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"STRONG" AND "WEAK" GLOBAL ENVIRONMENTAL PHENOMENAS

Abstract Many global environmental issues being subject of ambitious international environmental politics could look very different in terms of scientific justification. This was revealed during interviews made by the author with some leading American environmental scientists. All interviewed American scientists granted minor confidence to three environmental issues – deforestation, desertification and biodiversity loss, while two issues – the ozone depletion and climate change – were deserved high degree of confidence. The striking difference in evaluation of the global concepts of environmental issues is discussed in the context of the classical epistemological problem of coexistence of "strong" and "weak" theories in modern science. The normative character of epistemology suggests that some ways of raising scientific credibility of the backward environmental concepts can be proposed. Better justification of these global environmental issues can help to move forward the environmental politics which have shown mere stagnation during the last years.

Key words: Global environmental issues, Precautionary principle, Demarcation, Scientific credibility, Epistemology, Environmental policy

INTRODUCTION

More than 200 multilateral environmental agreements (MEAs) now exist, forming a central part of the framework for global environmental governance. Most have appeared within the last 20 years. Today no one person or small group of specialists can master the body of knowledge and skills required to address global environmental problems comprehensively. Moreover, beyond the challenges of strictly scientific considerations are questions that rest squarely in the realm of public values and thus in the domain of political decision: our responsibility to future generations, even to the biosphere generally; the extent to which we trade future costs and benefits against present ones; aesthetic considerations; and opportunity costs associated with the allocation of resources to address environmental issues versus other issues as poverty, health or education.

With respect to strictly scientific issues the key question is: how can the public properly assess the credibility of a particular scientific concept? For example, in the face of disagreement within the scientific community, should politicians take actions against only modestly substantiated threats or should they wait for more conclusive and consolidated scientific consensus? In their turn could the scientists undertake targeted efforts to raise credibility of their concepts?

Many policy makers and environmentalists refer to the so called Precautionary Principle that sanctions preventative measures in condition of great uncertainty. But others want to test

credibility of particular claims first in order to avoid wasting resources to address poorly substantiated hypothetical dangers. This paper investigates reasons for such testing on the example of key global environmental issues.

The idea for this paper came to one of the authors[1] as he was preparing a series of lectures on global environmental issues. During preparation of the course the author observed that theories of the global environmental issues differ greatly with respect to their level of scientific confirmation. The arguments supporting climate change, for example, looked to the author much more solidly grounded than those supporting "desertification".

Subsequently, the author visited the US spending several months as a Fulbright fellow at New York University (NYU). There he met several prominent American environmental scientists from different academic institutions. With them, in a series of short interviews the author discussed their views as to the level of confirmation of key global environmental issues – climate change, depletion of the ozone layer, desertification, deforestation, biodiversity loss.

These discussions brought two surprises. The first was the absence of any substantial difference among the views of those interviewed. Despite differences in expertise and background, the researchers (among them, biologists, hydrologists, climatologists, philosophers) were in agreement that only few concepts of global environmental issues deserve a high degree of confidence. The second surprise came with realizing that their position is very close to the author's one which he then believed was too radical to be shared by so many experts.

HOW CONFIDENT WE ARE ABOUT GLOBAL ENVIRONMENTAL THREATS?

This section is based on discussions of global issues with professors from several American universities and on their assessment of the level of confirmation of claims made with regard to those issues. The interviews lasted no longer than 30–40 minutes and focused on the comparison of five issues – ozone depletion, climate change, desertification, deforestation and biodiversity loss – that are widely seen as global threats to sustainable development of humankind in this century. All have been on the political agenda for many years and command considerable commitment of resources on the part of the national governments. It is therefore important to be sure that these five issues are analyzed in terms of genuinely "strong theories."

