (Morton, 2013: 160-61)

The Anthropocene, in fact, appears to be driven by new scientific advances, understood as enabling us to overcome the limitations of modernity. As Morton argues: 'Science itself becomes the emergency break that brings the adventure of modernity to a shuddering halt.' (Morton, 2013: 21) William Connolly focuses on the geo sciences revealing that the Earth's 'planetary force fields' - such as climate patterns, ocean conveyor systems, species evolution, glacier flows and air circulations - have always exhibited self-organizing capacities that can go through volatile and rapid changes. Thus, the Anthropocene is not new, except in the fact that human impacts amplify the non-linear and interactive effects of these forces in increasingly unpredictable ways (Connolly, 2017: 4).

The Anthropocene thus spells the end of science as the cheerleader for modernist discourses of progress, rather than the end of science per se. Science as uncertainty is seen to free us from narrow or blinkered approaches that assumed a 'happy ending' in the future, based

on the assumption of a telos of 'progress'. This is now off the table. It is the present not the future that is important. There is no possibility of debating what the future 'ought' to be like 'when it is the *what is* that obstinately requests its *due*' (emphasis in original) (Latour, 2013b: 126). There is no modernist future, regardless of whether we were ever modern or not, because we would need another five Earths 'to push our endless Frontier to the same level of development as North America' (Latour, 2013b: 126).

Perhaps emblematic of this shift is Anna Lowenhaupt Tsing's book, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (2015). Her starting assumption is the end of the modernist dream of progress, based on the division between humanity and nature: 'Without Man and Nature, all creatures can come back to life, and men and women can express themselves without the strictures of a parochially imagined rationality.' (Tsing, 2015: vii) The importance of the book as an exemplar of the affirmation of the Anthropocene is that it self-consciously does not set out to be 'a critique of the dreams of modernization and progress', but rather to think past their end; to take up the radical 'imaginative challenge of living without those handrails, which once made us think we knew, collectively, where we were going' (Tsing, 2015: 2). The Anthropocene thus enables us to think 'after failure', 'after progress', 'after the end of the world'.

For Tsing, living with the end of modernist dreams of progress need not be a negative experience. Rather, we can come to realise that modernity itself was a barrier to living fuller lives. Our assumptions of progress, the modernist telos that striving harder would lead to collective betterment, now seem no more emancipatory than religious promises of justice in the afterlife. Precarious and contingent life in modernity's 'ruins' can be empowering and creative, full of new possibilities which modernity foreclosed. As Tsing states: 'Progress is a forward march, drawing other kinds of time into its rhythms. Without that driving beat, we might notice other temporal patterns… agnostic about where we are going, we might look for what has been ignored because it never fit the time line of progress' (Tsing, 2015: 21). Her work, therefore, is constructed as a work of enablement, allowing the reader to make the transition from mourning modernity to embracing its demise:

> I find myself surrounded by patchiness, that is, a mosaic of open-ended assemblages of entangled ways of life, with each further opening into a mosaic of temporal rhythms and spatial arcs. I argue that only an appreciation of current precarity as an earth wide condition allows us to notice this – the situation of the world. As long as authoritative analysis requires assumptions of growth, experts don't see the heterogeneity of space and time, even when it is obvious to ordinary participants and observers… To appreciate the patchy unpredictability associated with our current condition, we need to reopen our imaginations (Tsing, 2015: 4-5).

New approaches towards governance in the Anthropocene are thus affirmative and constructive rather than deconstructive (Latour, 2004b). For these theorists, this world is fuller, livelier and more entangled than the soulless, simplified and atomised world of modernity. As

Quentin Meillassoux argues, the Anthropocene welcomes us to the 'great outdoors' (Meillassoux, 2008: 50), what really exists rather than what exists in the stunted modernist imagination. For Tim Ingold, the question: 'is not how to represent the world but: 'How to turn the world into something "real", how to make the world 'present'' (Ingold, 2015: 135). As Tsing argues: 'Precarity means not being able to plan. But it also stimulates noticing, as one works with what is available' (Tsing, 2015: 278). The greatest tragedy would thereby be not the death of modernity in itself but rather the refusal to see beyond this: 'If we end the story with decay, we abandon all hope – or turn our attention to other sites of promise and ruin, promise and ruin.' (Tsing, 2015: 18). If we refuse to affirm the Anthropocene, we are told that we are left only with the choice of nihilistic pessimism or with naively repeating the tragedies of the past. In fact, the Anthropocene is apparently serendipity itself, enabling us to develop just the sensitivities and new ways of affirmative thinking and being that we need to adapt to our new condition:

> What if, as I'm suggesting, precarity *is* the condition of our time – or, to put it another way, what if our time is ripe for sensing precarity? What if precarity, indeterminacy, and what we imagine as trivial are the centre of the systematicity we seek? (Tsing, 2015: 20)

In the ruins of modernity there is more life than could possibly have been imagined by modernist human subjects convinced of their separation from the world. Our realisation that we can no longer govern in old, modernist, ways, enables us to appreciate rather than fear the Anthropocene condition. Realising our precarious condition brings us back to the world: the Anthropocene is like an unseen force, imposing a new sociability and new set of sensitivities on the basis that we are no longer separate, no longer in control, no longer not interested in other actors and agencies with which we cohabit. The Anthropocene is thereby less a world of doom and gloom and extinction than an invitation to be curious, imaginative, exploratory, playful even.

Governance in the Anthropocene

Whereas, for the moderns, politics carved out a separate human sphere of freedom and autonomy in distinction from nature, for the no longer moderns of the Anthropocene the situation is reversed and it is the world itself that shapes and directs the content of politics. As William Connolly has argued, modernist social and political thought had neglected the ontological assumptions upon which it depended, treating them as a background that could be taken for granted (Connolly, 1995: 2-4). As considered above, it is precisely these assumptions that are challenged in the Anthropocene. A new set of ontological assumptions is beginning to inform contemporary social and political thought.

The new framings of governance in the Anthropocene privilege the 'is' of the world over the 'ought' of attempts to carve out a separate human space. Modern politics was oriented around the problem of the 'ought', how the world could be governed or organized in ways in which humanity could prosper. The struggle (often broadly construed in terms of a continuum stretching between Left and Right) was also a contestation over forms of knowing and acting in the world. This contestation was cohered around differing assumptions of human nature, such

as whether humans were rational or irrational, individualist or collective, and the extent to which states or governing authorities needed to intervene upon this basis. Today, this view of politics as a contestation over the nature of the human and how humanity can best be served is seen to be less central to contemporary concerns: and no longer as the 'be all and end all' of politics.

Perhaps an obvious analogy could be made with how the struggles of the warring kingdoms of Westeros, in the 'Game of Thrones' TV series, begin to pale into insignificance in comparison to the looming collective threat posed by the coming of winter and the White Walkers. Like the coming of winter, entry into the epoch of the Anthropocene is held to displace the modernist framework and context of political contestation. Modernist politics and governance assumed that the 'is' of the world would look after itself, i.e. that nature or the environment was just the backdrop or the stage for the great struggle between Left and Right. Today the positions seem to be reversed, winter/the Anthropocene is seen to push the politics of Left and Right from the foreground to the background. As Nigel Clark argues, 'the impression that deep-seated forces of the earth can leave on social worlds is out of all proportion to the power of social actors to legislate over the lithosphere' (the earth's upper mantle and crust) (Clark, 2010: KL 220-221). The relation between humanity and nature appears to be reversed:

> What does it mean to say that life, or the earth, or nature, or the universe are not just constellations of material and energy with which humans forge connections, but realities upon which we are utterly dependent – in ways that are out of all proportion to life, nature, the earth or the universe's dependence on us? (Clark, 2010: KL 917-918).

The reversing of the background and foreground is not entirely politically neutral. In fact, it is the aspirational politics of the Left, in its desire for greater freedom, autonomy and equality in social and economic life and for an increase in material wealth and its broader distribution, which appears to be particularly problematic. As Sara Nelson and Bruce Braun argue: 'In the context of these entanglements it is not clear what autonomy means, politically or ontologically' (Nelson and Braun, 2017: 224):

> As evinced in the notion of 'immaterial' production and an emphasis on the revolutionary possibilities offered by cognitive and communicative capitalism, the material conditions of this new economy of extractivism and the globalization of manufacturing remained unacknowledged… The understanding of human potentiality… depends on a sharp distinction between life and nonlife, human and nonhuman, and the movement's historical analysis and political imagination rely on a knowable, reliable, 'always there' nature that is neither used up nor filled with surprises (Nelson and Braun, 2017: 229).

As Jason Moore has illustrated, one of the key problems for those who believe in material progress as the key to human betterment has been that capitalism did not just exploit unpaid labour power but also the productive power of non-human labour. Thus, for Moore, it is not only that, as Marx noted, there is a tendency of the rate of profit to fall but there is also a tendency

for the rate of 'ecological surplus' to fall,[9] with the depletion of energy and mineral resources (Moore, 2015: 226). The drive to overcome boundaries to the appropriation of 'cheap nature' as well as 'cheap labour' gave capitalism a productive dynamic not based purely on the invisibility of human labour of unpaid reproduction (highlighted by feminist scholars, like Silvia Federici, 2012) but also on the invisibility of non-human labour and resources (an invisibility which is now all too visible). What was seen to be the expansion of progress and human potential can be read as actually the extractive machine of capitalism ceaselessly seeking new untapped resources to exploit on the 'cheap'. This form of organizing nature has now reached its limits, ironically because of the resistance of non-human 'nature' rather than a rebellion of humanity (Read, 2017). As Stengers notes: 'Today all Marxist or post-Marxist scripts must confront a perspective of destruction that Marx could not anticipate… which deeply perturbs any theory indifferent to the new, dramatic restriction of our historical horizon.' (Stengers, 2017: 383)

Dipesh Chakrabarty argues that 'logically speaking, the climate crisis is not inherently a result of economic inequalities'; if we had lived in a 'more evenly prosperous and just world' then 'the climate crisis would have been worse': 'Our collective carbon footprint would have only been larger – for the world's poor do not consume much and contribute little to the production of greenhouse gases – and the climate change crisis would have been so much sooner and in a much more drastic way.' (Chakrabarty, 2015: 49; see also Chakrabarty, 2009). Similarly, part of the problem of 'population' is 'due surely in part to modern medicine, public health measures, eradication of epidemics, the use of artificial fertilisers, and so on' and therefore 'cannot be attributed in any straightforward way to a logic of a predatory and capitalist West' (Chakrabarty, 2015: 50) Any imaginary of capitalism paving the way to socialism as a more progressive system, as Stengers argues, needs to be rejected on the basis that it 'would instead herald the perfect socioecological storm which systematic extraction is now unleashing' (Stengers, 2017: 387).

As Amitav Ghosh asserts, colonialization can be understood to have held back climate change: if the European empires had been dismantled earlier, for example, after the First World War, there is every chance that the economies of mainland Asia would have accelerated earlier (Ghosh, 2016: 109-110). Thus, the concept of human freedom that developed with the Enlightenment is held to disappear in the Anthropocene, as it is realized that humankind can never shed its dependence or transcend its constraints (Ghosh, 2016: 119): '…the Anthropocene challenges the modern definition of freedom, long conceived in opposition to nature… A freedom understood in this way sets human emancipation against nature, against the Earth as a whole.' (Bonneuil and Fressoz, 2016: 40) For Chakrabarty and others, the problem of global warming and climate change challenges political discourses of progress, based upon social justice and global equality and freedom from oppression: there is a 'growing divergence in our consciousness of the global – a singularly human story – and the planetary, a perspective to which humans are

[9] Highlighted as a 'metabolic rift' by McKenzie Wark (2015: xiv): 'where one molecule after another is extracted by labor and technique to make things for humans, but the waste products don't return so that the cycle can renew itself.'

incidental' (Chakrabarty, 2015: 55). Nelson and Braun argue that we are forced to accept that modernist or radical views of human autonomy and human freedom can no longer be credible today, 'if the Anthropocene represents the farcical realization of human autonomy in the form of planetary devastation – in which the 'production of man by man' appears to lead to his extinction' (Nelson and Braun, 2017: 233).

Taking a broader approach to problematise modernist approaches to governance in their entirety, William Connolly emphasises that the problem is epistemological rather than narrowly 'political' – or to do with capitalism per se. Modernist political frameworks of Left/Right contestation lacked an appreciation of the planetary processes, which are recognised today. While thinkers of the Right and the Left may have fundamentally disagreed over many issues they all shared a 'sociocentrism' or 'human exceptionalism', which placed humans as somehow above and separate from the world. They acted as if social, economic and political processes were all that mattered; that the 'environment' was merely the backdrop to the great human drama of social and political struggle. If the moderns considered changes caused by non-human forces and assemblages, these were considered to be set on a different and slower temporality than that of human or cultural transition and transformations:

> Sociocentrism, in individualist, nationalist, communist, neoliberal, and republican traditions, assumes that a political economy is either in charge of nature, or that the limits nature poses to it are set on long, slow time, or, in a more attenuated version, that if we lift the human footprint nature will settle down into patterns that are benign for us. Given any of these assumptions, questions of agency, explanation, and belonging in practice tend to devolve around attention to internal cultural practices. (Connolly, 2017: 20)

As Connolly and many other authors insist, modernist conceptions of governance, of belonging and community, of ethics and ideas of human freedom and human exceptionalism, based on modernist epistemological and ontological assumptions of reason and causal linearity all need to be reformulated and reconsidered. The contemporary consensus is that 'the Anthropocene concept obliges us to embark on a deep reconceptualization' of the categories and concepts of political science, including the understandings of human agency, of history, of politics and of democracy (Hamilton *et al*, 2015b: 9): 'Yet political theory, stuck in the Holocene, has been slow to recognise the Anthropocene and what it means. Most insights have come from philosophers and sociologists' (Hamilton *et al*, 2015b: 9) less tied to the assumptions and binaries of the formal political sphere of states and citizens.

This shift fundamentally alters the nature of politics and governance. Politics is no longer 'all about us' in the sense of what we might think a just or equitable world might be and instead 'all about the world itself'. Stengers captures this nicely in her view that, while the problems of the Anthropocene may be caused by the coupling of the material processes of capitalism and geological forces of nature, the brutal intrusion of the planet or Gaia means that 'Struggling against Gaia makes no sense: it is a matter of learning to compose with her.' (Stengers, 2015: 53) Stengers emphasises that '*there is no choice*' (Stengers, 2015: 58). This entails:

> …cutting the link… established [in the nineteenth century] between emancipation and what I would call an "epic" version of materialism, a version that tends to substitute the tale of a conquest of nature by human labor for the fable of Man "created to have dominion over the earth." It is a seductive conceptual trick but one that bets on the earth available for this dominion or conquest. Naming Gaia is therefore to abandon the link between emancipation and epic conquest, indeed even between emancipation and most of the significations that, since the nineteenth century, have been attached to what was baptized "progress." (Stengers, 2015: 58)

For Stengers, the modernist discourse of "progress" and of the possibility of a "happy ending" is over, which means that if 'emancipation' is to mean anything today it will be a question of our emancipation from modernist illusions of human exceptionalism. Key to this is paying attention to the reality of the world rather than human imaginaries: 'What it is a matter of being wary of are the simplifications that would still ratify a story of progress, including the one that enables us to see the truth of what we are facing.' (Stengers, 2015: 67)

Conclusion

Governance approaches highlighting the importance of planetary boundaries and the shift towards the Anthropocene can be increasingly understood as putting the nature of entangled being at the centre of politics rather than the designs or goals of the human as subject. The contemporary governance assumptions of the Anthropocene do not raise the possibility of alternative futures but instead seek to affirm the world as it currently exists, for these authors - many of them formerly radical and critical theorists of the Left - any alternative would merely reconstitute the view of man as a knowing subject separated from the world. Thus, the first point is that contemporary critical sensitivities necessarily affirm the idea that 'there is no happy ending' (Tsing, 2015: 21). As Danowski and Viveiros de Castro note, today we appear surrounded by a cacophony of contemporary voices, with new and sophisticated arguments, all determined to 'end the world' and even advocating that the 'real' world, 'in its radical contingency and purposelessness, has to be "realized" against Reason and Meaning' (Danowski and Viveiros de Castro, 2017: 3). There is little doubt that these views are powerfully expressive of the underlying sentiments driving the new governmental framings of the Anthropocene.

Thus, key to the transformation of understandings of governance is the contemporary perception of modernity as over. The arrival of climate change and global warming, indicating a new set of problems and potential limits to progress and development, seems to have coincided with an already existing exhaustion of the modernist episteme, creating a potent dynamic. As Claire Colebrook notes: 'The Anthropocene seems to arrive just as a whole new series of materialisms, vitalisms, realisms, and inhuman turns require us to think about what has definite

and forceful existence regardless of our sense of world.' (Colebrook, 2017: 7)[10] This is why, for many governance theorists, the Anthropocene appears as something that is non-negotiable. Jessi Lehman and Sara Nelson, for example, argue that: 'In the Anthropocene, we are always already living in the aftermath of the event.' The delayed dynamics of climate change mean that its impact is unavoidable while the entanglement of human and geological factors mean that human agency can never again be imagined in modernist ways (Lehman and Nelson, 2014: 444). Stephanie Wakefield asserts that: 'the crisis is the age. It is on this terrain of an exhausted paradigm – both historical and metaphysical – that a battle is underway' (Wakefield, 2014: 451). This sense of modernity as 'an exhausted paradigm' has enabled the new formulation of governance in the Anthropocene to rapidly cohere and appear to be powerfully vindicated in every extreme weather event or unexpected accident or disaster.

[10] In fact, Richard Grusin (2017: viii) argues that 'the concept of the Anthropocene has arguably been implicit in feminist and queer theory for decades'.

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Complex Governance for the Anthropocene

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Abstract

The Anthropocene presents formidable governance challenges, not only in terms of the large uncertainties that surround the impact of humans on the biosphere, but also because it is occurring at a time of profound transformations in international politics. This article builds on the recent literature on complex systems and international environmental politics and identifies some of the core elements of thinking about governance in the Anthropocene. After a brief reminder of the characteristics of a complex system and the challenges that this poses to some of the existing doxa, it proceeds with a discussion of key elements of the system, of aspects of its operation, and of the goals that one should pursue in terms of system dynamics. Approaching the governance of the Anthropocene as a complex system allows us to shape much of current research in IR into a coherent whole, as well as identify the contours of a global international governance system of the environment that takes advantage of the dynamics of the system rather than courting failure by attempting to simplify it.

Keywords: Anthropocene, International environmental politics, Complex Governance

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Introduction

Its debatable scientific merit apart, three ideas behind the concept of the Anthropocene make it useful: (i) nature is no longer independent from humans (Pattberg and Zelli 2016); (ii) the latter have the power to shape its dynamics to the extent that it can endanger their ability to attain whatever is defined as social goods; and (iii) environmental changes reflect the evolution of societies and are embedded in a profound transformation of international politics. The Earth is new both in terms of the evolution of the biosphere and human-biosphere interactions (which changes our image of nature) and in terms of international politics, which demands new ways of approaching the international governance of environmental issues.

Although attempts to apply concepts from complex systems theory to international relations are not new—see, for example, Rosenau 1990, Jervis 1997, Harrison 2006, Kavalski 2007, Clemens (2013)—, scholars have struggled to translate its key concepts into a better understanding of the dynamics of international relations and draw policy implications from them. A spate of books, special issues, and articles have eloquently made the case for "embracing complexity" (Boulton et al. 2015), yet International Relations (IR) scholars have been slow to do so. The literature is long on general admonitions and short on specifics that might provide guidance in order to apprehend that complexity. The profession uses the vocabulary, but either forgets the supporting reasoning or rejects it outright as a potential paradigm of IR. At the same time though, new conceptual tools have emerged that respond to that need, even though they may not be integrated into a coherent whole.

Indeed, scholars have increasingly turned their attention to the problems raised by the behavior of complex systems, notably through the analysis of models of cooperation, non-linear dynamics, networks, regime complexes, boundary-organizations, or multi-scalar governance. In many ways, research has *de facto* moved towards responding to the challenge of apprehending a complex system. Intellectually though, the prevailing discourse, both in academia and politics, remains steeped in analytical linear thinking that emphasizes centralized authority and prediction. Complexity is seen as a challenge rather than as an opportunity. Nevertheless, many approaches to contemporary international governance are manifestations of or adaptations to complexity, such as the development of private governance, the rise of regions, network analysis, multi-level governance, or the emphasis on local participation in order to address potential non-linear effects, and on promoting a dialectical construction of the science-policy interface. These developments are conceived outside a complex intellectual framework, however. Rather, they seek to respond to temporary problems and are appended to linear frameworks. How can complex systems thinking help us redefine both the nature of the problems and its political solutions? How can it facilitate an international policy-oriented agenda? How can we reconcile what takes place at different levels of governance and foster synergies among them?

The purpose of this article is to sketch some of the core elements of thinking about governance in the Anthropocene in a complex perspective: what does it mean to speak of "complex global governance of the Anthropocene"? The Anthropocene is the result of multiple

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factors, from technology, ideology, culture, consumption and poverty alleviation to a variety of domestic and international politics. My concern, however, lies in global governance where those factors converge.

Although it may sound like an oxymoron, governing complexity is far from being a new question (Jessop 1997). The very notion of governance, as articulated in IR, addresses the need to cooperate in solving common problems in the context of the fragmentation of authority and multiplication of actors. Thinking in terms of complex systems can help us identify the contours of a more relevant global international governance system of the environment. To that end, the article starts with a reminder of the characteristics of a complex system and the challenges that this poses in adopting new ways of thinking about international environmental issues. It then proceeds by looking at the elements of the system (part 2), its operation (part 3) and the goals that one should pursue (part 4).

1. The Challenge of Governing the Anthropocene in a Complex System

The Anthropocene, like many other concepts in global environmental governance, has first an instrumental value designed to raise awareness, mobilize decision-makers and citizens, and stimulate action in favor of more determined environmental policies coordinated globally. To be effective, the concept should be both intellectually fruitful and politically useful.

The Anthropocene is about the combined dynamics of natural and social complex systems each undergoing profound transformations. The notion of the Anthropocene goes beyond mass biodiversity extinction. It also encompasses the emergence of multiple disequilibria provoked by climate change as well as the disruption of the cycle of elements fundamental to sustaining life, such as nitrogen or the water cycle (Vitousek, Ehrlich et al. 1986, Vitousek, Mooney et al. 1997). The Anthropocene label thus points to irreversible dynamics under way that are the product of a system that can be characterized as complex. Apprehending it, limiting the scope of transformations within a reasonable time frame, building sustainable societies and ecosystems, and adapting to the impacts of the Anthropocene require new thinking. At the global level, the problem is particularly wicked, not only because it refers to nature-societies interactions that involve diverse actors, competing values and interests, and multiple uncertainties, but also because it emerges at a time of profound transformations of international relations.

Globalization has added uncertainty to the twin properties of interdependence: sensitivity and vulnerability. It increases the unpredictability of the system, for it means more actors, more linkages among issues, the existence of competing norms embedded in various regimes, and a multiplicity of forums (public, private, public-private) where norms and regulations are negotiated. Interdependence and globalization increase the uncertainty attached to (i) the meaning of events, (ii) the actions of other actors, and (iii) the consequences of one's own actions, which reflects the non-linear behavior of the system.

1.1 The nature of complexity

The nature of complexity and complex systems as applied to IR has drawn increasing attention (for example Harrison 2006, Kavalski 2007, Bousquet and Curtis 2011, Le Prestre 2017, Young 2017). Complexity eschews the simplification and reductionism of classical analytical thinking, which, although hugely successful, also lead to models that have difficulties describing and accounting for observed reality. To illustrate this shift of perspective, one distinguishes between the "complex" and the merely "complicated" (Morin 1990). A jet engine, which can be disassembled and reassembled at will, will work as intended if the engineers have calculated properly the characteristics of its thousands of parts and if the mechanics have assembled it right. It is very complicated. Something "complicated" can be solved by cutting it down into manageable parts. Complex problems, on the other hand, cannot be simplified without being strongly altered or "mutilated", and their behavior is not predictable from the knowledge of their parts (Morin 1990). The world is not a machine. From a complex perspective, the right question is not how to make the current system less complicated by centralizing authority, but how to "harness" (Axelrod and Cohen 1999) the complexity of the system in order to heighten its effectiveness.

Thus, a system is complex when it has multiple and diverse elements of various types, intricately interconnected with one another (thereby forming networks), which, in turn, leads to feedback loops and nonlinearity. It is also open (exchanging information with its environment) and hierarchical in the sense that the behavior and properties of higher-level systems are rooted in what takes place at lower levels. Whereas political systems are commonly described at only one level of organization, "complexity theory provides a framework in which the relationships between constructs at different hierarchical levels can be accommodated" (Parrott 2002: 2).

Distinctive attributes have been associated with complex systems, notably (i) self-organization and self-regulation (order emerges naturally from unpredictable non-linear interactions among agents); (ii) emergence (the system is more than the sum of its parts: new and unexpected structures, patterns and properties arise; at any level of analysis, order is an emergent property of individual interactions at a lower level of aggregation, rather than explained by causal drivers at the same level of analysis); and (iii) adaptation (a notion that goes beyond access to resources in order to include «fitness» and co-evolution, and that includes the issue of learning).

For each of these properties, contradictory dynamics can take place within complex systems. For instance, like other systems, complex systems are subject to path dependency. The behavior of a complex system is contingent on the local context and on the previous sequence of events.[1] They also regularly present surprises and unexpected outcomes. While complex

[1] For example, decision-makers are victims of their past decisions, that is of past strategies of adaptation. Actors tend to continue resorting to a specific adaptive behavior unless strong negative consequences have been observed, and this even in the absence of positive data linking the strategy and the observed results.

systems might appear chaotic at first because of nonlinearity, feedback loops, and tipping points (where a system suddenly flips to a very different state), their adaptability means that they also know phases of continuity. Just as some highly diverse ecosystems can only persist over time thanks to disruptive events, complex systems constantly regenerate themselves after destabilizing situations.

Two other aspects are central to the application of a complex systems perspective to international relations. First, by definition, complex systems cannot be controlled by a single source of authority able to capture all significant interconnections, and even less control their outcomes unless they are drastically simplified (as is an agricultural system for example, or dictatorships). Second, in complex social systems, issues are not merely technical; normative and political dimensions are inherent to the process, leading again to the potential of multiple equilibria, as in the case of sustainability (Haas 2016).

Ironically, even though discourse and policies remain steeped in linear thinking, the actual world and research in international relations have moved beyond such models. Much current work on global environmental governance is removed from the traditional hierarchical and regulatory-oriented model, and includes models of cooperation under anarchy, the notions of regime complex and linkage diplomacy, the redefinition of the science/policy interface, the development of multi-scale governance, the dissemination of certain norms (such as participation), and new instruments of governance involving a plurality of actors (non-governmental organizations (NGOs), business, international organizations (IOs), cities and sub-national political units, networks, regions) that claim legitimacy in the development and implementation of international cooperation. A complex systems approach offers a potential overarching framework for integrating these new avenues of research, and it starts with shedding or contextualizing received ideas.

1.2 Challenging the governance doxa

Thinking anew requires challenging elements of the governance doxa that has been driving advocacy, policy, as well as much of scholarship. This doxa is rich in conclusions or pronouncements that pass for knowledge but become questionable under a complex system perspective. Thus, critics of the current governance system have bemoaned (i) national sovereignty, (ii) institutional fragmentation (leading, they believe, to conflicts over authority, a waste of scarce human and financial resources, a lack of coherence, and a heavy diplomatic and financial burden); (iii) a lack of consensus on the norms that should prevail and on what should be avoided first; (iv) interstate disputes regarding the nature of acceptable risks and the role of science; (v) the United Nations Environment Programme's (UNEP now UN Environment) struggle to play a leading role in environmental matters and, more broadly the relative decline of the United Nations (UN) in global governance; (vi) conflicts among regimes, such as between the environment, on the one hand, and trade, development, and human rights on the other; and (vii) and the lack of implementation of existing agreements mostly due to the weakness of most current agreements. Let us briefly discuss three of the most common received ideas: that global

problems require global solutions; that strong treaties are needed to ensure cooperation; and that centralizing authority through powerful international institutions is key to dealing with the consequences of the Anthropocene.

1.2.1 Do global problems always require global solutions?

At one level, one may argue that it is not the scale of problems but their nature that drives solutions. Global problems (such as ozone depletion or climate change), where nobody can escape being impacted, differ from worldwide problems (such as biodiversity loss), that may affect all states but whose solutions are essentially local, national, and regional. Global problems, though they may be collective action problems, do not imply, by that very characteristic, that their solutions must include all actors and all related issues. It is not because everything is related to everything else that everything and everybody must be part of the analysis and solution.

This does not eschew the need to search for a way forward at the international level and for coordinating approaches devised at lower levels, which explains why international fora and agreements are necessary. However, neither does it mean that all actors have to be included in the solution, accept similar norms, and adopt identical policies. Indeed, defining global problems as requiring global solutions leads to an all-or-nothing approach, to a rally around a lowest common denominator, and to higher risks of failure either through blackmail or through the refusal of actors to act alone. The key issues are what happens at the national level in key states, the prospects for the diffusion of these policies and norms both horizontally and vertically, and whether potential free riders can significantly jeopardize the effectiveness of the regime in the long term. Globalizing problems does not hide regional and national differences; it may even exacerbate them. The call to transcend the state tends to assume that there are universal solutions to global problems, thus negating the importance of the local. Indeed, a strong research agenda now focuses on regions and multiscalar governance, that is the articulation of the global with local and intermediary levels of governance (see below).

1.2.2 Are strong treaties key to meaningful cooperation?

Another mantra, particularly popular with non-governmental organizations (NGOs) and legal scholars, is that to be effective, international environmental protection must rest on treaties that contain specific obligations and strong enforcement provisions. This belief calls for a few caveats.

First, compliance (that is, the extent to which parties fullfil their obligations) is not effectiveness (the extent to which the agreement helps change the behavior of relevant actors towards desired ends). States usually negotiate the obligations they believe they can fullfil and can be in compliance even though they have done nothing to implement the provisions of an agreement (Victor, Raustiala et al. 1998). Therefore, treaties that focus on compliance may miss the mark.

Second, this approach may assume the problem to be solved. If states are ready to accept strong measures that demand specific actions (with little room left for interpreting the obligations in light of their own circumstances) under threat of drastic sanctions, then those measures are probably not needed since all will be convinced of their value and none would have an incentive to cheat. The problem then moves from achieving cooperation among states to managing the coordination of national efforts.

Third, the search for stronger treaties may also make their conclusion less probable and reduce the possibility of future cooperation. States will not ratify an agreement without knowing the details of the sanctions for noncompliance (as the negotiations on the implementation of the Kyoto Protocol illustrated) and without being convinced that the process will be fair both in its spirit and in outcomes. The definition of a fair and equitable process is itself unclear and likely to be questioned.

Sanctions have to induce compliance and a gradual strengthening of commitments, rather than make the latter more difficult to achieve. In the case of the Kyoto Protocol, although notionally legally binding, they failed to guarantee the domestic implementation of commitments (particularly in federal systems) and also made it less probable that noncompliant states would later agree on a follow-up treaty. Treaties need to be flexible in order to adapt to specific implementation contexts that differ widely. For example, transboundary water issues require legal norms that can fit the characteristics of each case (Sohnle 1998). Finally, far from weakening international law, even a weak treaty may induce positive political dynamics within governments and civil societies that help disseminate norms and principles. It defines yardsticks for evaluating behavior, identifies a direction, and helps mobilize actors.

1.2.3 Powerful international institutions are not necessarily the answer

The belief in the virtue of centralizing authority at the international level is widespread. When it proposed the creation of "an IPCC for biodiversity" in 2005, which eventually became the IPBES, the French government envisaged "a single steering center that issues specific directives."[2] This belief in the virtue of centralization often takes the form of a call for a World Environment Organization (WEO) from scholars (see Biermann 2014), NGOs, some governments, and Popes (from John XXIII to Francis).

This is largely a solution in search of a problem. Conflicts among regimes, such as between environment and trade, which a global authority would be expected to minimize, are not the norm. No economic provision designed to facilitate the enforcement of an international environmental treaty has yet been denounced in the WTO. The WTO itself is not opposed to using environmental concerns in decisions about trade, but it is concerned with the results of

[2] Renaud Dutreil, France's minister of civil service, Address to the International Conference on "Biodiversity, Science and Governance," Paris, January 24–28, 2005.

such decisions and with using trade-related environmental measures (TREMs) in a discriminatory fashion.

One should distinguish among different types of conflicts. Case studies, for example, suggest that normative conflicts among MEAs may be relatively few (Kim 2013, van Asselt 2014). Conflicts over resources and turf, on the other hand, are real, but again, studies other than anecdotes looking at the impact of these conflicts remain few. In fact, the system has evolved tools to manage them and synergies are possible, such as the potential synergies between Reducing Emissions from Deforestation and Forest Degradation (REDD) and the Convention on Biological Diversity (CBD) (van Asselt 2014).

More fundamentally, better coordination does not automatically follow geographical or administrative centralization in the absence of an overarching consensus on the norms and principles that should be promoted. This has a triple meaning: (i) current institutional diversity reflects the diversity of perspectives and interests at play; (ii) states hesitate to grant extensive powers to a single institution they do not control; and (iii) a WEO would, in effect, have difficulties speaking with one voice. This difficulty is enhanced by fragmentation at the national level among domestic groups, ministries and levels of government, which creates tensions that are enhanced by participatory and decentralization policies. Such tensions could quickly paralyze a WEO. If the latter manages to possess the authority and resources that its supporters would like, states will then be all the more eager to control its outputs: competition among different priorities could then quickly lead to stalemate or incoherence.

Indeed, the influence of most states (not to mention civil society) might be far more modest in a WEO than in individual regimes. Issue linkage may encourage successful bargaining over some issues but impede progress on others. It is unclear why such an agency would be better able to facilitate implementation of national legislation and international agreements, and the scope of its potential responsibilities might create new fears of green imperialism. Finally, nothing suggests that a WEO could demonstrate the ability to adapt and escape the ills of other large organizations, namely uncertain legitimacy, waste of resources, internal paralysis, incoherence of activities, and competition with other institutions. Faced with these obstacles, this solution has had little traction, and international environmental governance reform based on this premise has been trapped in quicksand.

Complex systems self-organize into emergent forms that cannot be predicted from an understanding of the behavior of their parts. The current premise, however, is the opposite and posits that effective governance stems only from the behavior of units (actors, regimes) and that the issue is some sort of centralized coordination (Biermann 2014). This is linear thinking. Faced with the dead-end efforts of the past thirty years to revamp the architecture of international environmental institutions, it has become urgent to develop a new model of governance. Rather than a centralized model predicated on editing norms, rules, and procedures at the global level, an alternative one should be articulated that rests on the new dynamics of international politics, that is on the development, control, and harmonization of various governance networks, on regional differentiation, and on the integration of various levels of governance. In this context, three type

of questions arise pertaining to (i) the role of the elements of the system (section 2), (ii) the operation of the system (section 3), and (iii) the goals to be pursued (section 4).

2. Rethinking the elements of the system

2.1 The nature and multiplicity of the elements of the system

Though it remains dominant, the state now governs in alliance with other actors with whom it shares legitimacy. The latter have multiplied, sometimes thanks to the states themselves, and have even spawned new ones. Just as international organizations beget international organizations (Johnson 2014), NGOs beget NGOs, and networks beget networks.[3] In complex governance, neither the actors, their type (public, private, hybrid) or nature (unitary or not), nor their preferences are given. Indeed, the importance of networks compels us to see actors as non-unitary. Preferences are constructed from roles which stem both from the actors' location in the system and from their identities. Just as in domestic politics, international governance of the Anthropocene rests on harmonized and coordinated interactions among a variety of actors that act as partners while pursuing different interests.

Globalization, trade, and environmental concerns have made it impossible to separate domestic and external issues. As the number of relevant and legitimate stakeholders increases, so does uncertainty, but so do avenues of action and agreements among a variety of actors acting independently from the state. For example, the Pope and the mayors of large cities signed a declaration on climate and human trafficking in July 2015. Before the Paris climate accord of 2015, local authorities were the only international level of governance where agreements were concluded committing them to long-term action against climate change. Between 2000 and 2010, cities have organized into a network of networks on environmental issues, and have established themselves as a strong voice on climate change.

These actors, be they central government units, sub-governments, business, civil society groups, IGOs, form transnational networks and coalitions around which politics coalesces. They also operate at different scales. The challenge for governance is not only to understand the interaction mechanisms between different levels (Rosenau 1990), but also to allow for the construction of an intersubjective world that enables the mobilization of actors engaged in the definition and the implementation of various institutions that define a regime complex. This transformation of former subjects of international governance into stakeholders and partners, therefore, implies the development of participatory politics where stakeholders are associated with international discussions and problem framing, with the search for solutions, and with their

[3] For example: the UN General Assembly established the United Nations Environment Programme (UNEP) which was behind the development of several MEAs with their attending secretariats; the International Union for the Conservation of Nature (IUCN) created the World Wildlife Fund (WWF) that in turn founded TRAFFIC (the wildlife trade monitoring network); the International Council for Local Environmental Initiatives (ICLEI) led to the creation of the Cities for Climate Protection network (CCP), etc.

implementation. This points to the new dialectical relationship between science and policy, to the importance of retaining multiple points of access rather than centralizing authority, as well as to strengthening the capacity of certain coalitions of actors to move at different speeds.

Finally, networks as governance units comprising agents interacting nonlinearly and holding specific ways of apprehending the world (Wells 2009) lie at the heart of the governance of complex systems. The formal analysis of network (as opposed to the recognition that networks may be important new actors (Keck and Sikking 1998, Reinicke 1999) has consequently gained increased though belated popularity (Hafner-Burton, Kahler et al. 2009, Maoz 2011), particularly in the study of international finance, trade, or the environment.

Agents form networks based on their nature or purpose. The diversity of interactions among the different agents of global environmental governance is illustrated by the variety of hybrid networks that associate public and private actors (Dubash and Florini 2011). New forms of collaborations between various types of authorities (public, private and market) have given rise to a multiplicity of decentralized governance strategies (Lemos and Agrawal 2006): co-management (between state and community); outright delegation of authority (as in the management of protected areas delegated to NGOs); public-private partnerships (between state and market); private-social partnerships (between community and market); or private authority (between firms and NGOs). These new forms of collaborations, with “uncertain accountability mechanisms" (Smouts 2003, Dubash and Florini 2011), are complemented by intra-networks governance strategies such as the development of industry-wide guidelines.

Future international relations will increasingly involve the interplay of agents and their networks with hybrid networks of coalitions. Policy networks are particularly interesting in the context of global environmental governance. Examples are the Consultative Group on International Agricultural Research (CGIAR), the World Commission on Dams, the Global Water Partnership, the Roll Back Malaria Campaign, and the International NGO Desertification Network (RIOD). In this regard, networks have a key role to play in linking various governance levels, from the local to the global, or between regions either directly or through international organizations.

2.2 Rethinking the role of international organizations (IOs)

As arenas where various actors interact, IOs play a key role in the transformation of the Westphalian system into a complex system. The recent literature on international organizations has devoted a lot of attention to the role that IOs play or should play. March and Olsen (1998) suggest two ways through which international institutions may affect system change: shaping identities and capacity-building (March and Olsen 1998). The question of the functions that IOs play has two aspects of interest here: the first one is the twin issues of densification and fragmentation; the second one pertains to their role.

Densification has usually been seen as a problem to be overcome, and the notion of interplay among institutions (be they individual organizations or regimes) has spawned an active scholarship based on the assumption that the fragmentation of authority among international

institutions governing the environment is basically dysfunctional (Oberthür and Stockke 2011). From the viewpoint of regime complexes, Alter and Meunier (2009) have identified both positive and negative aspects, of densification of IOs on the behavior of agents, although their relative importance and what really constitutes a positive and negative impact of actors' behavior is very much open to debate. Complexity promotes dynamics that increase actors' strategic options, which may or may not be viewed as negative. For example, one may deplore or welcome that it leaves states significant latitude to interpret their obligations, thanks to forum shopping or through strategic inconsistency (where actors intentionally create conflicting rules in different forums so as to widen their options), or even that it facilitates exit via non-compliance, regime shifting, or withdrawal from IOs (Alter and Meunier 2009).

This applies to other actors as well. Whereas traditional students of regime interplay and international institutions deplore competition among institutions and actors, it can have both negative (such as turf battles and a failure to coordinate efforts) and positive effects (increasing total resources, spreading risk, allowing experimentation) (Alter and Meunier 2009). The same holds true for the emergence of small groups, which may both increase trust and promote groupthink.

Densification is not *ipso facto* negative. As in ecosystems, one should build upon diversity rather than try to reduce it, and thus favor decentralized authority. In this view, for example, MEAs of the biodiversity cluster are not a problem of institutional fragmentation, but adaptive features that may encourage effective governance through experimentation (Haas 2004, Harrison 2006, Jordan et al. 2018). Moreover, rather than focusing strictly on MEA secretariats, the more appropriate unit of analysis should be the convention governance system itself, that is the system of actors, norms, and interrelationships created by international regimes, of which secretariats constitute the administrative and coordinating unit. These units of evolution and adaptation are mission-oriented institutions, as opposed to management-oriented ones: more flexible (depending on their relationship with UNEP) and better able to learn, thus fostering the adaptiveness of the system.

