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THE CATASTROPHIC IRREVERSABILITY OF CLIMATIC ENGINEERING

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Abstract: *Different points of view on possible targeted climate regulation are commented with emphasis on the risk associated with the probable unpredictability of the outcome.*

КАТАСТРОФИЧНА НЕОБРАТИМОСТ ОТ ИЗКУСТВЕНИ ИЗМЕНЕНИЯ НА КЛИМАТА

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Резюме: *Коментирани са различни гледни точки за възможното целенасочено регулиране на климата, като се акцентира върху риска от вероятната непредсказуемост на резултата.*

There is no comparable consensus about what the idea of climate change actually means. If we are to use the idea constructively, we first need new ways of looking at the phenomenon and making sense of it. Not only is the physical climate changing, but the idea of climate change is now active across the full range of human endeavours. *Climate change has moved from being a predominantly physical phenomenon to being a social one*. Any confusion surrounding the term “Geo-engineering” could stall the debate on what may become a key component of the fight against climate change. A specific definition of geo-engineering as the “deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change” divides geo-engineering into two types: carbon dioxide removal (CDR) that acts to removes carbon dioxide from the atmosphere and solar radiation management (SRM), which involves reflecting sunlight back into space. New technologies that remove carbon from the atmosphere could be needed to combat man-made climate change. There’s a range of proposals such as launching giant mirrors into interstellar space to reflect the Sun’s rays, or injecting iron into the world’s oceans to rapidly increase the amount of phytoplankton that consume carbon dioxide. CDR technologies would be best suited to combat climate change. These include capturing carbon dioxide from ambient air as well as using land to soak up carbon. However, that SRM methods, such as constructing giant sunshades in space and pumping aerosols into the atmosphere to reflect sunlight, would not be long-term solutions and their usage offers potentially dangerous consequences. The point is that all of these geo-engineering proposals are related to the climate — specifically, technological solutions to minimizing the effects of anthropogenic climate change. For example, which theoretically could only be done at HAARP facility, ULF-waves in the ionosphere would knock the particles out of their natural spin, sending them tumbling down into the lower atmosphere to be harmlessly reabsorbed.

Climate change becomes an idea around which calls for environmental justice are announced, revealing the human urge to right wrongs. One way I do this is to rethink our discourses about climate change in terms of four enduring myths. I use "myths" not to imply falsehoods but in the anthropological sense - stories we tell that embody deeper assumptions about the world around us. First is the *Edenic* myth- climate is cast as part of a fragile natural world that needs to be protected. It shows that we are uneasy with the unsought powers we now have to change the global climate. Next, the *Apocalyptic* myth reveals our endemic worry about the future, but also acts as a call to action. Then there is the *Promethean* myth about climate as something we must control, revealing our desire for dominance and mastery over nature but also that we lack the wisdom and humility to exercise it. Finally, the *Themisian* myth talks about climate change using the language of justice and equity. The value in identifying these mythical stories in our discourses about climate change is that they allow us to see climate change not as simply an environmental problem to be solved, but as an idea that is being mobilized in various ways around the world. If we continue to naively understand the climate system as something to be mastered and controlled, then we will have missed the main opportunities offered us by climate change. From a practical perspective, that means rethinking our responses to climate change. Rather than placing ourselves in a "fight against climate change" we should use the idea of climate change to rethink and renegotiate our wider social and political goals. For one thing, climate change allows us to examine our projects more closely and more honestly than we have been used to, whether they be projects of trade, community-building, poverty reduction, demographic management, social and psychological health, personal well-being or self-determination. Climate change demands that we focus on the long-term implications of our short-term choices and recognize the global reach of our actions. This means asking both "what is the impact of this project on the climate?" and also "how does the reality of climate change alter how we can achieve this goal?"

Climate change also teaches us to rethink what we really want for ourselves and humanity. The four mythical ways of thinking about climate change reflect back to us truths about the human condition that are both comforting and disturbing. They suggest that even were we to know precisely what we wanted - wealth, communal harmony, social justice or mere survival - we are limited in our abilities to acquire or deliver those goals. Having established that climate change is as much an idea as a physical phenomenon, we can deploy it in positive and creative ways. It can stimulate new thinking about technology. It can arouse new interest in how science and culture interrelate. It can galvanise new social movements to explore new ways of living in urban and rural settings. It can touch each one of us as we reflect on the goals and values that matter to us. And, of course, the idea of climate change can invigorate efforts to protect ourselves from the hazards of climate change. It is important to note that these creative uses of the idea of climate change do not demand consensus over its meaning. Indeed, they may be hindered by the search for agreement. They thrive in conditions of pluralism. Nor are they uses that will necessarily lead to stabilizing climate - they will not "solve" climate change. This does not imply passivity in the face of change, however. Nor does it allow us to deny that our actions on this planet are changing the climate. But it does suggest that making climate control our number one political priority might not be the most fruitful way of using the idea of climate change.