Specifically, the following five claims were offered for the experts to comment and rank them as to level of substantiation:

Ozone depletion has been driven by human production of CFCs;

Global warming is anthropogenically driven process threatening major damage to humans and their environments;

Desertification is taking place on a global scale;

Deforestation is taking place on a global scale;

We have entered, or are entering, a period of mass extinction of species of considerable importance to human welfare.

The author's own ranging of the five issues in terms of their scientific credibility coincided with the order they are presented above. However, in the author's view, the space on which the claims are ranked is not evenly partitioned with respect to the five issues: there is a large break between ozone depletion and climate change, on the one hand, and the three remaining issues on the other. The American experts interviewed showed surprising consensus despite differences in backgrounds and expertise. In general the scheme drawn by the author

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was confirmed with single exception: the most experts place "desertification" issue on the one step down preferring to see "deforestation" on the third position. As the author the experts consider the two top issues as much more fully confirmed than all the others. The expert's comments concerning difference in credibility of the issues were valuable and interesting. Some news ideas emerged during the discussion. One was related to the criteria of "credibility" of an environmental concept. The author deliberately avoided to define strongly term of "credibility of concept" or "justification" during the discussion because one of the goals of the interviews was to ascertain whether diverse criteria come into play in evaluating concepts.

All the experts regard the "ozone depletion" concept as firmly established. However, it is important to note that for the most part the experts have no research experience with respect to the ozone problem. The only one to have such experience was cautious in his evaluation of the concept, stressing that some elements remain unclear. However, he also had no hesitation in placing this issue at the top of the list. Evidently, most of the experts see some confirmatory advantage in the existence of a clear mechanism that accounts for the phenomenon in question and in solid empirical verification of the process obtained, for example, during experimental airborne measurements of the stratospheric ozone over Antarctica in 1987. Thus two criteria emerge for the high ranking of ozone depletion: a theoretically clear mechanism of anthropogenic origin for the environmental issue and empirical confirmation of this causality.

All the experts ranked "climate change" second in terms of scientific confirmation. They stressed that theoretically the concept of human-induced change in the global climate is being well developed and looks plausible but empirical confirmation of the hypothesis about the causal link of observable warming and greenhouses emissions is less compelling because of the much more complex character of the phenomenon as compared with "the ozone depletion." The experts differed in relation to question how close the concept of climate change might be placed to that of "ozone depletion". Some regard the claims more or less equal in terms of substantiation while others find the evidence for anthropogenic climate change less persuasive. The first consider that existing models of climate change can be empirically tested by retrospective data or by observations of climate conditions in coming decade when the influence of solar activity can be controlled. Those who are less convinced point to the presence of noise in climate change data resulting from the multiplicity of factors capable of exercising influence (especially with respect to precipitation) and judge that changes in radiation change caused by increasing presence of greenhouses gases is too slight to be captured by direct observation. In view of these scientists, conclusions with respect to the anthropogenic character of climate change will rely on modeling efforts rather than observation. Despite this difference the scientists concurred in their "belief" in both ozone depletion and anthropogenic climate change. In relation to the three remaining environmental issues, such wording was never used.

The majority of the experts ranked deforestation third, well behind ozone depletion and climate change. Opinions of the experts varied very much concerning the weak elements of the concept. Some experts question empirical data on deforestation, regarding existent statistics on decrease of area of forests as unreliable and, certainly, exaggerated for tropical regions. Others regard deforestation as "simply fact." There was a decisive split among the experts (50:50) as to the very definition of "deforestation" as a global environmental issue. One group sees no problem in taking deforestation simply as the reduction of forested area globally or in some region of the world (say, South America or Central America). When invited to replace this conventional definition with a more "theoretical" one,

these experts declined. However, the second group rejected the conventional definition as excessive simplification and stressed the need to define deforestation with respect to the essential role of forests in biosphere stability. According to this group a decrease of forest area should be regarded as a global environmental issue only at the threshold where normal function of the biosphere (including global climate) is disturbed. Thus some scientists question the reality of deforestation grounds that empirical evidence indicating unprecedented rates of forest reduction is missing while others do so on the ground of oversimplified definition of the issue. The net result is that only very few experts grant even moderate confidence to the issue.