Second, although we need institutions, these do not have to take the form of IOs. Karns (2017: 342) has urged us to need to "think more seriously about how to deal with the decline or disintegration of IOs and with changes in global governance arrangements that result from domestic shifts within major powers, the emergence of new power centers and actors, and unanticipated crises". At the same time, Young (2017: E4102) insists on the need to make "a concerted effort to design institutional arrangements to address needs for governance in a manner that is tailored to the key features of the relevant issue areas, that takes advantage of opportunities to find roles for existing players, and that minimizes the need to build intergovernmental organizations that are costly to operate and likely to fall prey to a variety of bureaucratic problems."

Third, IGOs must be seen as open systems themselves that is "systems of interdependent activities linking shifting coalitions of participants" (Baum & Rowley, 2005 quoted in Ellis 2010). In this regard, network analysis should prove particularly useful when IOs are viewed not as

putative command-and-control organizations but as "networks of interdependencies" (Karns 2017).

The question of their scope has both a geographical and a functional aspect. First, IOs may be further decentralized. In some respects, for example, the WHO is actually a federation of regional health organizations,[4] which in some cases even predate the formation of the WHO itself, operate fairly independently and have their own relationships with donors. With respect to their functional scope, co-evolution may lead to the development interdependence or to the construction of niches (Abbott, Green et al. 2016) as a way of dealing with competition. Each path entails a trade-off. In the case of interdependence, it is between maximizing access to resources at the expense of autonomy associated with increased vulnerability. In the case of specialization, it may be a gradual lack of fit with the evolution of the environment and a movement to an evolutionary dead-end.

In a complex perspective, the role of universal IGOs moves from one of norm setting and regulation to coordination, harmonization, and orchestration. To be sure, some would like their functions to be "to construct the social world in which cooperation and choice take place and to help define the interests that states and other actors come to hold" (Barnett and Finnemore 2004: 162), which they would carry through intellectual leadership by gathering and filling knowledge gaps, or setting and monitoring objectives such as development targets. Current dynamics are different, however. These functions, if they are performed at all, may be the result of networks operating though them, or be thrust upon them from other levels of governance (such as the regional level), or be performed by different types of IGOs (concerts rather than universal IGOs, boundary-organizations or mission-oriented ones).

The concept of "orchestration" (Abbott, Genschel et al. 2011, Hale and Roger 2014) is a convenient way of referring to some functions that IOs have been deploying for some time but now pursue much more actively. It corresponds not to an expansion of their role-set but rather to its transformation. IOs find themselves at the center of networks of actors of various types that flow through them, that they sometimes help create and associate to the governance of an issue-area, thus helping put in place a system of "transnational new governance" (Abbott and Snidal 2010) that they do not control, however. In a way, IOs become catalysts of actions undertaken by other actors in partnership or not with them, and forums where actions are harmonized, rather than central regulating operators within a hierarchical authority system. In particular, Abbott & Snidal (2010: 323) see this evolution as "a fundamental shift in the role of IOs and states in global governance, from traditional forms of regulation" to support for private governance, and finally to more direct roles as "orchestrator and participant" in a system based on collaboration among diverse entities.

[4] These six regional offices are: Africa (AFRO), Eastern Mediterranean (EMRO), Europe (EURO), the Americas (AMRO), Southeast Asia (SEARO), and the Western Pacific (WPRO).

To be successful orchestrators, however, IOs must have some degree of autonomy (or else a mandate from member states) and the capacity to coordinate private actors and schemes. On the one hand, organization theory warns of a trade-off between organizational adaptation, key to the dynamics of complex systems (see below), and autonomy. On the other hand, there is a growing literature that argues that IOs enjoy some freedom of action based on their legitimacy, differences in worldviews and interests among their members, on their capacity to build clienteles and mobilize civil society through non-state actors, on their control of expertise or on the latitude of their mandate, or on the willingness of their principals to grant them some degree of independence (Abbott and Snidal 1998, Nielson and Tierney 2003, Barnett and Finnemore 2004, Hawkins and Lake et al. 2006). This leads to a wider rethinking of multilateralism.

2.3 Rethinking universal multilateralism and the role of the regions

When discussing the evolution and role of multilateralism in the complex governance of the Anthropocene, one must first distinguish between the process (traditionally consultation and concertation among at least three parties) and its embodiment, such as IOs and other structures (clubs, concerts, fora, etc.). In both cases, it is opposed to unilateralism, imperial hierarchy, bilateralism, or nationalism (Caporaso 1992). In practice, however, multilateralism is often reduced to the UN, and thus to universalism.

Multilateralism is largely understood as the willingness to use international organizations, be they universal or regional, or to handle issues in a multilateral setting, from ad-hoc coalitions to clubs, regional arrangements, inter-regional cooperation, all the way to universal organizations. Some would go farther and see it as a virtuous mode of governance based on shared norms, principles, and rules that govern relations among states (Hampson and Heindecker 2011). According to Ruggie (2012), multilateralism is a way of implementing general principles of conduct whereas bilateralism approaches issues on a case-by-case basis. No longer is it a mere means to pursue certain goals; it now has intrinsic value, which leads to debates on the role it should play and the forms it should take. Supporters of this approach emphasize its legitimacy, its potential to handle interstates issues equitably, and the primacy of rule-based over power politics (Ruggie 1992).

Though universal multilateralism may be facing deep challenges, regional multilateralism is lively. The current travails of multilateralism do not stem solely from a return to unilateralism on the part of one great power or from a reversion to nationalism in several countries; they are also a manifestation of the gap between the evolution of the international system and traditional conceptions of multilateralism. Instead of a questioning of multilateralism, it might be more appropriate to speak of the experimentation of different modes of governance likely to be more flexible, legitimate, and effective, reflecting both the diversity of the issues at play and the decentralization of power and authority in the system (Jordan et al. 2018).

In a context where uncertainty and surprises dominate, regions become a useful instrument of complex multilateral governance (Bäckstrand 2008), "laborator[ies] of an international system in the making" as Nguyen (2012: 60) has called them, with some of them

ambitioning to become gradually one of the attractors of this new multilateral system. In this context, regional organizations no longer act as mere relays of what takes place at the universal level, but are arenas where specific approaches to global problems are articulated based on the particular sensitivities, experience and modes of cooperation of their members.

Even though the principle of common but differentiated responsibilities attenuates them, the rules of universal multilateralism focus negotiations on the search for strategies applicable to all states, leaving their specific implementation to other levels of decisions, including the regional one. This globalist approach reached a dead-end in the case of climate change, which has masked the potential of regional governance as a pillar of global action. Some have judged the Kyoto Protocol and the Clean Development Mechanism as fundamentally unfair, while others have questioned a western model based on science, the state, and the market.

In opposition to a disembodied and homogeneous policy space, the region is where local cultures come to life. Although environmental issues and globalization encourage a convergence of norms, globalization also gives rise to a reaffirmation of local and regional identities. A regional perspective links the movement towards a global community around norms and governance processes (more transnational than supranational) to political dynamics that emerge from the concerns and perspectives of domestic civil societies. Being the locus where decision-makers and experts meet societies, regions can become laboratories of a new democratic model at the global level.

Building on Cox (2002), Amitav Acharya (2014) has elaborated on this perspective with the notion of "pluralistic universalism" that emphasizes the need to formulate, understand, respect, and exploit the existing diversity of multilateralism rooted, in part, in regional specificities and differences in political cultures. This requires, for example, fine-tuning data collection and interpretation, as well as the conclusions one draws from them. For example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) released four assessments in 2018 that divide the world into four regions (the Americas, Asia and the Pacific, Africa, and Europe and Central Asia) allowing for the specific threats (and conceptions of the threat) to biodiversity in each region to be made more apparent, leading potentially to the articulation of location-specific policy responses.

Global governance does not entail the weakening of states, which may form power concerts. Through the study of four cases (the internet, genetically-modified organisms, intellectual property rights (IPR) and public health), Drezner (2007) has shown why a great power concert is a necessary and sufficient condition for effective global governance. His argument is not limited to states' actions and takes into account the role of IOs and NGOs, and argues that domestic actors shape states' preferences. More specifically, studies of the G7 and G20 by Kirton and Kokotsis (2015) have highlighted the more conclusive contributions of concert governance and small group negotiation over the UN with respect to leadership and commitments to clean energy and addressing climate change, thanks to the limited number of participants, greater political cohesion, status recognition, and direct political control.

3. The Operation of The System (Processes)

3.1 Self-organization

Self-organization refers to order emerging naturally from unpredictable nonlinear interactions among agents. These patterns result from a bottom-up process rooted in the interactions of the agents. The form these patterns take cannot be predicted, and they may or may not "accord with an overarching principle such as maintaining stability and control, maximizing profits, or minimizing energy consumption" (Boulton et al. 2015: 17). Self-organization is a response to uncertainty. This is evident in the multiplication of clubs, in governance partnerships, in the rise of regimes and the dissemination of norms, or in the delegation of authority granted to NGOs in implementation and monitoring. Climate change governance provides a powerful example of self-organization with the development of governance schemes, transnational action networks, and the multilateral negotiating fora (Jordan et al. 2018).

The establishment of regimes and specific convention governing systems dealing with biodiversity can be approached as example of emergent self-organization. Although interests matter, MEAs cannot be deduced from the aggregation of “states’… conceptions of their own interests” (Michell 2003: 97) when preferences can be unclear and unstable in environmental arenas in which knowledge is uncertain, issues are complex, and material interests are “weakly or ambiguously affected” (Ibidem). The timing and content of MEAs are influenced by the strength of states’ interests in environmental protection relative to other concerns and by their power to promote those interests, by the knowledge and discourse that structure perceptions of environmental problems and their solutions, and by the efforts of individuals and groups in proposing solutions and pressing governments to reach a given agreement (Idem).

Every regime symbolizing a combination of specific standards, interests, power and knowledge, forming a specific governance system, is evidence of self-organization. Regime complexes, as arenas where rules are negotiated and implemented, can also be seen as higher order dynamic attempts at self-organization. Other examples include private governance, tri-partite governance among IOs-States and private actors, or policy networks. As in ecosystems, one should build upon diversity rather than try to reduce it, and favor decentralized authority.

3.2 Rethinking the rules of the system and the bases for political action

Actors do not have absolute freedom of behavior. It is easy, from there, to argue in favor of strengthening international law within a universalistic perspective, forgetting along the way other types of institutions. One example of this aspiration is the current campaign in favor of a global environmental pact. Focusing on the production of legal rules for their own sake may be counter-productive, however. Actors are also constrained by expectations, internal dynamics, networks, the distribution of power, the behavior of other units, as well as their own conception

of their role. Though treaties and regimes embody the rules of the system and are key, so are other systems of rules (institutions) that may be more informal.

The aim is not to produce rules but steer behavior. Goal-setting, therefore, is key (Young 2017), whereas the rules devised to achieve them are pluralistic. There are many ways of reducing carbon emissions depending on local or regional conditions. What is important are that the principles underlying these actions are shared, what Young (2017) has called "principled governance".

A complex systems perspective also requires thinking anew about power, authority, accountability, and legitimacy. In a complex system, the issue is not to determine which units or agents are dominant and able to resist change, impose policy directions, or affect outcomes; nor does power stem from asymmetric relationships as in complex interdependence. Rather, power is distributed and resides in the capacity to mobilize and form coalitions around a given discourse about the nature of the problem and of acceptable solutions, not in the retention of information but in the capacity to make sense of it and relay it. Policy networks, mentioned above, are particularly interesting in the context of global environmental governance. Oran Young's concept of institutional bargaining becomes particularly relevant: "Institutional bargaining focuses on building coalitions of those willing to contribute to the supply of public goods rather than on reaching agreement on mutually acceptable outcomes located at specific points on contract curves (Young 2017, E: 640).

Although authority can indeed be a simplifying force (Earnest and Rosenau 2006) through which agents reduce uncertainty at the cost of some autonomy, the contemporary foundations of authority are diverse and embedded in a variety of actors that claim and sometimes enjoy authority in their respective spheres, which the concept of polycentricity captures well (Jordan et al. 2018). Active participation on the part of a single dominant actor (commonly known in regime analysis as a hegemon) is not a necessary condition for success in solving international environmental problems (Young 2017). In addition, formal authority and power may not coincide, as organization theorists have shown. One of the functions of boundary organizations is indeed to manage the interactions among these different spheres of authority and power. Distributing authority, resources and capacities across multiple institutions may enhance relevance, flexibility, and legitimacy in dealing with complex governance of issues such as biodiversity (Koetz, Farrell et al. 2012).

However, if authority is fragmented and if power is based on process and interactions rather than status or capabilities, what happens to accountability? Can any actor be held responsible for the observed outcomes if the latter are the fruits of nonlinear processes? Already, coalitions among private actors have raised the issue of the democratic deficit of private governance (Smouts 2003). More specifically, how to ensure that non-state actors are held accountable, and to whom? Does it mean that business and sub-state actors should be brought more fully into dialogues with governments around climate change, for example? Participation and co-management cannot be divorced from accountability (for a further discussion, see Biermann 2014).

Politics becomes the struggle over the range and limits of fractal authority, and global ecopolitics revolves around their identification, legitimacy, and relationships, as well as the search for self-organization in order for cooperation and effectiveness to emerge. This leads to the questions of where to locate various instruments of governance (see, for example, the subsidiarity principle of the EU), and how to manage interscalar relations.

3.3 The system is a product of the past but history is a poor guide to the future

Path dependency means that history matters and constrains behavior. Global environmental governance has a history, and this history matters. Although distinct phases of evolution can be distinguished since the end of the 19th century in terms of dominant actors, problems, values, and objectives, each phase retains characteristics of the former to which new ones are added, thus rendering it more complex. Complexity increases with the number of agents, the links among issues, and the evolution of norms, knowledge, and technology, among other factors.

Path dependency means that current institutions will shape future governance systems (March and Olsen 1998). One never starts from scratch. UNEP's weak resources bear that out to the point where global environmental governance has often been equated with merely strengthening UNEP or replacing it with a new World Environment Organization (WEO) (Biermann 2014). In addition, the very existence of UNEP has triggered new arrangements designed to bypass it, with states preferring to create new entities (such as the former Commission on Sustainable Development) or to marginalize it (as in climate change). For example, the creation of the Intergovernmental Panel on Climate Change (IPCC), followed by the negotiations of the UNFCCC and the establishment of its secretariat, represent a string of conscious decisions not to give it more executive authority (von Moltke 2001). This was by some extent motivated by the fear of creating a powerful international environmental agency, a recurrent fear in the history of UNEP (Ivanova 2017). Although they are politically and financially independent from it, relations between UNEP and several biodiversity-related conventions administratively under UNEP, have been tense over the years, further encouraging MEAs to form coalitions of their own.

Not only does what happened before matter, but the order of events in which it has occurred is important in shaping the current governance system (Boulton et al. 2015: 41). The system has a history. In that regard, a specific aspect of path dependency is the issue of sensitivity to initial conditions. Biodiversity-related IGOs, for example, embody the norms, technology, and political relationships that prevailed at the time of their creation, and these will continue to inform their behavior as long as the nature of the membership and of the human resources remains the same. But because of other properties of the complex systems that allow for non-incremental change, the behavior of the elements of the system (agents) at time *t+1* is not predictable, although the structural state may be (as in a warming liquid: we can predict the future state of the system—say evaporation—but not the individual behavior of the molecules).

The point between predictability and unpredictability of the elements is a "bifurcation" (Prigogine 1997) where the system may go different ways. The future becomes structurally

different from the past. Understanding these bifurcations is one of the main challenges we face (Young 2017). Species extinctions, for example, are the ultimate examples of irreversibility, and ecologists have long strived to identify both the nature of tipping points and the processes leading up to them (with the notions of minimum sustainable gene pool, keystone species, etc.), as well as their impacts. The notion of critical boundaries is predicated on the need to identify potential tipping points before the earth system enters a new phase state with devastating consequences on societies.

Unintended consequences, of course, directly stem from nonlinearity. Ecologists have long integrated the possibility of surprises into their models. Policy analysts have more difficulty doing so. Linear thinking is present when one looks at the new IPBES as a way of improving existing performance through the coordination of a scientific consensus around the protection of biodiversity. However, the IPBES also represents a disruptive innovation as it tries to define for itself a new niche, thereby forcing units to adapt (such as MEA subsidiary scientific bodies) and changing the relationships within and between regimes and system attractors.

4. The Goals That One Should Pursue

One of the major impediments to thinking anew about global governance from a complex systems perspective has been to go beyond vague admonitions and translate them into policy guidance. What should we do differently? How can complex systems thinking facilitate a policy-oriented agenda? How can we reconcile what takes place at different levels of governance, and how can we foster synergies among them?[5] Many approaches to contemporary international governance already reflect an adaptation to complexity, such as insisting on local participation in order to address potential non-linear effects (Clemens 2013), or promoting a dialectical construction of the science-policy interface. These developments are conceived outside a complex intellectual framework, however. Rather, they seek to respond to temporary problems and are appended to linear frameworks.

The obvious starting point, therefore, is to "embrace complexity" (Boulton, Allen et al. 2015) rather than fight it. Complexity is inevitable. Rather than try to reduce it as the traditional analytical approach would do, one should acknowledge it and consider its properties in the design of governance institutions. Complexity leads to new definitions of the problem and ways of approaching solutions. There are no real solutions, only responses that will engender new challenges. Issues are managed but not controlled or solved. Although many aspects deserve to be discussed in this context, we shall take up two key aspects of this issue: the goals to be pursued and adaptation.

[5] This discussion is limited to the dynamics of the system. The associated issues of effectiveness, accountability, and equity are also central to thinking about international environmental governance (see Biermann 2014, Young 2017, Le Prestre 2017).

The first aspect pertains to stability, that is, maintaining the essential properties of the system, including its components, within an acceptable range over time. In a complex system, however, not only are oscillations important, tipping points or bifurcations become a central concern (Young 2017), for they entail a change in the fundamental structure of the system. These "tipping points" have been a central concern of researchers in climate and biodiversity sciences.

Stability differs from equilibrium and stasis. Simple systems usually are static and tend to equilibrium; complex systems are always dynamic and dissipative (Prigogine and Stengers 1984). The issue is not to avoid positive feedbacks, which, as Resnick (1997: 134) has pointed out, are not always negative. Indeed, biodiversity policy aims at creating synergies (or positive feedbacks) among sectoral policies and policy instruments. The diffusion of new values regarding humans' relationship to the natural world will, it is hoped, benefit from similar dynamics. Likewise, tipping points are approached negatively not so much because they represent a qualitative change of the system, but because they appear suddenly, thus preventing smooth adaptation.

Thus, the issue is not to try to avoid perturbations (indeed the latter may be inherent to the stability of the system as are recurrent fires in grasslands), but anticipate them and build the conditions for resilience. Although composite systems (such as the global biodiversity governance system composed of units of different kinds) produce more minor events than catastrophes, chain reactions of all sizes are an integral part of the dynamics of large interactive systems. Composite systems never reach equilibrium; rather, they evolve from one stable state to the next, each phase containing dynamics that will inevitably transform it.

We must then think first about the system before acting on it (Meadows 2008). The issue is not only normative but also structural. This to be sure, is not new: many environmentalists have blamed the nature of political and economic institutions for the ecological crisis since the 1960s; but one keeps underestimating the extent to which the nature of the system shapes behavior. We should first identify those relationships that reduce policy effectiveness (understood has impediments to behavioral change) and lead to undesirable results, then change them, rather than cast blame (Meadows 2008). The environmentalist discourse, however, is often long on preaching and fond of advocating for individual or institutional redemption. This means, for example, balancing those feedback loops, whether positive or negative, that are associated with outcomes one wishes to avoid.

In complex social systems, it is the relationships among units and the functions that the system performs that matters. In ecology, what survives is not the single species, but the ecology or community of flora and fauna that are adapted to the prevailing conditions (Boulton et al. 2015). In anthropology, it is the function it performs, not the rite, the tradition or the specific taboo that matters. Likewise, one would emphasize co-evolution dynamics among actors (referring to institutional and policy diffusion, or to the emergence of co-dependence) and the evolution of their interactions. It is in that sense, that the issue of resilience, a property of the system, should be approached; it is not simply the ability of resisting external shocks, or bouncing-back after a disturbance (Chandler 2014), but the maintenance of basic properties and functions over time, and the development of new ones that make adaptation more likely. A

resilient system is not static, it evolves. As it does, its future state cannot be predicted because different causes can produce the same effect and conversely, similar causes, different effects; but the range of possible states can be. We may not be able to predict the future, but we can limit the range of possible outcomes and control for their consequences (Young 2017). A complex system approach, then, insists on trying to anticipate rather than predict.

Since complex systems cannot be controlled, context matters. We should then opt in favor of adaptive management (Holling 1978) characterized by flexible policies and the plurality of views that inform it, since no particular epistemic community can possess all the necessary knowledge to form policy. Science, models, expert knowledge, and the policies based on them are not interpreted as ultimate answers but merely as a means to guide a cautious process of intervention in complex ecosystems. The goal of management shifts from achieving a single target to an integrated view of maintaining ecosystem and social resilience, avoiding for example, catastrophic and irreversible "flips" to undesirable stable states. The twin objectives are to build institutions capable of learning and able to adapt. These conditions must be present at the level of the agent (since learning takes place there), but the system must also be designed to facilitate learning and adaptation.

Learning is based on designing feedback loops into the system. One example is the Montreal protocol and its procedures of revision of the range of chemicals covered by the protocol and its amendments and parties' commitments. At the unit level, say IOs, this leads to the development of new links, the adoption of new goals, a change in policies, internal reorganization, or the restriction or expansion of the policy domain. If treated as possessing agency and autonomy, IO adaptation could be researched from the perspective of organizational learning (Levitt and March 1988, Haas and Haas 1995, Argyris and Schön 1996), and one should encourage the development of mission-oriented organizations (see supra).

The denser and more diversified the networks, the higher the probability of collective and individual learning. This does not eschew the state: this new consensual knowledge must be accepted and advocated by a coalition of hegemonic member states. Orchestration mentioned above, through the mobilization of non-state and sub-state actors, may also prove to be a good instrument of collective learning. So is multilateralism that encourages norms harmonization and allows participants' visions of a given problem to converge. Learning rests on the capacity to develop shared conceptions of what is known and must be known, on the existence of stable coalitions of actors, and on leaders. It also entails (i) the development and coordination of knowledge networks, (ii) the creation of arrangements that strengthen transparency and the dissemination of information and allow for feedback loops from a variety of actors, and (iii) strengthening the capacity for error correction through extensive evaluations of actions that have been undertaken.

Learning is rooted in pragmatism which becomes the guiding approach of complex governance, conceived as "an on-going process of problem-solving, deliberation, experimentation, sedimented over time as experience, identity, habit, skill, and knowledge" (Geyer and Ansell 2016: 5). It recognizes that problems are not given but socially constructed,

that values are contextual and that they spring from deliberation, and that experimentation is the only way of dealing with the inherent uncertainty of the world (Idem).

From there, complexity will shape the type of adaptation strategies that actors can use and affect their outcome. As Jessop (1997) points out, all governance systems "are prone to failure" if they do not evolve, because the targets and goals of governance evolve, the environment is turbulent, "competing governance projects for same object of governance" develop, and norms evolve regarding the handling of governance trade-offs. A complex adaptive system (CAS) has the capacity to learn from and adapt to its environment over time, especially when this environment also consists of like systems (Holland 1998). It is because the system is populated with agents that seek to adapt to their environment that we can speak about an "adaptive system." In the sense in which it operates (the inclusion of non-state actors in the governance of the CBD and the role of cities, the development of private governance, the creation of IPBES, the development of new concepts and new knowledge (however debatable they may be) such as ecosystem services, offsets, and "nature-based solutions"), the biodiversity regime complex can be approached as a CAS.

This understanding of system adaptability leads to two major points (Axelrod and Cohen 1999). First, CAS theory is used in cases where agents are capable of selecting adaptation strategies: agents select strategies, not outcomes because the system intervenes (changes in behavior can lead to no real advantage or payoff for the agents). Second, adaptability is first an attribute of the agent, not of the system as a whole (strictly speaking, the outcome is adaptive, but the system does not adapt per se, it evolves). It means that even if agents are successful in their individual adaptation, by no means can we infer that the global performance of the system will tend to cooperation and effectiveness. On the other hand, only if agents adapt can the system be adaptive.

Although adaptation is neither automatic nor universal, examples of it exist in each class of actors. As autonomous agents, IOs active in the environment have repeatedly proven capable of adaptation, such as the World Bank (changes in goals, norms, procedures, and policies), the Ramsar Convention (transformation of its mission), the Convention to Combat Desertification (CCD) (institutional innovations), or the International Whaling Commission (IWC) (changes in norms and rules). One example is the emergence of compliance governance systems at the convention level.

The CBD has gradually evolved such a system unforeseen by the convention. The evolving reporting system and various means of evaluating the national implementation of international agreements hold the potential for regime learning, for modifying the MEA's programs of work, and for devising new policies in order to improve the implementation record. States have changed or reversed policies. NGOs have formed transnational advocacy coalitions (such as the World Commission on Dams).

Business provides a good illustration of this adaptation. Historically, business actors have tended to oppose national and international environmental regulations, seen as limiting their

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competitiveness. To prevent adoption of constraining international regulations, they favored acting at the national level first. The 1992 Rio Conference on Environment and Development marked the beginning of a strategic change that took two forms: (i) an increased and more direct participation of the private sector in international environmental negotiations, and (ii) the development of innovative forms of governance, such as voluntary guidelines or certification schemes. Examples include the International Organization for Standardization (ISO 14000), the Forest and Marine Stewardship Councils, as well as various codes of conduct (Coalition for Environmentally Responsible Economics [CERES] Principles; Responsible Care, etc.).

From being an opponent, the private sector has gradually become a major partner in the development of a global governance of the environment. By promoting the idea of a partnership among the private sector, environmentalists, and the international community, the private sector has moved from laggard to "rule taker" to "rule maker" (Andrade and Puppim de Oliveira 2015). The CBD and states (such as Germany, Canada, and France) have adopted a strategy of engagement of the private sector, where business is seen as part of the solution.

Conclusions

As other authors have emphasized (e.g. Biermann 2014), the advent of the Anthropocene suggests the need to think anew about the nature of international environmental governance, a governance that takes advantage of the evolution of the system instead of fighting it; one that reflects the complexity of the issues and that acts as a counterpoint to existing models.

Although complexity theory has been applied to socioecological systems (Wells 2009), its potential for rethinking global governance has not been extensively probed. It deserves much more sustained attention. Rather than a methodology that could produce law-like statements, complexity is a method (Morin 1990), a roadmap of how one should think about phenomena, and pragmatism may very well constitute its philosophy. Moreover, it would be a welcome return to the notion that knowledge is contextual, in opposition to efforts by IOs and NGOs alike to come up with rules of governance that quickly morph into universal principles of public policy. This gives rise to a questionable doxa bound to disappoint for it may not be easily translated across time, space, and social systems.

Approaching the governance of the Anthropocene as a complex system allows us to incorporate much of current research in order to construct a coherent whole. Rather than being seen as the advent of chaos, paralysis, and effectiveness, the evolution of the global environmental governance system provides a set of tools for handling complex governance systems that take advantage of their properties and facilitate adaptation. However, seeing the governance of the Anthropocene as the product of a complex system does not mean that governance itself is always complex.

Simple policies can be adopted to deal with complex problems, and one issue is to investigate how best to govern the Anthropocene in terms of effectiveness (whose definition must include features of complex systems, such as adaptation and learning). It means adopting

a perspective from which new questions emerge. It leads to a redefinition of what is meant by science away from the modern tradition that thinks about the social and natural world and their interrelationships in dichotomous and linear terms, and "assumes the future is predictable [only a matter of knowledge] and that causes and effects are clearly related and measurable" (Boulton et al. 2015: 52).

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Strategic Diplomacy, Fractal Governance and the BRICS in the Climate Regime*

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Abstract

In the context of the COP 23 outcomes, the puzzling question is: how to save the climate? Starting from the multilateral negotiations that led to the Paris Agreement in 2015 and the French-Californian initiative "Make our Planet Great Again" as a response to President Trump's declarations, this article states that diplomacy and international law have to be more adaptive and inclusive. The emerging order from a fractal governance perspective and the power shift to Asia show the need of opening up for effective dialogue and attracting the BRICS to the UN sphere, not the BASIC.

Keywords: BRICS, Fractal Governance, Climate Change

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Introduction

There is a huge gap between what diplomats negotiate in multilateral regimes and what academics from law and international relations promote. There is the reality of interest-based politics and the official discourse based on ideal Kantian solutions, that is, based on what was Alexandre Kiss' ideal to save the Earth. And, whenever decision-makers listen to scholars, IR literature still lacks data about how it happens, despite of the IPCC and other scientific bodies' role[1]. Concerning the climate change regime, it is also key to assess how multilateral negotiations are reacting to scientific data, since this is not a linear process[2].

So, how to save the climate? How to relate international law and multilateral negotiations? Bodansky (2010) answered that international environmental law results from multilateral negotiations. This article takes the conceptual elaborations of strategic diplomacy (Goh and Prantl; 2017; Smith 2015a & 2015b) as an analytical starting point for tackling the complexity of the climate regime and propose how Brazil should collaborate to save the climate. In Smith's perspective, strategic diplomacy is related to the "generation and pursuit of a strategic vision" with the aim of offering "principles and guidelines" for a more long-term oriented policy-formation process (2015, p.115-116). This sought-after policy should ideally materialize in effect of the presence of a series of essential elements and lines of action, related to; 1) a stable institutional basis, 2) recourse extraction and coordination, 3) a unified strategic narrative, 4) the capacity of adapting this narrative to external transformations, and 5) the capacity of coordinated policy targeting (Ibid). Diplomatic agency is further complicated by the gradual dilution of hierarchies, objectives, relations and actions, as these are inserted within evermore complex networked processes, in which new constellations of actors and patterns of linkages result in a much muddier picture (Ibid). Flecther (2016), in the same vein, concluded that digital technology will lead to significant challenges in world politics and may empower myriad actors such as internet titans and citizens. Likewise, the Global Future Council on Energy predicts an "innovation tsunami" related to the global energy system (2018).

Goh and Prantl (2017, p.01) emphasize how the conduct of strategic diplomacy can be viewed as a process through which both state and non-state actors engage in a broad range of activities of framing, communicating, contesting, and negotiating their core interests and objectives. While much literature thus tends to focus on the bi- or multilateral interstate relationships as the basis for diplomatic activity, the strategic diplomacy perspective rather seeks to accentuate its systemic repercussions. "In a nutshell, the analytical focus is on diplomacy pursued to navigate the system rather than dyadic and polyadic state relations" (Ibid). This essential proposition rests on the premise that the character of the global order is marked by a set of key properties, formulated as 1) interconnectedness between the particular components

[1] Haas (2015) proposed the "epistemic communities" concept to show how scientists could have some influence in the decision-making process. But it is worth noting that scientists are not necessarily engaged in policy-making.

[2] See Schleicher, R. (2006) Ciência, política e institucionalização na cooperação multilateral contra o aquecimento global. Dissertação de mestrado. Instituto de Relações Internacionais. Universidade de Brasília. Leandra Gonçalves, for instance, has analyzed how politicians use scientific data in the fisheries regime. “Organizações Regionais para o Ordenamento Pesqueiro: o poder está ouvindo a ciência?” Tese de doutorado. Universidade de São Paulo. 2016.

of the system, 2) non-linearity, meaning that even minor events may constitute tipping points which bring about significant repercussions throughout the system and, 3) emergence, which means that the varied interactions between the particular components of the system may lead to qualitatively unique results.

With a specific end point (a precise objective) in mind, Prantl and Goh (2017) present a framework for concrete policy formulation and execution in line with the precepts of strategic diplomacy. This comprises of the definition of entry points, followed by the identification and pursuit of tipping points, with the ultimate goal of reaching the goal set. The notion of entry point helps to define focalized and concerted actions within an initial field, so as to avoid dispersion of recourses on multifold, but less effective efforts. The tipping points can be described as the instance at which an event becomes the catalyst of broader causal dynamics throughout the system, the conjunctional impact of which works to bring about the intended end point.

In our research, the end point of a climate regime is the "safe space for humanity" (Rockström et al., 2009) given that Brazilian economy depends heavily on agribusiness (Lamucci et al, 2018). In other words, Brazilians need to negotiate not only the mitigation of greenhouse gases (GHG) nor exclusively the transition to a low carbon economy. They also need to consider other regimes that threaten humanity as a whole, such as energy, oceans governance, nuclear weapons, global health and wealth.

Strategic diplomacy implies the analyses of the international scenarios, with their main actors, interests and windows of opportunities based on entry points. With a broader approach to climate challenges, negotiating agendas will be intertwined. The nexus among the threats and opportunities in the climate regime are complex and challenging (Orsini et al. 2013, IIASA[3], Mercure et al., 2017). Furthermore, solutions depend increasingly on technological solutions and on non-state actors, so strategic calculations may also prove wrong as uncertainties proliferate. In this sense, diplomacy and law are challenged to adapt to the new challenges, the rising powers, notably China and India (Diamond, 2018; Jaffe, 2018) and their growing interconnectedness in the climate regime[4].

Put bluntly, there are two simultaneous processes under way: one is the rise of non-state actors (privatization) (Flecther, 2016), which is better assessed with the fractal governance concept. The other is the empowerment of China and the BRICS, in which non-state actors have much smaller marge de manoeuvre. So, are we in a time of "multipolarity with no multilateralism" as the former Brazilian Foreign Affairs Minister Celso Amorim (2017) used to say?

If multilateralism was a concept forged by Washington during the GATT and NATO negotiations, now it is in deep crisis. International organizations no longer provide adequate answers to global environmental problems (Le Prestre, 2017) such as the planetary boundaries proposed by Steffen et al. (2015). The Western liberal order is being challenged not only by rising powers (Prantl, 2014; Morin and Orsini, 2015) but also by President Donald Trump's foreign policy (Blyth, 2016; Diamond, 2018). Likewise, the UN system failed to implement mandatory

[3] http://www.iiasa.ac.at/
[4] See, for instance, the 2017 Xiamen and 2018 BRICS Declaration.

rules in order to solve the climate problems (Viola, Franchini and Lemos, 2013; IPCC, 2017). For example, there is an enormous fragmentation in the legal system in relation to climate policies. As a consequence, establishing the responsibility of the state in relation to environmental and climate damages remains a key challenge for international law (Alfaia Jr., 2014).

In this broader context, "Make our Planet Great Again" was a response the French President Emmanuel Macron[5] and former governor of California Arnold Schwarzenegger made to Trump's slogan de "Make America Great Again", to show the North American citizens that being the world superpower, it is their responsibility to ensure a safe Planet for the rest of humanity[6].

The first part of the article emphasizes the complexity thinking (Kavalsky, 2016) looking for the main tipping point, that is when conditions for a systemic change are produced (Prantl and Goh, 2017). The second part focus on three main processes of multilateral negotiations and entry points, that is, how and where to start building effective solutions for climate threats.

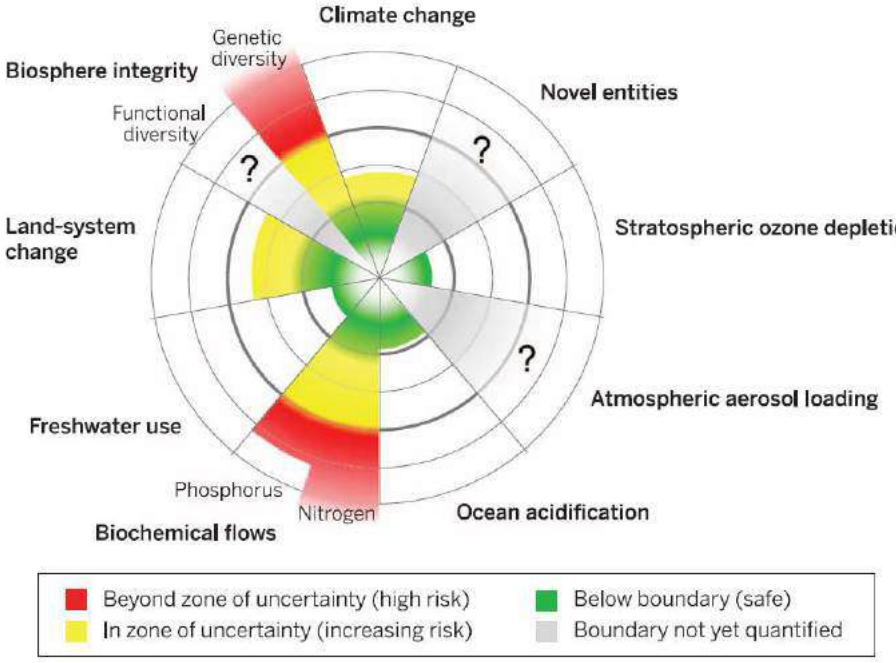
Part 1 - Complexity in multilateral climate negotiations

Complexity has several sources. One of them is biological, but the main issue here is that the IR research agenda is now is focusing more on a systemic view and the interactions among the parts instead of breaking the system into small parts like the international regimes, rational actors' theories or the *problem-solving theories*[7]. Assuming that the sum of the parts is much bigger that the whole, complexity thinking and strategic diplomacy may be more useful to effectively approach the climate regime.

Concepts like environment, sustainable development and climate are too broad to be consensually and properly defined worldwide[8]. The interactions between land, atmospheric and ocean living beings (and human activities) are complex and unveiled (Biermann, 2014; Beau and Larrère, 2018). The planetary boundaries below show how important these interactions are, notably in relation to biochemical flows and genetic diversity.

[5] President Macron also hosted the One Planet Summit on 11 December 2017 in order to boost financing of climate related initiatives.
[6] It corresponds to the legal principle of general interest of humanity (l'intérêt général de l'humanité).
[7] Dostál, J. Theory of Problem Solving. Procedia. Volume 174, 12 February 2015, Pages 2798-2805.
[8] Mireille Delmas-Marty offers reflection on that by opposing two kinds of knowledge: savoir savant (scientific) and savoir sachant (traditional).

Figure 1 - Planetary boundaries



Source: Steffen, W. et al. "Planetary boundaries: Guiding human development on a changing planet". Science, v. 347, n. 6223, 2015.

Undoubtedly, climate is not only an environmental issue, so the COPs need to expand their agenda or to be recognized as the hub for climate diplomatic action. The oceans, the poles, energy, agriculture, transportation, biodiversity and biodiversity beyond national jurisdictions (BBNJ) are not treated together, nor are they approached in a coherent way under the UN auspices. This reveals the challenge of fragmentation in international law and diplomacy. Furthermore, other law branches contribute to the juxtaposition of legal regimes such as trade, intellectual property rights and energy (Barros-Platiau and Maljean-Dubois, 2017).

Nuclear weapons must also be remembered since they do pose a potential threat to life on Earth. Nuclear armed states have constantly improved the lethal capacity of their arms thus contributing to the arms race that now include Israel, India, Pakistan and North Korea. The UN 2017 Treaty on the prohibition of nuclear weapons[9] opened for signature on September 27, 2017, did not have the support of the NATO members[10], that is, key OECD[11] countries. It did not have the signatures from China, India and Russia also, the key BRICS members. If nuclear disarmament is not linked to the state obligation of not causing damages outside its jurisdiction, nor to the responsibility to protect and not even just our right to a healthy environment, then who is really working to save the climate?

In sum, multilateral negotiations reveal how states act in cacophony, therefore putting the effectiveness of international obligations in question, in terms of commitment and

[9] Adopted by the UN General Assembly in July 2017 with 122 votes for and only the Netherlands voted against. Singapore abstained.
<http://www.un.org/apps/news/story.asp?NewsID=57139#.WesuV1u3yUk> Acessed on 28 October 2017.
[10] <https://www.nato.int/> Acessed on 28 October 2017.
[11] <http://www.oecd.org> Acessed on 28 October 2017.

compliance. As a consequence, this is not a simple legal fragmentation issue that could be resolved with a more up-to-date umbrella treaty signed in Paris in 2015, because states have not reached basic consensus yet. Not to mention all non-state actors working in parallel tracks. If this is so, the climate regime´s tipping point was not the Paris Agreement, but the Copenhagen Accord in the COP 15. The reason for that is that in 2009 the USA and China reached an agreement, which led to the Copenhagen Accord in 2009, with a few supporting countries (Dubash and Rajamani, 2010). Considering that the tipping point depended more on the diplomatic consensus between Washington and Beijing (the invisible giant G2) than on the UN members' votes in 2009, the Paris Agreement is just a new good start, after the climate quagmire since the US left the 1997 Kyoto Protocol.

With or without the US, the reelection of President Xi Jiping in October 2017 confirms the trend of a more globally active Beijing diplomacy based on the "Chinese dream" and the "Belt and Road Initiative"[12]. The Chinese leadership in the transition to a low carbon economy is linked to the New Development Bank, which has mainly projects on renewable energy[13]. On top of that, rising powers, especially China, are replacing Western powers in the leadership process (Jaffe, 2018). Two recent examples are the Chinese immediate reaction to President Trump's abandonment of the Paris Agreement and of the UNESCO, both in 2017. This only reinforces the conviction that the power shift from the West to Southern Asia is getting stronger, although China is still a "partial power" as Shambaugh puts it (2013), since it lags far behind the USA in terms of technological capacities (Brooks and Wohlforth, 2016).

Besides this state-level analysis based on the invisible G2, there is a second significant process related to other stakeholders from the private and public sectors, notably companies, NGOs, and subnational actors, like cities and networks, discussed next.

Climate governance has changed so fast and deeply that diplomacy and international law need to adapt faster. The MOPGA initiative is only one example of fractal governance and it is linked to other initiatives such as the R20[14]. The high ambition coalition (HAC) promoted by the Marshall Islands in 2015 that gathered more than a hundred countries to support the signature of the Paris Agreement is another. Cities, subnational states[15] and NGOs are effectively acting as the sovereignty-free actors Rosenau described (1992). All those political arrangements are quite new and amorphous, maybe ephemeral too.

Fractal governance leads to the analysis of small parts that promote the emergence of order from below (Schneider, 2012). That means the obsolescence of the "command and control" legal mechanisms in international law, because sovereign states can no longer afford it, apart from China. The same goes for the "commitment and compliance" logic, since states need companies to help implement sustainable infrastructure projects to change, for instance, the national energy mix (Tasca, 2018). As a consequence, hierarchy and the use of force are less

[12] One Belt One Road Initiative (OBOR). <https://www.cnbc.com/2017/08/24/chinas-belt-and-road-initiative-could-be-the-next-risk-to-the-global-financial-system.html> Acessed on 29 October 2017.
[13] <http://www.ndb.int> Acessed on 28 October 2017.
[14] <https://regions20.org/> Accessed on 28 October 2017.
[15] California, Paris, Rio de Janeiro, etc...

important too. It corresponds better to the bottom up mechanisms the climate regime is increasingly adopting, notably with the INDCs[16].

In sum, there are two co-evolutionary "tectonic changes" in friction that demand adaptation skills from diplomats, decision-makers, law-makers and scholars: the rising powers reinforcing top-down processes (China and India) and the networks proliferating in bottom-up ones (in Western countries mostly). How to put them all together at the same negotiating table? Who wants to open up the dialogue? Will this ever happen? Those are difficult questions for the future, considering that by 2050 emerging ecnomies' GDP will be three times higher and there will be 30% more people living there (Global Future Council on Energy, 2018).

Part 2 - Opportunities for diplomatic action

As mentioned above, entry points are multiple. Related to life as a whole, environmental and climate negotiations have to deal with oceans, energy, health, biodiversity beyond national jurisdiction (BBNJ), and others. Forests have their own agenda, but they were included in the Paris Agreement with the REDD+ mechanisms. Trade and energy are different regimes treated by the WTO and the IAEA separately[17]. Transportations are a big challenge since they are an important source of GHG emissions and they need the best available technology to improve in market scales, within the ICAO[18] and IMO agendas for example. As a result, defining entry points in multilateral negotiations is not a simple task. Before doing so, there are three drivers of international affairs to be considered: privatization, interconnectedness and complexification (Kavalski, 2016).

Privatization of decision-making processes is embedded in a larger context resulting from broader access to information and communication technologies, empowering asymmetric actors in multilateral arenas (Green, 2014; Fletcher, 2016). The internet is surely the main one, but there are also social technologies to be considered, like the non-state actors networks[19] and social mobilization. Because market actors have accumulated so many resources in relation to states, privatization is a key challenge for diplomats and academics (Khanna, 2016; Fletcher, 2016). Nonetheless, civil society, though more informed and connected, is not necessarily better mobilized for climate action now than it was in 1992.

The interconnectedness among actors and issues brings up the need for a systemic approach related to climate change. As Baie et al. (2016) put it: "The Anthropocene encapsulates a world of intertwined drivers, complex dynamic structures, emergent phenomena, and unintended consequences". Therefore, the fractal governance approach implies that concepts such as hierarchy, power, linearity, authority and legitimacy are less relevant as analytical tools to understand the global climate governance in the Anthropocene epoch. For instance, some

[16] Intended Nationally Determined Contributions designed under the U.N. Framework Convention on Climate Change (UNFCCC). <http://unfccc.int/focus/indc_portal/items/8766.php> Accessed on 28 October 2017.
[17] World Trade Organization and International Atomic Energy Agency.
[18] International Civil Aviation Organization and International Maritime Organization.
[19] Such as: R20, Under2 coalition, NAZCA (Non-State Actor Zone for Climate Action).

european markets traditionally import oil from Russia. The current UN economic sanctions against Moscow prevents Russian oil exploiters from using the best available technology. As a consequence, they cause avoidable environmental damages. Will Europeans continue to finance this unsustainable activity or will they invest more in energy alternatives?

The complexification of international affairs results from the two other drivers above. Their impacts on diplomacy and international law show that the negotiations processes are closer to the XIX than to the XXI century. That is, since the end of the XIX century, world conferences led by Western powers, notably Europeans, pretend to promote planetary democracy, but only some States have voice. The so-called "universal values" in fact are a legal and political construction aiming at consolidating a "shared view" to harmonize diversity - of cultures and views of the world. As a result, obligations are progressively less precise and hard (Abbot and Snidal, 2000). Delegation mechanisms are nonexistent in the climate regime, so international organizations are in general are rather toothless. Finally, only soft law mechanisms seem to be accepted widely, such the UN 2030 Agenda for Sustainable Goals.

One of the essential entry points for firmly engaging with mitigation of climate change is the BRICS. The BRICS group has been accounting for an increasingly large share of global global CO2 emissions, and due to being at a point well below their structural saturation in terms of energy consumption, climate conscious action by the BRICS becomes a quintessentially important element in combating climate change (Wu et al., 2015; Rinaldi and Martuscelli, 2016). The group is constituted by highly heterogeneous countries, which does not appear to be the case in terms of their official standpoints, as well as their effective actions taken[20], in relation to climate change. Thus, while Russia continues to express very limited concern with the issue of climate change, and also has refrained from taking any significant steps in order to reorient its emission-heavy economy, China, on the other hand, has clearly stated its ambition to be a central part of the global energy transition, and has become the leading investor in renewable energy in a very short time span (Jaffe, 2018). India, Brazil and South Africa have often displayed adherence to combating climate change at the international level, though their record in terms of following up on these non-binding commitments at the domestic level is rather more mixed.

Yet, in spite of these differences, a certain commonality can nonetheless be detected in terms of their skepticism of adhering to climate change protocols operating with caps defined by total national emissions. Considering the different developmental contexts characterizing the BRICS, and well as their comparative historical emission records, - with the possible exception of Russia in relation to this parameter - these countries have often pointed to the somewhat irrefutable circumstance, that capping emissions close to their current level, followed by reduction obligations, would wield a much more favorable edge towards developed countries. Strategic diplomatic action should take this into account when devising a course of action towards ensuring the BRICS' adherence to a credible climate regime. Smith´s (2015, p.115-116) conceptualization of the different stages in strategic diplomacy, formulated as institutional basis,

[20] O'Neill, J. "New Rules for the New Global Economy". Interview by the Project Syndicate, on July 27, 2018. available at: https://www.project-syndicate.org/onpoint/new-rules-for-the-new-global-economy-by-jim-o-neill-2018-07?barrier=accesspaylog. Accessed on August 5, 2018.

recourse coordination, strategic narrative, adaption of this narrative, as well as policy coordination constitute a useful analytical point of departure.

The fact that climate issues have been on the agenda since the earliest BRIC(S) meetings (BRICS, 2009) as well as the fact that mutual confidence and routinely interactions have become laid down with time, means that a certain institutional basis, with capacity for further amplification with climate action in mind, does appear to exist. The issues of the (re)framing of a strategic narrative of climate action, combined with the coordination of recourses, becomes essential. This means that first of all, the precondition for emphatic engagement within climate mitigation regimes by the BRICS must necessarily rest upon a strategic narrative which takes the notion of common, but differentiated responsibilities (CISDL, 2002) into account. In more concrete terms, this would imply a relative reorientation of focus on emission reduction commitments from the total national level, and towards per capita emissions. The proliferation of such redefined narrative becomes essential in order to stimulate the redirection of organizational and financial recourses of the BRICS towards climate change mitigation. Since China is the world largest exporter and second largest importer, the transportation sector is key for Beijing and its trade partners inside and outside the BRICS.

An important tipping point should be highlighted as the instance at which investments in increasingly accessible and competitive renewable technologies becomes viewed by BRICS states as strategic asset acquisition, rather than as a cost. Concomitantly, cooperation, technology-sharing, and coordination between these nations also mean that positive-sum synergies might be reached, which stand in contrast to the often-zero-sum logic characteristic of the geopolitics of fossil fuels. The emphasis upon sustainability as a criterion for credit concessions of the New Development Bank (NDB, 2017) might give a hint of this institution's potential to serve as a vehicle for the proliferation of sustainable technologies and infrastructure projects, in the case that political will exists. Firm common commitments to regimes are fed out of the belief that in the long run, they will benefit the individual interests of their participants (Keohane 1984; Stein 1993) which in the case of the BRICS would depend upon tangible positive spillovers of energy-related cooperation.

Adaptation of the strategic narrative to the changing global conjunctures and geopolitical challenges, as well as policy coordination stands as the reproduction and perpetuation of the strategic policy engagement. This does not mean that instances of cooperation might not come under stress by either structural or conjunctural developments, but as long as the overall positive sum synergies are attained through these states' adhesion to global regimes based upon (sustainable) energy related concerns, their fundamental interests in preserving these regimes should maintain constant. The main challenge of strategic diplomacy thus appears to be related to ensuring that the transitional "push" towards sustainable energy brings about a switch towards an alternate path-dependency which rests upon the common interest in the development and incremental refinement of effective legal instruments, that serve to keep states in line with their collective commitments.

A second entry point which we chose to accentuate can be formulated as the reorientation of national and international energy-related regulation towards a systemic bias in

favor of renewable solutions. This derives from the observation that market forces are capable of accelerating the transition towards a more renewable energy system, but for this to materialize, economic incentives and correctional measures need to be provided by the political authorities. Consistent behavior-molding regulation thus aims to accelerate the movement towards a tipping point, at which renewables become the most economically viable alternative, is reached. Regulation which discriminates between "dirty" fossil based energy, and "clean" renewable energy - and thereby takes the atmospheric environmental externalities into account (Sandmo, 2011) - becomes necessary in order to advance the timeframe for reaching such a tipping point. The most important aspect of this regulatory turn towards sustainable energy is that it is conducted in a consistent manner, and implies a long-term focus upon certain pre-established goals. This may create a level playing field, at which the private sector is clearly informed about the politically defined confines of the business space in which it will have to operate, in order to plan for longer periods ahead. In line with Doris et al. (2009), it can be presumed that a close public-private coordination, with a focused public policy framework as the regulatory background, has a strong potential to spur transitions towards a renewable energy system.

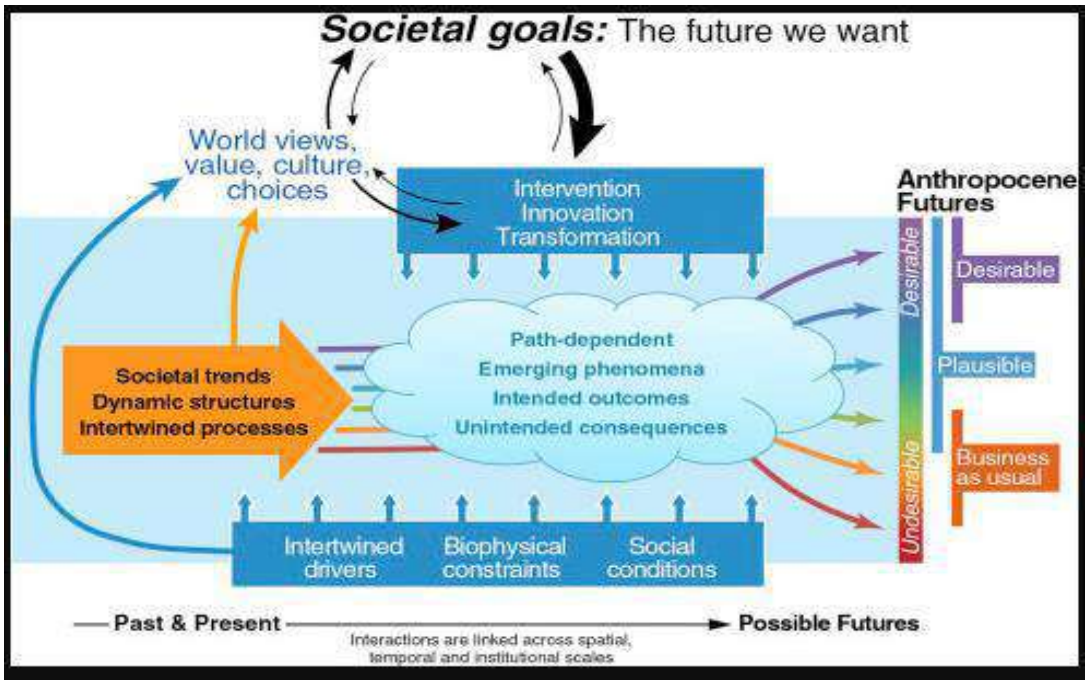
Yet, a certain degree of international lower-benchmark, implying that essential principles with a positive edge towards renewable energy are more broadly adopted, also becomes important. This is not only because of the importance that all of the largest global economies contribute to the energy transition, but also in order to avoid that the immediate competitive advantages associated with lax regulation of fossil fuel consumption are not overtly exploited by some large industrial countries; dynamics often described as a "race to the bottom". But as the price-tipping point between renewable and fossil fuels are reached in some countries, and within certain technological fields, this may well also materialize as a strategic competition in relation to providing the most favorable conditions for organic growth of renewable sectors, or rephrased; as a "race to the sky". As the competitive dynamics of future geopolitics of energy are bound to be redrawn by the advent of non-finite generation systems, a new series of challenges are posed in terms of the productive insertion within global commodity chains and technology platforms associated with these. As the case of the German, - and later Chinese - public policy engagement within solar energy has proven, the productive and technological developments, and the timeframe for their commercial maturation, is by no means disconnected from the mode of regulation to which they are subjected. Presuming that competitiveness and self-interest will continue to define the interactions between modern states, being the last to join this process of gearing national energy regimes toward productive recalibration might well wield serious strategic repercussions for the laggards.

Given the need to work harder and collectively to build "the future we want"[21], as shown in Figure 1 below, the entry points should focus on complexity, responsibility and equity issues (Beau and Larrère 2018). So far, climate talks have focused more on mitigation of GHG emissions,

[21] Outcome Document. A/RES/66/288 - The Future We Want. Available at: https://sustainabledevelopment.un.org/futurewewant.html. United Nations Conference on Sustainable Development in Rio de Janeiro from 20 to 22 June 2012.

deforestation and national economic costs, named "green economy" in 2012 Rio+20 Conference. However, energy production and consumption should be the main priority, in order to promote the shift from self-interested states energy security to planetary security. Also, responsibility is the key background for effective multilateralism, including historical, present and future public-private responsibilities. Likewise, nuclear technology should be used only for peaceful means, because it makes no sense to work to save the Planet and prevent humanity from having a safer future. We propose, with a growing number of observers, that negotiations shift from the state level to the per capita data level, assuring more equity to each human being. In other words, that every human being has the same rights independently of his/her nationality. Finally, the ecosystems' approach definitely enables us to include the oceans in the climate talks, since oceans are suffering great climate change impacts that in turn reduce their capacity of providing ecosystem services, notably CO2 sequestration (Büscher, Form, Riebesell, 2017), thus threatening global health and wealth, as shown below.

Figure 2 - Societal Goals: the future we want



Source: Baie et al. (2016). Available at: http://www.sciencedirect.com/science/article/pii/S0959378015300546#fig0005. Access on 25 October 2017.

Conclusions

From a systemic analysis of climate change talks since 1992, we propose that two major shifts have to be considered by decision makers and scholars. One is the power shift to Asia, giving China under Xi Jinping the leadership role in the transition to a low carbon economy, and placing the BRICS at the center of the climate agenda, thus reinforcing a state-led top-down

process. This is better understood using IR analytical tools related to complexity thinking, such as the strategic diplomacy concept. India is also rising in Asia and may deepen the ongoing power shift. The other is quite the opposite, translating a new cleavage inside the declining West, that is, the proliferation of private-public networks composed of entrepreneurs, subnational actors and NGOs.

In this context, diplomats and other public authorities are demanded to look for more results-oriented processes since the main results from the UN talks are disappointing, after 23 annual COPs. They were rather to postpone expensive and effective measures, make empty promises of transfers of technology and additional resources and the creation of funds that will most probably never meet their goals. Instead, companies and private actors are looking for solutions to stay in the world market and on the diplomatic stage. International law also needs to adapt to these two tectonic changes and not to blithely assume that non-binding norms or the 2015 Paris agreement will suffice.

In this sense, multilateralism will be more effective if technology, energy, oceans, nuclear weapons and transportation are seriously taken into account in the next COPs and afterwards. The main question remains: who wants to make our Planet great again? Nuclear powers? Rising powers? BRICS members? The High Ambition Coalition and likeminded alliances? Billionaire entrepreneurs?

Finally, complexity, responsibility, and equity are not yet shared principles and values, but they need to be, for the sake of our safe space for humanity.

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Boundaries, Governance and the International Order*

Sai Felicia Krishna-Hensel**

Abstract

The article examines the distinctive character of the interconnected world of the twenty-first century. The analysis explores the influence of technology on the international system in the modern age, leading up to the unique challenges of the contemporary world. Historically, advances in transportation, scientific breakthroughs, and their military applications have profoundly influenced the ability of states to project power and have had an impact on political structures and configurations. There appears to be little consensus on how these changes influence the debates on power, deterrence, diplomacy, and other instruments of international relations. Traditionally, scholars of the international system have focused on the possession of knowledge and weapons that provided a military advantage in the interpretation of power configurations. Our argument is that the twenty-first century world has a different technological emphasis, that of communications and its supportive satellite and internet infrastructure that forms the basis of the information revolution. The new technologies have succeeded in creating an alternative universe presenting a governance challenge to traditional institutions, laws, and concepts of territoriality.

Keywords: Governance, Technology, Information Revolution

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Introduction

The Anthropocene has been conceived as a period of human dominance of the environment and is credited with fundamentally changing the planet. The term has been popular amongst analysts discussing the irreversible environmental changes that are occurring. It is, however, increasingly being invoked by a wide range of fields such as literature, history, and culture. Humans have undoubtedly been a transformative force for ages through their mastery of the environment by realizing the potential of fire, the wheel, tools, and other technological inventions. This in turn enabled them to participate in group hunting, agriculture, and urbanization among other such developments. The impact of technology and science on human societies and polity has been world-changing throughout time and calls in question the utility of establishing a specific date for the beginnings of the Anthropocene.

The concept of the Anthropocene, of human impact on the environment is an appropriate context against which to evaluate human political and social institutions. It is instructive to consider the influence of some of the principal technological revolutions which are transfiguring the international order. This analysis focuses on the evolution and challenges of an interconnected borderless world that is replacing the great power international system that ensued from the development of technologies that expanded human range across existing boundaries of land and sea.

The contemporary international system is a collection of national societies designated as nation states. It had its modern origins in the Westphalian international order which was perceived to have epitomized the integration of disparate peoples into unified nations that further enabled populations to establish progressive economies and cohesive cultures. The national societies that emerged emphasized a shared political system, culture, and financial system based on a participatory sense. These industrial nations faced challenges in the world that followed as technological innovation steered economies into a post-industrial era of significant social and economic change.

This analysis proposes to examine the impact that the extraordinary developments in science and engineering have had on a renewed interest in the discussion of the influence of technological change on the international system. While structural changes in the international system are influenced by many factors, the role of technology in effecting changes in power configurations among nations has been widely discussed by scholars. Most of the discourse has involved an assessment of the role of industrial progress in shaping the organization of the international order. This is particularly relevant in the context of contemporary breakthroughs in technology that have called into question the ability of the nation-state to continue to function effectively in a changing environment. The international order is faced with the prospect of a borderless world and challenges that transcend traditional physical, cultural, and institutional barriers.

The influence of technology in shaping the international order can be considered in a number of phases including, the scientific developments of the 16th and 17th centuries that enabled an era of expansion and initiated the great power configuration of the times, the nuclear technology of the twentieth century that led to the balance of power, and the communications

technology of the twenty first century that challenged the existing boundaries in a globalizing world. The first period witnessed the replacement of traditional rulers and monarchies (Wolf, 1962), and the emergence of the nation-state as the primary unit in the international system. Great power status was based on economic power based on industrial strength. The transition from the expanding world to a borderless world was bridged by the introduction of atomic energy and nuclear weapons which, for the first time, brought into play, the concept of deterrence and a heavy reliance on diplomacy. A fragile equilibrium based on a balance of power marked the twentieth century milieu. The unique challenge posed by the information revolution and other communications technologies to the existing international system is explored in the final section of this analysis.

The international system can be assessed in the context of broad changes in structure, as well as in terms of particular interactions between states. Order has characterized international relations when there has been equilibrium in the system based on an acceptance of the *status quo* and the position of the component states within the often-hierarchical arrangement. “An international system is in a state of equilibrium if the more powerful states in the system are satisfied with the existing territorial, political, and economic arrangements” (Gilpin, 1981). Underlying this perspective is the suggestion that equilibrium is sometimes reflective of resignation when the goal of asserting superiority is unattainable and a state will settle for the status quo as the least objectionable choice (Wolfers, 1962).

This would indicate a measure of realism in international relations. Changes brought about, within, and between states, through socio-religious factors or technological developments has led to disequilibrium and concurrent disorder. The assumption that the basic goal of international relations has fundamentally remained the same through the ages is a significant component of the discussion of change in the international system. Many scholars see the international system in terms of an ongoing struggle for wealth and power among its constituents operating in a state of anarchy (Gilpin, 1981. p. 7).

The transformation of the international system has been steered by differing rates of change. Gradual change has characterized some phases of history while other periods have been reflective of dramatic and rapid change. The industrial revolution, the nuclear revolution and the contemporary information revolution can be considered as analytic benchmarks in providing an understanding of the changing nature of power and relations between states. The ongoing discussion on whether technological innovation leads to revolutionary change or evolutionary change (Skolnikoff 1993) suggests that radical change has been induced by conflict in some instances and by technological innovation at other points in time. Scholars are divided on the emphasis that should be placed on technological progress as an independent variable in the study of relations between states and as a factor in analyzing power configurations in the international system. While technology increases the options available to policymakers in their pursuit of the goals of the state, it simultaneously leads to hurdles in the decision making process. Quite clearly, the material environment has a significant influence on transformation although the social conditions and prevalent ideologies cannot be ignored in the analysis of change.

The evolution of social values and political interests can be attributed to gradual change. Unexpected dramatic change, on the other hand, can be found in historical points of reference.

The dramatic sequences would include technological breakthroughs, political revolutions and other conflict-based scenarios. In such instances, the period of adjustment is compressed, thus resulting in the perception of rapid or dramatic change. Instability also plays a role in such perceptions. Thus, major political changes in the international system can be identified and understood more easily than progressive, gradual change. Both gradual evolutionary change—i.e. process-based change--and dramatic change—i.e. event- based change-- have their proponents.

This is reflected in the contrast between a deterministic approach and a predictive interpretation of change. Though it is tempting to explain change in universal terms, it is obvious that the conditions of the historical past are in many ways substantively different from those that prevail in the modern world. The discussion of change as a gradual process or as an event-based phenomenon, obscures the reality that systemic adjustments are often driven by actors responding to the variables driving change.

The Expanding World and Emergence of the Great Powers

The engineering and scientific breakthroughs of 16th and 17th centuries advanced the nature of transit and enabled nations to extend their reach across the oceans as well as across the land. A number of scholars have emphasized the significance of navigational advances during the formation of the modern European states system (Mahan, 1897). The advances in transportation profoundly influenced the ability of states to project power by facilitating movement of materials, military forces, and armaments. Maritime technology and naval aviation were seen as a transformative influence on the projection of power in the modern age.

The land routes and highways of earlier periods were no longer seen as the primary conduits of commerce or as instruments for the projection of military power. The development of sea power had introduced a new highway that benefited countries with a shoreline. This perceived disadvantage to hitherto land based communications routes was not universally accepted. Halford Mackinder (1904) (1962) discussed the historical dominance of land routes and their modern transformation. He argued that railroads and improvements in communication had removed any disadvantages of being landlocked. The disagreements on the relative significance between land and sea power did not alter the fundamental agreement that technology and innovation served to stretch the boundaries of human behavior beyond the limitations of the environment.

The development of railroads, chemical industries, telegraph, electricity, and the internal combustion engine served as a transformative influence on the predominantly agrarian economies of the time, ushering the industrial revolution. The great industrial nations were sharply differentiated from states that were lagging in industrial progress by an increase in total productivity that was achieved through the mechanization of agriculture and manufacturing production. Possession and control over raw materials was considered a necessary and important element of national power and contributed to the perception of strength. Power and industrial advantage served to highlight the widening gap between small states and the great powers. These changes impacted the national political process and figured prominently in the discussion of great power status in the international system.

The strength of industrial nations lay not only in possessing resources and production facilities, but also in the ability to maintain and develop a sustainable knowledge base. Hence, the training of scientists and engineers and the support of research became an important component of political power. Innovation served to broaden the options available to policy makers and, at the same time, inserted greater complexity in the decision making process. This will be more apparent when we examine the changes wrought by the nuclear revolution and the information revolution.

The focus on the interconnections between industrial growth and military strength has prominently featured in interpretations of the foreign policy positions underlying the balance of power in the international system (Taylor, 2004), a historical framework that suggested a close association between "power in production, power in the state, and power in international relations" (Cox, 1981). It was a logical step forward to assert that industrial strength, based on the presence of a highly skilled workforce with a superior ability to process an abundance of raw materials, was a contributor to the projection of military power (Kennan, 1966). Relations between states, alliances, and other interactions were driven by perceptions of relative power and status based on technological superiority (Waltz, 1965).

A related contention suggests that innovation is fundamental to maintaining superiority since it diffuses, enabling nations to challenge the dominance of established powers in the international system (Gilpin, 1994). Gilpin noted, as an example, that while the United States continues to be the dominant and most influential state in the system, its ability to "govern" the system as it did in the past is diminishing. It is increasingly unable to maintain the existing territorial divisions and arrangements and its traditional domains of influence and to enforce the rules that govern the global economy. "The redistribution of economic and military power in the system to the disadvantage of the United States has meant that costs to the United States of governing the system have increased relative to the economic capacity of the United States to support the international status quo" (Gilpin, 1981, p. 232).

The international order was determined by states that had the advantage in materials, facilities, and knowledge for the production of advanced weaponry over those which were lacking. States with advanced technologies dominated the system using their advantage to influence the policies of weaker members and to create dependency relationships.

The Balance of Power in a Nuclear World

The social and political implications of atomic energy have permeated our understanding of the international order. The nuclear age led to an acknowledgment that it was imperative to envision a new international order centered on the common interest of all states to prevent massive destruction. There was an uneasy sense that in the absence of a common understanding, neither fear nor recognition that the use of modern weapons has the potential to destroy civilization would prove to be an inhibiting factor in modern conflict. The foreboding that peace was increasingly at risk in such an environment fueled the concern that a preemptive strike could be a tempting strategy in the calculus of confrontation. The contention that, historically states have demonstrated a predisposition for conflict (Hamilton, 1941) is often invoked against the hypothesis that scientific progress would lead to fundamental change in the behavior of states.

The nuclear revolution led to a significant investment in managed conflict and revived the need to examine other instruments of power and diplomacy. A leading outcome of the nuclear era was the evolution of the international system into a bi-polar world composed of two distinct constellations of states (Fox, 1949). This configuration was seen as resulting in a sort of equilibrium that was, nevertheless, subject to periodic crises and proxy conflict. The paradox of nuclear weapons was the conferral of national status and power on states possessing this technology, simultaneous, with a decline in the option of realistic deployment. The value of a nuclear arsenal was essentially as a deterrent that enabled states to continue to maintain their conventional capacities. Prior to the nuclear age, deterrence between nations did not have the conceptual significance that it acquired in relation to the premise of unacceptable retaliation. Based on the recognition that it was unthinkable to envision a nuclear exchange, or a conventional conflict that could escalate into a nuclear exchange, the possession of nuclear weapons was seen as a deterrent to conflict.

This prompted new strategic thinking that emphasized the size and technological superiority of nuclear armaments to assist in signaling the futility of an engagement between potential challengers. Nuclear deterrence and strategy continued to evolve as policy makers attempted to determine vulnerabilities in a nuclear shield which would invite a pre-emptive attack. International relations increasingly came to be defined in terms of a balance of power based on possession of nuclear weapons, and simultaneous efforts to establish global collective security. A realistic assessment of the limits of war entered the calculus of superpower relations (Wolfers, 1962).

The possession of nuclear arms has led to the concept of deterrence as a contributor to the stability of the international system. *Deterrence relies on maintaining the technological advantage and that requires continually keeping up with scientific advances* (Mahan 1897). MAD (Mutually Assured Destruction) is what keeps deterrence relevant as a strategic option. Central to the balance of power that deterrence represents is the awareness that both parties have the same destructive potential. Should technological advancement enable one side to develop faster, more accurately deliverable weapons, the incentive to use the weapons as a 'limited strike' increases. An effective deterrent is only possible when there is transparency through open communication and unrestricted information so that both parties acquire parity. The effectiveness of deterrence presupposes rational actor theory and would have no place in the calculus of leaders who have a messianic and radical world view .

The nuclear age encouraged the consideration of the deployment of a multiplicity of instruments other than atomic weapons to achieve great power status. This was expected to ensure equilibrium in the international order. The traditional propensity to apply force to achieve superiority and military advantage, was substituted by the possession rather than use of such weapons. This led to the initiation of new protocols, the revival of diplomacy, the concept of nonproliferation, and arms control agreements. The post-nuclear environment saw a fundamental alteration of policy imperatives. The realization that the control of nuclear proliferation was beyond the capacity of individual nations led to an increasing reliance on cooperative protocols and policy initiatives that derived from international organizations and institutions.

Mandelbaum (1981) opined that: "technology and politics have combined to create what has been called a nuclear weapons 'regime': a system of international obligations (formal accords, tacit commitments, and informal understandings), and doctrines (when, where, why, how, and which nuclear weapons ought to be used) that together govern the role of nuclear weapons in war, peace, and diplomacy." The nature of the new scientific advances was accompanied by the belief that "advancing technology makes war more horrible and presumably increases the desire for peace" and "each major advance in the technology of war has found its prophet ready to proclaim that war is no longer possible" (Waltz 1965).

As scientific breakthroughs have led to greater sophistication in size, destructive potential, and delivery of nuclear warheads, there has been a greater incentive to maintain an open dialogue between the major nuclear powers. The nuclear revolution thus emphasized the necessity for radical change in political thinking since the new technologies challenged traditional thinking on conflict that balanced political goals with proportionality of destruction.

The expansion of nuclear proliferation introduced a new urgency for diplomatic solutions to conflict resolution, and elevated negotiation to a central role in international relations. An important effect of nuclear weapons on politics was the exploration of disarmament as a solution to the impasse presented by nuclear warfare. Driven by the virtually unusable nature of this technology in war, the pursuit of cooperative disarmament required states to consider removing the sources of insecurity that could lead to conflict. The frameworks representing this approach tended to exclude the non-nuclear powers and often those states that had acquired weaponry outside the accepted protocols. The responsibility to formulate conditions for this objective was given to the UN disarmament commission, a body composed of all UN members.

The commission met infrequently but it did serve to articulate world opinion on the issue. As an international instrument, its function was limited since the most significant initiatives at disarmament would have to come from the two main powers that possessed large stockpiles of weapons--the Soviet Union and the United States. The idea of unilateral disarmament was urged on by peace movements and extensively discussed in various forums. The proponents of nuclear disarmament had no investment in deterrence as a strategic policy.

Tension-reducing and confidence-building agreements, such as 'non-aggression' pacts, 'no first use' pledges and other measures, have been proposed and honored up to this point. A number of arms control measures accompanied the attempt to reduce, to control, and hopefully to eliminate nuclear weapons. The effort to reach agreement on the quantity and quality of weapons stockpiles were reflected in the SALT (Strategic Arms Limitation Talks), SALT I (1969-72) and SALT II (1979). While they remained unratified, they provided useful precedents for controlling and limiting major weapons systems. A related treaty involving efforts to limit the use of nuclear weapons from the sea bed was the Seabed Treaty (1971). The conduct of international relations in the nuclear age has been marked by dialogue involving meetings, conferences, and draft treaties.

The drive toward nuclear non-proliferation has not been effective in discouraging the spread of nuclear technology and has been thwarted by the existence of an underground network involving technical assistance and political encouragement. The principal signatories to

the NPT (Non-proliferation Treaty) have predictably been most of the major nuclear powers, with a few notable exceptions primarily among the emergent nuclear states. The major powers do not possess the ability to convince states to desist from acquiring the nuclear weapons. It is doubtful whether they will be able to prevent non-state actors from acquiring and using these weapons. The underlying problem is the calculus involved in using atomic weapons. Many non-state actors are not invested in survival as the ultimate goal of conflict. They are more likely to subscribe to the vision of mutual destruction in the pursuit of a higher, other-worldly reward.

The development of nuclear technologies provided an opportunity for states to engage in a measure of cooperation on the peaceful use of atomic energy. Knowledge based dominance characterized the inherently unequal relationship between the donor nations and the recipient states and established yet another measure for differentiating superpower status in the international system.

The emergent nuclear powers, unconstrained by the concept of non-proliferation, have added an element of uncertainty to the existing balance that has characterized the relations between the two major nuclear powers. It is unclear whether the new entrants to the nuclear circle are inclined to subscribe to the code of conduct that has defined the behavior of the super powers, or whether their political goals allow for large scale devastation. The acquisition and use of nuclear arsenals by non-state actors and groups represents the uncontrollable and unknown danger posed by nuclear proliferation (Mandelbaum, 1983). The fundamental concern is fear that the newcomers do not subscribe to the accepted rules by which the traditional actors of the international system operate (Van Creveld, 1989).

The Borderless World and the Networking Revolution

Advances in the areas of chemical, biological, nuclear, and communications during the twentieth and twenty first centuries have transformed the traditional dynamic of the international order. These scientific developments have led to the emergence of a globalized, interconnected world, that is at once complex, interdependent, and often borderless.

The twenty-first century is increasingly being defined by communications technology and its satellite and network infrastructure. The evolving role of communications technology characterized by speed, wide availability and distribution has long been seen as transformative of societies and statecraft by analysts of the international system. Some scholars have suggested that transnational challenges would lead to a revolution in statecraft distinguished by the evolution of nonmilitary instruments and processes (Sprout, 1962). The central role played by global information networks in conduct of international relations has been extensively examined in Howard H. Frederick's (1993) *Global Communications and International Relations.*

The progress in communications technology has led to a fundamental reassessment of many of the assumptions underlying the structure of the international system. Contemporary scientific development has altered the accepted ways of thinking about the nature of war, national boundaries, and the principal actors in the international system. The effect of communications technology and the information revolution is global in scope and significance, and has extensively transformed the economic, social, and political landscape. The dynamics of

the information revolution have inserted a new motive force in international relations, the economy, trade, and in aspects of personal life. Governments are faced with unprecedented challenges emanating from emerging technologies that represent a large measure of uncertainty and risk.

The technologies that are expected to have the most significant impact on the nature of governance and decision making are computers and electronic communications, as well as chemical and biotechnological developments that enable individual non-state actors to brandish a level of power that was hitherto confined to the collective control of the state. Technological progress underlies both cooperation and conflict between states--a reality that is particularly relevant to understanding the interdependent world shaped by information technology.

The political implications of communications technology are manifest in the shifting scenarios of power in a transnational environment today, as a result of the information revolution, power has shifted in the direction of information possession and information control. Individuals have been empowered by access to information, while states and institutions exert power by controlling and blocking access to the networks. Exerting control over information is complicated by the structure of networks which constitute an essentially decentralized system of interconnected nodes that operate independently.

The internet's underlying technologies have been widely dispersed through its large-scale diffusion and its worldwide networks have resulted in the creation of a global community. As the conduit for rapid information flows, the global networks have no precedent in the history of technology. Information technology is being increasingly viewed as a basic resource of mankind, along with energy and wealth.

Large databases containing immeasurable details of interest for potential disruption are globally available. Groups and individuals have undetected and anonymous access to open public sources of information. It is easy to access detailed knowledge about nuclear power plants, public buildings, airports, and ports, transportation networks and even about measures to counter-threats. The world wide web offers intelligence on critical economic nodes, providing the opportunity to probe for structural weaknesses in systems and to predict cascading failures throughout related networks. Weapons, such as bombs, can be assembled with information available openly and the internet is used as a communications channel for coordination and planning.

Networking that enables subversive groups to operate as decentralized units independent of a central command and control configuration provides the additional advantage of reducing transmission time, concealing identity, and being relatively difficult to pinpoint. The internet has led to the erosion of hierarchical structures in many organizations, but especially among transnational groups whose activities have a global reach. The information revolution has created digital capital that is empowering groups and individuals in ways that often challenge the dominant power of the nation-state. Those nation-states with the greatest freedom of information and the technology for its transmission have political and economic influence.

The new technologies are seen as fundamentally altering the accepted boundaries of time, and space representing a challenge for political theorists accustomed to physicality (Wolin, 1960). Many analysts observe that the new technology is enabling people to conquer time. Real time transmissions of events require instant responses which are not structured into the decision-making process that has traditionally characterized the international system. Financial transactions, for example, can occur almost instantaneously. The global economy is based on financial data transmissions that discount national borders and facilitate the empowerment of remote markets by placing them in the same playing field as the economic powerhouses. Networks facilitate information and disinformation flows at an accelerated rate that makes it difficult to absorb, organize, and react in a measured manner. Responses are required to emerge at a speed that is not structured into the existing decision-making process.

Communications networks are also responsible for shifting people's spatial orientations based on traditional economic, social, and political boundaries. This has resulted in a dual trend of the reconfiguration of accepted identities and of the simultaneous reinforcement of traditional identities. The representation of the new environment as one of distant proximities, in which demographic and social distances have been compressed by the dynamics of technology, is central to Rosenau's insightful analysis of the fundamental changes that differentiate the information age from previous periods. It goes a long way toward making the case for a new conceptual and terminological framework for the study of international relations in the information age (Rosenau, 2003).

There is a broad consensus that contemporary technologies have resulted in constructing an alternative universe whose governance presents a challenge for conventional institutions and laws that rely on traditional concepts of territoriality. The need for a new conceptual vocabulary to describe the environment in which innovative integrated technologies, communications networks, and information utilities operate, has been both recognized and addressed, to some extent. The most commonly used term for describing the new realm or organization whose functioning poses a significant challenge for the conventional economic and political system is Cyberspace.

The term enables the visualization of the electronic databases and flows of information, the source and consumers of that information in a virtual world that crosses and blurs the boundaries of the world that is familiar. Geographically, it crosses and blurs physical boundaries, while sociologically, the communities of cyberspace cross societal and cultural boundaries. Politically, the governance of the virtual world results in a unique challenge for national and international institutions. The power of networks is diffused beyond the sovereign states' capacity to exert control. The result has been that policing the internet has varied and included self-regulation as well as government censorship.

Cyberspace can be conceived of as a new (virtual) planet separated from and simultaneously existing within the known geographical world. It is defined by its lack of an identifiable spatial presence, as well as its seemingly borderless nature and its fluid and constantly changing (virtual) communities. The mapping of cyberspace, identifying its

communities, and comprehending its vulnerabilities, is a step towards determining the level of governance that is needed. Complementing the evolution of the internet itself and the private and public regulatory initiatives that have characterized its life span is the evolution of the debate on governance that has oscillated between the advocates of an open network that is largely self-regulated and those that cite security concerns in support of state intervention.

The global diffusion of technology and industrial production is propelling the forces for internationalizing the state in the sense that it is internationalizing the policy process in areas such as arms control, internet governance, and global environmental policy. Skolnikoff (1993) suggests that technological change underlies decentralization of power and suggests that it would be difficult for absolute power to continue to be exercised in the new technology-driven political environment. He notes that "there is today a large and expanding sector of national and international activities not under the direct control of governments, nor accountable to them, that impinges on the authority of governments and constrains to varying degrees their freedom of action or ability to order events. This is arguably the most significant aspect of evolution in international affairs that has accompanied technological change." He is convinced that the new technological environment will place limits on national action.

In *The International Imperatives of Technology* (1972), he articulates his position definitively, suggesting that the degree of international regulation and control over the internal affairs of nation-states would be in excess of anything that has ever existed. Interdependence impels cooperation in a global economy. Such analysis highlights the increasing realization that states no longer possess exclusive access to destructive technologies. With the proliferation of knowledge through the Internet and the growing presence of non-state actors, biological, chemical, and nuclear technology is within the reach of a larger constituency in a global world. Technology has given an advantage of sorts to the forces of asymmetric warfare and provided them with the means for communication and the knowledge for manufacturing weapons. In the contemporary world, the possibility of NBC (nuclear, biological, and chemical) being first used by non-state actors is particularly alarming.

We have been conditioned to believe that financial capital contained in physical assets with monetary value is a most valuable resource. In the twenty-first century, the most valuable capital is progressively non-physical and weightless. Much of traditional finance and money is now manifest as digital capital. Financial transactions, bank accounts, shares, bonds, and similar financial instruments have been transformed into data exchanges independent of physical documents and ledgers. The gravity-bound capital of previous centuries--land and physical wealth-- has acquired a virtual character. Digital capital is increasingly a major new domain of power and property based on new paradigms and scope.