The experts place the "desertification" in the fourth position in terms of scientific credibility. However, in this case the fourth position says very little about negligible credibility granted to the concept of "desertification". Actually 100 percent of interviewed scientists definitely said the issue was non-existent. The wording "it's tricky thing" occurred frequently. Most importantly, the scientists pointed to the absence of any empirical evidence confirming a steadily unfolding "desertification" in the regions of the world. Secondly, they pointed to the lack of clarity in the use of the term desertification which varies in thrust across policy documents and publications (from mismanagement of farming in semi-arid zone to the advance of great deserts). If we regard desertification as a global change caused by anthropogenic factors, then we must recognize the absence of any plausible theoretical explanation as to how human activity might cause desertification (aridization) globally. The experts pointed out that precipitation variability is ruled by caprices of global atmospheric circulation and all great droughts began and ended abruptly due to the change of circulation. It is worth noting that the credibility of desertification is rejected on three parameters: empirical evidence, theoretical explanation and confusion in the term itself.

Finally, the experts (with one exception) grant no credibility to the concept of the "biodiversity loss" and rank this issue as the least tenable. Biodiversity loss issue can be broadly defined as unprecedented decline, caused by human activity, in number of extant species, in their genetic (population) diversity, and in the variety of ecosystems. Among the most skeptically minded experts were biologists who stressed the extremely complex character of "biodiversity". They pointed out that as many classical theoretical problems of biology (for example, the problem of species borders) are not resolved, they cannot represent publicly the "biodiversity loss" issue with any confidence. The total number of species of any part of the world is still unknown (presumably 90%). The experts definitely rejected the hypothesis of observable mass extinction at present. All experts stressed the difficulty of gathering empirical evidence supporting the notion of loss of biodiversity. There are two ways to measure the rate of extinction of species. One is based on direct evidence of loss of known species. In this case the rate is not high when compared with the historical average. The second is based on an assumed correlation between the fraction of habitat destroyed by human activity and the fraction of species lost therein. When applied to the total number of species presumably resident in the area before human invasion, this correlation yields a fantastically high rate of loss of species. The method is obviously speculative because the total number of existing species is still poorly approximated and the correlation between number of species and areas of their habitats is not established. Perhaps, it would be more reasonable to suggest that it is not the diversity of species generally but the diversity within single species that is more affected by habitat loss. In summary the experts see no reliable way to obtain empirical evidence supporting mass extinction, find only weak theoretical substantiation (How could it happen?) and excessively broad definitions (from genes to ecosystems). Some experts think that the issue of loss of species should be addressed on the basis of cultural and

quality-of-life considerations rather than from that of mass extinction.

CRITERIA OF SCIENTIFIC CREDIBILITY

There are still be few works suggesting criteria of credibility of environmental concepts. One of most original comes from Weiss [2006] who proposes a complementary twelve-point scale of certainty, based on a hierarchy of standards of proof used in various branches of US law in specific legal situations, and have assigned arbitrary but plausible quantitative probabilities (borrowed from so-called Bayesian statistics) to each point of the scale. It shows that even at low levels of certainty (10–20% in Bayesian terms) adoption of some serious actions may be called for (in legal practice the action can be as serious as "stop and frisk for weapons"). At very low levels of certainty (less than 1%) no actions are sanctioned ("does not justify stop and frisk"). The scale captures the thrust of the Precautionary Principal: action may be taken in the absence of near certainty to avert harm. According to Weiss [2006] this scale "could be the basis for a clear and understandable expression of uncertainty for policy makers".[2]

The proposed scheme, however, provides no basis for assigning particular events to particular points of the scale. Should biodiversity loss, for example, be assigned "reasonable suspicion" (1–10%), "reasonable belief" (20–33%) or "substantial and credible evidence" (67–80%)? Evidently, a special set of criteria is required to construct a "credibility index." In the absence of agreed instructions, assignments are arbitrary.

Popular view regards a "credible" scientific theory as having been confirmed by multiple observations. An account which empirical observation contradicts lacks credibility. Weiss, apparently, uses the term in this sense. An expert is expected to decide whether an outcome enjoys 10% or 80% confidence, given the strength of empirical evidence favoring it. However, this is a simplification of science. As seen from summary of the interviews, scientists use a variety of criteria to establish the credibility of any claim or account. The anthropogenic hypothesis of ozone depletion is credible because it offers a transparent and coherent account of the observation and because it has been confirmed by the correlation of ozone loss and the presence of anthropogenic substances in the stratosphere. From the point of view of scientists climate change, and its possible anthropogenic origin, is difficult to confirm by empirical observation because the climate is a complex system with many feedback loops and considerable noise. However, the concept earns a high degree of confidence due to the existence of a clear and theoretically plausible mechanism in the form of greenhouse gas emissions which drives the process. An account of low credibility lacks just such a mechanism to explain the observation and the empirical evidence to support it. Moreover, an account loses in credibility when subject to multiple and ambiguous readings (desertification) or excessively broad definition of terms (biodiversity loss). Such flaws not only prevent empirical testing but self-evidently undermine theoretical formulation.

LINKING EPISTEMOLOGY AND ENVIRONMENTAL STUDIES

Perhaps, evaluation of the credibility of concepts should be dealt within epistemology which has practiced a complex (holistic) approach to science. We may regard science as an enterprise that while constructing theories and seeking their empirical confirmation is shaped by social and political values and personal limitations. This is a classical problem of critical rationalism, namely the demarcation

[2] Other authors as well have seen the analogy between the precautionary principle and legal process. Peter Saunders said: "Moreover, like the legal principle, the precautionary principle does not demand absolute proof. A jury is not supposed to convict only on the balance of probabilities – the standard used in civil actions – but it does not need absolute proof that the defendant is guilty. It must only be convinced "beyond reasonable doubt" (Saunders 2000).

between strong and weak theory (or pseudo-theory) addressed by Karl Popper (in 1934), who advanced the notion of falsification as a criterion. Among those who followed Popper – Thomas S. Kuhn, Imre Lakatos, and Paul R. Thagard, each held his own position on the ways to demarcate "sound" science.

The views of the scientists in the interviews concerning assessment of credibility of global issues was improvisation on their part but their improvisations show the complex character of the problem which corresponds to classical epistemology. However, the experts did not explicitly raise any epistemological questions and, when directly asked about the relevance of Popper's notion or those of the post-positivists, they were skeptical. This is remarkable given that most of the scientists in my sample hold to the distinction between weak and strong theories. A few experts (with philosophical backgrounds) said that if they were to decide to write on the subject they would certainly take an epistemological approach. Philosophers of science and environmentalists share rather little. Maureen Christie [2000], a philosopher of science who analyzes the history of our understanding of ozone depletion with reference to Popper, is unusual in her concern with epistemological aspects of environmental studies.

However, there is benefit in referring our interviews to classical epistemology. The striking results of the interviews might be dismissed by reference to the subjectivity of the exercise. The selection of interviewees was anecdotal (although based on their professional records). The scientists are all specialists in particular areas and cannot know the ins and outs of other areas. Their opinions might be ill-founded. Nor were they in full agreement on some issues, as when in the evaluation of deforestation some questioned its empirical validation while others stressed only improper definition of the issue. Their responses do not conform to the dominant views found in official international reports.[3]

The experts proposed quite different criteria which do not lend themselves to easy systematization in a single scale such as that of Weiss. However, relocating this exercise in philosophical context reveals striking differences in credibility and confirms the epistemological opposition of "weak" and "strong" theories in modern science.