Cyber technologies have succeeded in altering the scope and meaning of invasion through cyber threats, which are a blend of cybercrime and cyber war and which are often undifferentiated in terms of the kind of destruction caused, as well as the required level of defense. The cyber threat is the idea that organizations or individuals may be spying on, tampering with, or preparing to inflict damage on electronic networks These intrusions have several goals, some are classified as simple cybercrimes involving identity theft and essentially representing a modern form of burglary and highway robbery. Cyber warfare is an attempt to

infiltrate secure economic systems and infrastructure grids to paralyze the economy and effectively neutralize societies.

These assaults are designed to destroy the electronic systems underlying financial transactions including banking; disrupting transportation networks such as air traffic, inducing massive power failures such as blackouts and definitely aiming to disable defense and national security infrastructures. Defending against such threats challenging since this is a realm where the attacks are continually evolving, requiring a constant response. Virtual invasions are a cost-effective strategy to project power and dominance and can dispense with the need to invest in military organization, hardware and personnel. Cyber-attacks may emanate from states, non-state actors, or a combination of forces.

Cyber-attacks originating from a suspected nation-state present a real threat. The sophistication is reflected in extremely focused targeting of defense engineering data. The security of electronic information systems continues to be viewed with complacency in the absence of dramatic and attributable cyber invasion. Electronic-commerce systems are already in a constant war against online fraud, requiring high investment in risk management. The most desirable solution would be international efforts to secure data networks, under the assumption that as states become more integrated into the global structure of interrelationships, financial and otherwise, it will be essential to develop cooperative international protocols to secure the networks.

Conclusion

In conclusion, advances in technology, and, the information revolution, have demonstrated the limitations of borders in a globalizing world. Additionally, the interpretation of power configurations in the international system that had traditionally relied on measurements of military superiority was now challenged by a new perspective. An important and widely held view was that scientific breakthroughs in themselves were not as significant as their military applications in determining the impact on political structure. The military superiority, that was achieved through technological progress and contributed to political prestige and economic power was now up for review.

Scientific advances and industrial progress continue to be integral to the discourse on power and status in international relations. It is equally evident that advanced military technology with its enormous potential for destruction creates an environment for exploring diplomatic and other alternatives to war and contributes to the evolution of strategic alternatives, such as deterrence. In a world that finds itself technologically limited to conventional conflict, peace becomes a critical objective. Finally, a remarkable development of the advance of nuclear, biological, and chemical weapons is the prospect that the principal players in international affairs may include a new set of systemic actors such as the individual and small group and may no longer be confined exclusively to nation-states.

The proponents of a transformed world order draw our attention to the concern that the presence of these actors---the individual, the NGO and the terrorist group-demonstrates that there is no effective state control on their access to technology and their unchecked ability to

communicate across borders can have far-reaching consequences. It is the role of these elements that is central to much of the discussion surrounding the establishment of a global order reflecting multiple influences.

The diffusive potential of technology has demonstrated the ease with which individuals and non-state actors can have access to sophisticated weapons and introduces an element of uncertainty into the strategic calculus. Retaliation degrades as an option in an environment where the adversary cannot be identified and actors may have no determinate and recognizable location.

Many analysts see conflict and competition rendered obsolete by integrative economic forces (Krugman). In the past, economists thought that only goods could be traded across borders, while most services could not be imported and therefore were not subject to the same pressures from international competition. Technology has undermined this assumption and the movement of services from the West to the developing world has shifted the power equation. The transformation of the geo-political environment is driven by change that operates in a virtual world that poses tremendous challenges for governance.

These challenges exceed the capacity of any one state or group of states and require cooperative institutions, policies, and enforcement mechanisms. This has led some analysts, such as Peter Drucker, Alvin Toffler and Esther Dyson to envisage a multi- governance structure based on multiple identities and loyalties held by the population. The debate on the new world order has coalesced primarily around two perspectives-- one proclaiming the continued relevance of the nation state and its institutions, and the other anticipating the eventual development of and strengthening of supra and transnational bodies which would supersede, in some instances, at least the authority of the individual state.

The argument for the continued relevance of the nation state in setting policy rests on the observation that if technologies are the driving force behind the development of the supra-national institutions of the modern age, then the lack of access to these technologies by a large proportion of the global population continues to give the upper hand to national elites that control access to technology. This argument reinforces the justification for the continuing supremacy of the state in the international order.

The issue is whether the new technologies are leading to fundamental alterations in the structure and functions of the international, or more aptly, the global system. Of particular interest is the challenge posed to traditional power structures by the asymmetric threats and the newly emergent actors empowered by the new technologies. The analysis is placed within the context of the early discussion surrounding the factors responsible for the rise of the West, including the technologies contributing to the industrial revolution, as well as the differing emphasis placed on the importance of technological innovation as a determinant of change in the international system. The traditional views of territorial possessions as indices of power, and of territorial expansion as the principal course through which states acquired prosperity and security is re-examined in light of the contemporary technologies. The current focus has shifted to an assessment of information possession and control of communication as indices of global power.

As the dynamics of globalization overtake territorial borders creating a greater interdependency and communications technology outstrips traditional social collectivities the nation state itself becomes somewhat diminished in its ability to manage the transcendent forces in play. Globalization has increased the interconnectivity in hitherto unimaginable ways. Interdependency has greatly increased and migration has blurred the boundaries of nationality and political loyalty. Much of this is attributable to technological advances that have enabled international mobility amongst peoples through travel and connectivity via the world wide web.

The wave of new technologies that have emerged over the centuries have created new economic opportunities and power constellations that have determined the shape of the international system. It is possible to envision a world in which the smart power represented by information technology is surpassing armed force and military superiority. Contemporary technologies, with their potential for transnational outcomes, appear to be leading us into an ever more cooperative world.

An alternative viewpoint presented by Lewis Mumford is critical of the utilitarian perspective underlying the analysis of technology in society. This perspective attributes the emphasis on technology to the utilitarian bias that dominated the scientific community in the nineteenth century and seeks to place technological development within the framework of other cultural and social influences. Discussing Leonardo da Vinci and his forays into the scientific future, Mumford observed that Leonardo himself committed to paper even more remarkable forebodings of the world than science and mechanization would eventually bring into existence (Mumford, 1967). As we consider the impact of information technology on the study and conduct of international relations in the contemporary world, it is interesting to note Mumford's prescient thoughts.

The erosion of national political power as a consequence of transnational forces impels a reassessment and reorganization of the contemporary global order. It is increasingly obvious that the system, as it is presently configured is inadequate to confront the ongoing challenges. Conventional solutions are not designed for the unconventional transnational environment. Governance mechanisms of the new era need to address financial regulation, construct adaptable democracies, and envision cooperative solutions for conflict resolution. The architecture of current technological systems offers an opportunity for reconsidering the concept of citizenship so it can reflect more accurately the reality of migrant movement that supersedes boundaries and territorial identity.

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Anthropocene and Water

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Abstract

The Anthropocene is the new and current geological epoch in which the human being has become an agent of planetary changes. This comes with several endangering consequences for the survival of the human species. This article primarily discusses the increasing environmental impacts of human activity since 1950, as well as issues related to water governance. Considering that such issues are usually integrated in the natural sciences but still largely escape human and social sciences, this article is a contribution to the latter fields of knowledge as it draws on international relations and geopolitics.

Keywords: Water; water resources; governance; Anthropocene.

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Introduction

Water is an abundant natural resource, which is unevenly distributed on the planet. Considering the total quantity of water on the planet amounts to approximately 1.3 billion cubic kilometers, oceans account for 97% of water and the remaining 3% is divided between glaciers, groundwater, lakes, rivers and the terrestrial atmosphere. Bhaduri et al. (2014) and Pereira and Freitas (2017) argue that the current water situation, especially in terms of the anthropic impacts on water systems, is a matter of concern since human societies influence the hydrological cycle in significant yet uncertain ways, that affect water resources beyond their natural limit. This natural limit exceeding results from the patterns of consumption and production imposed and widely disseminated by global capitalism. Such patterns endanger the survival of human beings and indicate that concepts such as security and threat do not only regard wars and power struggles, but also the consequences of human actions on the environment.

According to Pereira and Freitas (2017), 11% of the global population (783 million people) does not have access to drinking water, while the use of fresh water has tripled over the last fifty years. This use of fresh water has brought the environment beyond its recovery capacity. The Worldometers database (2015 apud PEREIRA; FREITAS, 2017) shows another important fact related to this issue: while the demand for fresh water increases by approximately 64 billion cubic meters per year, many countries and regions still face water scarcity. These water-related issues do not only concern underdeveloped or developing countries, but also some of the wealthier states, such as the United States, Portugal and Spain that also face problems associated to access and use of water resources. Hence, contemporary societies do not only face challenges regarding ecological resilience but are also confronted to problems caused by their own political and economic instability and inequalities. This scenario therefore calls for changes in governance, especially in terms of developing global cooperation and defining a common agenda on water resource problems.

There is no doubt that problems related to water availability are highly relevant to national and international policies. However, the lack of adequate political commitment remains a challenge that contemporary societies need to face and overcome. Although the contributions of human and social sciences to the subject are still incipient, these specialized fields of knowledge would enable us to deal more efficiently with the governance of “climate change, saltwater intrusion into coastal areas, population growth, deforestation, land degradation, pollution, the unsustainable use of water and poor water management” (PEREIRA; FREITAS, 2017, p.1).

In what follows, the global water issue is analyzed by taking the Anthropocene social and biological conditions into account, which present new challenges and opportunities to the governance of water resources. Firstly, we will discuss the concepts of Anthropocene and planetary boundaries, presenting their core features when related to the use of natural resources. Secondly, we will specifically address the water issue in the Anthropocene and the

risks, consequences and challenges involved. Finally, we will present orientation for change in water governance.

Anthropocene and planetary boundaries

Since 1950, the effects of human activities on Earth, such as deforestation, mining, fishing, agriculture, use of nonrenewable energy sources, atomic bomb testing, and population growth, have increased and reached a global scale (Steffen et al., 2015). Given that the proportion of these changes is so significant, it is already possible to consider that the Earth has entered a new geological epoch. As stated by Dipesh Chakrabarty (2009), this means that the human being has become a geological agent.

The Anthropocene hypothesis was first presented by Paul Crutzen (CRUTZEN; STOERMER, 2000; CRUTZEN, 2002), 1995 Nobel Prize in Chemistry. Crutzen argues that the environmental impacts of human action are worldwide and modify soil, atmosphere composition and climate. The Holocene, a geological period that began 11 700 years ago, would be coming to an end and a new geological epoch would be emerging. If the Holocene is a period of relative environmental stability, the Anthropocene is characterized by exceeding planetary boundaries and ecological resilience (VIOLA; BASSO, 2016).

These planetary boundaries are related to the question of global environmental sustainability and "[discuss] safe operating limits for humanity in relation to critical issues arising from human occupation of the Earth" (ARTAXO, 2014, p. 17). Rockström et al. (2014) identify nine planetary boundaries: (1) climate change, (2) loss of stratospheric ozone, (3) acidification of oceans, (4) biogeochemical cycles of nitrogen and phosphorus, (5) changes in the integrity of the biosphere associated with biodiversity loss, (6) land use change, (7) use of water resources and freshwater consumption, (8) loading of aerosol particles into the atmosphere, and (9) introduction of new entities and chemical pollution. These limits surpass the local/regional scale and are viewed as global systemic threats, as they act as risks to the prosperity of human societies in the long run.

Artaxo (2014) and Veiga (2017) state that limits 1 (climate change), 5 (changes in the integrity of the biosphere associated with biodiversity loss) and 4 (biogeochemical cycles of nitrogen and phosphorus) have already been exceeded. Limits 2 (loss of stratospheric ozone), 3 (acidification of oceans), 7 (use of water resources and freshwater consumption), 8 (loading of aerosol particles into the atmosphere) and 9 (introduction of new entities and chemical pollution) are approaching their limits, whereas limit 6 (change in land use) has already been reached.

This diagnosis shows that anthropogenic actions are responsible for reaching and exceeding these limits. According to Veiga (2017), "[...] it is a fact that of all the carbon dioxide released in the atmosphere and produced by human activities, three quarters was emitted in the last seventy years" and "the amount of synthetic nitrogen (in particular from fertilizers in agriculture) increased from 4 million tons to over 85 million tons" (VEIGA, 2017, p. 236). The emission leap of these two chemical elements, coupled with the increase in water consumption

by extensive irrigation in countries such as China and India, coincides with the "Great Acceleration" thesis (STEFFEN et al., 2015).

Considering what we have seen so far, one can state that the Anthropocene hypothesis goes along with the awareness of planetary boundaries (CUNHA, 2012; ARTAXO, 2014). This demonstrates awareness of the fact that human beings "significantly influence the functioning of the earth system in many areas" and that the changes arising from anthropogenic actions "are clearly identifiable beyond natural variability and are equal to some of the great forces of nature in their extent and impact" (STEFFEN et al, 2004, p. 4). Pereira and Freitas (2017, p. 526) argue that the new world of the Anthropocene is dangerous, complex, unstable and uncertain, differing significantly from the Holocene. Consequently, “the central role played by humans in defining the physical frameworks that regulate major processes of the Earth System […] poses major challenges to achieving water security. In this setting, local and global spheres are interconnected, working together to generate ‘glocal’ challenges” (PEREIRA; FREITAS, 2017, p. 522).

Anthropocene and water

The changes introduced by human beings in the environment directly affect the water cycle, which in turn, has an impact on the entire ecosystem. The increasing extraction of hydrocarbons and groundwater in coastal areas, the removal of rocks and sediments by mining activities, the modification of the coast and the construction of dams are some examples of interventions affecting the Earth's climate, chemistry and surface. Ocean volumes, and more specifically the water cycle, are also affected (CASADEVALL, 2016). Steffen, Sanderson and Tyson (2004) exemplify these impacts on the water cycle by taking into account the type of vegetation observed on the Earth's surface and its role in water transpiration into the atmosphere. Since vegetation roots store water, it is an important controller for environmental balance. Therefore, any changes in vegetation such as those caused by deforestation, can modify the flow of water between the Earth and the atmosphere.

Water cycle and Earth system dynamics are responsible for connecting terrestrial and marine ecosystems, transporting material and other components of the global environment (STEFFEN et al, 2004). Consequently, the water cycle connects ecosystems. Human societies are therefore vulnerable to any changes brought to the water cycle. As Casadevall (2016) mentions, the central point is that water issues have a global scale due to its transboundary nature. Ribeiro (2012, p.5) adds that while the importance of natural resources changes over time, this does not occur when it comes to water, since it relates to "the production of the material basis of existence, whether in the production of shelters or in the production of food". Artaxo (2014) develops a similar argument to the effect that water, its distribution, management and use, are capable of influencing food production, biodiversity, climate and water security.

According to Casadevall (2016), the Anthropocene epoch deepens the global water resource problem. Water availability and management on a regional and global scale are interconnected with the ways in which human beings developed their actions on Earth. He shows that international and regional cooperation are essential, especially considering that consequences of the Anthropocene are unknown. Admitting the unpredictability that the

Anthropocene brings to the Earth system and to its inhabitants becomes one of the first steps for changes to occur. These changes are initially individual and must spread to other spheres of social life.

Changes in terms of international cooperation between States are difficult to achieve (Viola; Basso, 2016). The difficulty is primarily political, since cooperation implies the transfer of state sovereignty in favor of more robust intergovernmental agreements. In a world still politically and theoretically designed for and by the nation-state, intergovernmental cooperation is seen as a threat to sovereignty, that is to the loss of "control over a territory, by the monopoly of the use of force, among other forms" (RIBEIRO, 2012, p.1). According to Ribeiro (2012), the conventional concept of sovereignty apparently lost its meaning in a globalized world. However, in the international system, sovereignty is present and includes discussions that support country positions in multilateral forums, as well as discussions involving neighboring states, such as transboundary water management. Although water is considered a global common good[1], its essentiality and economic value hinder the occurrence of necessary cooperation. This does not mean that we are underestimating the fact that, since the second half of the twentieth century, there has been a considerable improvement of cooperation between nation states. As Viola and Basso (2016) argue, during this same period, society has witnessed the emergence of new international regimes exemplified through international law, human rights, trade, the fight against the proliferation of nuclear weapons, public health and the environmental human imprint. All these subjects have become recurrent topics of international policy.

One can therefore identify a trend towards the emergence of a "global environmental order" – as coined by Ribeiro in the early 2000's (Ribeiro, 2001). Ribeiro (2010) advocates the consolidation of such an order, stressing the advance in international conventions on environmental problems mainly as a means of reflection, opportunity for cooperation and legitimation of environmental policies. The international environmental order would be driven by international meetings, treaties and documents, many of which would be coordinated by United Nations (UN) bodies. This is confirmed by Veiga (2013) who states that, between 2005 and 2011, 27 bilateral agreements, 22 agreements, 59 additives and 10 international environmental protocols were signed. These facts should be highlighted because, in an international society characterized by diversified agenda and national interests, the consolidation of international agreements represents a progression towards positive changes, even though they remain insufficient and far too slow considering the importance and scale of the problems faced by nations all over the world. Despite the progress in cooperation at all levels, when it comes to global commons such as water, the "discrepancy between unequal reality and normative equality becomes ostentatious and explains to a great extent the inability of the international regime to obtain efficient solutions to the problem" (VIOLA; BASSO, 2016, p.6).

The Anthropocene clearly demonstrates that the environment's stability is not to be taken for granted and that the current situation requires immediate policy reform. While water problems are not afforded the same publicity as international wars and armed conflicts, nor are

[1]According to Viola and Basso (2016, p.3), "common goods are characterized by non-exclusivity - it is not possible to exclude their use from those who do not contribute to their provision".

on the same threshold as climate change, loss of biodiversity and changes in biogeochemical cycles, scholars such as Peter Gleick and Ismail Serageldin, an ex-World Bank vice-president, have already pointed out that water problems are likely to encourage international conflicts. Gleick (1995, p. 83) states that "water and water supply systems [have] been the roots and instruments of war". We must consider that there is a long history of conflict over access to this natural resource. Since water involves fundamental aspects for the survival of the human and other terrestrial species, any changes in their system and functioning can be considered to have an impact as relevant as the world wars, which justifies the argument that water governance is an effective threat to the stability of the international system.

Water governance in the Anthropocene

Rockström et al. (2014) distinguish four features related to water issues: (1) political, social, cultural and economic changes, (2) water security, (3) water accessibility, quantity and quality, and (4) vulnerability to extreme events. These spheres should not be taken separately but should rather be intertwined. To deal with them, according to Bhaduri et al. (2014), it is necessary to develop a multi-scale and interdisciplinary approach enabling us to understand the complex and interconnected nature of the global water system. Political, social, cultural and economic changes concern new social and ecological approaches capable of developing an integrated governance of water and terrestrial resources (ROCKSTRÖM et al., 2014). Steffen, Sanderson and Tyson (2004, p. 38) confirm this perspective by stating that "strategies for water management must increasingly take on regional integrative approaches".

The second feature relates to water security[2] and comprises a multidimensional and interdependent set of different factors which enable a population to ensure access to water and sustain both human and ecosystem health in the occurrence of water-related disasters – such as droughts, floods and landslides (UN-WATER, 2013). In this context, State and science are the main agents. According to UN-WATER (2016), ensuring water security means identifying critical issues related to water in a local, regional and/or global scale. Bhaduri et al. (2014) argue that although most problems and solutions to water security reside in governance, expert knowledge about the global cycle of water and its entanglements with the global environment is an essential aspect. Thus, water security depends both on political will and the scientific development of new methodologies and governance models.

The third feature concerns water accessibility, quantity and quality[3]. Ensuring these three aspects is a tangible need for any country, however this does not guarantee that inequalities and conflict over water use will be avoided. Therefore, new organizational mechanisms in water distribution must be developed, encompassing the entire population, in urban as well as in rural areas. Here, water issues interweave with economic, racial, cultural and historical aspects.

[2]Cook and Barken (2012) define "water security" in four main aspects. Water security takes into account the quantity and availability of water for consumption, covers the risks and consequences of floods, aims at conditioning and treating water quality and focuses on sustainability.

[3]Water quality is linked to its physical parameters (color, turbidity, temperature, taste and odor), chemicals (pH, alkalinity, acidity, hardness, chlorides, nitrogen, phosphorus, dissolved oxygen, organic matter, inorganic, and organic micropollutants) and organisms (indicator organisms, algae, and bacteria) (VON SPERLING, 1996).

Finally, the last feature addresses vulnerability to extreme events such as droughts, floods and contamination of water resources. Such events have a deep impact on water supply, global food production, biodiversity and human well-being in general. Addressing the vulnerability of populations to these events requires a better understanding of the underlying mechanisms and possibilities of improvement in global governance (BHADURI et al., 2014).

Final considerations

The Anthropocene brings multiple challenges to Earth system governance. Water availability problems, as argued in this article, are a central issue for this new epoch since it is directly related to the present and future of human activities, in all their complexity. Since water is a global scarce resource and a source of conflict, it has to be addressed by intergovernmental cooperation. This means that we need to develop new models of water governance on a global scale, which would enable us to deal with the growing water scarcity in various regions. This is one of the major challenges of the 21st century.

The inefficiency of the current water governance mechanisms stems not only from the still nationally-based political-legal systems, which are often unable to deal with increasing trans-territorial competitive uses of water resources, but also by increasing social pressures, changes in social needs and by environmental impacts of human action restricting access to it. Since water issues range from the individual to the global institutional system, public awareness is paramount. Based on this, the present article sought to emphasize some necessary changes in water governance. As mentioned previously, human and social sciences have a very important role in the development of a scientific diagnosis of the current global situation. Stakeholders engaged in the political decision-making process must take into account the complexity and the scale of cultural and biological relations created in the Anthropocene epoch. Since local boundaries have been exceeded in the last decades, water governance should thus rely on political approaches characterized by a multiactor and multifactor based process, leading to an increasing internationalization of water governance.

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International Civil Aviation Organization as a climate governance forum: an analysis of the Carbon Offsetting and Reduction

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Abstract

In 2016, States agreed to address international civil aviation greenhouse gas (GHG) emissions at the International Civil Aviation Organization (ICAO). The article describes the route to the agreement reached by ICAO's 39th Assembly and presents the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), in order to contextualize the scheme and point out some of its limitations. We situate the debate about the international regulation of emissions at ICAO taking into account the contribution of the aviation sector to the global environment, which requires the enlargement of the scope of analysis, in order to consider the ethical implications of the consequences of climate change to communities and to the environment. CORSIA could be considered a call to responsiveness of the aviation sector for its contribution to climate change. The results of negotiations so far indicate the agreement does not represent a sufficient and comprehensive response to the challenges posed to the global environmental system.

Keywords: Climate Change; Aviation; ICAO

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Introduction

In 2016, States agreed to address international civil aviation greenhouse gas (GHG) emissions at the International Civil Aviation Organization (ICAO). For the first time, an agreement involving emissions by a specific sector was reached, and the negotiation process occurred in an International Organization with the focus on aviation and not on environmental issues. Because of that, ICAO became an important forum of climate governance, with a relatively autonomous agenda of the United Nations Framework Convention of Climate Change (UNFCCC), the main traditional forum of climate negotiations. In this forum, the response to deal with climate change reflects some of the main actors interests involved and the principles and values of the ICAO.

The article describes the route to the agreement reached by ICAO's 39th Assembly and presents the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), in order to contextualize the scheme and point out some of its limitations.

The article begins with the theoretical framework of climate governance, which refers to the set of actions taken by state and non-state actors to deal with the issue of climate change. We situate the debate about the international regulation of emissions at ICAO taking into account the contribution of the aviation sector to the global environment. The international air transport emissions of GHG is of nearly 2% of the total amount of emissions, with prospections of significant growth. Recognizing aviation emissions as contributors to change the global environment system also requires the enlargement of the scope of analysis, in order to consider the ethical implications of the consequences of climate change to local communities and to the environment. Then, we present the route to the agreement reached by ICAO's 39th Assembly, based on the ICAO's reports. After, we present the CORSIA's final design. Lastly, we point out some of its limitations from economic and environmental perspectives.

Theoretical framework: climate governance in the Anthropocene

We acknowledge in the literature of climate governance the theoretical framework of our analysis. Climate governance is a normative concept to refer to the set of actions taken by state and non-state actors to deal with the problem of climate change in different forums, from local to global level. In each of these forums, actors define issues of concern; they influence, demand or implement rules and programs; and act (hierarchically or not hierarchically) to produce impacts across borders (OKEREKE, BULKELEY & SCHROEDER, 2009). In doing so, they adapt their actions according to the forum – forums in which negotiations take place collaborate to define the result, because in these places actors share certain practices, symbols, behavior, principles and rules. In each international (or transnational) forum – for example, an International Organization –, specific relations of power take roll in way of governing and producing results.

The traditional forum of climate governance is the UNFCCC and specially its meetings, the Conference of Parties (COPs), which occur annually since 1992. But, considering the complexity of the issue and the international institutions involved in the climate change debate (RAUSTIALA & VICTOR, 2004), since 1992 several state and non-state actors have been dealing with the issue

in other more or less institutionalized forums. In different forums, actors seek to influence other actors other more or less institutionalized forums. In different forums, actors seek to influence other actors in order to establish political and economic agreements based on their interests (AVANT, FINNEMORE & SELL, 2010). In different forum, different actors may be brought to the debate, with different shared principles and values to be taken into consideration.

In this sense, we address the ICAO negotiation process involving emissions of greenhouse gases from the aviation sector taking into account other relevant actors (other than States) to the negotiation process, without a pre-assumption of hierarchy among them, in order to highlight different interests and concerns that are not specific to the climate change debate.

Besides, we do not address the results of negotiations at ICAO based only on a cost-benefit analysis nor on the national interests involved – which are traditional approaches in International Relations field. Because climate change affects societies, and therefore encompasses international relations in a much broader sense, we find it necessary to recognize that the results of negotiations about aviation emissions have implications to the functioning of global environment system and it causes changes to communities and environments in different levels and in very different ways.

Beyond the focus on interstate political negotiations and agreements, it is relevant to situate the debate about the international regulation of emissions at ICAO taking into account the contribution of the aviation sector to the global environment. Air transport impact on economic activities may not be underscored, especially if one considers that it has interconnected societies in a much easier and faster way. Nevertheless, it has also collaborated to change the functioning of global environment system. Aviation emissions are not mere externalities to be taken into account at the service final prices. If we are reshaping the biosphere and, consequently, the way we live on Earth, it is important to frame the debate about emissions by the aviation sector both in a cost-benefit analysis and in its long-term impacts on the environment. Aviation emissions collaborate, to some extent, to change the global environment system, for humans and no humans.

In the most varied fields, scientific studies of climate change confirm an unprecedented transformation of the planet's biophysical conditions. This transformation is caused by the intensified human actions of exploration, production, consumption, disposal and final destination in the last five decades. This set of transformations motivated a group of scientists from the field of geology to propose we would now be in the Anthropocene (see CRUTZEN, 2002), a new epoch of the history of our planet.

Over the last century, we, humans, have modified the physical conditions of the planet by promoting transformations in the soil and eliminating countless life forms (biodiversity), extracting ores and committing more than half of the water available for consumption, overexploiting the oceans with fishing activity and burning fossil fuels. We release into the atmosphere high quantities of greenhouse gases, create materials not absorbed in natural cycles of regeneration, among other transformations caused by human action. This would indicate the beginning of this new geological age, the Anthropocene, marked by the possibility of extinction of the human life on earth caused by humans .

The accumulation of knowledge in relation to these transformations and the recognition by the field of geology, as well as of the climatology, sustains that what gives cause to them is the human action. In that sense, it is recognized that the cause for recent climate change is "anthropogenic", a term used in the 1992 UNFCCC. This finding is central to the field of international climate policy, insofar as, since it has been caused by human actions, it is a matter of political actions. It is a result of wills, choices and power relations that affects human and nonhuman beings in a specific and complex way (CUDWORTH & HOBDEN, 2013).

Therefore, studying climate policies (as the regulation of emissions from aviation) requires us to enlarge the scope of analysis, considering some of the consequences to communities and environments, besides ethical implications of the distribution of these consequences. The Anthropocene approach

> emphasizes an integrated perspective of evolving social-ecological systems that require not only active management of human influences, but also the adaptation of human societies to inescapable changes. The governance of such societal adaptation processes, from local to global levels, pose formidable challenges for policy (BIERMANN, 2016, pp. 2).

The literature about the Anthropocene challenges traditional International Relations approaches to take into account the limits of a state-centric economistic lens that assumes a narrow anthropocentric view about the changes in the global environmental system. In this sense, “No longer can the discipline deny these interconnected risks, threats, and physical effects, or maintain an obsolete image of the world built upon clean divisions between humans, states, and global systems” (HARRINGTON, 2016, p. 4).

Among the challenges to IR field, the studies about International Organizations may be engaged in offering more consistent analysis and prospections, and not framing climate policies as a simple management of States wills achieved by the limited logic of the ‘least common multiple’ (VIOLA et al. 2013). As a consequence of this approach in our analysis, we find it necessary to reflect about the results of negotiations at ICAO not only to States and societies involved, but also to the global environmental system.

Finally, this exercise of extension of the elements to be taken into account must include time as a central issue of concern. The result of an international negotiation process is not the same if it provides the chance for postpone measures that has significant economic impact to the industry sector, for example, or if creates mechanisms that perpetrates environmental harmful practices because of diluted deadlines for entering in force. Some sense of urgency of results must be considered, due to the consequences and implications that aviation emissions cause to the global environmental system.

The response from the international aviation to climate change

The International Civil Aviation Organization (ICAO) was created in the 1940’s by the Chicago Convention, aimed first and foremost at promoting the harmonization of norms and procedures related to safety, security, facilitation and economic development of air transport worldwide (ICAO, 1944). As a specialized sectorial United Nations agency, ICAO sets up the so-

called Standards and Recommended Practices (SARPs), which are included as Annexes to the Convention. Once adopted by the Organization, an international standard becomes legally binding to all its member States (OBERTHÜR, 2006).

Most of the ICAO work has been primarily focused on the more technical regulation of the air transport. Composed by an Assembly, which conveys in a triennial basis, and a permanent Council with a restricted membership, all the ICAO decisions are founded in the recommendations of technical commissions, especially the Air Navigation Commission. Due to this very nature, it may be argued that consensus is frequently achieved by ICAO members as there is a common interest to promote connectivity and integration in the sector.

Environmental issues, in its turn, were seen a very narrow perspective and were only inserted on ICAO's agenda in the 1970's. The first volume of Annex 16 on Environmental Protection was intended to restrict noise disturbances from aircraft while the second volume dealt with the emission of heavier gases that affected local communities. The response from the organization for those topics was to foster the improvement of aircraft engines technology taking into account the three pillars: technological feasibility, environmental benefits, and economical reasonability (ICAO, 2016a).

Although climate change was not even part of ICAO discussions, the contribution of international aviation to the overall Greenhouse Gases (GHG) emissions cannot be disregarded. Estimations of the international air transport contribution to the total GHG emissions account for approximately 2%; however, the IPCC prospects indicated that this amount could reach more than 5% until 2050 (Figure 1), if no mitigation action was adopted by the sector (IPCC, 1999).

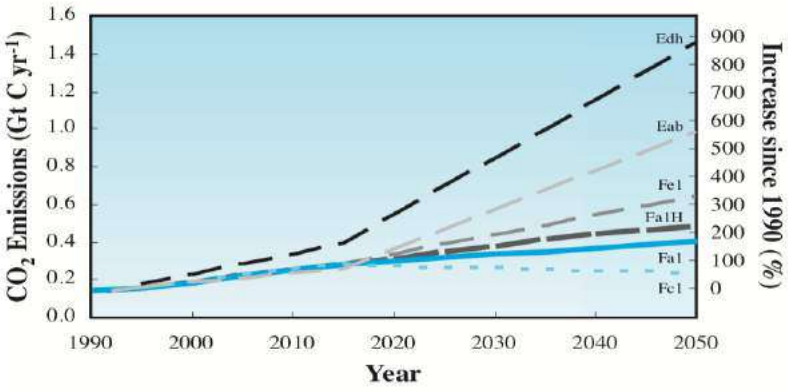


Figure 1: Total aviation carbon dioxide emissions resulting from six different scenarios for aircraft fuel use. Emissions are given in Gt C [or billion (10^9) tonnes of carbon] per year. To convert Gt C to Gt CO_2 multiply by 3.67. The scale on the righthand axis represents the percentage growth from 1990 to 2050. Aircraft emissions of carbon dioxide represent 2.4% of total fossil fuel emissions of carbon dioxide in 1992 or 2% of total anthropogenic carbon dioxide emissions. (Note: Fa2 has not been drawn because the difference from scenario Fa1 would not be discernible on the figure.)

Source: IPCC, 1999

As the international climate regime was becoming more consolidated, though, ICAO was called for taking more incisive steps towards more ambitious measures to curb its GHG emissions. Even if no mentioned on the United Nations Framework on Climate Change (UNFCCC) was directly made on the international transportation, the Kyoto Protocol clearly gave the mandate to negotiate a comprehensive agreement to curb GHG emissions from the international aviation to the respective sectorial organization, i.e. to ICAO. Article 2(2) from the Kyoto Protocol established the following:

> The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.

In the early stages, ICAO was very reluctant in fulfilling this mandate, and the reasons for that impasse are threefold. Firstly, for its very nature, emissions from the international transport are very difficult to allocate among states. As most part of the emissions ends up the upper atmosphere, the questions that arise were how to designate responsibilities among members states on a certain international route operated by a specific airline (OBERTHÜR, 2006). The second reason for the ICAO inaction was the high influence that the industry exerts on its member states. The International Air Transport Association (IATA) is an observer member at ICAO and very fiercely advocates for the industry interests in many of its technical and high-level meetings. And, last but not least, ICAO is a very technical specialized UN agency aimed at harmonizing the standards on the civil aviation field that hardly had to deal with highly sensitive issues. When called to take actions on a less consensual and more political discussion with many conflictive interests, the Organization came to a kind of deadlock on how to conciliate its cornerstone principle of non-discrimination as enshrined in the Chicago Convention with the precepts consolidated in the UNFCCC.

At first step to limit or reduce the environmental impact of aircraft engine emissions, ICAO took the easiest route, placing especial emphasis on the use of technical solutions related to operational and technological measures. In this regard, emissions reduction should be achieved by a framework consisting of economically efficient and technologically feasible strategies, such as better air traffic management, fuel efficiency, technological improvement in engines and in ground equipment (ICAO, 2007a). At this stage, no long-term goal or target of CO2 emission reduction was adopted by the Organization.

The perspective though that the European Union would adopt unilateral actions to include intracontinental flight that had as origin or destination an European country was a trigger factor for a more incisive response from ICAO (GONÇALVES, 2016). Following the EU Directive 2008/101/EC, non-European countries and the industry rejected any unilateral action from states or grouping of states that could entail a patchwork of different regulatory frameworks and, thus, could increase transactional costs for airlines (ICAO, 2007b; ICAO, 2007c; ICAO, 2007d; ICAO, 2007e).

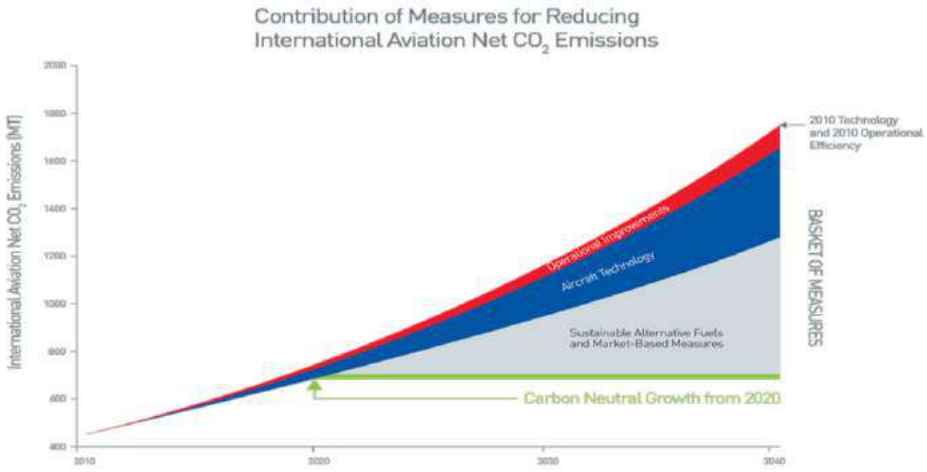
The more incisive response from ICAO came by the Resolution A37-19, in which Member states resolve to establish the global annual average fuel efficiency improvement of two per cent

until 2020 and an aspirational global fuel efficiency improvement rate of two per cent per annum from 2021 to 2050. In addition, consensus was reached towards the global aspirational goal carbon neutral growth from 2020 onwards (ICAO, 2010). As important as those goals are for the global effort to address climate change, ICAO has not introduced any restriction on the economic growth of the sector, as no reduction emission target was not even considered by states. The economic feasibility had prevailed over more environmental ambitious measures.

States were also asked to submit, on a voluntary basis, their action plans where information related to the set of measures in order to reduce their CO2 emissions should be compiled. This document had two main objectives. Firstly, it should assist ICAO to evaluate the level of effectivity of the aforementioned goals; second, it should be a means to assess the need for assistance from its member states. Nevertheless, the document was nothing but a letter of intentions as no required measures was set forth by the Organization.

According to ICAO's projections (figure 2), though, only operational and technological advancement would not be sufficient to help the sector to achieve its neutral growth target. Even considering the new stricter CO2 emission standard for new aircraft engines to be produced from 2023 onwards, inner solutions will have to be complemented by a basket of measures so as the international aviation can achieve neutral carbon growth. Along with the sectorial measures and the intensive use of sustainable alternative fuels, it became evident that the increasing demand for air transport will push the sector to offset its emissions from some king of market-based measure (i.e. cap-and-trade scheme or revenue mechanism).

Figure 2 – Growth emissions prospects for international aviation and the contribution of measures for reducing CO2 emissions



Source: ICAO, 2017.

As the response from ICAO was lagging behind to what was expected from some of its Members (i.e. European states), the European Union threated to in the EU ETS all international flight overpassing the European territory from 2016 onwards. The prospect of creating a patchwork of different offsetting schemes regionally prompt ICAO to act more incisively. The

industry interest became aligned to the adoption of a global response to climate change not only because it would be more cost-efficient but also because it was clear that the industry could not sidestep the issue any longer. A compromise was reached under ICAO on a stop-the-clock-policy. The European Union would wait for ICAO to move forward in designing a global MBM scheme aimed at reducing or offsetting emissions from international aviation (EC, 2012).

ICAO decided, therefore, to develop a global MBM scheme to be implemented from 2020 onwards (ICAO, 2013). As a result of three years of intense negotiations, States adopted a Resolution, by which means the CORSIA, which stands for Carbon Offsetting and Reduction Scheme for International Aviation, was established (ICAO, 2016b). CORSIA is thus the ultimate response from ICAO to address its impact on climate change. It consists of an economic measure through which CO2 emissions growth above the baseline will have to be offset by the purchase of emissions unit credits in the carbon eligible markets.

CORSIA is meant to be a temporary response though. Designed to be implemented in a phase-in approach, it supposedly should last from 2021 to 2035. In the first two CORSIA is meant to be a temporary response though. Designed to be implemented in a phase-in approach, it supposedly should last from 2021 to 2035. In the first two phases (from 2021 to 2026), it has a voluntary character, in the sense that only the routes of those states that willingly join the scheme will have offsetting requirements under CORSIA. In the third phase, which starts in 2027, CORSIA will be mandatory for all states that have a significant share individual of international aviation activities in RTKs in year 2018 above 0.5 per cent of total RTKs or that are part of the 90% world RTK. Exception are granted to Least Developed Countries (LDCs), Small Island Developing States (SIDS) and Landlocked Developing Countries (LLDCs) unless they volunteer to participate in any phase.

This phase-in approach was aimed at addressing the principle of differentiation among countries accordingly to their respective capabilities, as enshrined in the UNFCCC regime. On the other hand, as non-discrimination is a basilar principle in ICAO, in a same route all air operators will not be differentiated by their nationality. In this sense, if a route is included under CORSIA, all airlines operating that specific route will have offsetting requirements. A route is included under CORSIA only if both state pairs are part of the scheme; if one leg of the route is exempted, there is no offsetting requirements at all.

The attribution of offsetting obligations will be made according to a very tricky formula. In the first years of the scheme, the market share will be mainly considered to designate how much each airline will have to offset. Therefore, more consolidated airlines with a larger share of the global operations and, thus, with greater GHG emissions, will pay relatively more than smaller operators. Starting in 2030, though, an individual factor will be increasingly added in the formula, and so the individual growth rate will play an important part as well in the distribution of offsetting requirements.

The limits of the ICAO response

After almost 20 years, ICAO has chosen, among different possible measures to induce emission reduction, an economic mechanism that compensates (not reduces) emissions. All the airlines that operate routes covered by the system will have to buy carbon credits – or carbon reduction certifications – from carbon offset project developers (projects to reduce GHG emissions in different sectors like agriculture, industrial gas, cook stove, forestry projects, energy-sector types, etc.) that transact credits in carbon markets.

Offset is one of the simplest carbon market mechanisms that exists, and the possibility of buying credits from different sources give buyers flexibility to comply their obligations. Besides, a significant number of airlines already has offset programs, through which passengers may neutralize their individual travel emission contribution. In this sense, CORSIA do not imply a significant amount of investment or operations' adaptation. For carbon markets consultants, investors and project designers, CORSIA may represent an important increase in demand.

However, CORSIA has significant limits that allows characterizing it as a feeble response to climate change. Below, we synthesize six aspects of the system' limits.

a) The IO constitutive concern is to preserve the sector's interests, not the environment

As ICAO is an intergovernmental organization whose main actors are states, many of the constraints that hamper more ambitious actions in the international climate regime may also have played an important role, which may have led the Organization to a more consensual answer that hardly is the best solution from an environmental standpoint.

It can also be argued that the ICAO response to climate change was mainly centered in industry friendly solutions partly because the industry exerts a strong pressure on the decision-making process, but also because environmental goals are not enshrined in the ICAO Convention and were only inserted on the agenda in a later stage. According to the Chicago Convention (ICAO, 1944), the Organization has, as one of its main objectives, to meet "the needs of the peoples of the world for safe, regular, efficient and economical air transport" (emphasis added).

b) There are not reduction targets and the sector plans to growth

Although ICAO claims that CORSIA consists in a resolute step from the international community in its efforts to mitigate greenhouse gas emissions by taking sector-wide action at a global level, it fails to foster an internal transition to a more efficient and cleaner energy matrix. As there is no reduction target for the sector, air transport will likely continue its economic growth as long as it is able to transfer the cost of its emissions to other sectors in the economy. Investment not only in sustainable alternative fuels that can definitively replace bunker fuels, but also in more disruptive technologies would certainly have to be considered in a much larger scale by ICAO.

More ambitious measures will need to be considered especially when taking into account the growth projections in the demand for air transport. According to IATA forecasts (IATA, 2016), demand of passengers for air transport will nearly double in the next 20 years, and the major driver for this demand will come from the Asia-Pacific region.

c) There are no clear parameters to environmental integrity of the credits allowed at CORSIA

The Resolution does not set clear parameters to guarantee the environmental integrity of the credits allowed at CORSIA. In 2018, some important elements are still at the negotiation table, in particular those related to the quality of carbon offsetting credits and the criteria for their eligibility under CORSIA.

Besides, the voluntary design in its first phases and the absence of a strong commitment about the quality of the offsets indicate the system may not be able to incentivize the aviation sector transition to more efficient technologies (MURPHY, 2018). Doubts remain on the environmental integrity of some projects even in reliable carbon programs, as the Clean Development Mechanism (MICHAELOWA, 2012). In short, there is no consensus on the effectiveness of carbon offsetting schemes to really deliver environmental gains.

d) CORSIA may have undesirable effects from an economic perspective

From an economic standpoint, CORSIA is also debatable. While this individual factor was included to incentivize improvement in efficiency, in practical terms, market distortions could be created under ICAO, subverting the very basilar principle of non-discrimination. As fast growing and new entrants will certainly have more offsetting requirements than more consolidated airline, they will also pay relatively more operating the same route under CORSIA. The cost impact of CORSIA will thus be different between operators and will create important competitive distortions, whose extent is still unknown.

e) CORSIA is a limited solution to respond to a serious and urgent problem

ICAO has not introduced any restriction on the economic growth of the sector, as no reduction emission target was not even considered by states. As there is no reduction target for the sector, air transport will likely continue its economic growth as long as it is able to transfer the cost of its emissions to other sectors in the economy. Given the projections of an increasing demand, the industry will hardly find inner solutions to curb its emissions. If sustainable alternative fuels are not developed in a larger scale to meet the current and future demand, CORSIA may become a permanent scheme, lasting much beyond 2035, when it was supposed to come to an end. So, a considerable weak mechanism will probably be maintained as the main international politics to deal with aviation emissions.

As a result of political choices, the weaknesses of CORSIA must be evaluated also by its ethical implications: it is a deliberated weak response taken by a group of actors that may collaborate to intensify changes and impacts to the global environmental system.

The ICAO agreement is founded on the comprehension of climate change as a serious challenge: it is a problem caused by anthropogenic action and it is urgent to act in order to reduce emissions and mitigate its effects. ICAO's response to the problem, however, does not seems to take into account this urgency or seriousness until now.

There is a distance between recognizing the seriousness of the climate change problem and the significant contribution of aviation, and building a strong set of actions, engaging actors and mobilizing the institution to respond to the problem. ICAO reached the first important part:

it has recognized the problem, but if it does not respond coherently to engage in building strong responses to the challenge, the designed system may be characterized as greenwash for airline companies.

f) Participation of civil society and other non-state actors besides the industry was very limited

Participation of international non-governmental organization has been very limited under ICAO. The only NGO represented as an observer member in ICAO is the International Coalition for Sustainable Aviation (ICSA), which is a congregation of six different actors, all of them based in developed countries. As broadly represented as it may be, though, ICSA may not speak up for the international community as a whole, as the voices from local communities, especially those located in developing countries and that may be the most impacted by any international measure, are not be taken into consideration. In this regard the limited participation of NGOs may have negatively affected the final result in the aviation sector not only because other visions and perspectives were disregarded but also because it may have ultimately legitimized the scheme, as at least ICSA had influenced, to some extent, the decision-making process under ICAO.

Conclusions

The approval of the first international agreement involving hundreds of States to deal with the emissions of a specific sector is an important achievement. However, it is a deeply restricted step, considering the problem it seeks to address and the changes it may cause to the global environmental system.

CORSIA is the result of a negotiation process in an International Organization. As mentioned before, IOs tend to produce “lowest common multiple” decisions, and CORSIA is a good example of this lack of stringency. It is a system designed to allow flexible compliance of rules. The central interests mediated in the negotiations that resulted on the approval of CORSIA were trying to preserve the sector growth and the national interests involved while also responding to climate change.

As stated, hardly will CORSIA be effective in reducing emissions from the sector, as it will only foster the continuous growth of operations as long as the carbon price remains attractive. Nonetheless, CORSIA takes place of other potential politics with possible higher impacts to the global environmental system – like, for example, approving stringent rules for speed up emission cuts and promoting higher efficiency gains. Considering the criteria involving the quality of the carbon credits still under discussion at ICAO, CORSIA may be transformed in an effective greenwash for airline companies.

CORSIA could be considered a call to responsiveness of the aviation sector for its contribution to climate change. The results of negotiations so far indicate the agreement does not represent a sufficient and comprehensive response to the challenges posed to the global environmental system.

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Environment and Inequality: A Complex Relationship

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Abstract

The objective of this article is to discuss the mutual relationship between environment and inequality. This is a subject that received few attention from the environmental point of view. The economic perspective is usually predominant. Environment is a broad, transversal subject which keeps interfaces with a number of disciplines and affects important dimensions of the human life. We selected two central issues in order to explain their mutual relations with poverty and inequality: climate change and biodiversity. The relation between climate change and poverty/inequality is easier to be understood, in spite of the fact that it is a complex relationship. It is sufficient to consider the natural disasters and the increasing number of environmental refugees. However, in some exceptional cases, global warming may have a favorable effect on poor population living in very cold geographic areas. Insofar as biodiversity is concerned, the question is more controversial. There is a visible dependence of natural resources on the part of poor populations. The depletion of natural resources has a direct impact on the survival of these populations, and this will bring about increased inequality. But the need to conserve biodiversity in protected areas may affect the source of subsistence of low-income population.

Key Words: Environment, Biodiversity, Climate Change, Poverty, Inequality

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Introduction

This paper aims to analyze the relationships between the environment, on the one hand, and poverty and inequality on the other. Many existing texts and books analyze each of these issues separately, but few studies based on research work focus on the reciprocal relationships between them. This Working Paper presents a review of the existing literature.

The environment is a very complex theme that cannot be reduced to a single system of causality or a main cause that would explain the rest. Society can no longer be explained by prioritizing a cause as a basis from which the whole social system can be understood (for example, class struggle in Marx, power in Foucault, symbolic capital in Bourdieu etc.). As a theme, the environment is a crosscutting, multidisciplinary dialogue between the natural sciences and the social sciences. Understanding would derive from the relationship between these areas of knowledge, rather than in-depth study of each specific area.

Bearing in mind the central importance of focusing on the relationship as the subject for study, we selected two environmental issues - biodiversity and climate change - to examine their impacts on poverty and inequality. Likewise, we will examine the impacts of poverty and inequality reduction policies on the environment. Part I and Part II of this Working Paper are devoted to unraveling the mechanisms and instruments to explain the effects of biodiversity conservation and climate change policies on inequality and poverty. In addition, we will explain the effects that policies combating poverty and inequality have on biodiversity and climate.

In order that these mechanisms can be identified better and their operation understood, they were analyzed independently of some of their political or economic connections. The environmental perspective maintains a dialogue with its interfaces - biology, geography, sociology, political science, economics, law etc., but cannot be reduced to any particular one. Therefore, we examine the conditions under which an environmental protection policy may lead to a reduction of or an increase in poverty. We examine the circumstances under which a social protection policy for reducing poverty and inequality may contribute to protecting or degrading the environment.

We note the limited availability of information on the relationship between the environment and inequality. Official United Nations and international institution documents prefer to address the issue of poverty and ignore inequality. It is a mistake to imagine that the eradication of poverty would cause necessarily the reduction of social inequality. This latter consideration is of great importance in the complex problem of the environment and sustainable development. In this way, the delicate question of inequality on an international and domestic level is set aside on purpose in each country.

The economic system "regulator" is the international market, which demands goods and services of great environmental impact, as wood, meat, soy, minerals etc. Greenhouse gas emissions (mainly CO2) in using fossil fuels continue to contribute to global warming, despite the warnings made by scientific bodies since the Kyoto Protocol in 1997.

Developed countries count only 15% of the world population and use about half of global resources. This causes great damage to the environment, for example, by releasing into the atmosphere 45% of greenhouse gases emissions in 2004. The poorest 37% of the world's population account for only 7% of emissions (Galgóczi, 2012). In recent years, criticism of development indicators, such as GNP - which is exclusively economic and does not consider quality of life which is not limited to production and income - increased. For example, numerous proposals have been made to replace the GNP by a household income measurement, and not a product measurement.

Economic thought prioritizes the dominant productivist vision and remains a prisoner of the idea that growth is infinite and can be reached by all countries, provided they follow the recipes of economic conservatism which prevails in some international institutions. Only recently they have begun to worry about the depletion of natural resources threatening the very survival of the planet and humanity.

Environmental damages caused by development policies are not shared equally. Environmental injustice exists. The majority of effects of this damage fall on low-income populations, racially discriminated groups, traditional ethnic peoples, working class neighborhoods, marginalized and vulnerable populations.

To combat this inequality, the Environmental Justice Movement emerged in several countries. This movement denounces the fact that the harmful effects of development always fall upon the most vulnerable populations (Alier, 2011). Environmental injustice is caused by a perverse system of production, land occupation, ecosystem destruction and pollution, which undermines the health of residents of poor neighborhoods, often excluded from development projects which leave the poor without safe drinking water, proper garbage collection and sewage treatment in the periphery of cities and devoid of citizenship rights.

As environmental degradation and social inequality are justified by the ideology of progress and economic growth, in Part III we look at the case of Brazil, where the environment is considered a hindrance to the economic developmental model dominant today.

Biodiversity, Poverty And Inequality

Pursuant to the Convention on Biological Diversity of the United Nations (CBD), biodiversity is crucial to the reduction of poverty, due to the basic goods and ecosystem services it provides. They include the provision of food, fiber and medicine, soil formation, air quality and climate regulation, the regulation and quality of water supply, and the cultural and aesthetic value of certain plants and species.

Biodiversity is also integral to key development sectors such as agriculture and livestock, forestry, and fishing or tourism. More than 1.3 billion people depend on biodiversity and on basic ecosystems goods and services for their livelihoods (availability of usable land, water, plant and animal species). Poverty and disappearance of ecosystems and biodiversity are closely related.

Poor people are the direct beneficiaries of a number of ecosystems and biodiversity services. The most affected economic activities are subsistence agriculture, livestock, fishing and informal extractivism, which are the activities developed by most poor people in the world (TEEB, 2012).

Since the poor are particularly dependent on the goods and services supplied by biodiversity, development strategies that ignore their protection undermine poverty alleviation and are therefore counterproductive. For this reason, it is crucial for development and poverty alleviation strategies and programs to prioritize biodiversity. In developing countries, natural capital is estimated to be a quarter of total wealth as compared to 13% in middle income countries and 2% in high income OECD (Organization for Economic Cooperation and Development) countries (UN CBD, 2010).

Indeed, over one billion people live with less than one dollar a day in rural areas. They largely depend on natural resources for their subsistence and are deeply affected by their degradation. According to the OECD, in low-income countries the wealth based on environment stands for about 25% of the total wealth, while in developed countries less than 4% (OECD, 2003). As a matter of fact, according to information from the United Nations CBD:

1) nearly a sixth of the world's population depend on protected areas for significant percent of their livelihoods.

2) Over a billion people in developing countries rely on fish as a major source of food and 80% of the world fisheries are fully or overexploited.

3) Cost of global network of marine protected areas conserving 20–30% of the world's seas: up to $19 billion annually creating around one million jobs.

4) Number of people in the world who rely on timber and non-timber forest products: 1.6 billion. Annual rate of deforestation: 13 million hectares (or roughly the area of Bangladesh).

5) Sixty percent of ecosystem services have been degraded in fifty years and the cost of failure to halt biodiversity loss on land alone in last 10 years is estimated to be $500 billion.

6) Percentage of people in Africa estimated by WHO (World Health Organisation) to rely on traditional medicines (plants and animals) as the main source of their health care needs: 80%.

7) Number of times more likely a person living in a poor country is to be hit by a climate change-related disaster than someone from a rich country: 79.

There seems to be no doubt that biodiversity is extremely important to poor people, but the relationship between them is complex and cannot be reduced to causal factors. Land ownership and water are usually not available to poor population in rural areas who depend on agriculture and wild plants and animals for food. They are vulnerable to extreme climatic events

often produced by ecosystem degradation. In addition, in those low-income areas biodiversity is part of culture and is connected with identity and spiritual values.

However, we cannot say that biodiversity conservation is always a means to reduce poverty and inequality. And, on the other hand, poverty alleviaton is not always a means to ensure biodiversity protection. The complex relations between biodiversity and poverty/inequality have been explored by the International Institute for Environment and Development (IIED) as found in Roe&Elliot, 2005:

1) There is a geographical overlap between biodiversity and poverty in the national and sub-national level.

2) The whole world depends on biodiversity for the goods and services it provides, but poor people are particularly dependent.

3) Poverty may contribute to biodiversity loss, but this is only one of a number of factors. Conservation or overexploitation of biodiversity depend on several factors, especially external governance actions.

4) Conservation activities may have negative consequences for poor people, but others may benefit them. Governance factors play again an important role here.

5) Local people are often perceived as undermining conservation. Public policies should be conducted to protect aspects of biodiversity that are critically important for their livelihoods as well as to ensure protection of endangered species.

6) Poverty reduction activities can cause biodiversity loss. In fact, traditional policies of rural development – based on primary commodity production – have been harmful for both biodiversity and poor people. New approaches to reduce poverty and inequality, based on local knowledge and processes are tackling biodiversity loss, with a view to achieving the Millenium Development Goals.

1. Inequality and Biodiversity Loss

Biodiversity loss is due to the effects of several factors, as overexploitation, pollution, habitat degradation etc. (MA 2005a). In view of the importance of biodiversity to human life and of the fact that biodiversity loss is irreversible, its degradation is one of the most important threats that humanity faces nowadays (Chapin et al. 2000; Tilman 2000; MA 2005a).The impact on biodiversity is chiefly determined by social and economic activities. For example, the transformation of primary forest into land for agriculture or cattle, market pressures, agrobusiness production of commodities, deforestation for subsistence of small peasants etc.

There are no indications that the conversion of natural ecosystems into agriculture will be reduced in the near future. The demand for food and also meat consumption are expected to increase with population growth. And a small increase in global temperature would reduce the agricultural productivity of tropical and sub-tropical countries (IPCC, 2007).

Although it is well known that socioeconomic factors are responsible for biodiversity loss, their role has been overlooked until quite recently (Naidoo & Adamowicz 2001; Asafu-Adjaye

2003). The traditional approach was to review the relationship between socioeconomic factors and environmental change in general (e.g., Ehrlich & Holdren 1971; World Bank 1992; York et al. 2003). Usually, such studies are concerned with the relationship between environmental change and gross domestic product (GDP) or GDP per capita.

Studies of biodiversity loss with an economic perspective have not taken into account the consequences of the distribution of economic wealth. However, empirical evidence shows that inequality has a negative effect on other social outcomes and institutions (e.g.,Ronzio et al. 2004; Ross et al. 2005; Wilkinson & Pickett 2009). Social inequality has a significant effect on the environment (e.g., Ostrom 1990; Boyce 1994; Baland et al. 2007). According to Olson (1965), small groups with considerable inequality - when the majority of the wealth is in the hands of a few - are interested to conserve, no matter what the poorer members of the group do. Other more recent analyses agree with this perspective (e.g., Itaya et al. 1997).

In spite of this, other authors think that inequality may hinder conservation, and can thwart the collective action required for environmental protection (Boyce 1994; Dayton-Johnson & Bardhan 2002; Baland et al. 2007). These studies suggest a connection between inequality and environmental degradation, but the relationship with biodiversity was demonstrated only recently (Mikkelson et al. 2007). Based on the Red List data of the International Union for Conservation of Nature (IUCN), Mikkelson et al. (2007) state that greater inequality is associated with the number of threatened species. In the USA, for instance, the population decline of bird species is greater in the states with higher socioeconomic inequality. (Mikkelson et al. 2007). The Chart below shows the relation between the Gini Index of Inequality and the Proportion of Species Threatened.

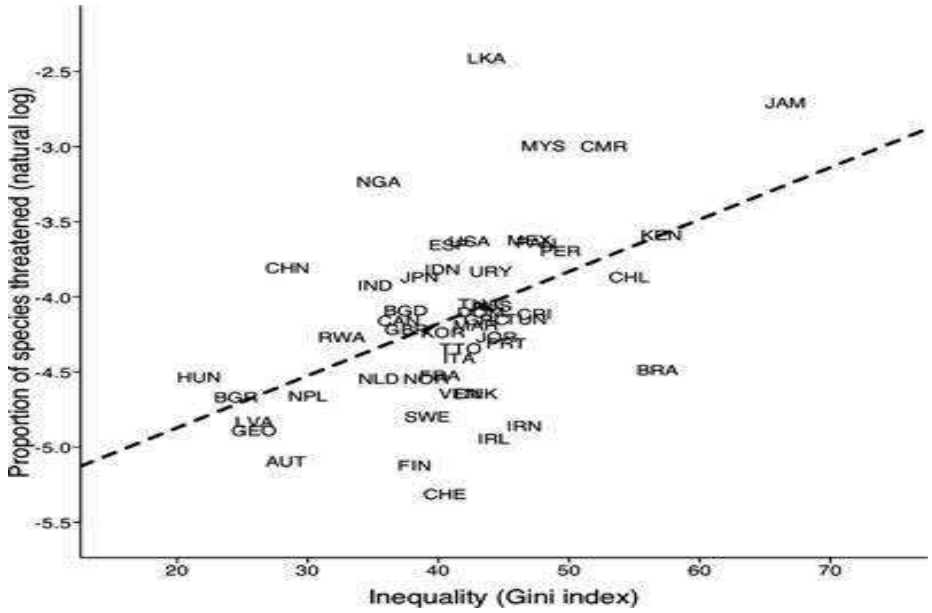


Figure 1. Correlation between the Gini index and the proportion of species threatened (dashed line, best fit of that relationship). Countries indicated by the three-letter codes assigned by the International Organization for Standardization (ISO).

Source: Holland, T.G., Peterson, G.D.,Gonzalez, A. 2009

Inequality may influence biodiversity in several ways that can be considered as individual or collective effects. Individual are those effects in which inequality changes the behavior of individuals, and collective effects are those mediated through environmental management institutions which, either formal or informal, play an important role in how communities manage their natural resources. Collective decision making and action, when effective, can avoid overexploitation. Nevertheless, greater inequality usually affects the effectiveness of these institutions (Boyce 1994; Dietz et al. 2003).

For some authors, environmental degradation is supposed to be greater in intermediate-equality societies and lower in highly equal and highly unequal societies (Baland & Platteau 1999). In very unequal societies, individuals are stimulated to conserve the resources they profit from, and this would have a favorable effect on biodiversity (Olson 1965). And, in very equal societies, groups will collectively manage conservation more effectively (Ostrom 1990).

This theory which advocates better conservation at the extremes of inequality is not based on empirical data and was criticized by other authors. Countries are usually too big for individual conservation decisions to benefit the individuals themselves. Thus, this potentially positive effect of inequality is not likely to occur at the broader scale of countries where institutional decision-making is the predominant pattern.

The importance of inequality as a factor producing environmental degradation in general is recognized theoretically by many different disciplines (Ostrom 2001; Dayton- Johnson & Bardhan 2002; Ronzio et al. 2004; Baland et al. 2007). Insofar as biodiversity is concerned, other studies provide empirical confirmation of the importance of inequality as a determinant of biodiversity loss in particular (Holland et al.'s 2009, Mikkelson et al.'s (2007).

2. Biodiversity: A Path to Poverty Reduction?

It is generally accepted that biodiversity provides the poor an insurance against risk, particularly food security risks, risks from environmental hazards, and health risks. As the poor have few alternative sources for protecting themselves, they have a higher dependency on biodiversity for dealing with risk. Poor people tend to depend disproportionately on relatively low value goods and services from biodiversity, while richer groups utilize those resources if they have higher commercial values.

In this connection, the IUCN – International Union for Conservation of Nature - launched an ambitious Conservation for Poverty Reduction Initiative to secure and improve rural livelihoods through the improved management of ecosystems across the developing world. The Initiative puts into practice the growing experience with and understanding of the ways in which better management of ecosystems can increase livelihood security, improve human health, and reduce poverty. It develops knowledge, empowers communities, and promotes policy changes to provide rural communities with the natural resource base on which to build a healthy future (IUCN 2008).

A research published in the review Public Library of Science (PLOS) demonstrated that healty ecosystems, with great diversity of plants and animals, can reduce the transmission of certain infectious and parasitic diseases that lead to discrepancies in the per capita income of population from tropical and temperate countries (Public Library of Science (PLOS) Biology, 2012).On the other hand, more than half the global value of ecosystem services which benefit the poorest people Real emissions reductions credits mean that the credits must be binded to projects that exist services pay the people responsible for those services, global benefits to poor communities would increase around 50 per cent, and payments would reach over a dollar per person per day for a third of the 1.1 billion people living in extreme poverty (Turner, BioScience, January 2012).

Biodiversity can be a means for poor people to escape poverty, particularly in areas with scarce economic opportunities. But the relation between biodiversity and poverty is very complex and dynamic. For poor people, biodiversity loss can be better (other sources of income) or worse (disappearance of livelihoods). In some cases, biodiversity conservation can be an obstacle to the economic improvement of poor people, while in others it is extremely important when absence of alternatives prevails.

At least six conservation mechanisms have been a route out of poverty in some places: community timber enterprises, nature-based tourism, fish spill-over, protected area jobs, agroforestry and agrobiodiversity conservation (Roe 2010). hus, it can be taken for granted that the poor depend disproportionately on biodiversity for their subsistence needs and that biodiversity conservation can be a route out of poverty under some circumstances.

Conservation policies and actions usually are oriented towards preserving biological diversity. In order to produce direct benefits to poor people, what is more important: biological diversity or biological mass.

Recent studies (Balmford et al. 2008) show that the direct benefits to people depend more on the abundance of particular species than the number of different species. This indicates that direct benefits to poor people come more from biomass than from biodiversity. In the long range, however, biodiversity is the foundation for biomass production.

3. Poverty Reduction: A Path to Biodiversity Protection?

In spite of the overlapping between biodiversity and poverty from the geographic point of view and the consensus regarding policies proposed by international institutions, the biodiversity-poverty relationship is very controversial.There are very different approaches, from a vicious cycle of poverty leading to environmental degradation and thence to more poverty, to a win-win scenario where environmental conservation contributes to poverty alleviation. But the benefits usually are not equitably distributed, and the poor are generally the biggest losers. The biodiversity-poverty relationship is critically affected by social and economic factors, as governance, policies on poverty and biodiversity protection, and population growth, for instance. (Tekelenburg et al. 2009).

Some analysts support the so-called Environmental Kuznets Curve, according to which environmental quality declines as income rises until income reaches a certain level where environmental quality improves. But this theory has been much criticized by other authors (Dasgupta et al., 2006), including by some supporters, based on the argument that once a species is lost, the extinction is forever. A number of analysts state that poverty alleviation in itself will not contribute to conservation. As wealth increases, so does the demand for wildlife (Robinson&Bennet, 2002). Other experts emphasize the apparent incompatibility between biodiversity and development, arguing that States with high material wealth have low biodiversity wealth and vice versa (Koziell & Saunders, 2001).

Biodiversity loss in itself cannot be said to help poverty reduction, but it is true that many economic development activities towards income increase may have negative impacts on biodiversity. If, one one hand, poverty can be the cause of biodiversity loss, the same can be said of wealth. Deforestation, for instance, can be produced by local demand for agricultural land, but even more by international demand for timber and trade in forest products on the part of industrialized countries (UN Millenium Project, 2005).

Indeed, other factors as governance, security of land tenure and access to resources may have a greater impact on the way in which people take action for overexploitation or conservation. Poverty is only one factor. Reducing poverty will not necessarily lead to biodiversity conservation, unless the other drives are also addressed (Roe & Elliot, 2005).

Usually, poor people live in an informal economy, which results in underevaluation of their assets and underestimation of the benefits of a proper ecosystem management. Income from ecosystems, also called environmental income, can be a fundamental encouragement for the economic empowerment of the rural poor. Thus, poverty reduction may lead to biodiversity conservation only if connected to clear conservation objectives, strategies, policies and actions, in an appropriate governance context (WRI, 2005).

4. The Poverty Trap

It is not sufficient to say that the poor depend significantly on biodiversity for income and subsistence. This should be reviewed carefully. It is true that poor people make extensive use of natural resources, but it should be added that these are low-value resources, oriented to subsistence. They don't have access to or are excluded from high-value resources.

This condition has been called "the poverty trap" (Angelsen and Wunder 2003). Poor people are linked with low-value resources, and these low values will perpetuate poverty. Thus, dependence on low-value biodiversity resource is an indication of poverty. The only way out to escape the poverty trap seems to be migration to urban areas to leave the forest (Levang et al. 2005).

Here we have an apparent paradox, inasmuch as resources based on biodiversity have always been considered as an essential factor to provide food safety for the poor. However, when this dependence is reproducing poverty conditions, alternative livelihood strategies should be

adopted. The Table below shows the relationship between dependence on biodiversity and inequality in some regions.

Table 1: Equity implications of biodiversity resource dependence

Reference	Region	Resource	Impact on inequality
Fisher 2004	Southern Africa	Forests	Reduces by 12%
Jodha 1990	South Asia	CPRs	Lowers Gini coefficient
Kamanga *et al.* 2009	Southern Africa	Forests	Lowers Gini coefficient
Mamo *et al.* 2007	East Africa	Forests	Lowers Gini coefficient
Reddy and Chakravarty 1999	South Asia	Forests	Reduces inequality
Shaanker *et al.* 2004	South Asia	NTFPs	Lowers Gini coefficient

Source: CBD Technical Series No: 55

Data in the Table above show improvements in distribution patterns related to livelihood strategies for biodiversity dependence. However, if dependence of richer groups on high value resources is taken into consideration, this distribution result could be worse. In other words, a policy based on biodiversity will not necessarily reduce inequality.

Until recently, the prevailing opinion was that "the only hope for breaking the destructive patterns of resource use is to reduce rural poverty and improve income levels, nutrition, health care and education" (Wells and Brandon, 1992). But this has not happened in many developing countries. China, Indonesia and Brazil, for example, have greatly reduced rural poverty while continuing to draw down their natural capital. (Roe, 2010).

Two basic reasons explain today why reduction in rural poverty and better incomes, health care and education may not improve biodiversity degradation: First, natural resource consumption tends to increase with income. Second, people with better economic conditions benefit more from natural resource: they have capital to exploit the resource. Reduction of rural poverty will not necessarily prevent biodiversity degradation. Conservation policies should provide permanent benefits to local people. There are conservation mechanisms that can benefit both poor people and biodiversity

A number of studies reviewed the challenges faced by conservation projects regarding poverty and inequality. Four challenges have been found as common to all:

1) Not only were elites more likely to participate, but they were often the main recipients of conservation-induced livelihood benefits.

2) Conservation projects sometimes led to a widening of income disparities.

3) Better-off households with higher social capital were more likely to participate in a conservation initiative.

4) There was some evidence that women could have realized greater livelihood gains from projects but were excluded due to discrimination (UN CBD, 2010)

5. Biodiversity-Poverty Combinations

Ecosystem degradation has traditionally been considered to produce negative consequences to well-being. Nevertheless, according to the Millennium Ecosystem Assessment (2005), ecosystem degradation has brought about important improvements in human well-being (World Resources Institute, 2005). This apparent paradox was explained by several factors as, for instance, inadequate concept of well-being by prevailing indicators and the excessive weigh given to food production concerning other factors (Raudsepp-Hearne et al. 2010).

But increased food production resulted in more benefits to urban areas than to rural population. Out of 840 million undernourished people (Griffon, 2006), three-thirds live in rural areas depending on agriculture. In view of the fact that agricultural products have lower prices in the national and international market, increase in food production may not have benefited poor people in rural areas.

Furthermore, the argument that degration of ecosystem services leads to development should be analysed more carefully. In fact, usually this kind of development replaces the so-called natural capital by man-made capital. The poor people affected by biodiversity erosion will remain poor as ecosystem services degrade. As a result, if conservation cannot be said to be directly linked to poverty alleviation, it may at least avoid extreme poverty (Sukhdev et al. 2011).

Less poverty usually means less biodiversity, creating a 'win-lose' situation. Overexploitation can lead to a collapse of the system and an increase in poverty with even more loss of biodiversity, and become a 'lose-lose' situation. Reducing poverty while conserving biodiversity - a 'win-win' - can more probably be achieved on a local scale (Tekelenburg, 2009).

In fact, higher or lower poverty levels may coincide with an increase or decrease in biodiversity in all possible combinations. The relationship between biodiversity and poverty involves a number of factors, linked to socio-economic context, ecosystems and production processes, market integration, access to capital, management skills and productivity. Cross-cutting factors play an important role such as population density and growth, ecosystem sensitivity to degradation, governance, and policies on poverty alleviation and biodiversity protection. Policy interventions may shift negative trends towards a more positive direction, making them policy driven (Tekelenburg et al 2009).

6. Poverty or Inequality?

From the sustainability point of view, the poverty alleviation agenda may conflict with biodiversity conservation concerns. In this connection, the following issues should be taken into consideration. Although it is increasingly recognized that the poverty concept is complex, it is still measured, to a large extent, in terms of money. Just as GDP remains the main indicator of development, poverty is still evaluated on the basis of monetary criteria.

Misleading conclusions can be derived from this, inasmuch as other factors that are important to well-being are overlooked. Poverty reduction cannot be identified with increased consumption of material goods. The exclusive quantitative approach considers to be individual progress if someone reaches the level of material consumption of the class immediately higher.

All of these misleading notions are now being rejected. Emphasizing that "more equal societies always do better", some authors demonstrate the negative effects that inequality has on societies: eroding trust, encouraging excessive consumption, increasing anxiety and illness (Wilkinson & Pickett 2009). More than poverty, inequalities have negative impacts on biodiversity (Holland et al. 2009).

All attempts to blame the poor for biodiversity loss cannot be taken seriously, once wealth is clearly the main cause. If natural resources are limited and if poverty is to be reduced, the first step of a responsible policy should be to reduce the gap between the rich and the poor. The focus on poverty in sustainable development policies leads to the wrong idea that the solution is to increase GDP.

Poverty alleviation is generally presented by international institutions as a win-win scenario: economic growth would benefit all segments of the society. On the other hand, emphasis on inequality reduction would benefit low-income sectors to the detriment of higher classes. Hence, the difficulty to implement inequality reduction policies in most countries. There are, however, some examples that try to relate poverty alleviation with inequality issues, as found in the document "Fighting poverty and reducing inequalities" from the French Ministry of Foreign Affairs, published in 2011. But there is no doubt that further research is needed to assess the role of inequality regarding biodiversity and sustainable development.

Climate Change, Poverty And Inequality

1. Vulnerability

Climate change is considered to be a real threat to the efforts towards poverty and inequality reduction and to the policies aimed to reach economic and social development. Benefits produced by past economic growth can be affected, and people disempowered. Strategies to face climate change issues and to combat poverty are closely linked. Excessive rainfalls leading to floods, droughts, desertification, extreme climate conditions will affect

natural environment and also the livelihood of poor population. Climate change is an important factor to keep poors in the so-called poverty trap.The Stern Review (Stern, 2006) and the IPCC 4th Assessment Report (IPCC, 2007) have developed an important study of the relationship between climate change and poverty. Throughout a quite long time, the scientific community was divided concerning the anthropic causes of climate change. After decades of debates, the United Nations finally accepted the conclusions of IPCC in relation to this issue. We can say that today there is a large consensus about climate change impacts.

The most known aspect seems to be the rise in temperature level. There are connected problems, however, that should not be overlooked: floods, changes in rainfall pattern, rise in sea level, water shortage, drougts etc. These impacts have different effects on different regions and countries.

The traditional concept of poverty was based only on monetary aspects to measure well-being. GDP was the predominant indicator. Nowadays, not only income, but also social and psychological aspects are taken into account, such as education, health, human rights, empowerment, degraded environments etc. Impacts of climate change on poverty should take into consideration all of these aspects (Narayan et al. 2000).

Although climate change impacts affect more heavily poor people, all segments of the society, in all countries and regions, are vulnerable to the global warming. Either rich or poor, all countries will have to adapt to face the increasing climate change impacts. A recent research work pointed out that in relatively more unequal societies, reductions in income inequality relate to lower per capita emissions. The Gini coeficient and emissions per capita go in the same direction, i.e. when inequality increases, emissions increase and when inequality decreases, emissions decrease (Grottera C, 2012).

Poverty in the traditional sense – measured in monetary terms – is considered to be more vulnerable, because poor families have less ability to adapt. But there are other factors besides income affecting living conditions: land, ecosystem, social and institutional organization etc. Low income is not the only factor and sometimes not the most important (Magnan, 2010).

2. Unequal Distribution of Impacts

Climate change is expected to affect developing countries more seriously than the developed nations, in view of their climate condition, dependence on natural resources and a certain lack of capacity for adaptation (IPCC, 2007). Damages caused by climate change in Latin American and Caribbean countries, for example, are expected to vary from 1,3% to 7% of the Gross Domestic Product by 2050, if adaptation actions are not taken into account (Verner 2010). From 2000 to 2005, the average cost per year of damage produced by climate change is estimated to reach around 0.7 percent to 0.8 percent of GDP (Nagy et al. 2006).

And this damage affected much more poor people, whose number is estimated to be 100 million people in the region (World Bank, 2008). Poor people is more vulnerable because their dependence on natural resources is greater and their ability to deal with extreme weather

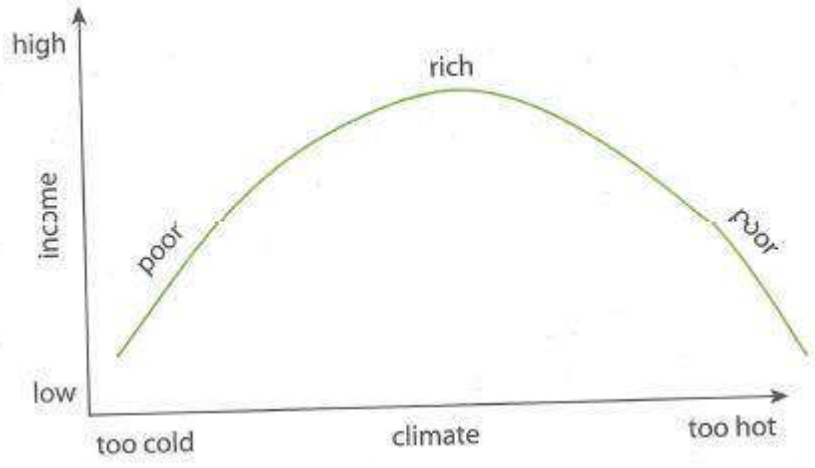
conditions is usually reduced. In spite of the fact that climate change impacts cannot often be avoided, there is much room to develop policies to implement mitigation actions designed to combat the causes of climate change, and also adaptation actions with a view to fighting their consequences.

As the economic and social development will be affected in the next years, it is extremely important that climate change issues be incorporated into development policies (Stern, 2006). As poor people are the most affected social group, it is their interest that governmental policies take mitigation and adaptation measures so that the vicious circle of poverty and inequality be reversed into a path towards sustainable development.

The question to be tackled is to explain how climate change affects the livelihood of poor population, and how poverty affects the capacity to face extreme natural events. The negative effects of climate change have a greater impact on the poor, who depend on natural resources and live in fragile environments subject to natural disasters as floods, droughts, landslides etc. By 2015 more than 375 million people are likely to be affected by climate related disasters – a projected increase of 54% – and this threatens to overwhelm the world's current capacity to respond (OXFAM, 2009).

The impacts of climate change have a very unequal distribution, affecting the social groups in a different way. This is one of the greatest social injustices existing nowadays. The economic and social development becomes more difficult in extreme weather conditions, either too cold or too hot. Regions with moderate temperatures tend to be richer than regions with extreme weather. As shown in the Figure below, poor countries are more sensitive to climate change than rich countries.

Figure 2 - Theoretical Relationship between Temperature and Income



Source: Andersen and Verner (2010)

In addition to this relationship between temperature and income, there are other important factors affecting poor people. In rural areas, they are dependent on agriculture which is very sensitive to extreme weather. In both rural and urban regions, they usually live in fragile

areas that are more subject to natural disasters. They have less access to public infrastructure and less savings to face the consequences of natural disasters.

As climate change affects poor people more than other groups, poverty and inequality tend to increase with climate change. As a matter of fact, recent surveys indicate that the growth of income in less developed countries has been affected by climate change over the last half century, while developed countries remained unaffected (Dell et al. 2008).

Specific situations, however, should always be taken into account. In Brazil, for instance, poverty is more concentrated in north and northeast which are supposed to become warmer faster than the south and southeast. People living in those hot areas are expected to be more affected by increased warming than those living in cooler regions. As a result, climate change is expected to bring about an increase in poverty and inequality in Brazil.

On the other hand, the situation in Bolivia is completely different. Poor people live mainly in the cold highlands, and would this way get more benefits from warming than the richer population living in the hotter low lands. Under these circumstances, poverty and inequality in Bolivia tend to be reduced with additional warming. Thus, the climate-income relationship may be very different from one region to another. In other words, the effects of climate change on income, poverty and inequality may be considerably different from country to another.

3. Impacts on Some Latin American Countries

The expected increase in temperature over the forthcoming 50 years in Brazil should produce a decrease of 12% in the per capita income, as an average. Of course, the northern and northeastern states will lose much more than the national average and the south and southeast. A good picture of this situation is shown in the Table below.

Table 2 : Brazil: Estimated Impact of Climate Change on per Capita Income, 2008-58

Region	***Impact on per Capita income (% change)***
North	- 22.5
Northeast	- 19.8
Center-west	- 15.6
Southeast	- 7.2
South	- 2.9
Brazil	- 11.9

Source: Andersen and Verner (2010)

Climate change should increase inequality and poverty in Brazilian municipalities. The poorest regions will probably undergo a considerable reduction in income, in view of the increased temperature. A research work conducted in five Latin American countries indicated that the effects of climate change are negative for Brazil, Chile and Peru, where income is expected to decrease. Bolivia would be granted a small benefit and for Mexico no important impact is expected insofar as income is concerned.

Poverty is expected to increase in Chile, Brazil and Peru, decrease in Bolivia and for Mexico no reliable forecasts have been suggested. In relation to inequality, it is expected to increase in Brazil, decrease in Bolivia and remain unchanged for the other three countries.

Table 3 - Climate Change and Municipal-Level Income, Poverty and Inequality

Country	***Effect of Future climate change on average incomes (% change)***	***Effect on poverty***	***Effect on inequaty***
Bolivia	2.9	Decrease	Decrease
Brazil	-11.9	Increase	Increase
Chile	-6.7	Increase	Neutral
Mexico	Neutral	Neutral	Neutral
Peru	-2.3	Increase	Neutral

Source: Anderson and Verner (2010)

In view of the data above, we have to be more careful regarding the prevailing arguments about climate change always affecting poor people disproportionately and causing poverty and inequality to increase. In Brazil and Chile, the poor people live in the warmest areas and their situation is expected to worsen with additional warming. On the other hand, in Bolivia and Peru the poorest population live in cold highlands and could benefit with the expected warming effects of climate change.

The climate change effects, as a matter of fact, are not so important for income in some countries. They could benefit more with education. In Bolivia, for instance, a 2°C increase in temperatures would increase consumption levels about 3 percent, while a two-year raise in education levels would increase per capita consumption levels by 47 percent. In Brazil, a 2°C increase in temperatures would bring about a 12 percent reduction in average incomes, while a two-year increase in education levels would cause a 94 percent increase in incomes (Andersen and Werner 2010).

The geographic factor is extremely important to explain the vulnerability of poor countries. These least developed nations are usually warmer, have high rainfall precipitations and are dependent on agriculture, a sector highly sensitive to climate. A changing climate

produces alterations in rainfall and temperature patterns which will affect crops in tropical regions. In addition, health risks will increase as, for example, disease vectors like malaria mosquitoes.