It is also important to recall that epistemology is a normative discipline and its final aim is to improve science. We think it wrong to reject any concept as totally unscientific. Weak concepts can be reformulated and improved to allow testing and assessment with respect to other demarcation criteria. Proponents of particular concepts must be willing to rework them so that they comply with the demands of scientific discourse. Recall that Popper [1978] changed his mind about the testability and logical status of the Darwinian theory of natural selection. As he wrote: "I am glad to have an opportunity to make a recantation. ... The theory of natural selection *may be so formulated* that it is far from tautological". By "may be so formulated" Popper believed that a theory that looked suspect to him for many years could be reformulated to allow empirical testing.

TO RAISE CREDIBILITY OF ENVIRONMENTAL CONCEPTS

MORE COMPETITION, MORE CREDIBILITY

The main indicator of a "strong theory" is that it faces acute competition from alternative theorizing. The alternative theory appears in the wake of the dominant theory as a reaction to its difficulties. The dominant theory has already made great strides

[3] For example, a survey of emerging issues carried out among scientists for *GEO 2000* listed the top three environmental threats (from the total number 36) as climate change (51%), scarcity of fresh water resources (29%), and deforestation/desertification (28%) (Global Environment Outlook 1999). However, according to the experts' evaluation the "desertification" as well "deforestation" issues are not deserved significant level of scientific confidence yet.

accompanied by extensive search for facts that confirm the theory but in this way new facts that challenge the dominant theory have inevitably accumulated. Although the dominant theory could settle the situation via the elaboration of additional hypotheses, not all scientists are happy and eventually propose a new theory to cover old (confirming) and new (discrepant) facts. The alternative theory plays the important role of external critic whose aim is to falsify the dominant theory as Popper wanted "real science" to do.

With environmental studies competition between concepts typically arises between two accounts of origin – anthropogenic and natural. The dominant concept of climate change suggests that observable and predicted global warming results from the anthropogenic increase of greenhouse gases in the atmosphere. The alternative concept argues that global warming is taking place due to the astronomically driven transition of the Earth from past-glacial to mid-glacial eras. Existence of two competing camps concerning climate change needs no demonstration as we find estimates about fraction of scientists from each camp in current literature. The dominant theory of ozone depletion asserts that the anthropogenic substance CFCs being accumulated in the stratosphere are the principal cause of formation of "the ozone hole". An alternative theory suggests that "the ozone hole" could be the result of upwelling of ozone poor troposphere air because of a climate shift. Yet another account pointed to an increase in solar activity between 1976 and 1984. Christie [2000] investigates the collision of alternatives in detail.

In contrast, "the weak theory" is too thinly formulated to give birth anomalies. The weak theory changes little over the years and reiterates the same formulations and arguments. Despite stagnation, as the theory seems self-evident, it can have many adherents. Difference in views among its proponents may exist, but rather than compete, they simply coexist. Little work is done to settle these differences. It is close to Kuhn's characterization of pre-paradigmatic science where the difference of views of scientists often concerns basic definitions. At least three concepts of global environmental issues – desertification, deforestation and loss of biodiversity – correspond to this stage of the development.

Remarkable differences in the meaning of the term "desertification" provide a useful illustration. The French botanist Aubréville, who first proposed the term in 1949, took desertification to be a negative change in semi-humid (but not semi-arid!) regions manifesting a decline of soil fertility, erosion, and thinning vegetation [Dregne 1986]. Today this meaning has all but been abandoned in favor of usage with strong geographic localization to semi-arid areas. "Desertification" has also been understood as the spreading of major world deserts into neighboring areas[4]. Many experts speak of the expansion of deserts and cite figures for the rate of this expansion. However, other experts consider desertification to be a desert-like transformation of lands in semi-arid zones caused by mismanagement, namely overgrazing and excessive tilling. This understanding prevails in modern conventions on desertification. According to more sophisticated concepts, human activity in semi-arid zone changes local climate for drier ones as a result of weaker convection in the atmosphere that causes aridization of the area [Charney et al. 1977]. These meanings coexist rather than compete. Little is done to clarify this difference and no competing arguments in favor of any meaning are found in the current literature. To move forward with clarification of the concept of "desertification" different meanings of the term must be settled first.

[4] "...the idea that the Sahara was a vast sand field advancing in great waves like the incoming tide of a sea became attractive to numerous writers on desertification that it now represents a common view on the subject" (Cloudsley-Thompson 1974). There apparently is something fascinating about the idea of an expanding desert threatening mankind. Encroachment of moving sand dunes on desert oases and transportation routes is an aspect of desertification that is of small areal extent but is locally important and highly visible" (Dregne 1986).

MORE THEORY, MORE CREDIBILITY

It is also essential for environmental concepts to offer a distinction between mechanisms (*what a phenomenon is it by itself?*) and evaluation of potential dangers (*what danger is posed to humankind?*). A clear distinction indicates conceptual maturity. Concepts of climate change and depletion of the ozone layer clearly distinguish these two aspects. Theory ascribes atmospheric warming to increasing concentrations of greenhouse gases (CO_2, most importantly). Other research models the possible impact (danger) of a much warmer climate on agricultural productivity, frequency of extreme weather events, health, disease, etc. Stratospheric chemistry investigates depletion of the ozone layer in relation to reactions between ozone and anthropogenic substances while impact evaluations explore the potential dangers of increasing radiation for human health and ecosystems.

For such global issues as deforestation, biodiversity loss, and desertification, the distinction between mechanism and impact receives scant attention. Factually the conceptual treatment of these issues is limited to declarations about their negative impact which figures as self-evident. Deforestation is bad because it results decline of forests. Such tautologies are a trap for environmental studies. Some of the scientists in our panel suggested that notion deforestation should not be limited to a narrow focus on the decline of forested area. There is no theoretical issue in the decline of forested area. Rather the notion should extend to the global function (service) of forests in the biosphere including global climate (some experts particularly stress the climate aspect). Such an extension would be the basis for a new definition of deforestation.

It is evident that global biodiversity loss is a serious concern for Earth and its population. To take this issue seriously is to move beyond this observation to search out the mechanisms that drive it. Some observers consider that the current situation is comparable to the largest geological catastrophes of the past. Surprisingly, no theory of this assumed mass extinction has been elaborated. Rather, it has been suggested in the literature of the last 30 years that current large-scale extinction of species results from the reduction of natural habitats. All estimates about current rates of extinction are based on this assumption with different variations. For example, O.E. Wilson, assumes that loss of 90% in the area of natural habitat is accompanied by a 50% loss in species [Habitat Loss and Biodiversity 2002]. Similarly WWF biologist T. Lovejoy projected loss of biodiversity at one-third as a result of suggested loss of 50% of tropical forests by 2000 [Lovejoy 1980]. The loss of species globally (based on such assumptions) varies between 33% and 50% which is comparable to the extinction rates associated with largest catastrophes in the geological history of the planet. None of the experts in the interviews took it seriously. The total number of species on the Earth and in any particular region (including the rainforests) is unknown.

At the same time the situation with "desertification" looks more advanced due to attempts to propose a theory of mechanism (and it gives the author ground to place this issue at higher position than "deforestation" in his ranging of the issues). Charney has suggested that the presence of more dust from degraded lands might decrease atmospheric convection with the result of less rain and diminished cloud formation in semi-arid areas [Charney et al. 1977]. This conjecture stimulated research into the origin of dust in areas neighboring the Sahara desert but remained unconfirmed [N'Tchayi et al. 1997]. This demonstrates nonetheless that Charney's theory can be empirically tested (and thus falsified) by observation. However, these attempts are scarce and are not at the focus of research devoted to desertification. More common are studies in which experts discuss potential danger for local populations and countries at risk. Differences in the meaning of the basic term mentioned above are typical.