Climate change is an important factor behind inequality between poor and rich countries. There is a great variability of climate change effects according to several factors. Vulnerability, as defined by IPCC, is related to how a system is affected by climate. In this connection, the geographic factor plays an important role, as many poor countries are located in tropical areas. This means that that they are subject to extreme climate conditions – excessive rainfall, floods, droughts, etc.

Small variations in climate may result in a heavy burden for developing countries, especially those which are more dependent on agricultural activities. The geographic factor, however, should not be overemphasized. There is no geographic determinism: social, economic and political conditions should also be taken into consideration.

Dependence on agricultural rural production is generally related to low income and more vulnerability to climate change. When subsistence agriculture and urban poverty are combined, there seems to be an increased poverty level (Hertel et.al. 2010). Climate change can affect poor people in a number of different ways: water shortage, food security, extreme climate events, health problems, high temperature, diseases, environment migration and so on.

Adaptation to climate change effects requires several actions that should be integrated in a national public policy and considered as a priority for international assistance. Among these actions, the following should not be overlooked: better infrastructure and buildings, climate resistance crop varieties and technologies, and appropriate management practices to face natural disasters.

The total international funds for adaptation in 2007 was equivalent to $ 279 million (UNDP, 2007). This amount is highly insufficient to cover existing needs. A substantial increase in international aid for development is required to help poor countries to face their heavy climate changes impacts.

4. Summing Up

Climate change management and poverty reduction are closely linked. Policies designed to combat poverty and the negative effects of climate change should be considered as two challenges in one strategy. This strategy should emphasize low-carbon objectives for developing countries. Renewable energy can eliminate or reduce dependency on imported fossil fuels. On the other hand, substantial reductions and even elimination of deforestation will protect water supplies and biodiversity.

Nevertheless, only mitigation actions will not be enough to deal with global warming problems: the greenhouse gases, both those existing already in the atmosphere as well as those to come in the next years, require immediate action from Governments and the private sector.

As a result, along with mitigation actions, adaptation actions are required, especially for poor countries, which are more hardly affected than rich nations. And challenging inequalities is at the heart of climate change adaptation (Fischer, IIED, 2013). The September 2013 IPCC Report confirmed that climate change is human-induced. Warming will probably exceed 2º C, which is the level beyond which global warming will produce serious changes to the planet. Other points that have been emphasized are as follows:

- Atmospheric concentration of greenhouse gases are now at levels unprecedented in the last 800.000 years. The burning of fossil fuels is the main reason for a 40% increase in CO2 concentrations since the industrial revolution.

- By the end of the century, global temperatures are expected to rise by 0,3% (optimistic scenario) to 4,8% (pessimistic scenario), depending on how carbon emissions are controlled. Sea levels are expected to rise a further 26-82cm. As a third of CO2 emissions will be absorbed by oceans, they will undergo an increased acidification.

- Heatwaves will probably be more frequent and last longer. Wet regions will receive more rainfall, and dry regions less (IPCC, 2013).

Climate change will undoubtedly have an important impact on social and economic development, especially for poor people. In fact, they are more vulnerable to the effects of climate change and less prepared to face the costs of adaptation. This is tremendously unfair, because their contribution to the emission of greenhouse gases is considerably inferior to that of rich countries.

The developed countries, with only 15% of the global population, use about half of global resources and produce a significant part of environmental degradation. They have been responsible for 45% of the greenhouse gas emissions in 2004, for example. The 37% poorest of the world population are responsible for only 7% of these emissions (Galgóczi, 2012).

As the Intergovernmental Panel on Climate Change has pointed out (IPCC, 2007), while Africa accounts for less than 4 per cent of greenhouse gas emissions, this continent may by 2020 have between 70 million and 400 million people exposed to water shortage caused by climate change. In order to compensate this injustice, developed countries should provide the funds required by national programs with a view to tackling climate change impacts.

Environment In Brazil: A Threat To Development?

1. Developmentalism at Stake

In Brazil, as generally occurs in all countries on a developmental path, the priority is economic growth. After decades of neo-liberal domination, the predominant developmental vision increasingly considers the environment as an obstacle to development. Over the last ten years, successful economic policies resulted in an important increase in incomes and decrease in inequality (IBGE/Contas Nacionais/IPEA). This successful result was utilized to strengthen the

current prevailing governmental developmentalist strategy which considers environment as a threat to development.

Research conducted in 1997 by ISER/CPDOC showed that nature appeared in first place among reasons for pride in being Brazilian. A recent study in April, 2012 by the Ministry of the Environment showed an advance in relation to previous studies. Among those that feel more pride in being Brazilian (43% of the total), the principal reason for pride is the environment (28%), followed by socioeconomic development (22%).

Virtually 100% of the population consider "care/protection of the environment" important. With regard to the identification of problems, the environment is ranked sixth, behind health/hospitals, violence/crime, unemployment, education and politicians. and above housing, income distribution, inflation, etc.

Those who said that the main problem in Brazil is the environment increased from 5% in 1997 to 13% in 2012. And those who said there is no environmental problem in Brazil or had no opinion, dropped from 47% in 1992 to 11% in 2012.

Research shows a significant evolution in Brazilian environmental awareness. An indicator of this change is in the number of people who spontaneously did not think to mention an environmental problem in the country or in their city. This number went from 46% in 1992 to 10% in 2012.

It appears that the notion of romantic love of nature that so much contributed to the consolidation of national identity has shifted from the imagination and collective unconscious to the level of awareness of the problems to be addressed by public policy. Thus, the degradation of nature destroys the self-esteem of the Brazilian and conflicts with the notion of progress and growth trumpeted to the four winds in developing countries. This is because the official economic and social discourse does not incorporate the issue of the environment, dealing with it separately as if it were an externality.

Public social, economic and environmental policies are discussed in different ministries and institutions that rarely interact with each other. The proposal of a Sustainable Development Council comprising the economic, social and environmental ministries with decision-making power fell flat after the United Nations Conference on Environment and Development (UNCED) held in Rio in 1992.

Public policies in the environmental area are engendered in a field where conflicting economic, political-institutional, ecological and social issues reside. The promotion of sustainable development should be guided by the search for a socially just and ecologically friendly society, which presupposes a series of strategic actions that meet joint efforts of the state, market and civil society at the local, regional and national levels.

It is important to note that the time frame of politicians and businessmen is usually short term. Politicians have short mandates and entrepreneurs aspire to the greatest profits in the shortest period possible. Environmental policies require a long-term horizon. They should not be seen as an obstacle to growth, but as constituent elements of development. Since the

environmental issue is long term and affects humanity's way of life, it is present in the social and economic question. Moreover, in general it cannot be solved by a single country, since environmental problems are global.

But today's developmental model, which succeeded the neoliberal model that has prevailed for decades in Latin America, prioritizes the quantitative aspects of economic growth and the proper policy to combat poverty, toward reduction of social inequality. And it ignores the reasons for sustainable development, since it still considers the environment as an obstacle to development.

Pollution, environmental degradation, over-exploitation of natural resources, global warming, natural disasters, affect more poor people than the rich . In spite of this, public policies dealing with poverty and inequality usually do not take into account destruction of the environment which brings about environmental migrations and refugees. This fact calls for a revision of social policies designed to eliminate or reduce poverty and inequality.

Another factor requiring a review of present approach to social inequalities is the irruption of differences in the fight for equality in the public sphere (Reis, 2011). In the 18th and 19th centuries, the historical process to create the Nation-State has suffocated differences on behalf of equality. As all people are members of the same nation, differences have been ignored and, as a result, inequality has been maintained or increased regarding black people, women, indigenous people, homosexuals etc.

In last 19th and first half of the 20th centuries, the objective was to build and strengthen the National State and ensure its continuous development by means of economic growth. Thus, the disregard of differences and the destruction of nature were simultaneous processes. As of the second half of last century, however, the weakening of the Nation State as a result of globalization made possible the resurgence of social diversities that began to be accepted and the issue of environmental degradation as a global problem to be recognized (Vieira, 2001).

Environmental discourse has advanced, but remains in the background against the prevailing social and economic discourse. Outside the rhetoric of official UN conferences, the three "pillars" of economic, social and environment remain separate, with enormous difficulties of dialogue. There is no doubt, however, that the environmental discourse has left the collective romantic imagination and overflowed from academia and from the activism of non-governmental organizations to influence projects and programs vying for power in the political arena.

2. Biodiversity

Brazil is one of the richest countries for biodiversity in the world. And one of the seventeen countries that together have 70% of the planet's biodiversity. The combined terrestrial biomes (Atlantic Rainforest, Amazonia, Cerrado, Caatinga and Campos do Sul) houses 20% of the species on the planet, and 20% of the total global flora.

Such biodiversity reinforces the importance of policies oriented to conservation and sustainable use of biomes, since 60% of endangered species are in protected territories, and approximately 75% of Federal conservation areas are home to such populations. The perspective is the conservation and sustainable use of biodiversity and forests, in the face of threats represented by the effects of climate change and overexploitation of natural resources. According to the Ministry of Environment, Brazil has approximately 1, 5 million km2 of area covered by conservation units, which corresponds to 16.6% of the national continental area and 1.5% of national Brazilian territorial waters.

According to the United Nations Environment Program (UNEP), Brazil is responsible for the protection of almost 75% of the entire protected area established in the world since 2003. The Botanical Garden Research Institute of Rio de Janeiro in 2010 published the "List of species of flora of Brazil", cataloging 40,982 species existent in the country - and each year about a thousand new species are described in Brazil. This demonstrates the potential wealth of the country, to the extent that the resources of biodiversity represent an important source of income and employment generation, contributing significantly to the GDP.

Considering the area covered by units of state and federal conservation and Reservas Particulares do Patrimonio Natural – RPPN (Private Reserves of Natural Heritage) in the country, the majority is located in the Brazilian Amazon biome, as can be seen in Figure 1. Considerable portions of the Cerrado and Atlantic Rainforest area are also protected, with 10.9% and 6.4%, respectively.

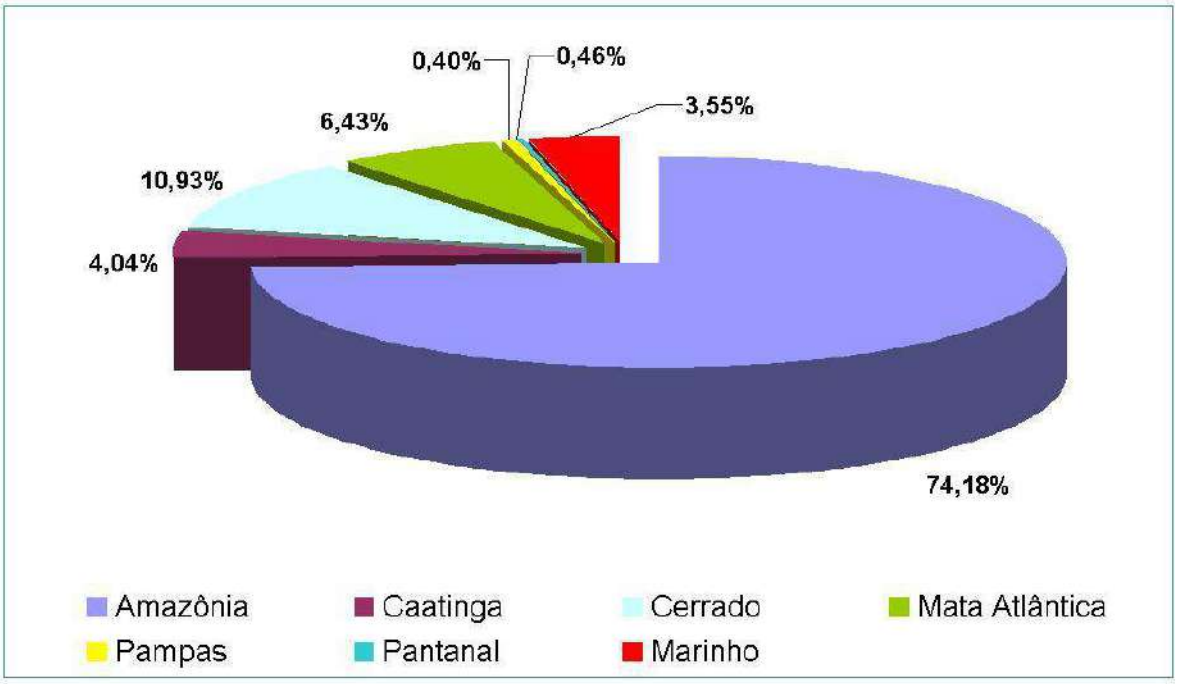
Besides the areas which are part of the SNUC (National System of Conservation Units), the indigenous lands represent approximately 13% of the Brazilian territory, and quilombolas territories are also considered protected areas. The rich social diversity, represented by more than two hundred indigenous peoples and local communities (quilombolas, caiçaras, seringueiros etc..), together forms an invaluable collection of traditional knowledge on conservation and use of biodiversity.

In Brazil, the units of conservation have been criticized for often not leaving the paper, for numerous gaps and weaknesses, such as pending land regularization, lack of officials and lack of basic infrastructure, lack of revision or absence of management plan, among other problems. But lack of resources is not always the problem. An example is what happens in Camara Federal de Compensacão Ambiental (Federal Environmental Compensation Board), whose bureaucratic functioning makes difficult and sometimes prevents the application of funds for projects in support of conservation units.

The definition of priority areas for conservation, sustainable use and sharing of the benefits of biodiversity is an important tool developed for territorial planning and management, allowing the identification of areas and priority actions based on specific criteria established for each biome: 26.6% of priority areas are located in the Amazon biome, 21.6% in the Atlantic Rainforest, 18.9% in the Coastal Zone, 15.7% in the Cerrado, 8.9% in the Caatinga, 2.8% in the Pampa and 1.9% of the Pantanal.

Policies for conservation and sustainable use of biodiversity and forests depend increasingly on a cross-sectional model of public policy implementation. Brazil still needs to move forward in the valorizing agro-biodiversity and socio-biodiversity products, through access to public policies and territories, value aggregation, consolidation of markets, economic and environmental sustainability of different production systems, environmental consideration for services rendered, contributing to conservation, food sovereignty and nutrition, and income generation.

Figure 3 - Area covered by conservation units SNUC (federal, state and RPPN) by biome, 2010

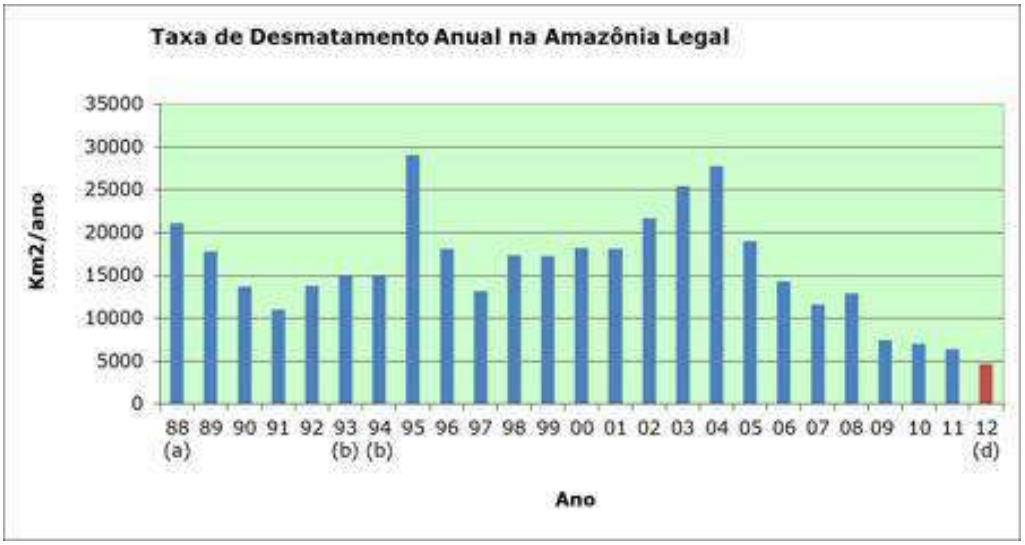


Source: Ministry of Environment, 2010.

Environment In Brazil: A Threat To Development?

With regard to forest cover in recent years there has been a reduction of the indices of deforestation in the national territory. The Amazon, which already has lost 14.6% of its original cover, has had significant reduction of deforestation, reaching in 2012 the lowest index of deforestation since official measurement began n 1988: 4,656 km2. Figure 2 clearly shows that reduction.

Figure 4: Annual deforestation rate in the Amazon



Source: Instituto Nacional de Pesquisas Espaciais (2012).

3. Climate change and renewable energy[1]

Unlike industrialized countries, where the burning of fossil fuels is the main cause of estimated emissions of CO2 - greenhouse gas (GHG) that directly influences the change of climate and represents 80% of global carbon emissions into the atmosphere - emissions in Brazil result from changes in land use, primarily from conversion of forests for agriculture and livestock.

A study released in the second half of 2009 by the Ministry of Environment shows that deforestation is responsible for more than half (51.9%) of the emissions of carbon dioxide in the country. The second activity in Brazil that contributes to global warming is agriculture and livestock, with 25%, followed by the energy sector, with 20%. Following are industry and waste with 1.7% and 1.4%, respectively.

In general, the loss of forests worldwide contributes about 17% of emissions of greenhouse gases. In Brazil, the annual agriculture-oriented grain planting represents only 4.9% of the deforested area (34,900 km2). Extensive livestock, with expansion and continued growth since the 1970s, is the main cause for deforestation in the Amazon, with 62.2% of almost 720,000 km2 deforested in the Amazon so far.

As a function of the high participation of renewable energy in the Brazilian energy matrix, the generation of electricity from hydropower, the use of alcohol in transport, bagasse from sugar cane and vegetable charcoal in the industry, the share of CO2 emissions by the use of fossil fuels in Brazil is relatively small. Nevertheless, it should be noted that Brazilian energy consumption is still modest compared to industrialized countries. Even so, Brazil is still one of the largest emitters of greenhouse gas in the world.

[1] When not otherwise indicated, all data below come from Vieira, L. and Cader, R. (2013).

On the other hand, the question of energy produced in the world is highly relevant to the extent that the change in climate is a global problem and most of the emissions of greenhouse gases come from an unclean energy matrix, i.e., not renewable. It is worth remembering that the change of climate in the world is the result of a historical increase, since the Industrial Revolution, of the atmospheric concentration of greenhouse gases, mainly from burning fossil fuels and land use alterations.

The IPCC Scientific Report IV (2007) presents evidence of changes in climate that may significantly affect the planet more strongly in less developed countries located in tropical region. The results indicate an increase in average global temperatures between 1.8 °C and 4.0°C by 2100. The main conclusions of the report suggest, with over 90% assurance, that the global warming of last fifty years is caused by human activities.

Initial studies on the effects of climatic changes in Brazil, developed by the National Institute of Pesquisas Espaciais (INPE), based on IPCC scenarios, indicate that the areas considered most vulnerable are notably Amazon, with what is called savannization, and the Northeast. The increase in global temperature - which can record up to 4.0°C more later this century - will cause impact on Brazil and all nations of the world. However, it is the poorest populations that will be the most affected, since the intensification of extreme climatic events, the processes of desertification and loss of arable land will lead to food shortages and supply of potable water, spread of diseases and losses in economic and social infrastructure of the country.

With Decree n. 6263, November 21, 2007, Brazil published the National Plan on Climate Change. And the Congress approved Law n. 12.187/2009, the National Policy on Climate Change and the National Fund for Climate Change. As a result, the area for tree planting is expected to increase from 5.5 million hectares to 11 million by 2020.

But some months before the approval of the National Policy on Climate Change, the government reduced taxes on the production of motor vehicles without a required improvement in standards of consumption of fuel or a support for the development of public transportation.

With the publication of Law no. 12.187/2009, Brazil adopted voluntary actions to mitigate emissions of greenhouse gases, in order to reduce by 36.1% and 38.9% its projected emissions by 2020, based on the values of the period 1996-2005. The industrial and agricultural sectors resisted targets imposed by the federal government. It is another example of how conflict between economic, environmental, and social interests permeates contemporary environmental policy.

It is important to highlight the important contribution of hydroelectric generation in the country for reduction of emissions of greenhouse gases. Brazil has a relatively "clean" energy matrix with low levels of emissions of greenhouse gases per unit of energy produced or consumed. The problem here is the usual absence of consultation and benefit sharing with local communities in project development, such as the Madeira, Xingu and Tapajos rivers whose riparian and indigenous communities are harmed by it.

Created in April 2002, the ambitious Incentive Program for Alternative Sources of Energy (Proinfa) created by Law n. 10.438/2002 and coordinated by the Ministry of Mines and Energy,

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is a project of great relevance for the generation of renewable energies in Brazil. The program was considered a great initiative to have contributed to the birth of the wind industry in the country, allowing Brazil to have one of the cheapest wind energies in the world. On the other hand, there are other actions that would cause less impact and increase energy supply in Brazil, such as the restructuring of existing hydropower plants.

There is no project on a national scale for this purpose, which would increase supply capacity and reduce the need to deploy so many new environmentally and socially high impact megapower plants. In this sense, Brazil has yet to move forward much in the construction of a new paradigm in the production matrix, and the state has a key role to play in fostering such change which requires climate changes mitigation and adaptation measures. It is a cross-disciplinary and strategic theme that interacts with various sectors of environmental, social and economic policies, and implies the need for interaction of the various actors involved in such policies/sectors for the construction of a new sustainable economy.

4. Impact of Climate Change

The Brazilian Climate Change Panel Report, released in September 2013, estimates an increase in temperature of 6 degrees by 2070, with a drop in agricultural production. Brazilian agriculture may suffer annual losses of U.S. $ 7 billion. Based on the hectares cultivated in 2009 and at the current production conditions, the projections for 2030 show large reductions in area. Beans will fall from 54.5% to 69.7%. For soy, the reduction is estimated at between 15% to 28%. Wheat, from 20% to 31.2%. Corn from 7% to 22%. Rice, from 9.1% to 9.9%. And cotton, 4.6% to 4.9%. Coffee, for example, needs 18 º C to 22 ºC, as an average.

Yet over the next seven years, soybean planting could lose 20% productivity. By 2050, the area planted in rice can recede 7.5%, in corn, 16%, and power generation be threatened by a reduction of up to 20% in river flow (PBMC, 2013).

Analyzing the report, former Minister Marina Silva said that "this is because the government's agenda and backwardness of agribusiness sectors stand for dismantling environmental legislation and decided to amnesty those who deforest, as if forests and rivers hold back the country and agriculture. Now they turn against the Indians and their lands, to reduce them and open them to the mining and agriculture "(Silva, M. 2013).

The flow of major rivers of the country and the supply of groundwater, responsible for supplying drinking water to the population, may be affected if the temperature rises to 6º C in the next decades and rainfall decreases in accordance with the scenario which considers that the levels of greenhouse gas emissions remain high.

In this scenario, agriculture and energy sector in Brazil may be strongly affected, with risk of sudden drop in Gross Domestic Product (GDP) and constant crises involving the energy supply and food security. The Report of the Brazilian Panel on Climate Change made the following estimates for climate change in Brazil by 2100:

Figure 5 - Projection of Climate Change in Brazil until 2100

Source: G1 - September (2013).

According to the document, the temperature in Brazil may increase from 3° C to 6° C by 2100, a situation that would be even more critical with a possible shortage of rainfall. In the Amazon, for example, in 2100 the temperature may rise about 6º C and rainfall distribution may fall in the region 45%.

Deforestation and burning in the biome can contribute to dramatically alter the hydrologic cycle of the forest (mainly between the months of July and November), extending the season of drought and changing rainfall distribution in the country.

The accentuated heat, up to 5.5º C higher than the present recorded temperature, would trigger a process of desertification in the Caatinga biome which is now considered endangered. In the same high emissions scenario, the Pantanal would suffer a 45% reduction in rainfall and an increase of 4.5° C in temperature. According to the high emissions scenario, the Atlantic Rainforest and Pampa also record an increase in temperature by 2100, a bit milder compared with other regions. However, what is worrisome, according to the report, is the growth in the rates of rainfall.While in the South / Southeast Atlantic Rainforest the amount of rain could

increase to 30% in the coming decades, in the Pampa, which covers the southern states, grows 40% - which increases the risk of floods and landslides in coastal areas.

These are projections in extreme scenarios of emissions of greenhouse gases. If in 30 years we do not change this current rate, the average annual temperature in the country should increase 1º C "(Volume 1 of the Report -" Scientific Basis of Climate Change ").Important basins of eastern Amazonia (near Para) and the Northeast may have significant reductions in their discharges. The estimate is down 20%. According to the document, the Tocantins River, which passes through Goiás, Tocantins, Maranhão and Pará, can be reduced up to 30% in quantity.

This decrease would, for example, affect the generation of electricity by hydropower and distribution of electricity in the country. Also, it would force the government to use thermoelectric power which is considered dirtier. In the South of the country, the Paraná-Plata may have a flow increase between 10% and 40% in the coming decades.

As for the oceans, the document says that acidification will be marked if greenhouse gas emissions remain high and the potential for fishing throughout the Brazilian coast could shrink by 6% over the next 40 years.

Climate change will reduce the productivity of almost all crops existing in the country today. The forecast of economic losses caused by frost and drought in agriculture is around R$ 7 billion annually by 2020.

Scientific forecasts indicate that if nothing changes in the emission scenario, in the next seven years the planting of soybeans will have lost 20% of their productivity and 24% by 2050. By the same year, the rice acreage in Brazil may reduce 7.5%, to 16% of corn, and cotton cultivation may decrease 4.7%. The orange crop may also be injured by diseases harmful to fruit. It is estimated that by 2050 climate will influence the loss of 10% of all the coffee planted in the country. In contrast, the heat can benefit sugar cane, a plant very resistant to heat and drought.

The year 2020 marks the deadline for compliance with the Brazilian goals for emission reduction announced in 2009 during the Copenhagen climate conference. At the time, Brazil pledged to decrease total national emissions between 36.1% and 38.9% compared to 2005 levels. In June this year, the government announced that the country has reached about 62% of its goal. To reduce emissions after 2020, it will be crucial to deploy a lower power consumption model of economic development with greater proportion of renewable energy.

In urban areas, the poor are those that suffer most from extreme events, especially landslides caused by heavy rains. It will be necessary to prepare plans for protection and prevention throughout the country, especially in the coastal zone, where the majority of the population lives. The investments in infrastructure, which is a priority today, bring about environmental impacts which in turn contribute to increase the ecological consciousness and encourage protests and action by environmental organizations and the movement for environmental justice (Herculano, 2002; Milanez,B. e Fonseca, I. 2010). In the next years, the social and environmental conflicts are expected to increase if the official economic decision-making does not take into account the warnings and recommendations of the socio-environmental agenda.

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QUO VADIS HUMANITAS?*

Giorgio de Antoni**

Introduction

In September, 2016, the Working Group on the Anthropocene reached the conclusion that "The Anthropocene concept...is geologically real" (AWG, 2016), therefore proposing the formalization of the term Anthropocene inside of the International Commission of Stratigraphy.

The recognition that "the human impact has now grown to the point that it has changed the course of the Earth history...." (Zalasiewicz et al., 2017) is the basis of the new denomination of the contemporary epoch. Notwithstanding, if, in one hand, inside of the international group of geologists, "a different trajectory for the Earth system" (Carrington, 2016) begins to find empirical evidence, on the other hand, particularly among the scholars of the social and human sciences, even though recognizing breaking elements in the history of Earth caused by the impacts of human activity over the global ecosystem (Hamilton, 2016), the concept of Anthropocene encounters many criticism over the fact that it operates a certain generalization and simplification of the problem (Malm and Hornborg, 2014; Brondizio et al., 2015; Bonneuil et Fressoz, 2016; Moore, 2017). According to those scientists, the word anthropocene can only be interpreted when contextualized, taking into consideration "the local variations and social inequalities" (Biermann et al., 2016).

To recognize scientifically that humankind (as the expression "anthropocene" suggests) had a decisive role in determining the course of Earth's history leads us not to give enough importance to the fact that the change has occurred by the specific initiative of a small part of the globe able to impose its own economic and political view. Nevertheless, the critics do not tackle the scientific data itself.

*"Quo vadis?" is a Latin expression that means: "Where are you going, humanity?". I thank professor Yara Magalhães, responsible for the Centro de Referência em Educação Integral e Ambiental – CREIA, and professor Rubens de Morais Silva for the observations and suggestions to the previous versions of the text.

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If since always, the peoples of the Earth molded the environment to their needs (Turner et al., 1990), it has been only recently that mankind acquired such power to modify the fundamental structures of life on the planet. Since 1750, it has been launched, on the atmosphere, more than 555 billion of metric tons of carbon, a level that has not been yet known for the past 800.000 years. The exercised pressure over the non-human life reduces the existence of other species, enabling the start of a probable sixth mass extinction in the history of Earth; human action introduces new elements that alter the evolutive process on Earth: antibiotics, pesticides, genetically modified organisms, etc. (Lewis and Maslin, 2015).

The Weberian "disenchantment of the world" is no longer just the emancipation of the religious and metaphysical fundamentals that sustained western civilization, but the disenchantment of the world structured in reaction to those fundamentals or preceding them. The euphoria that marked the emergence and the way of Modernity is little by little substituted by the centrality of the risk of possible catastrophes[1]. In fact, for the first-time humanity experienced its "impotent power" (Bonneuil et Fressoz, 2016, p. 34) and has to make an extreme appeal to the responsibility for the next generations present and future, more than for its technological genius (Jonas, 1990).

The more frequent use of the word "crisis" in all the areas of the complex contemporary system is for sure a sign very representative of the planetary impasse. Over the last decades, the perception of living a turning point[2] in history has inspired, first, the elaboration of a "crisology" (Morin, 1976) and, later on, the draft of a "colapsology" (Servigne, 2015). The consistent perception of a turning epoch, also confirmed by the introduction of the term anthropocene, has provoked a great literary production which content goes from the negation of the transformation in act to a catastrophic interpretation, most of the time aiming to instigate a responsible attitude facing the challenges of the moment. Even though recognizing the importance of rapid and efficient intervention inside of a relatively breath space in time, the present article proposes to contribute to a reflection that encompasses the slow way of cosmic evolution, in which the anthropocene is a step.

Braudel's distinction between short and long times helps to understand the difference and the complementarity of the two diverse approaches (Braudel, 1958). The first is focused on the actuality of the presented facts, in a specific historical juncture, while the second considers a wide historic arch, "*l'histoire de longue, même de très long durée*" (Idem, p.11), as it is in the case of this text[3]. In fact, the novelty of the anthropocene, beyond resending to themes that

[1]As Latour highlights: "What makes the Anthropocene a clearly detectable golden spike way beyond the boundary of stratigraphy is that it is the most decisive philosophical, religious, anthropological and [...] political concept yet produced as an alternative to the very notions of 'Modern 'and 'modernity'" (2013, p. 77).

[2]See the Greek origin of the word crisis and its various meanings in the works of Bauman and Bordoni (2014, p. 1).

[3]In a previous article I've tried to explain how the various crisis that followed each other in the contemporary world (the economic crisis, the social crisis, the environmental crisis) have revealed the "crisis of the 'system', understanding with this word the complexity, the interconnection and the finality that characterize the civilizational project of the current epoch" (De Antoni, 2014).

interest present and next generations, offers the space to rescue the big questions that characterize the emerging of western civilization in ancient Greece and that Modernity sacrificed in the name of progress: who are we, where do we come from and where do we go. It is the theme of evolution that our epoch impels us to resume, not in Darwinian terms anymore, in which inspiring principles propelled the so-called development of the west, but in a wider optic, in a manner of urgency, in defense of the human species and of life in general.

At first, we will try to consider the contributions of some great contemporary historians and scientist over the limits that characterize each civilizational circle advancing the hypothesis that we are in the conclusion of the period inaugurated with the Modernity. Soo we will see how this hypothesis is shared by some great ancient traditions that base their knowledges on the sacred texts and millenarian experience. Finally, Bergson's and Whitehead's analysis will introduce us to the little-known problematic of evolution and, nevertheless, extremely important, to which visionaries like Teilhard de Chardin and Sri Aurobindo will give a rational-spiritual view, showing, therefore, how science and mystics meet.

Draft of a colapsology history

A quick exam of the authors that highlighted the entropic character of the civilizations naturally takes us to distinguish between two phases: the first, constituted by thinkers which the contribution have an analytical-predictive mark, product of the comparative study of past societies; the second, with its beginning in 1950, year indicated as the start of the Great Acceleration of the Anthropocene (Lewis and Maslin, 2015, p. 176), when the theme receives more attention and assumes the shape of a critical analysis of the dominant economical socio political and global system. Among the two phases, in the time-space that coincides with the First and Second World War, an intermediate period that will see three great authors as protagonists: Spengler, Freud and Toynbee. Under the influence of the current events that happened in Europe, they will evidence, in a way that is always more incisive, the decline of the West.

The idea that any given civilization would always come to an ending point is not new to the philosophical-scientific reflection. Perhaps, after Heraclitus's panta *rei*, the man who first deepened the relativity of the great civilizations is, in 1300, Ibn Khaldun, a great knowledgeable of the four influential civilizations of the time: the Arab and the Berbera on the north of Africa, the Western Europe, and the Mongol civilization. According to the Islamic scientist, civilizations are born, grow and decay within a cyclical process that generally extends itself for the duration of four generations (Ibn Khaldun, 1967, p. 183). The reached state of great comfort, of luxury and prosperity, with the relative corruption of its citizens, would inevitably lead to the decline (Idem, p. 468).

Centuries after, Giambattista Vico, the great historian who questioned the principles of the northern European Enlightenment, in his monumental work "New Science", in 1725, observed that civilizations, when reach the point of maximum development, start a period of

decline and decadence. The cause of this terminal phase, according to Vico, has to be attributed to the abuse of the laws by the responsible and to the subversion of the natural order with acts contrary to those of justice[4] that drives societies from "barbarism of sense", in which societies have fought against in order to affirm themselves, to "barbarism of reflection", due to the fact that "each follows his own pleasure or caprice[5]".

In 1800, the swiss historian Jacop Burkhardt observed that in order to better understand our civilization it is indispensable to know the crisis that allowed the passing from the Middle Ages to Renaissance (Burkhardt, 1960). His critique of Modernism is exactly against the ideology that tries to make this moment a new beginning of history by rejecting the pass and the previous knowledge (Hinde, 2000, p. 12). In his work "Reflection on History" (1950), on the fourth chapter about "The Crisis of History", he does not leave unnoticed the positive value of a crisis: "Crises bring out greatness, but it may be the last" (Idem, p. 136). In addition, the final act is usually provoked by a disequilibrium among the main institutions of a society. To Burkhardt, the three central powers of a civilization are the State, Religion and Culture. While the first two try to conserve the stability, the third is unpredictable because it is connected to human nature[6]. Since the dawn of time, nations have failed by the revolts "of classes and castes against a despotism or the oppression of a sacred law" (Idem, p. 139). It is interesting to notice in "Judgement on History and Historians" a reflection, placed in a parenthesis that anticipates the inherent challenge of the Anthropocene predicting the vanishing of humankind[7].

Burkhardt's thoughts about history becomes particularly important once it attracted the interest of Nietzsche, that having arrived at the University of Basel as to be professor of Classical Philology, have watched the classes of the swiss historian about the study of history. The preface of Nietzsche's last book "Will to Power", conjecture the end of the European civilization:

> What I relate is the history of the next two centuries. I describe what is coming, what can no longer come differently: *the advent of nihilism.* This history can be related even now; for necessity itself is at work here. This future speaks even now in a hundred signs, this destiny announces itself everywhere; for this music of the future all ears are cocked even now. For some time now, our whole European culture has been moving as toward a catastrophe, with a tortured tension that is growing from decade to decade: restlessly, violently,

[4]«[...] since without order [...] human society cannot stand for a moment [...] » (Vico, 1948, §1100).

[5]« [...] In this way, through long centuries of barbarism, rust will consume the misbegotten subtleties of malicious wits, that have turned them into beasts made more inhuman by the barbarism of reflection than the first men had been made by the barbarism of sense. For the latter displayed a generous savagery, against which one could defend oneself or take flight or be on one's guard; but the former, with a base savagery, under soft words and embraces, plots against the life and fortune of friends and intimates» (Idem, §1106).

[6]« In praise of crises, we might say that passion is the mother of great things, real passion, that is, bent on the new and not merely on the overthrow of the old » (Burkhardt, 1950, p. 158).

[7]« (It is a moot question how long our planet may still tolerate organic life and how soon its solidification, the exhaustion of carbonic acid and of water, will be coupled with the disappearance of tellurian mankind.) » (Burkhardt, 1999, p. 238).

> headlong, like a river that wants to reach the end, that no longer reflects, that is afraid to reflect. (1968, p. 3).

Burkhardt's positioning in the analysis of history has distanced itself from the Hegelianism as much as from the positivism leaving a space for a new critical view in which Nietzsche could take advantage in a manner totally unexpected and original. Nihilism, as destruction of the culture and of the values of the West, constituted, in the thoughts of the author of "Thus spoke Zarathustra", the destruction of the Western civilization.

In 1918, Oswald Spengler, a reference in the field of colapsology, would make the starting point of his work "The Decline of the West" out of the Nietzschean interpretation, as he himself attested in the conclusion of the speech done in the occasion of the eightieth birth anniversary of Nietzsche: "No one writes history any more without seeing things in his light. [...] he [Nietzsche] showed history as it really is. His heritage is the obligation to live history in the same way" (Spengler, 1924, pp. 8 e 10)[8].

Spengler's central point of analysis of the universal history is the concept of Culture understood as an organism, a set of aspects (religion, art, science, philosophy, political and social forms) that expresses the specific worldview of a human group. One thing is Culture "as total sum of its profound possibilities", another is "the sensitive phenomenon or the appearances" that are conceived in reality (1927, p. 104). As the body, Culture as a whole also has a soul (Idem, p. 9) from which it receives a creative impulse, the extraordinary capacity to inject innovative elements in the static juncture that are going to transform the space and the society in which it emerges. The development of Culture, under this perspective, correlates to the biological process: "Each Culture has its own new possibilities of self-expression which arise, ripen, decay, and never return" (Idem, p. 21). To Spengler, the civilization is the final phase of a Culture, its inevitable fate – distanced perception from the linear view of history that predominated in the mindset of the epoch.

The symptoms that reveal the decline of the West are visible in the importance that the external world grants to the profound forces of the soul[9]: "Being as been confused with waking-being, life with the means by which it expresses itself" (1928, p. 55). Product of this transformation is the mechanization of the intellectual activities and the enslavement to the machinery (Idem, p. 504), the dictatorship of the money (Idem, p. 506), and the triumph of the will of power over the truth and justice (Idem, p. 507).

The Spenglerian philosophical pessimism over western history has been shared by the recent psychoanalysis' discipline inaugurated by Freud. In his book "Civilization and its Discontents", first published in 1929, he explains that, if the civilizing process, in one hand,

[8]After his death, Spengler was buried with a copy of Goethe's "Faust" and a copy of Nietzsche's "Thus spoke Zarathustra", the two authors that he considered the most representative of the German culture as explained in the cited speech.

[9]See diagram in Spengler, 1927, p. 154.

allows humankind to advance in science and in the organization of the world, on the other, it inhibited the natural profound drives.

> If civilization imposes such great sacrifices not only on man's sexuality but on aggressivity, we can understand better why it is hard for him to be happy in that civilization. [...] Civilized man has exchanged a portion of his possibilities of happiness for a portion of security (Freud, p. 4507).

According to Freud, the mismatch between the drives of the man and his repressive conditionings imposed by civilization generates "a sentiment of unconscious culpability" (Idem, p. 4523) that is in the origin of all neuroses. This sense of guilt will perhaps reach heights that the individual finds hard to tolerate (Idem, p. 4522), threatening the civilizing process as a whole.

Years later, another macro historian, Arnold Joseph Toynbee, in 1934, was starting the publication of his masterpiece "A Study of History" that would end in 1961. To him, the cause of civilizational collapse is a sort of social malady like a war or a revolution (1951, p. 128); and never a result of external aggression[10], a homicide, but the consequence of an internal degeneration, a suicide.

In the years that followed Toynbee's contribution, the years of the Great Acceleration within the Anthropocene, the theme of civilization is resumed by Braudel, in 1963, in his book "Grammaire des Civilisations" (1993), and, in 1997, Huntington, with the publication of The Clash of Civilizations, inaugurates a new interest about this topic that rises progressively, instigated by globalization and by the revival of the regional cultures and autonomies. But, without a doubt, the first author to call the attention, in the second phase of this quick draft of colapsology, is the archaeologist Joseph Tainter, for his particularly incisive analysis linked to the typical production and complexity of the developmentalism phase initiated in the 60's.

In 1988, Tainter tried to offer a general explanation of the collapse of complex societies and its implications today, exposed in the book "The Collapse of Complex Societies". On the counter flow of the dominant thesis that points to the destruction of the environment as the main cause of the implosion of a civilization, Tainter shows that:

> Collapse, as viewed in the present work, is a political process. It may, and often does, have consequences in such areas as economics, art, and literature, but it is fundamentally a matter of the sociopolitical sphere. A society has collapsed when it displays a rapid, significant loss of an established level of sociopolitical complexity (1988, p. 4 [sic]).