Theoretical development of global environmental concepts must be priority for their proponents.

CONCLUDING REMARKS

With the exception of ozone depletion, which rose to prominence in 1987, the global issues considered in this paper came to world attention at Rio World Summit at 1992. At that summit only conventions on climate change and biodiversity loss were adopted. Two others – deforestation and desertification – were framed in convention format only significantly later. In the 17 years since the Forum, the state of environmental policy with respect to the five issues has changed remarkably. In terms of effective policy, the ozone depletion issue has been a resounding success. Forward movement on climate change ranks second. After some suspension associated with the slowing of environmental policy in the USA, the convention and associated Protocol promise to move much faster in the coming years. There is little doubt that results will be achieved soon.

Far more problematic is the development of policies in relation to the other three issues. Desertification was the subject for international policy many years before the Rio Conference. The problem was first put at the policy agenda at 1977 at a special UN conference on desertification. However, at the Rio Forum negotiations on the convention failed. One of the reasons was uncertainty as to the definition of the subject. Four years later (1996) the convention came into force due to enormous efforts at mediation by the UN. However by 2007 less than one-third of all countries had presented a plan of action while financing for convention efforts was on hold.

Although deforestation has been subject of international policy considerations since the end of 1970s, this issue is bogged down to an even greater extent as no convention has yet been adopted. The problem is subject to different interpretations. At the Rio Conference, some countries insisted that forests are a global ecological resource a view not shared by countries which export timber. A special UN Forest Forum worked from 2000–2005 to establish shared understanding for a convention but failed.

The Biodiversity convention somehow gained more support from parties at Rio in 1992 but progress has been modest. As of 2008, 189 countries had ratified the convention, but only a fraction of these have developed a Biodiversity Action Plan (BAP) which should provide a full inventory of individual species, with emphasis upon the population distribution and conservation status. The most common characterization of BAP is that it is a "daunting task" as only an estimated ten percent of the world's species are believed to have been described, mostly plants and lower animals. Moreover, such plans come with heavy associated costs.

Difficulties in the development of the environmental policies can be explained in part by the existence of different interests of the parties involved. Still, the role of scientific status of the issues under scrutiny should be not overlooked. The struggle to achieve agreement on international environmental issues is waged on highly competitive ground where political and economic interests are frequently deeply conflicted. In this struggle only claims which enjoy high credibility will overcome the subrational self-interest of all parties.

ACKNOWLEDGEMENTS

The research was done in the frame of Fulbright fellowship granted to Nikolay Dronin and the author appreciates R. Wagner School of Public Management, New York University for warmly hosting, and Professor Dennis Smith for being encouraging academic advisor. We also thank Dr. Renee Richer from Weill Cornell Medical College in Qatar, for her kind regarding and commenting the paper.

We thank as well all the panelists: Professor Stephen Pacala, Director of Princeton

Environmental Institute, Professor Michael Oppenheimer, Director of the Program in Science, Technology and Environmental Policy at the Woodrow Wilson School, Princeton University, Professor Simon Levin, Director of Center for BioComplexity, Princeton University, Professor Dale Jamieson, Director of Environmental Studies at New York University, Dr. Tyler Volk, Associate Professor of Biology, New York University, Dr. David Holland, Director of the Center for Atmosphere Ocean Science, New York University, Dr. Andrew Robertson, Research Scientist, International Research Institute for Climate Prediction of the Earth Institute of Columbia University, Dr. Richard Seager, Senior Research Scientist, Lamont Doherty Earth Observatory of Columbia University, Dr. Michael Hill, Professor, Department of Earth System Science and Policy, University of North Dakota, Dr. Rebecca Romsdahl, Assistant Professor, Department of Earth Systems Science and Policy, University of North Dakota. ■

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