In order to understand the sociopolitical complexity, a recent experience in the history of humankind, it is necessary to consider two fundamental concepts: inequality and heterogeneity. A high degree of heterogeneity is the factor that determines the complex society (p.23). One of the characteristics of complexity is the focus around a center, not

[10]« [...] civilizations have not met their death from an assassin's hand [...] we have been led [...] to return a verdict of suicide» (Toynbee, 1951, p. 120).

necessarily geographical, that legitimates (p. 27) the entire social, political and economic system. The collapse corresponds to a process of decline of complexity (p. 31) and of increase of inequality, whose trajectory Tainter describes in four points:

1. human societies are problem-solving organizations;
2. sociopolitical systems require energy for their maintenance;
3. increased complexity carries with it increased costs per capita, and;
4. investment in sociopolitical complexity as a problem-solving response often reaches a point of declining marginal returns (1988, p. 194).

Once a certain level has passed, the costs of complexity begin to rise in the field of food, energy and raw materials used. The information sector tends to be more and more specialized, making access expensive and higher investment in bureaucracy for the organization of society. Thus, while the number and costliness of organizational investments increases, the proportion of a society's budget available for investment in future economic growth must decline (p. 195).

In substance, Tainter associates the Declining Marginal Returns[11] to the rise of complexity. The decrease in gain will lead to less investment in complexity, considered less attractive, causing "separation or disintegration" and thus making society vulnerable to collapse (p.195 and 198). Bonaiuti, based on this theory of Tainter, advances to the hypothesis that "the developed capitalist societies entered a phase of decreasing rent - in spite of the silence of the official sources"(2013, p. 72).

After the original contribution of Tainter, a fecund scientific and cinematic[12] on the subject production exploded in the 2000s (Diamond, 2007, Fagan, 2008, Stenger, 2009, Morton, 2013, Oreskes and Conway, 2014, Servigne, 2015, Angus, 2016 ...). A study, partially sponsored by NASA's Goddard Space Flight Center, approaches the subject by concluding that our civilization is bound to collapse if nature's rates of depletion are not reduced and resources are not distributed more evenly (Motesharrei and al., 2014). Of all the publications, it is worth mentioning the work of Jared Diamond, published in English in the year 2004, and found ample consensus in the public opinion for being one of the first at the turn of the century to present the thesis of the civilizational collapse due especially to environmental issue. Indeed, after a comparative study of extinct past civilizations, Diamond concludes that there are five causes that can lead to the end of a civilization - namely: environmental damage, climate change, hostile neighbors, decline the support of friendly neighbors and the way in which society responds to its environmental problems (2007, 13). However, while ancient societies were delimited by territory and space of influence, today "they are so integrated that we run the risk of facing a worldwide collapse" (Idem, 455). Two choices will be crucial: the courage to practice long-term reasoning and the willingness to reconsider old values (Idem, 457).

[11]« The marginal return on investment in complexity is at present the best explanation of collapse » (1988, p. 203).

[12] [1] Cf. https://en.wikipedia.org/wiki/List_of_environmental_films there is a list of movies that deals with the environmental situation and the humanity future.

The different and often complementary contributions of the colapsologists led some authors, albeit with different approaches, to talk about the Great Transition[13] (Raskin et al., 2002; Hopkins, 2008, Bonaiuti, 2014, Karlberg, 2014), understood as "transition to another model of society "(Bonaiuti, 2014, 24) or the entrance of history into “Planetary Phase of Civilization” characterized by “a profound shift in the condition of society and the dynamics driving change”[14]. There begins to be an ever-greater recognition in the scientific world of the awareness that we find ourselves not only in the "Great Transformation," described admirably by Polanyi, but in a Great Transition: the first, occurred within the same society and civilization; the second, from one civilization to another. His encounter with the analogous conclusions of some great millenarian traditions deserves to be remembered here.

The present historic moment in the light of ancient knowledges

Any approximation between science and traditional knowledge implies a certain availability to integrate the positive and analytic criteria of the first with the spiritual and intuitive view of the second, which does not make distinction between sacred and empirical. The great question raised by Pascal in the beginning of Modernity[15], a triumphant rationalist context, comes back to the fore in a more disenchanted atmosphere: the tension between *raison* and *coeur* reproposes itself, this time, between the principles of Western rationality, in one hand, and those of the heart, of the non-Western[16] cultures, on the other. In fact, the crisis or the collapse, more or less perceived, of the Western civilization, presents itself as the proper moment to acknowledge the limits of reason[17] and highlights the importance of the heart logic and other world views (Mignolo, 2005). It is inside of this resumed dialogue (Grof, 1984, pp. 1-32) that the contribution of great traditions assumes bigger importance.

The study of ancient science is always propelling more interest among contemporary researchers. The extraordinary capability of the ancient people of calculating the time having as reference the astronomy gave the starting point, starting from the 1970s, to a research field called Archaeoastronomy, that is the study of the practice and the use of astronomy in ancient cultures (Teresi, 2002, p. 91). Among others, three millenary traditions are particularly interested and competent in the calculus of long, very long duration: The Mayas, the Hindus and the culture of the Andean People in Latin America.

[13]Cf. http://greattransition.org/

[14] http://greattransition.org/about/what-is-the-great-transition

[15] « *Nous connaissons la vérité non seulement par la raison mais encore par le coeur, c’est de cette dernière sorte que nous connaissons les premiers principes et c’est en vain que le raisonnement, qui n’y a point de part, essaie de les combattre* » (Blaise Pascal, §110: https://www.ub.uni-freiburg.de/fileadmin/ub/referate/04/pascal/pensees.pdf)

[16]Cf. Guerrero Arias, 2010.

[17]About the “epistemological fallacies” of the scientific knowledge see Bhaskar (2008, p. 26), also Latour (1987) and Stenger (1997).

In the great ancient cultures, the relationship with the time constitutes a fundamental element in the social and religious life. The Maya civilization excelled in the chronologic representation by the high astronomical and mathematical knowledge reached, that found in the Maya calendar its maximum expression, considered a jewel of Maya crown (Aveni, 2009, p. 65). In the years before 2012, the Maya Calendar has fomented a big interest because of a recently deciphered text (in 1996), that marked a correspondent data of the end of the world. The North American society got itself particularly sensitive and vulnerable to this information, at the point of some scientists (archeologists, astronomers) get in the field to bring some light on the subject.

The fast diffusion of the belief had origin in the so-called Maya Long Count calendar, one of three calendars used by the Central American civilization. According to one of the possible translations of the text found in the Monument 6 of El Tortuguero, an ancient Maya city, the date of December 21 (or December 23, according to calculation moment) of 2012 would correspond to the 13° B'AKTUN[18], a time were the Maya Long Count calendar will be reset to restart a new cycle of 5.125 years. Many scientist including Restall and Solari, considered the apocalyptic view inappropriate, due more to the Christian-Western cultural heritage of the Milenarismo idea, than to the original signification of the Maya culture (2011, p. 49). Indeed, the prophecy described in the El Turguero were lately resized by the successive archeological documents found, showing the predictive behavior of the sculpted phrases and the importance that the Mayas attributed to a cycle conclusion. The scientist's hypothesis was corroborated by the words of a xamã that, interpellated about the sense of the data of December 21 of 2012 taken from the Maya Long Count calendar answered: "Only the cycle will end. Time will continue, and we will learn to live in peace and harmony, for we are all a part of a plan to help the gods complete the creation and perfection of the world" (2009, p. 165). Contrary to the expectations about the end of the word the Maya people interpreted and interprets this data as the start of a new cycle; in the same sense that the anthropologist John Hoops commented the millennial chronogram of the Maya Calendar: "It's a time when there is an opportunity for spiritual rebirth and a transformation of consciousness, which has to do with the identification of metaphysical realities, which will help manifest a global culture of Peace" (Pappas, 2012).

The Hindu culture, one of the oldest in the word, is known for being the only religion to have a schedule of the universe with time scales that correspond to the modern cosmologic science, and to believe "the idea that the Cosmos itself undergoes an immense, indeed an infinite, number of deaths and rebirths" (Sagan, 2001, p. 259). The Vedas, that was the biggest inspiring source of the Hinduism, and, later, the Rigveda, the sacred book, had a strong impact in the middle eastern culture (Das, 1958) to the point that John Bowle affirm, categorically, that Plato would have been influenced by the Hindu vision (1962, p. 91). From the point of view of the Vedic spirituality, the time perception is due to our dualism state, but through time despairing in the measure that we reach a state of unity.

[18] 1.872.000 days correspondents to 5.125,3661 years, computable from the "zero date" of the Maya Calendar: August 13 of 3114 B.C. (Callaway, 2011).

The time is cyclical and goes repeating to the infinite the creation process, of which Brahama is responsible, while Vishnu take care of the life preservation and Shiva have the destruction power. The cosmic cycle are divided in Kalpas each one corresponding to a day and a night of Brahma, computing 4,32 billions of years. All the Kalpas are composed by 14 Manvantaras, a space of time between two deluges, that correspond singularly and in an approximated way, to 71 maha yugas, the minor cycle whose unity is calculated in 4.320.000 years, and subsequently subdivided in four ages. The Hindu cosmology indicates, in the end of each age, a process of dissolution of the world called pralaya, to which would follow the new age (Klostermaier, 2007, pp. 495-496). According to the cosmologic calculus of Vedas, we would be living the seventh Manvantaras, of 14, and the fourth maha yuga, called Kali Yuga. The 5.100 years of Kali Yuga correspond to the 2000 a.C and should reach to the cycle conclusion in 2025.

The Puranas holy texts, "describe the present age as close to universal chaos and final destruction" (Idem, p. 495), in broad pralaya.[19.]

> Pralaya, the end of a cycle of aeons, is the temporary disintegration of a universal form of existence and of all the individual forms which move in its rounds, but that is only a momentary pause, a silent interval followed by an outburst of new creation, reintegration and reconstruction in which they reappear and recover the impetus of their progression (Sri Aurobindo, 1997, p. 421).

In the Andean Cosmovision does not exist a supreme creator that gives origin to the Cosmos, nor the idea that the world is determined by mechanic principles. The Cosmos hit- or –miss is responsible by its own creation and continues to solve "intelligently" the problems that surges. The main motivation of the human being life is to tune with the Cosmos Force, feeling part of the Whole, and collaborate with the evolutionary process of the world (Gordon, 2011), not as knowledgeable, motivate by the analytic reasoning, but as "cosmoledgeable" (Gonzales y Illescas, 2002, p. 27), capable of embrace the Total Reality. The Andean cosmogony manifest itself through progressive cycles with breaks by a transition state called Pachakuti, a word *quechua* and *aymara* whose term *Pacha* means world, time and space or state of being; while *kuti* means change, turning or something that comes back to itself (Steele and Allen, 2004, p. 226). Pachakuti was also an Inca hero that reorganized and reestablished a prosperity epoch to the Inca people, and most likely, the founder of Machu Picchu (Gamboa y Ocampo, 2007). Since the cosmic transformation periods succeed each five hundred years, the ninth Pachakuti starts (?) of in the Conquest "*que inicia la ruptura del orden cósmico [...], allí se inaugura un período de caos y destrucción, a partir de la muerte de Atahualpa em Cajamarca*" (Guerrero Arias, 2010,

[19]The Historical Dictionary of Hinduism gives the following definition of Pralaya: "Dissolution. The end of a cosmic cycle or century of **Brahma.** At the end of a cycle, the forces of chaos and entropy overcome the forces of order, or **dharma**, and the universe dissolves, returning to a potential state. There follows the great sleep, or mahapralaya, after which a new **creation** will emerge and a new century of Brahama, lasting for trillions of years, will begin. The karmic states of the beings in the universe at a time of the pralaya will determine their character in the new cycle» (Long, 2011, p. 231[sic]).

p. 230). According to the quechua and aymara traditions we are in the tenth Pachakuti which the indigenous nations of Abya Yala[20] are rescuing the mystic Andean patrimony and proposing its alternative vision to the traditional system of market economy (Huanacuni Mamani, 2015). The passage from the chaos to a new order, with the Pachakuti myth indicates, does not match totally with the old myth of eternal return well explained by Mircea Eliade (1993), but develop in a spiral way, advancing progressively and creatively, introducing complete unprecedented elements.

However, how was possible to keep the original set of Andean Cosmo vision after the westernization of the Latin America (Guerrero Arias, 2010), through the colonization process? The small people of Q'eros, because they live at 4.400 meters in the highest mountains in the southeast of Peru, stayed preserved of the European contamination and become legit depositary of the mystic of the Andean traditions. The interpretation of the millenary heritage in the current international context took the Andean spiritual guides to make manifest a prophecy that preannounced the "return of the Inca", not in the sense of restoration of the old empire, but as "a social transition to a new era of wealth and abundance the like of which has never before been experienced"[21].

A specific phase known with the name of Taripay Pacha, literally "The Age of Meeting Ourselves Again"[22] to be held in four moments: the first will be characterized by three years of cosmic change (Pachakuti); followed by seven years of growth of the practice Ayni which means "Sacred reciprocity. If you give you will receive and if you receive you must give back."; the third moment will hold a twelve years period of maturing aiming to create the indispensables conditions to the introduction to the new era; the last one will be a prosperity time and evolution of the consciousness. According with two great masters of the Q'ero population, Don Manuel Quispe e Don Jesús Qana the first Pachakuti moment would had begun in 1 August 1990; the second in 1 August 1993; third in the 2000 year and the last, the new era, from 1 de August of 2012.

Willaru Huarta, a shaman of the tribe Q'ero, comment the following text of the current epoch:

> Native Quechan Incan prophecies predicted the white man's coming would bring 500 years of materialism and imbalance. But now they say that era is

[20]« **Abya Yala »** means « Continent of Life » in the language of the Kuna peoples of Panama and Colombia. The Ayamara leader Takir Mamani suggested the selection of this name (which in the Kuna use to denominate the American continents in their entirety), and proposed that all Indigenous peoples in the Americas utilize it in their documents and oral declarations. 'Placing foreign names on our cities, towns and continents, he argued, is equal to subjecting our identity to the will of our invaders and to that of their heirs.' The proposal of Takir Mamani has found a favorable reception in various sectors ». (http://abyayala.nativeweb.org/about.html).

[21]http://www.inka-world.com/en/prophecy-inkas.html.

[22] The « The Inca glossary » presents also others complementary translations as: "A Quechua saying that means time to find yourself. This time is now.", ou "Alternately translated as the age of re-encounter, encounter of the universe, or encounter of oneself; refers to a prophesized golden age of human experience in which we encounter ourselves once more as being one with the universe... » (http://www.incaglossary.org/t.html).

> coming to an end and the Age of Aquarius will signal the return of light to the planet and the dawn of a golden era. We live in a time of the fulfillment of prophecy. Humanity should ...return to the inner spirit, which we have abandoned while looking elsewhere for happiness (Field, 2011, p. 11 [sic]).

As it's possible to verify, through the fast excursus about the time vision of the three culture millennia presented, temporal dimension is never dissociated of the space dimension; one and other are the two faces of the same coin, as shown by Einstein in its general relativity theory. Additionally, the universe, the macro world is always interpreted as a hologram of the micro: know the universe is to know yourself, and the own personal evolution a lecture key of the cosmos. That is why the scientists were at the same time priests, because were mediators between the human history and the universe movement. The conclusions of three big civilizations about the unicity and originality of the current epoch, although with some differences, point to a phase of big transition and big change, according to the current astrological studies that are confirming the back of Saturn (Hollis, 1994; Svoboda, 1997) or the Aquarius epoch (Amao, 2012, p. xv). This unprecedented coincidence between the scientific reflections related to the civilization collapse and the detection of a Big Transition, and the ancestral knowledge according to which we would be in a conclusion of a big circle of history and in the beginning of another, constitute an important fact in the modern history that, if admitted, gives room to an ulterior question: Where is the humanity going to?

Groping in the future

When the theme of the future enters speeches and projects, it is generally technological progress in question, the appearance of the fourth industrial revolution and its consequences in people's lives[23].

Rarely the attention is directed to the transformation of the human by itself, in the advance of the way to be of the humankind. In the modernity spirit, the human spirit investment was mainly directed to the interests and objectives of the *homo faber,* after, *homo oeconomicus*, believing that the improvement of the *technê* would have modify the being of the individual. Lewis Mumford, an excellent investigator of the beginning of the industrial adventure, express himself in this way:

> The modern men believe in the mechanic conception of the world, not as a usual instrument of order - which it is – but as a final revelation of the truth. All that cannot be put in this idolum is not real. Objective uniformity: subjective chaos.

The mistake of looking at its own identity out of itself, in the way of the mythical Narcissus, one more time, in the twilight of Modernity, could be fatal to the subjective and collective experience of humanity. In this sense, the insurgent peoples, rooted in its own

[23]Cf. https://www.weforum.org/focus/shaping-the-fourth-industrial-revolution and https://www.youtube.com/watch?v=rbXJMAFRM7I.

original millenary culture, perhaps are paradoxically advanced by facing the changes in the current epoch.

In spite of the powerful dominant ideology that accompanied the industrial revolution and its developments, it did not lacked men endowed with extraordinary lucidity who knew how to put the problem of the limits of human knowledge and the need for an evolution of consciousness; and to point out the next stage of humanity. Among them, four big thinkers of the XX century will be objects of attention: Henri Bergson and Alfred North Whitehead, authors that go against of the *Zeitgeist*, on one side; and on the other side, Teilhard de Chardin et Sri Aurobindo authentic visionaries of the future world.

The evolution theory of Darwin certainly shaped a great moment of human history, to the point that no scientific discovery equals in impact and in the way of thinking and judging during the Victorian epoch and in those that succeeded it (Hofstadter, 1955, p. 7). However, the time spirit silenced some scientific contributions that target a more complete view of the evolutionary process. Alfred Russel Wallace, well-known coauthor with Darwin of the evolution theory by Royal Society, rushed in the forgetfulness because of his ideas: one of those were that "the raison d'être of the Universe was the development of the human spirit" (Flannery, 2010, p. 36). The contribution of Henri Bergson who was born in the same year of the publication of The origin of the species, in 1859, can be considered the highest point of the attempt to integrate, in the Darwinian conception, scarified aspects by the fundamentally empiric and materialist epistemology of the epoch.

The main objective of the masterpiece of Bergson "*L'Evolution Créatrice*", which gave him the literature Nobel prize, in 1927, is to show, from Darwin and Wallace conclusion, that if life is evolution, so it has to explain not only men's formation, but also the knowledge and the intelligence that is designated to think the matter (2007, p. V). In this sense, our rationality, and the modern science as its product, are extremely limited because it proceeds as a cinematographic method, perceiving the series of angles that succeeds, but not its movements; the fragmentation of episodes, but not its dynamism, its *élan vital*. Always, according to Bergson, the mechanic explanations, despite its success, reveal only a small part of the real (p. 353). Contrarily to the Kantian affirmation, in which human intelligence is enough, it would need a intuition « *supra-intellectuelle* » (p.359). "*Pour penser le mouvement il faut un effort sans cesse renouvelé de l'espirit*" (Idem, p. 328). And the spirit, to Bergson, manifest itself by a movement of search of the meaning of life, in the sense of existence, of the human activity and the events, overpassing the mechanic, and the spiritual inertia that it holds. It is the intuition that walks in the same direction of life and that introduces us in the immediate consciousness, soon, and after, in the expanded consciousness that puts us in contact with the unconscious, the interior world unknown.

To talk about the spirit is to talk about the consciousness, synonym of the freedom and choice, while the matter obey the laws of necessity.

> Bref, les choses se passent comme si une immense courant de conscience [...] avait traversé la matière pour l'entraîner à l'organisation et pour faire d'elle, quoiqu'elle soit la nécessité même, un instrument de liberté. Mais la conscience a failli être prise au piège. La matière s'enroule autour d'elle, la plie à son propre automatisme, l'endort dans sa propre incoscience» (Bergson, 2006, pp. 19-20).

Evolutionary theory, in order to be such that, should take into account the *modus vivendi* of the structure of consciousness and matter, and the way in which the two have progressed through history by interacting with each other. The insertion in the process of evolution and the centrality of consciousness in this movement are the conditions to go beyond the human, thus continuing the route of the evolutionary process.

> Si nos analyses sont exactes, c'est la conscience, ou mieux la supraconscience, qui est à l'origine de la vie. Conscience ou supraconscience est la fusée dont les débris éteints retombent en matière; conscience encore est ce qui subsiste de la fusée même, traversant les débris et les illuminant en organisme. Mais cette conscience, qui est une exigence de création, ne se manifeste à elle-même que lá où la création est possible. Elle s'endort quand la vie est condanné à l'automatisme; elle se réveille dès que renaît la possibilité d'un choix » (Bergson, 2007, pp 261-262 [sic]).

According to Bergson, the whole history of life in the cosmos is a struggle between the effort of consciousness to elevate matter, and the overwhelming impulse of matter, which seeks to imprison, more or less completely, consciousness. Releasing consciousness, therefore, means dynamizing the movement of evolution, overcoming the natural tendency of matter to inertia and the status quo. According to the author of "*L'Evolution Créatrice*", where the evolution process may have found a dead-end street, starts the new challenge of humanity to acknowledge its strength and its unity inside an impulse capable of "*culbuter toutes les résistences et de franchir bien des obstacle, même peut-être la mort*" (Idem, p. 271). In essence, the path of human evolution, far from being finished, can continue its unfolding insofar as contemporary man moves from the primacy of matter to the primacy of consciousness.

Bergson's ideas had a strong impact in many scientists and philosophers, beyond those Whitehead, Teilhard of Chardin and Sri Aurobindo.

Whitehead, lately recognized as the greatest philosopher of the twentieth century (Stengers, 2011, p.9), was a great mathematician who, after his brother's death in World War I, went from a mechanical interpretation of the universe to an interest in Philosophy. Continuing Bergson's reflection, he also questions the foundations of modern science:

> The progress of science has now reached a turning point. The stable foundations of physics have broken up [...]. The old foundations of scientific thought are becoming unintelligible. Time, space, matter, material, ether, electricity, mechanism, organism, configuration, structure, pattern, function, all require reinterpretation. What is the sense of talking about a mechanical

> explanation when you do not know what you mean by mechanics? The truth is that science started its modern career by mechanics? (1948, pp. 17-18).

Regarding the theory of evolution, he asserts that the language of materialistic philosophy is incapable of describing the "creative" aspect of evolution as part of the assumption that all activities of organisms are external and underestimate complexity. Whitehead's contribution can be summarized briefly into two fundamental assertions: the first is concerned with demonstrating the creative movement of time by claiming that fact is first and foremost a process (Idem, 71), an act in continuous becoming that escapes the question of reason. "An actual entity is a process, and is not describable in terms of the morphology of a 'stuff.'" (Whitehead, 1978, p. 41), against the view of the "gross fact" or simply given (Idem, p. 42). The second seeks to synthesize the opposites and dualities that produce the creative moment: "In formal logic, a contradiction is the signal of a defeat: but in the evolution of real knowledge it marks the first step in progress towards a victory" (Whitehead, 1948, p.186).

Therefore, creativity is a multiple, unpredictable and synchronous process that escapes conventional scientific categories and appeals directly to intuition (Whitehead, 1978: 21), the only one that is able to reconcile opposites, to combine together the staticity and the flow at the same time (Idem, p.347). According to Whitehead, it is not possible to understand evolution without changing the laws that so far explain evolutionism (Whitehead, 1948, 45); nor can we think that the evolutionary threshold reached by modern man is the 'final' point of evolution (Ford 1984: 269). The elevation of consciousness, understood as the ability to synthesize what is complex (Whitehead, 1961, 269), will allow "the postulation of a more complex mental phase" (Idem, p. 172) that goes beyond the mental as is known. "Thus, the future of the Universe though conditioned by the immanence of its past, awaits for its complete determination the spontaneity of the novel individual occasions in their season they come into being" (Idem, 255). In Whitehead's thought, once again, the call to consciousness-intuition becomes indispensable and urgent for the future of the universe, surpassing the empirical-positivist view.

At the same time, the analysis of the boundaries of the dominant materialist ideology was also shared by Carl Gustav Jung, who, in 1931, in a lecture entitled "The Spiritual Problem of Modern Man", returned the subject by showing the consequences of this view in the psyche and confirming the importance of the role of spirituality, understood as the search for one's soul, a theme that, at that time, would be taken up and expanded by Teilhard de Chardin and Sri Aurobindo, albeit with different language and experience.

Teilhard de Chardin, priest and Jesuit, was before all a man of science, researcher in the geology and paleontology fields. This double identity of scientist and religious at the same time caused him many problems with the Church: one of his masterpieces, "*Le phénomène Humain*" was interpreted as a threat to the classic theology and for that, the Vatican refused the imprimatur to the publication. He himself would justify his religious and scientific pioneering with the following words: "*Je n'ai pas découvert laborieusement le Tout. Mais c'est lui, qui, par une sorte de «conscience cosmique » s'est présenté, imposé à moi* ». (1965, 61).

The cosmological view of Teilhard de Chardin puts man as the "key to the Universe", trying to distance himself from the modern anthropocentrism:

> "*L'Homme, non pas centre statique du Monde – comme il s'est cru longtemps; mais axe et flèche de l'Évolution – c'est qui est bien plus beau*" (1955, p. 30). The importance of man derives from the fact that he is the highest point of the realization of the Universe and that consciousness, "*la substance et le sang de la Vie en évolution* » (Idem, p. 197), in him becomes completely recognizable. According to Teilhard de Chardin, the force of consciousness has propagated and continues to propagate in the Universe in successive stages: starting from cosmogenesis to continuing in geogenesis, to psychogenesis. The introduction of thought and reflection would have inaugurated a new phase, that of Noogenesis[24] , the beginning and continuation of the development of the Spirit (Idem, 200): « *Perfection spirituelle (ou 'centreité' consciente) et synthèse matérielle (ou complexité) ne sont que les deux faces ou parties liée d'un même phénomène* » (Idem, p. 57). "*Nous passons, en ce moment même, par* un changement d'Age" (Idem, p. 237 [sic]), we are in a transition moment (Idem, p. 311), forwarded in the total realization path of Awareness, the Ômega point.

How to face this phase of the history of humanity? Teilhard de Chardin points out three lines of action: first, the organization of research for a science at the service of man, in his dual material and spiritual dimension; second, the discovery of the human object as an element of the universe and key to all science of nature; and finally, the conjunction between science and religion (Idem, pp. 310-317). Faith in man as the manifestation of the cosmos fuels the march to the next stage of evolution.

> To place faith in Man [...] we understand here the more or less active and passionate conviction that pure humanity, in its organic and organized totality, has before its eyes a Tomorrow. A Tomorrow formed not only of succeeding years, but of superior stages to be reached by a way of conquest. Not only survival, we understand well, but a certain sense, beyond life or super-life (Monestier 1967, 30).

To Teilhard de Chardin, the next phase of evolution of the planet will be the concentration of knowledge about humanity itself, getting thereby to discovery its collective mind, by its own nature connected to the cosmic awareness experience (Sethna, 1981, p. 21).

The view of the Jesuit and scientist is naturally rooted in Western culture and Catholic-Christian theology, from which he elaborates his own original interpretation of the evolution of the cosmos. Although element of rupture of the religious and scientific mentality of the time, the language used mirrors a specific *weltanschauung* of the world: the western and Christian. In this context, the contribution of Sri Aurobindo, considered "the Voice Incarnate of India's

[24] In or with reference to the writings of Pierre Teilhard de Chardin: the development of the stage or sphere of evolutionary development dominated by consciousness, the mind, and interpersonal relationships, see: https://en.oxforddictionaries.com/definition/noogenesis

Soul"[25] by the greatest Indian poet and writer Rabindranath Tagore is complementary to the Teilhard de Chardin's thought. From the millennial Hindu wisdom, reaches the unity of conclusions in the diversity of cultures and peoples. In fact, Sri Aurobindo was not just a product of India. From an early age he studied in England, Cambridge. At the age of 21, he returned to India and, by his influence and writings, prepared the ground for Gandhi's action in the process of liberation from English domination.

The theme of evolution runs through all of his 37 books published, but is thoroughly treated in the seminal work of Sri Aurobindo "The Life Divine" where there are 12 chapters dedicated to the subject.

His interpretation questions the theory of evolution as insufficiently grounded (Sri Aurobindo, 2005: 858), while it is limited to the physical and biological aspects of Nature: we know that there is evolution but we do not know what it is (Sri Aurobindo, 1949, pp. 138). It is only possible to understand the phenomenon from a supramaterial, spiritual perspective. The *Agni*, Consciousness-Force, is the key to interpretation with its two main movements of involution and evolution (Satprem, 246): *Himself the play, Himself the player, Himself the playground* (Sri Aurobindo, 2005, p. 111). The involution would be the realization of the presence of the power of the Spirit in the Unknown Matter of its potentiality and its dormant consciousness. The word evolution, in its original sense in Latin, indicates a movement that rolls from the inside out. Now, without an a priori content, the evolutionary process becomes impossible: "Nothing can evolve out of Matter which is not therein already contained" (Idem, p. 95).

Evolution is the dynamic and concrete action of Consciousness-Force that gradually produces the manifestation of the soul in material existence: first the evolution/organization of Matter; then the evolution of Life in Matter; and finally, the evolution of Mind in Living Matter. Man is the highest point of this creation, ignorant because unconscious of the spiritual energy that inhabits him (Idem, 860); and, at the same time, "The human condition is a stage of transition" (Sri Aurobindo, 1999: 829). The next step will be a further progression of the human race, beyond itself, when it will have reached "a certain level or a certain point of stress of the evolutionary impetus" (Idem, 875). In this passage, the mean factor would be the transformation in a higher state of consciousness, from the mental to the supramental consciousness. To Sri Aurobindo, humanity has reached a crossroads where:

> "A spiritual evolution, an evolution of consciousness in Matter in a constant developing self-formation till the form can reveal the indwelling spirit, is then the keynote, the central significant motive of the terrestrial existence » (2005, p. 856).

Mira Alfassa, companion and faithful interpreter of the message of Sri Aurobindo after his death, describes in other incisive words the grandeur of the moment: *"[…] une heure*

[25] http://www.sriaurobindoinstitute.org/saioc/Sri_Aurobindo/tributes/namashkar_from_rabindranath_tagore

exceptionnelle […], une époque unique […], on a cet immense bonheur, ce privilège inestimable d'assister à la naissance d'un monde nouveau […]" (La Mère, 2009, p. 178).

However, what is the role of humanity in this cosmic conjuncture, in which man have the privilege of being able to walk towards the infinite?

> It is only by rising toward a higher consciousness beyond the mental line [...] that [man] can emerge from his inability and his ignorance. His full liberation and enlightenment will come when he crosses the line into the light of a new super conscient existence [...]. It would mean a new creation on earth, a bringing in of the ultimate powers which would reverse the conditions here [...]. (Sri Aurobindo, 2012, p. 260).

The questions raised by Bergson, in a clear and systematic form[26], enriched by Whitehead's analyses and Teilhard de Chardin vision, has found in Sri Aurobindo the highest and lucid expression of the new stage that awaits humanity.

Conclusion

In the definition of the Working Group on Anthropocene, the Anthropocene, considered "a potential geological epoch", along with previous epochs, and the end of the Holocene[27], is a turning point that puts all humanity in a new situation, previously unknown. As Latour affirms "No postmodern philosopher, no reflexive anthropologist, no liberal theologian, no political thinker would have dared to weigh the influence of humans on the same historical scale as rivers, floods, erosion, and biochemistry", putting a conclusion to the omnipresent anthropocentrism and the past forms to interpret the nature (2013, p. 77). Suddenly we are obligated to think in geopolitical terms (earth politics) and not only in scientific knowledge; in monogenism terms (the conviction of the oneness of this planet) more than monotheism (Sloterdijk, 2007 p. 34). Gaia, changed from only a decorum or supply of natural resources, becomes the main actor, demanding the emergence of a new *ánthropo* and a new political subject. But, the novelty, not just scientific, raised by the Work Group on Anthropocene is suffrage also by an ample literature, that identifies, in the crises of the contemporary world, the conclusion of a historic phase and the time of a Big Transition turned to change from one model of civilization to another.

Related to the scientific data, we searched an association with the chronological investigation of some millenary traditions, that through the mathematical calculus and the astronomical studies even predicted big transformations around the 21th century. Perhaps the profound difference between the conclusions of science and those of ancient cultures is the different highlight placed on the same fact: scientists in the comparative study of extinct civilizations and in the analysis of the destructive action of man; the great traditions

[26]Was defined « *Le choc Bergson* ».

[27]https://quaternary.stratigraphy.org/workinggroups/anthropocene/.

announcing the beginning of a new stage of history, corresponding to the opportunity of a personal and collective spiritual evolution. However, the coincidence of the two interpretations is a singular fact, a prelude to dialogue and mutual respect.

On the other side, the boundaries of knowledge driven by reason and the necessity of an ulterior expansion of the consciousness were well exposed by Bergson and Whitehead. However, what could the thinking of such excellent authors go against the dominant ideology, wholly impregnated with the social evolutionism espoused by Spencer, whose success in the Victorian era was unmeasured[28] ? The facts were in charge to uncover what the conventional culture had hidden. It is the message of the anthropocene, albeit cryptic or not entirely clear, whereas, as we have seen before, the subject is debated in a short space of time to solve conjunctural problems. But the anthropocene has not only this meaning. As it is known, the term, of Greek origin, is formed by two words, *ánthropos* (human being) and *kainós* (new). The same word anthropocene, used to designate the post-Holocene era, can be interpreted to mean "new human being" (*kainós ánthropos*)[29]. In here is the sense of Teilhard de Chardin and Sri Aurobindo contributions, particularly incisive and originals. This does not mean denies the development, in all the fields that accompanied the modernity and accelerate vertiginously in the Post-Modernity. As well highlighted by Sri Aurobindo, the man has advanced in the knowledge of the physic word, in the science, in the control of the space around itself, in the particularly utilitarian and superficial of the nature laws. But, "he is what he always was in the early beginnings of civilization": continue fundamentally to manifest the same capabilities, the same qualities, the same flows, the same mistakes and the same frustrations (Sri Aurobindo, 2005, p. 864). The Barbarism[30], once defeated, is always there lurking, ready to come back and defeat the masterpiece of the civilization (Delpech, 2005). The men today are not wiser than the visionary and the old thinkers. In the Paul's Valery words: "*Le monde moderne se façonne à l'image de l'esprit de l'homme*" (1945, p. 165). The cause, of the progress in all the areas and a certain regress in the human values, does to the fact that such technological advance did not reach "the spiritual evolution, the consciousness evolution the progression of the manifestation of the soul in the material existence" (Sri Aurobindo, 2005, p. 868). This progress did not take the human race beyond itself, overcoming the transformation of the mental being.

The notorious Israeli historian Harari, in his book "Homo Deus", notes that "This is all the fault of evolution. For countless generations our biochemical system adapted to increasing our chances of survival and reproduction, not our happiness." (2015, p. 34), toward which human evolution tends. According to Teilhard de Chardin and Sri Aurobindo, the next stage will be, to the first, "*L'Humanité; l'Esprit de la Terre; la Synthèse des individus et des peuples; la Conciliation paradoxale de l'Élément et du Tout, de l'Unité et de la Multitude* » (1955, p. 295) and to the Indian philosopher "A change of consciousness is the major fact of the next

[28]Between 1860 and 1903 were sold 368.755 books of Spencer (Hofstadter, 1955, p. 34).
[29] This expression appears in one of the Plutarch's works, great Greek historian. (Liddel & Scott, 1901).
[30] Here the term is used to indicate a pre-civilization stage. On the discussion over "barbarians", "savages" and "civilized" see Levi-Strausse's "Race et Histoire" (1961).

evolutionary transformation, and the consciousness itself, by its own mutation, will impose and effect any necessary mutation of the body" (Saint-Hilaire, 1996), knowing that "[...] the progress of the mind, the growth of the soul, even of the mind and soul of the collectivity, depends on the individual, on his sufficient freedom and Independence " (Sri Aurobindo, 2005, p. 721).

The sense of the new phase of the Anthropocene thus becomes manifest in its entirety. It is not only a matter of solving the crises that disturb human organization, of avoiding the extinction of species and the collapse of global civilization, of considering present and future generations, all attitudes indispensable for the preservation of life. But the Anthropocene is not just that. The purpose of this text, which is too brief for a theme as relevant as the future of mankind, was to highlight the propositional aspect, the noble perspectives that invoke the becoming of the human being, besides the *technê*, contained in the Anthropocene. Focus your attention on the path of longue durée, no doubt, will make easier the responses to the urgencies and the challenges that humanity faces.

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Opinion Paper

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From Scarcity to Abundance: The New Geopolitics of Energy*

Michael T. Klare**

For most of the Petroleum Age, and even as recently as ten years ago, the politics of energy were largely governed by perceptions of *scarcity*: the assumption that global supplies of most primary fuels were finite and would eventually prove insufficient to satisfy rising worldwide demand, resulting in intense competition over what remained. The enduring prevalence of this view led many oil-importing nations to establish close ties with their major foreign suppliers and to employ force on occasion to ensure the safety of overseas supply lines. This outlook guided American foreign policy for over half a century, resulting in several U.S. interventions in the Persian Gulf area. Recently, however, a combination of technological and political considerations – the introduction of hydraulic fracturing ("fracking") to extract oil and natural gas from previously inaccessible shale formations on one hand and rising concern over climate change on the other – has largely extinguished the perception of scarcity, introducing entirely new dynamics into the geopolitics of energy.

Looking into the future, it looks as if *abundance*, not scarcity, will govern the politics of energy. Whereas it was once thought that the major sources of oil and natural gas would soon run dry, prompting an all-out struggle among major consuming nations for control over what remains, it now appears that supplies of fossil fuels will remain plentiful for the indefinite future, eliminating any need to prepare for conflict over their possession. While this is good news for the oil-importing states, it is bad news for the oil-exporting countries, many of which will have to adopt new economic models to avert extreme economic distress. Other developments of equal significance will also unfold as this shift from scarcity to abundance gathers momentum. Before examining these outcomes in greater detail, however, it is worth reviewing the traditional

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perspective on energy geopolitics and how that outlook is being undermined by recent developments in the field.

The Energy-Scarcity Mantra

Up until the onset of this century, the geopolitics of energy was largely driven by a long-held mantra consisting of five cardinal principles: (1) oil was the world's leading primary source of energy, and always would remain so; (2) the United States and its Western friends and allies, members of the Organization for Economic Cooperation and Development (OECD), were the primary users of oil; (3) the Middle East possessed the world's largest reserves of oil, and so would remain major producers for the indefinite future; (4) an uninterrupted flow of affordable oil was an essential precondition for the stability of the world economy; and (5), as a result of the other four points, it was necessary for the United States (aided, where possible, by its allies), to use force when necessary to ensure the safe flow of Middle Eastern oil to Western refineries.

Looking at energy data from that time, it is not hard to understand why this mantra possessed so much credibility. In 1990, according to the Energy Information Administration (EIA) of the U.S. Department of Energy, oil provided approximately 40% of total world energy, and was expected to retain its dominant position for decades to come. The United States accounted for nearly one-third of the world's total consumption of oil that time, 20.5 million barrels a day out of a worldwide total of 66.5 million barrels. Although many countries were contributing to the global oil supply, only the Persian Gulf producers were able to generate the added volumes needed to satisfy the petroleum requirements of countries like the United States with inadequate reserves of their own. With production in most other areas expected to decline in coming years, the Middle East – believed at that time to possess two-thirds of the world's remaining recoverable supplies – would be providing an ever-increasing share of the world's future requirements.

These trends had been evident since the early 1970s, when oil production in the United States reached a peak and began a long decline, forcing this country to become increasingly dependent on imported, especially from the Middle Eastern oil. This was the backdrop to promulgation of the "Carter Doctrine" – the geopolitical expression of the scarcity mantra – in January 1980, following the Soviet invasion of Afghanistan. "The Soviet effort to dominate Afghanistan," President Carter declared, "has brought Soviet military forces to within 300 miles of the Indian Ocean [and so] poses a grave threat to the free movement of Middle East oil." Given the West's critical reliance on that oil, any attempt by Moscow or another hostile power to seize control of the region "will be regarded as an assault on the vital interests of the United States of America, and such an assault will be repelled by any means necessary, including military force."

To ensure that this dictum could be fully implemented, Carter established a new military organization, the Rapid Deployment Joint Task Force (RDJTF), and ordered it to assemble a rapid-reaction contingent for employment in the region. His successor, Ronald Reagan, elevated the RDJTF to a full-scale regional command, the U.S. Central Command (Centcom), and gave it authority over all U.S. combat forces in the greater Gulf region. Reagan also invoked the Carter

Doctrine when ordering U.S. forces to escort Kuwaiti oil tankers through the Gulf during the later stages of the Iran-Iraq War of 1980-88, claiming that Iranian attacks on those tankers constituted a threat to the free flow of oil and so threatened vital U.S. interests. President George H.W. Bush advanced a similar argument three years later when announcing the deployment of American troops in Saudi Arabia following the August 1990 Iraqi invasion and occupation of Kuwait. "Our country . . . could face a major threat to its economic independence" if oil deliveries from the kingdom were curtailed, he declared, and so "the sovereign independence of Saudi Arabia is of vital interest to the United States."

In more recent years, Centcom has been given responsibility to prosecute the wars in Iraq and Afghanistan and to combat terrorism throughout its extensive territory; however, one of its key tasks remains ensuring the safety of oil shipments from Gulf producers through the Strait of Hormuz and to destinations beyond. Iranian leaders have made repeated threats to block the Strait in retaliation for any U.S. (or Israeli) effort to strike Iranian nuclear facilities, and this has consistently prompted assurances from Washington that Centcom will take whatever action is necessary to keep the Strait open to oil traffic. "We will ensure the free flow of energy from the region to the world," President Barack Obama told UN delegates in a speech to the General Assembly on September 24, 2013.

This picture – the centrality of oil in world energy consumption, U.S. reliance on imported oil, the pivotal importance of Middle Eastern oil in global markets, and an inclination to employ military force when needed to ensure the safe flow of global oil shipments – prevailed well into the beginning of the 21st century. Indeed, it gained renewed vigor in the early years of the century when many independent analysts began to warn of an imminent "peak" in world oil production, followed by a gradual contraction in global supplies. Some experts put the peak as early as 2015, others at 2020 or so. Natural gas was said to be capable of providing a temporary supplement to the dwindling oil supply, but then it, too, would reach a peak, plunging the world into chaos and conflict.

The Age of Energy Abundance

What a difference a few years can make! Less than ten years after these apocalyptic scenarios proliferated, the prospect of oil and gas scarcity has totally vanished, and does not appear likely to return in any conceivable future. Instead, the world is drowning in surplus petroleum, resulting in sustained low prices and economic misery for most oil companies and major producing countries. The world is also beginning to move away from reliance on fossil fuels altogether, rendering obsolete many of the strategic plans intended to ensure the safe flow of oil. What happened in this (relatively) short amount of time?

Two big things occurred. The first is hydro-fracking. Developed by independent producers in the United States to exploit oil and gas supplies trapped in underground shale and other "tight" rock formations, fracking combines two innovative technologies: horizontal drilling, or the use of flexible drilling rods to exploit shale formations that extend laterally for long distances; and hydraulic fracturing, or the use of high-pressure water laced with sand and

chemicals to generate fractures in these formations and thereby allow the escape of the oil and gas trapped therein. First employed to extract natural gas from shale "plays" in Texas and Pennsylvania, the technique has more recently been used to obtain oil from formations in Colorado, Texas, and North Dakota.

The increase in U.S. oil and gas production via hydro-fracking has been nothing short of sensational. In 2009, according to the EIA, "tight oil," or petroleum recovered from shale and other hard-rock formations, amounted to only 250,000 barrels per day; by 2015, it had soared to 4.9 million barrels per day and, according to the latest EIA projections, will reach an estimated 7 million barrels in 2040. Despite a continuing decline in other forms of domestic petroleum output, this increase is so great that it will perpetuate America's status as one of the world's top oil producers for decades to come. The picture for natural gas is equally striking. In 2009, U.S. production from shale stood at about 9.3 trillion cubic feet; by 2015, it had jumped to 18.6 trillion cubic feet, and is now predicted to reach 35.6 trillion in 2040. These are extraordinary achievements, with few precedents in the history of hydrocarbon production.

Up to this point, most of the progress in utilizing hydro-fracking to exploit shale reserves has occurred in the United States, where the technology was first developed and put to use. The U.S. is also blessed with mammoth oil and gas-bearing shale formations, and so the potential for future increases in output here remains substantial. However, other countries also possess large shale reserves. According to the most recent EIA estimates, Russia possesses almost as much shale oil as the United States, and three countries – Algeria, Argentina, and China – possess larger reserves of shale gas. All of these countries, as well as others identified by the EIA with large shale reserves, are now attempting to exploit these formations, albeit with varying degrees of success. Whether or not they are ever fully developed, the sheer existence of these reserves – coupled with the widespread utilization of fracking technology – ensures that oil and gas will remain abundant for a very long time to come.

The second big development of the past ten years is the huge increase in international concern over climate change, accompanied by a vigorous worldwide effort to slow its advance by imposing curbs of various sorts on human emissions of greenhouse gases (GHGs), especially carbon dioxide released in the combustion of fossil fuels. Global warming has, of course, been a major concern since the 1980s, as demonstrated by the signing, in 1992, of the United Nations Framework Convention on Climate Change. This was followed by various efforts at the local, national, and regional level to impose curbs on CO_2 emissions and promote the installation of non-carbon-based sources of energy, particularly wind and solar systems. It is only in the past decade, however, that the political will has materialized to move these endeavors from the margins to the mainstream, with a demonstrable shift in energy utilization. In the United States, for example, many states have adopted "renewable portfolio standards," requiring electrical utilities to derive a certain percentage (often 10% or more) of their total generating power from renewable sources of energy. The European Union, for its part, is implementing its "20-20-20" climate and energy package, requiring that member states jointly reduce their GHG emissions by

20% over 1990 levels by 2020, secure 20% of their energy from renewables by that year, and achieve a 20% increase in energy efficiency.

As a consequence of these, and many other such measures, the demand for renewable energy has soared around the world and the manufacturers of wind turbines and solar panels have ramped up production, investing in new cost-cutting technologies and mass-production techniques. This, in turn, has resulted in a dramatic reduction in the price of these options, further stimulating demand. The U.S. cost of solar power, for example, dropped by 70 percent between 2009 and 2015; similar gains have been observed in the delivery of wind power. With costs dropping and demand rising, the installation of wind and solar power has experienced an extraordinary surge. In the United States, electricity generation from wind rose by 2,600% between 2001 and 2015, jumping from 7 to 190 million megawatt-hours, while similar gains have been achieved in solar power. Rapid growth of this sort is expected to continue in the years ahead, as more and more countries adopt measures to curb CO_2 emissions and promote use of renewable energy. According to the International Energy Agency (IEA), worldwide consumption of renewables in electricity generation (excluding hydropower) will climb by 450% over the next quarter-century, jumping from 1,316 terawatt-hours in 2013 to 7,248 terawatt-hours in 2040. In this way, as well, an era of energy abundance is upon us.

The big question, of course, is how the surge in renewable energy output will affect the global demand for fossil fuels. At present, renewables still constitute too small a share of the total energy mix – about 15% -- to threaten the dominance of carbon-based fuels, but that is changing rapidly. In 2015, for the first time, renewables surpassed coal as the leading source of newly installed electric power around the world, adding an additional 153 gigawatts to global generating capacity. Expecting this trend to continue, the IEA revised its projections for future renewables growth, seeing a steady erosion of coal's once dominant position in the power sector. As for oil and natural gas, the picture is somewhat different: petroleum-based fuels are still predominant in the transportation field, and gas is viewed in many communities as a less-polluting alternative to coal. Nevertheless, the strong appeal of renewables in the power sector has softened the demand for gas in some markets, while the growing appeal of hybrid and all-electric cars has begun to erode the demand for oil. While there is no consensus on the matter, some analysts now foresee the advent, perhaps in the late 2020s, of peak *demand* for oil – completely reversing the conversations over peak *supply* that so animated the first decade of the century.

The Middle East's Declining Geopolitical Centrality

Of the many geopolitical implications of the new energy order, the first and most significant, perhaps, is a decline in the geopolitical centrality of the Middle East. During all those years when the Persian Gulf region was perceived as the principal fount of the world's primary energy supply, it is hardly surprising that the major oil-importing nations, led by the United States, attached overarching importance to stability in the region. By the second decade of the 21st century, however, it was no longer evident that the United States would remain dependent

on Middle Eastern oil to meet its petroleum requirements, or indeed that the region would ever again play the pivotal role in world energy that it had in the past. True, Middle Eastern oil will continue satisfy an important share of the energy needs of some U.S. allies, such as Japan and the EU countries, but with fracking spreading around the world it appears likely that other suppliers will be offering a reliable alternative to the Gulf producers; in light of the growing concern over climate change, moreover, many of these countries are taking steps to reduce their reliance on fossil fuels altogether.

This reappraisal of the Persian Gulf's geopolitical significance clearly underlay the Obama administration's 2011 decision to shift the main focus of U.S. strategic planning from the Middle East to the Asia-Pacific Region. Although the energy dimensions of this shift – popularly known as the "pivot" strategy – was never made explicit, Obama has top aides made it clear that, in Washington's view, Asia had come to replace the Middle East as the principal focus of U.S. planning. "After a decade in which we fought two wars [in Iraq and Afghanistan] that cost us dearly, in blood and treasure," Obama told the Australian Parliament on November 17, 2011, "the United States is turning our attention to the vast potential of the Asia Pacific region. "As the world's fastest-growing region and home to more than half of the global economy, he continued, Asia would now receive the bulk of U.S. policy attention and military engagement. "As we end today's wars [in the Middle East], I have directed my national security team to make our presence and mission in the Asia Pacific a top priority."

In line with this outlook, President Obama undertook the phased withdrawal of American combat forces from Iraq and Afghanistan along with the redeployment of some U.S. military capabilities from that region to the Pacific. However, circumstances do not always allow for the attainment of one's strategic preferences, and Obama's desire to focus on the Pacific has been stymied by the rise of ISIS and the chaos in Syria. In response to ISIS-inspired terrorist attacks in France and the United States, coupled with rising international concern over the fate of civilians in Syria, he has been forced to reverse course and increase the American military presence in Iraq and Syria. Obama made it perfectly clear, however, that he would never approve an intervention on the scale of that undertaken by President George W. Bush in Iraq and Afghanistan, and none of the candidates in the 2016 presidential campaign advocated such a move.

While sharing in the consensus view that another large-scale deployment of U.S. ground forces in the Middle East is off the table, Donald Trump has proposed an odd exception to the rule: the use of military force to seize Arab oil fields and use the proceeds to finance American operations. "I always said, take the oil," he told Matt Lauer of NBC News on September 7. "We go in, we spent $3 trillion," he said, speaking of the Iraq war. "We lose thousands and thousands of lives, and then look, what happens is we get nothing. You know, it used to be to the victor belong the spoils." Aside from the dubious moral legitimacy of appropriating oil from Iraq, a nominal U.S. ally and a sovereign nation, there is the practical issue of accomplishing such a feat. Most analysts believe this would require a sizeable military force spread out over a large territory for a considerable length of time, inviting constant sabotage and terrorist attack – exactly what

Trump says he wants to avoid. It is unlikely, then, that this proposal will survive for long once Trump enters the White House.

Up until now, Trump's main interests in the Middle East have been the war against ISIS and what he views as the flawed nuclear pact with Iran, and this is likely to remain the case once he assumes office. These are major topics of concern, and are bound to command the attention of U.S. policymakers for some time to come. But these issues aside, the Middle East is not likely to retain the pivotal status in U.S. policymaking it long enjoyed while its oil exports were deemed so critical to the American and the world economy.

If, however, the Middle East is not destined to retain its central role in U.S. foreign policy, will it gain greater status in that of other major powers? This is difficult to predict, but it there doesn't seem to be any rush to fill the dominant role long played by the United States. True, Russia has sought to preserve the preeminent position it long enjoyed in Syria by providing arms and military support to the embattled regime of Bashar al-Assad, but it has paid a high price for its involvement – both in rubles and international prestige – so it is unclear how far Moscow is prepared to go in protecting its foothold there. Other powers, including China, India, and Japan, have been more active in the region, sending high-level emissaries and signing trade deals, but none appears willing to replace the United States as the region's principal gendarme. As time goes on, then, it is conceivable that the Middle East will become less important as a cockpit for international competition – still constituting a source of friction and tumult in world affairs, but hardly the only such region and not necessarily the most significant.

Tough Times for Petro-States

One of the most immediate and powerful consequences of both abundant oil and slowing fossil fuel demand is the dramatic plunge of petroleum prices. From a high of $115 per barrel in June 2014, Brent crude – the industry benchmark blend – plummeted to a low of $26 per barrel in January 2016 before recovering to the $50 mark this past summer. This descent had a devastating impact on oil-producing countries such as Algeria, Angola, Nigeria, Russia, Saudi Arabia, and Venezuela that depend to a considerable extent on oil income to stimulate the economy and finance government expenditures. Algeria and Nigeria, for example, rely on oil and gas production for approximately 60% of government revenues; in Russia's and Venezuela's case, it's about 40-50% of such income. During the boom times, when oil prices were robust, these "petro-states," as they are often called, spent colossal sums on public works and other social amenities, winning widespread public support; but now, with prices in the doldrums, they have had to cut back on such endeavors, causing economic hardship for many and provoking widespread social unrest.

From a geopolitical perspective, the most significant outcome of all this is the political trajectory pursued by the Russian leader, President Vladimir Putin. As a consequence, both of low oil prices and the economic sanctions imposed by the EU and the U.S. following Russia's seizure of Crimea, Russian government spending (other than for the military) has been slashed and the economy has fallen into prolonged recession. Ordinary Russian citizens have experienced

a substantial loss of income, with real monthly wages now worth only 87% what they were in August 2014. This, in turn, has sparked widespread strikes and protests – although nothing yet on a scale large enough to threaten the survival of the central government. Perhaps in fear of just such an eventuality, Putin has stepped up Russia's military involvement abroad, thereby stoking nationalistic fervor at home. Russian television and other media – largely controlled by the Kremlin – regularly extol Russia's alleged successes in the international arena but rarely, if ever, mention the budget cuts or the protests at home. To what extent this syndrome will lead to continued Russian adventurism in the future cannot be foreseen, but the persistence of low oil prices is likely to remain a factor in Putin's continued quest for notoriety in the international sphere.

Also grabbing the international spotlight is the current political disorder in Venezuela, where the embattled president, Nicolás Maduro, is facing massive protests by the opposition, which seeks a national referendum aimed at ensuring his ouster. Here too, low oil prices have played a pivotal role. While prices were high, Maduro's predecessor, the widely revered Hugo Chávez, siphoned billions of dollars from the state-owned oil company, Petróleos de Venezuela, S.A. (PdVSA), into his so-called "missions" for the poor, elevating millions of people out of poverty. Chávez (who died in 2013) also borrowed billions of dollars to finance these endeavors, assuming that continued high oil prices would make repayment a non-problem. But with prices now less than half of what they were when Maduro took office, the missions have had to be scrapped and what little money the government retains is being used to pay back the loans. As in Russia, the country has fallen into recession and the living standard of most citizens has declined. Vital commodities are no longer available outside the black market, and many people report severe malnutrition. It is hardly surprising, then, that an ever-increasing share of the population appears to favor Maduro's recall via a referendum.

Low oil prices are also generating budget difficulties and political turmoil in other oil-producing countries. In Nigeria, budget cutbacks in 2014 and 2015 – combined with deeply ingrained corruption – helped cause a series of setbacks in the military's campaign against the Boko Haram terrorist organization, provoking widespread anti-government sentiment. This led, in the 2015 presidential election, to the defeat of the incumbent, Goodluck Jonathan, and his replacement by Muhammadu Buhari, a former general who promised to clean up corruption and wipe out the terrorists. Buhari has achieved some success in those efforts, but the persistence of low oil prices has impeded his efforts to improve economic conditions in depressed parts of the country, including the Niger Delta region, where a long-dormant insurgency is again challenging government control.

All of these countries, and the others like them, will be forced to adapt, as best they can, to a time of petroleum abundance and anemic demand. Some, like Russia, may be tempted to perpetuate their dependence on oil exports for as long as possible, while others appear determined to diminish their reliance, focusing instead on the development of other sources of income. Of particular note in this regard is the announcement of a long-term drive of this sort by Saudi Crown Prince Mohammed bin Salman, the second in line to the throne and head of Saudi

Aramco, the state-owned oil company. In announcing his blueprint for this drive, "Saudi Vision 2030," Prince Mohammed asserted that Saudi Arabia – the world's leading producer – was dangerously "addicted" to oil and would need to develop other streams of income, such as tourism and e-commerce. Many obstacles stand in the way of success of this ambitious venture, but the very fact that the Saudis are even contemplating such a scheme reveals the degree to which the old mantra of oil's perpetual centrality has begun to fade.

Smart Cities and Green Superpowers

While the plight of the petro-states represents one aspect of the changing energy landscape, another is the emergence of "green cities" and the outbreak of a competition to join the front ranks of what have been called "green energy superpowers." Just as the rise of the petroleum industry in the final decades of the 19th century ignited a global race to discover and control new sources of crude, the current surge in demand for alternative sources of energy is spurring a similar drive to master the production and distribution of renewable technologies. While still in its early stages, this competition has the potential to alter the geopolitical map in new and interesting ways. Exactly how, of course, cannot be foreseen, but we are glimpsing some beguiling hints of what this new world might look like.

One of the most conspicuous expressions of this transformation is the avid competition among major cities to be perceived as being ranked among the world's top "smart cities" or "green cities" – large metropolises with advanced low-carbon energy and transportation systems and a strong commitment to environmental sustainability. Cities like these, it is said, will enjoy an economic and political advantage in the years ahead as they will be better positioned to attract investors, entrepreneurs, and creative types who identify with technological innovation and a green agenda. "There's a compelling moral imperative but also a fantastic economic case to be a green city," said Andrea Reimer, deputy mayor of Vancouver, at an April 2015 conference of local governments.

With this in mind, cities like Vancouver are competing with each other for the claim to be the "greenest." That city, for example, has pledged to obtain 100% of its heating, cooling, and electrical power from renewables by 2030 or 2035 and 100% of its transportation requirements by the middle of the century. Other big cities are now rushing to join the list of future "100% green" title-holders. When campaigning for mayor of London last fall, Sadiq Khan promised that, if elected, he would strive to make that city 100% carbon-free by 2050. "Yes to 100% London," he declared. "If it's good enough for Sydney and Copenhagen and New York, why not London?" (Khan won his campaign to be mayor in May 2016.)

On an even larger scale of endeavor is the emerging competition to be anointed one of the "green energy superpowers" of the future – a goal often embraced by Hillary Clinton during her 2016 presidential campaign. There is, of course, no shared understanding of what this concept might entail, but there is no doubt that many world leaders hope that their country will gain increased economic clout as a result of their early mastery of non-carbon energy technologies. The Obama administration, for example, provided loans and other assistance for

the development of advanced solar and battery-storage industries. Germany, as part of its *Energiewende*, or energy transition, has placed a high premium on the installation of solar panels and wind turbines – investing it, for a time, with claim to the world's largest installed solar capacity. But China is now soaring ahead, having recently overtaken Germany as the number one solar-power generator. Under its 13th Five-Year Plan, moreover, China plans to triple its solar capacity between now and 2020, adding 15 to 20 gigawatts of solar capacity every year over this period; similar advances are also mandated in the installation of wind turbines.

Those, like Hillary Clinton, who advocate for success in the race to become a green energy superpower typically argue that the transition from a carbon-based economy to one powered by alternative forms of energy will unleash a tsunami of innovation and investment, creating new wealth and jobs. But those who retain a stake in the carbon economy and fear the disruptive effects of an energy transition claim the opposite, saying the abandonment of fossil fuels will squander the nation's existing economic and employment advantages. This was a major component of Donald Trump's successful presidential campaign, and no doubt is reflected in the arguments of oil, gas, and coal producers in China, Russia, and Europe. Trump has pledged to rescind many of the measures adopted by the Obama administration to curb fossil fuel use, and to disregard the 2015 Paris Agreement on climate change. How successful he will prove in fulfilling these promises remains to be seen, but for now the United States has abandoned the race for green energy supremacy.

Will Trump's victory in the 2016 election deter other leaders from pursuing early success in this race, or will they see it as an opportunity to gain added advantage? Alas, it is too early to tell. At present, it seems obvious that power is slowly slipping away from the once dominant oil-producing countries, but it is not yet apparent that a parallel shift has occurred in the direction of prominent wind and solar-generating countries. It may be that more time will be needed to detect such a trend, or that, in an era of energy abundance, no particular geopolitical advantage accrues to the pioneers of renewable energy, as the necessary technology is becoming widely available and the wind and sun are available to all.

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Extinction: What it Means to Us*

Martin Rees**

It's a privilege to speak here today. But I do this with diffidence. That's because I'm a physicist - trying to understand only the inanimate world. Much of this still baffles us. But it should be an easy task, compared to the complexities of living things and their ecologies. It's biologists, ecologists and social scientists who face the most daunting intellectual challenges. Those are the disciplines represented at this meeting.

You may think that, as an astronomer, I worry about asteroid impacts. I do, but not very much. It was such an event 65 million years ago that many think did in the dinosaurs. But the probability of such a catastrophe is one in 100, 000 each century - no bigger now than it was in the remote geological past.

The effects that should worry us more are catastrophes induced by humans – whose probability is now far higher – and is rising fast.

The Earth has existed for 45 million centuries, but this is the first when one species, ours, is so empowered that it can determine the planet's future – the first when technology could enable us all to live in fulfillment. Or – to take a darker view – the century where our follies could foreclose the immense potential for further evolution. We're deep in the anthropocene.

The choices and decisions we make today will resonate at least into the 22nd century – and if we get them wrong, we'll bequeath future generations a bleak future. We surely need to look ahead – and horizon scan - further than most politicians and planners do.

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* Lecture given at the Joint PAS/PASS Working Group on Biological Extinction, Casina Pio IV, 27 February - 1 March 2017; Pontifical Academy of Sciences, Vatican City. Reproduced with permission from the author.

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In particular, if our despoliation of nature causes mass extinctions — by neglect, by error, or by malign intention, then, to quote E O Wilson, "it's the action that future generations will least forgive us for".

Our focus at this workshop will be to address the threats that stem from humanity's ever-heavier collective 'footprint' on the planet – which is depleting resources, impoverishing ecologies, changing the climate. And also, we should address the threats stemming from misuse of biotech or other powerful technology.

Even with a cloudy crystal ball there are two things we can predict decades ahead - The world will be more crowded. And it will have a changing climate.

A Word About These Two Trends

Fifty years ago, world population was about 3 billion. It's now 7.3 billion. But the growth is slowing. Indeed, the number of births per year, worldwide, has levelled off. Nonetheless world population is forecast to rise to around 9 billion by 2050. That's partly because most people in the developing world are young. They are yet to have children, and they will live longer. The age histogram in the developing world is becoming more like it is in Europe.

Experts predict continuing urbanization – 70 percent of people in cities by 2050. Even by 2030 Lagos, San Paulo and Delhi will have populations above 30 million. To prevent megacities becoming turbulent dystopias will surely be a major challenge to governance. As it will be to ensure that rural populations aren't left behind.

Population growth seems currently under-discussed. That may be partly because it's deemed by some a taboo subject – tainted by association with eugenics in the 1920s and 30s, with Indian policies under Indira Gandhi, and more recently with China's hardline one-child policy. And because forecasts of mass starvation have proved premature. Up till now, food production has m kept pace – famines stem from wars or maldistribution, not overall shortage.

Can 9 billion people be fed? We'll be hearing from experts at this workshop. But my layman's impression is that the answer's yes. Improved agriculture – low-till, water-conserving, and perhaps involving GM crops – together with better engineering to reduce waste, improve irrigation, and so forth – could sustainably feed that number by mid-century. The buzz-phrase is 'sustainable intensification'.

But there will need to be lifestyle changes. The world couldn't sustain even its present population if everyone lived like Americans do today – each using as much energy and eating as much beef.

But none of us need live as profligately as that. Indeed, all can, by 2050, have a good quality of life — provided that technology is developed appropriately, and deployed wisely. That should be our message – in Gandhi's famous mantra – Enough for everyone's need but not for everyone's greed.

Population trends beyond 2050 are harder to predict. They will depend on what people as

yet unborn decide about the number and spacing of their children. John Bongaarts and others will be discussing this later.

As we'll hear, if families in Africa remain large, then according to the UN that continent's population could double again by 2100, to 4 billion, thereby raising the global population to 11 billion. Nigeria alone would by then have as big a population as Europe and North America combined, and almost half of all the world's children would be in Africa.

Optimists remind us that each extra mouth brings also two hands and a brain. Nonetheless the higher the population becomes, the greater will be all pressures on resources, especially if the developing world narrows its gap with the developed world in its per capita consumption. And the harder it will be for Africa to escape the 'poverty trap'.

And, as well as rising population, there's a second firm prediction we can make – the world later this century will be warmer.

Climate change will hit hardest those who have contributed the least to its cause. Heat stress will most hurt those without air conditioning, crop failure will most affect those who already struggle to afford food, extreme weather events will most endanger those whose homes are fragile.

Unlike population trends, climate policies certainly aren't under-discussed, even though they are under-acted-upon.

It's still unclear just how fast the climate will change – how much the climatic effects of rising CO_2 are amplified by associated changes in water vapour and clouds.

But despite the uncertainties, most would agree that under 'business as usual' scenarios we can't rule out, later in the century, really catastrophic warming, and tipping pints triggering long-term trends like the melting of Greenland's icecap.

But even those who accept this assertion have diverse views on the policy response. These stem from differences in economics and ethics – in particular, in how much obligation we should feel towards future generations.

Economists who apply 'commercial' discounting (as, for instance, those in Bjorn Lomberg's Copenhagen Consensus do) are in effect writing off what happens beyond 2050 – so unsurprisingly they downplay the priority of addressing climate change in comparison with shorter-term efforts to help the world's poor.

But if you care about those who'll live into the 22st century and beyond, then, as economists like Stern and Weizman argue, you deem it worth paying an insurance premium now, to protect those generations against the worst-case scenarios.

So, even those who agree that there's a significant risk of climate catastrophe a century hence, will differ in how urgently they advocate action today. Their assessment will depend on expectations of future growth, and optimism about technological fixes. But, above all, it depends on an ethical issue – in optimizing people's life-chances, should we discriminate on grounds of date of birth?

[Consider this analogy. Suppose astronomers had tracked an asteroid, and calculated that it would hit the Earth in 2080, 65 years from now – not with certainty, but with (say) 10 percent probability. Would we relax, saying that it's a problem that can be set on one side for 50 years – people will then be richer, and it may turn out then that it's going to miss the Earth anyway? I don't think we would. There would surely be a consensus that we should start straight away and do our damnedest to find ways to deflect it, or mitigate its effects.]

A Word Now About Other Threats To The Environment That Come From New Technologies

Here we can't make firm forecasts decades ahead – smartphones, for instance, would have seemed magic only 20 years ago. So we can't conceived what advances might emerge by 2050.

Technology should be our friend. Without applying new science, the world can't provide food, and sustainable clean energy, for an expanding and more demanding population. These advances will offer inspirational challenges for young scientists and engineers.

But we need wisely-directed technology. Indeed, many of are anxious that some, especially biotech and robotics, are advancing so fast that we may not properly cope with them – and that we'll have a bumpy ride through this century. And there are portents.

The new CRISPR – cas9 gene-editing technique is hugely promising for eliminating harmful genes in humans. And 'gene drive' programmers are being promoted as a method wiping out species – mosquitos that carry diseases, even parasitic imported species like grey squirrels in Britain. But surely caution is in order here. There's a risk of disturbing ecological balances.

These technologies will need regulation, on prudential and ethical grounds.

Back in the early days of recombinant DNA research, a group of biologists met in Asilomar, California, and agreed guidelines on what experiments should and shouldn't be done. This seemingly encouraging precedent, has triggered several meetings to discuss the much more powerful recent developments in the same spirit.

But today the research community is far more broadly international, and more influenced by commercial pressures. What I find scary is that biotech involves small-scale dual use equipment. Indeed, biohacking is burgeoning even as a hobby and competitive game. I'd worry that whatever regulations are imposed can't be enforced worldwide, any more than the drug laws can – or the tax laws. Whatever can be done will be done by someone, somewhere. Regulating the huge facilities in the nuclear arena is a doddle in comparison.

Let's Recall What's Meant By Sustainable Development

The Brundtland Commission in 1987 introduced this phrase. It was defined as: "development that meets the needs of the present – especially the poor – without compromising the ability of future generations to meet their own needs."

There seems no scientific impediment to achieving a sustainable and secure world, where all enjoy a lifestyle better than those in the 'west' do today. We can be technological optimists.

But the intractable politics and sociology – the gap between potentialities and what actually happens – engenders pessimism. Politicians look to their own voters – and the next election. We downplay what's happening even now in far-away countries. And we discount too heavily the problems we'll leave for new generations.

Our responsibility – to our children, to the poorest, and to our stewardship of life's diversity – surely demands that we don't leave a depleted and hazardous world.

Here the great religious faiths can be our allies. The Catholic Church, for instance, transcends normal political constraints – there's no gainsaying its global reach, nor its durability and long-term vision, nor its focus on the world's poor. And that's why the Holy Father's Encyclical on climate and environment was so important. It had huge resonance and smoothed the path towards a consensus at the Paris climate conference in December 2015

Partha Dasgupta, along with the climate scientist Ram Ramanathan (who sadly can't be at this workshop) achieved great leverage by laying the scientific groundwork through the Study Week on climate and environment.

So, in summary, the pressures of rising populations, climate change, and the risks of misusing powerful technologies will aggravate the type of devastation that this workshop is about – loss of biodiversity.

But let's remind ourself why this matters. We're clearly harmed if fish stocks dwindle to extinction. There are plants in the rain forest whose genes may be useful to us. But there's a spiritual value too. To quote E. O. Wilson again 'At the heart of the environmentalist world view is the conviction that human physical and spiritual health depends on the planet Earth' . Natural ecosystems – forests, coral reefs, marine blue waters – maintain the world as we would wish it to be maintained. Our body and our mind evolved to live in this particular planetary environment and no other.'

But even this is too anthropocentric a focus – those who call themselves 'environmentalists' would proclaim that biodiversity, the intricate variety and beauty of the natural world, has intrinsic value over and above its benefit to us humans. And of course, the Encyclical affirmed that humans had a duty of care towards the rest of God's creation.

We all surely want to 'sign up' to this goal. But there's a big problem in achieving it – basically, because our secular institutions – despite their global range – don't plan long-term enough.

Those who built St Peters Basilica and Europe's great cathedrals thought the world might only last another thousand years – and they knew of nothing beyond Europe. But despite these constricted horizons, in both time and space – despite the deprivation and harshness of their lives – despite their primitive technology and meagre resources – they built huge and glorious buildings they never lived to see finished – and that uplift our spirits centuries later.

What a contrast to so much of our discourse today! Unlike our forebears, we know a great

deal about our world – and indeed about what lies beyond. Technologies that our ancestors couldn't have conceived enrich our lives and our understanding. Many phenomena still make us fearful, but the advance of science spares us from irrational dread. Unlike our forebears we know that we are stewards of a precious 'pale blue dot' in a vast cosmos – a planet with a future measured in billions of years– whose fate depends on humanity's collective actions this century. So, it's shameful that our horizon is shorter than theirs.

Spaceship Earth is hurtling through the void. Its passengers are anxious and fractious. Their life-support system is vulnerable to disruption and breakdowns. There's too little horizon-scanning to minimize long-term risks.

The stakes are high. And the threats are real. It's a wise maxim that 'the unfamiliar isn't the same as the improbable'.

And I give the last word to a secular sage – the biologist Peter Medawar:

"The bells that toll for mankind are ..... like the bells of Alpine cattle. They are attached to our own necks, and must be our fault if they do not make a yuneful and melodious sound."

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Homage to Eneas Salati: The Quest for Amazon Sustainability

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In the 1970s Eneas Salati shattered the long dominant dogma that vegetation is simply the consequence of climate and has no influence on it whatsoever. By examining the isotope ratio of oxygen in rainwater from the Atlantic to the Peruvian border he established unequivocally that half the rainfall of the Amazon basin is internally generated (Salati *et al*., 1979)[1]. Basically, water that falls as rain is largely returned to the westward moving airmass through evaporation off the complex surfaces of the forest and through evapotranspiration. Accordingly, the hydrological cycle recycles water five or six times until the moisture laden air rises up the slopes of the Andes, cools and precipitates out to produce the 20% of the world's river water that is the Amazon river system.

From that moment it was clear that the cycle is essential for maintaining the Amazon rain forest and raised the question of how much deforestation would cause the cycle to unravel and flip the Amazon forest into a savannah state. Modeling was finally applied to this question and suggested that the tipping point was in the range of 30-40% and that the eastern and southern

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[1]Salati, E., A. Dall 'Ollio, E. Matsui, J. R. Gat. (1979) Recycling of Water in the Amazon, Brazil: an isotopic study. Water Resour. Res. 15, 1250–1258.

Amazon was more vulnerable to Amazon dieback[2]. That suggested the tipping point was rather distant.

Subsequently the human footprint globally led to the recognition of the Anthropocene and it became increasingly clear that a sustainable planet depended in part on a stable Amazon. In the same systems sense that led to Salati's amazing contribution, we explore how to achieve a sustainable Amazon from the local to the global scale.

With time, however, it has become clear that there are additional factors pressing on the Amazon and its hydrological cycle. One is the extensive use of fire as highways and sideroads have penetrated the Amazon. The other is climate change. Lovejoy and Nobre (2018)[3] believe that the synergy between those factors and deforestation moves the tipping point to the vicinity of 20% deforestation quite close to the current extent.

Obviously, it makes no sense to discover the tipping point by actually tipping it, and the unprecedented droughts of 2005, 2010 and 2015/16 – which are expressed all the way to the far western Amazon suggest that: 1) they are early flickers of possible state change and; 2) the tipping point is close to hand. It also means that climate change must be rigorously addressed and limited to no more than 1.5 degrees Celsius (Lovejoy and Hannah, 2019)[4]. Indeed, the sustainability of the Amazon and the global climate are mutually dependent because of the immense amount of carbon in the great forests and other ecosystems of the world.

It is also possible and quite sensible to build back a margin of safety by proactive reforestation, some of which could help fulfill Brazil's commitment (Independent Nationally Determined Commitment = INDC) under the 2015 Paris climate agreement.

All of this also means that managing the Amazon sustainably is central not only to the future of the Amazon and global climate, but also to those parts of South America to its south which benefit substantially from moisture deflected southward as a consequence of the encounter of westward moving air masses with the Andes. To some extent Brazil's aspirations as a global agricultural power depend on maintaining the integrity of the Amazon hydrological cycle.

Fundamental to that must be a new vision for a sustainable Amazon: one that integrates human aspirations into – using von Humboldt's term -- a robust functioning Hylea. That will require transforming conventional forms of development by revising infrastructure ambitions from relatively conventional ones to ones that are sustainable and respect the natural infrastructure as well as the social infrastructure. From the outset with the construction of the Belem-Brasilia highway there was spontaneous colonization to the surprise of most. There clearly

[2]Sampaio, G,,Nobre C. A., Costa M. H., Satyamurty P., Soares-Filho B. S., Cardoso M., (2007). Regional climate change over eastern Amazonia caused by pasture and soybean cropland expansion. Geophys. Res. Lett. 34, L17709.
[3]Lovejoy, Thomas E.; Nobre, Carlos (2018). Amazon Tipping Point. Science Advances, 21 Feb 2018: Vol. 4, no. 2, DOI: 10.1126/sciadv.aat2340
[4]Lovejoy, Thomas E.; Hannah, Lee (2019). Biodiversity and Climate Change: Transforming the Biosphere. Yale University Press.

needs to be a radical redesign of transportation infrastructure pivoting away from standard *rodovias* (highways) to other options.

Central to it should be a reversion to the historic transportation system namely the rivers. Obviously, some work will be necessary to make the rivers navigable in certain places but this need not consist of massive engineering works that modify the flow drastically. Where rapids are an issue it is possible to create ways around or through them without drastically affecting -- and in some instances completely destroying -- the natural systems important for fish so central to the local diet. It is quite telling that Manaus is a very successful city while still almost entirely dependent on river and air transport. Water transport is universally much more economical than any other kind.

Where the purpose is transport of goods then a rail system specifically for freight *not passengers* could supplement the always cheaper river transport. Great care will need to be taken to discourage spontaneous colonization along railways (as happened along the railway to Carajas) perhaps by making it elevated in key places.

Where highways already exist one way to curb spontaneous deforestation is to flank them with protected areas of various sorts (indigenous areas, conservation units sensu strictu, and various forms of sustainable development reserves such as the extractive reserves pioneered by Brazil after the assassination of Chico Mendes). This has been experimented with in southern Amazonas along the Tapajos with some success (although there are challenges which have more to do with inadequate budgets for enforcement than anything else).

The last 2-300 km of BR-319 from Porto Velho as it extends to the south bank of the Amazon has been problematical for years as it is very low lying and prone to flooding. There are regular calls for paving it which would only lead to more deforestation. If there is an inevitable and powerful argument to make it more functional then the best course would be to make it an elevated highway. Not only would it be more functional because it would be above the flood zones but also the maintenance would be considerably less.

Ironically maintenance is almost never included in decisions to build highways. In wet tropical areas maintenance for highways is very expensive. In contrast although construction of an elevated highway is more expensive than the conventional one, maintenance is considerably less. Full cost accounting including avoided environmental damage would argue strongly for elevated highways.

Lest the foregoing seem hopelessly dreamy there already is an example in the Atlantic Forest region of Brazil: the Imigrantes highway in Sao Paulo. The actual impact on the forest is literally 2 ½% of the conventional because only concrete pillars displace the forest. Maintenance costs are trivial in comparison because the road is entirely concrete.

There needs to be a drastic revision of the energy plans for the Amazon away from mega-dams to a modern vision that includes run of river. That would permit natural sediment flow (which will drastically shorten the effective life of ones which completely block a river). That

would also permit passage of migratory fish that swim the length of the river in their life cycle and are central in the Amazon diet.

While a lot of the motivation for the Amazon hydro projects is to provide energy beyond the Amazon, within the Amazon, especially in cities, solar energy is still largely nascent and could make a serious contribution while simultaneously reducing the need for other sources.

While solar could reduce some of the pressure for transmission lines it is unlikely to eliminate the need. There is a strong argument for elevated transmission lines in those cases as is already the case in the line that crosses the Amazon bringing power from Tucurui to Macapa and Manaus. Elevating them high above the forest actually eliminates the need for cleared rights of way. The latter are extremely expensive to maintain, are destructive of the forest, and provide access and opportunity for spontaneous colonization. Modern sensor systems can eliminate that expense because they can guide helicopters exactly to where a problem has occurred, so the repair can be done with minimal disturbance to the forest.

Relatively little attention is paid to role urban areas can play in contributing to a sustainable Amazon but with suitable creativity I believe sustainable cities which provide a reasonable quality of life are possible. Manaus is an interesting example not because of the economic free zone which of course helps but is not the key part of the story. Yes, as the economic product of the city grows the Amazonas deforestation rate declines because there is economic opportunity in the city; but almost without conscious planning the majority of the industry consists of assembly plants using materials not extracted from the forest.

Manaus is not a perfect example. There is some urban sprawl. More street trees would make it a cooler and reduce energy needs for cooling. There is some land grabbing and there needs to be serious consideration of the agricultural imprint. Nonetheless if approached seriously and comprehensively a sustainable Manaus could become a valuable example.

Amazon fisheries need serious management improvement. The challenge is complicated because the important catfish species use the length of the river system in the course of their life span and also because many important fish species depend on floodplain forest during the highwater months of the year as their major food source in the entire year. The latter make those species particularly suitable for aquaculture – a potential that has been developed commercially in a significant way by the state of Acre. There remains a serious management challenge not only of the floodplain forests as an important underpinning of a segment of the commercial fish but also of those species the life spans of which include multiple Amazon nations.

Extractive industries could be an important part of a sustainable Amazon. A pioneering example is the Camisea gas fields in Amazonian Peru where the exploration phase pioneered a new model – the Offshore-Inland model – conducted without building a single road. Now in production phase, the wells are connected by pipelines that are both buried and reforested above. There are elaborate sensor systems so if a problem occurs it can be easily pinpointed and then accessed by helicopter. This system has also been followed at Urucu and should become standard practice for fossil fuel exploration and extraction throughout the Amazon.

Other extractive industries require road access but there is no reason the roads cannot be closed afterwards to eliminate the access problem over the long term. In other cases, there needs to be a conscious plan to deal with the necessary workforce to minimize its impact and provide a sustainable trajectory after the resource has been extracted. An excellent example of this is the Juriti mine near Santarem.

Major drivers of deforestation are agricultural sectors like soy and cattle. Neither make sense as growth industries in an Amazon which needs 80+% forest cover to function as a system. At the moment there is a moratorium on soy expansion in the Amazon and there are efforts for more sustainable cattle production as well as supply chains that will not accept beef associated with deforestation. Agroforestry efforts add to tree cover and provide reasonable lifestyles but need to increase in scale. Oil palm could become a major driver of biodiversity loss by replacing forest.

Forestry is often included in the economic possibilities for the Amazon and there have been important efforts involving low impact logging and the Precious Woods sustainable forestry east of Manaus. By and large, however, it is fair to say that to date most of the efforts to practice sustainable forestry have not been very successful and that monitoring/regulation need considerable improvement. Too much of the history of forestry in the Amazon has been illegal logging and high grading of mahogany and the like. It is not easy to find truly sustainable Amazon wood.

One area of important potential economic activity that is surprisingly limited in its development to date is ecotourism. The number of quality ecotourism operations is really limited and there is no ecotourism training center so getting quality information from guides is unfortunately rare. There is tremendous growth opportunity here with the possibility of multiple destination trips which could include more city visits to institutions like the Museu Goeldi in Belem and INPA, MUSA (the Museum of the Amazon) and the Museu do Indio in Manaus. It is encouraging that Belem is developing an Aquarium (many of the great aquarium fish of the world like the neon tetra come from the Rio Negro and tributaries). By and large ecotourism seems better developed in western Amazonian countries like Peru and Ecuador, and a spurt of growth is likely in post-Farc Colombia.

Sportfishing is probably better developed as an industry but also has unexplored potential. The Peacock Bass may be the world's most prized freshwater sportfish.

Above all, the long-term sustainability of the Amazon and its amazing biodiversity requires a sustained investment in science in which the Amazon countries are major partners. The history of biological science is littered with examples of transformations of understanding of the life sciences that provide human benefit and economic opportunity. In a world striving for sustainability the life sciences have some of the greatest promise. Some of the Amazon countries have world class scientific institutions and scientists but they tend to be starved for funding. Modern science and information systems can unlock this potential. Eneas Salati as the first to understand the Amazon works as a system would certainly understand this potential, but would

be the first to acknowledge that many others have understood and will understand the potential of the world's greatest repository of biodiversity.

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