The world's climates will keep on changing, with human influences now inextricably entangled with those of nature. So too will the idea of climate change keep changing as we find new ways of using it to meet our needs. We will continue to create and tell new stories about climate change and mobilize these stories in support of our projects. Whereas a modernist reading of climate may once have regarded it as merely a physical condition for human action, we must now come to terms with climate change operating simultaneously as an overlying, but more fluid, imaginative condition of human existence. Many policymakers have traditionally seen climate models as irrelevant, but some argue that recent advances are making such models an essential tool in informing policy choices. A quick tour of the Internet reveals some very strong feelings on the subject of climate models. Unsurprisingly, on climate contrarian sites, such models are described in all sorts of unflattering terms and dismissed out of hand as fundamentally useless. However, in more rational forums, and sometimes even among scientists themselves, one occasionally comes across a basic ignorance of whether climate models are any good, and, even more importantly, what they are good for. By the time one gets to policymakers, climate models are seen at best as black boxes, and at worst as simply irrelevant to their detailed concerns. However, climate models – appropriately used – might have a vitally important part to play in breaking through some of the log jams now hampering policymakers. Models of any stripe are simply quantitative or numerical expressions of the theories we have for how the real world works. This gives us a hint: models are useful for tying together causes and effects in complex systems where answers are often only obvious in hindsight. We can apply them for climate changes in the past – global changes in temperature or rainfall patterns inferred from the paleoclimate data for instance – and help attribute events to causes. Indeed, the attribution of any particular climate trend or set of events is inherently a model-based exercise. Without a way of telling the difference that any particular cause might have, how can we recognize its fingerprint in the real world? The other use is in helping chart the course of the future. For the climate, there are two kinds of possible predictability. The first is based on extrapolating seasonal and interannual changes based on precise knowledge of today's state of the atmosphere and ocean combined with an understanding of how the various modes of variability in the ocean might develop. Whether these efforts can provide useful information on regional climate on year-to-year and longer timescales is currently being explored. The more usual source of predictability, however, is considering the long-term changes related to increases in greenhouse gases, a volcanic eruption or other changes in the composition of the atmosphere. The first relies on a thorough understanding of patterns like El Niño or the North Atlantic ocean circulation, while the second tries to average over that variability to predict changes in the mean state. For this second kind of prediction, you always need a scenario for what might happen to the drivers of climate change. Will carbon dioxide concentrations continue to increase? Will air pollution continue to decrease in the developed world but increase in the developing world? How fast will tropical deforestation progress? These scenarios are highly dependent on economics or political decisions and so qualify easily for the "hard prediction" category. Nonetheless, economists do their best to make a range of reasonable estimates for plausible futures and calculate the resulting changes in emissions. But climate is complex. There are multiple causes, giving rise to multiple effects such that the interactions among the various components – like low-level ozone, aerosols (airborne particles) and clouds – can get hideously complicated. Ozone near the ground is created from the soup of emissions from car exhausts, factories and fires, and it is a public-health problem as well as a greenhouse gas. Aerosols too can come from multiple sources: sulphur-dioxide emissions from coal-burning power plants produce sulphate aerosols in the air; black carbon (soot) and organic-carbon aerosols come from incomplete combustion of biomass and even from the complex organic molecules emitted by plants. They all interact directly with the Sun's radiation to either block it (for sulphates) or increase absorption (black carbon). They also have indirect effects by changing how easy it is for clouds to form, or by changing how reflective snow is (black carbon effectively makes the snow dirtier).

Since 1980, the tropical North Atlantic has been warming by an average of a quarter-degree Celsius (a half-degree Fahrenheit) per decade. Though this number sounds small, it can translate to big impacts on hurricanes, which thrive on warmer water. More than two-thirds of this upward trend in recent decades can be attributed to changes in African dust storm and tropical volcano activity during that time. African dust and other airborne particles can suppress hurricane activity by reducing how much sunlight reaches the ocean and keeping the sea surface cool. Dusty years predict mild hurricane seasons, while years with low dust activity have been linked to stronger and more frequent storms. About 70 percent of it is just being forced by the combination of dust and volcanoes, and about a quarter of it is just from the dust storms themselves. The result suggests that only about 30 percent of the observed Atlantic temperature increases are due to other factors, such as a warming climate. This adjustment brings the estimate of global warming impact on Atlantic more into line with the smaller degree of ocean warming seen elsewhere, such as the Pacific. Volcanoes are naturally unpredictable and thus difficult to include in climate models. Satellite research of dust-storm activity is relatively young, and no one yet understands what drives dust variability from year to year. Scientists have a new tool for understanding how events in one region, such as wildfires, can affect air quality in areas far away. Observations from NASA's Multi-angle Imaging Spectro-Radiometer (MISR) show that the plumes of dust, smoke and particles from wildfires or volcanoes often rise past the atmospheric boundary layer, the turbulent lowest portion of the atmosphere, and are injected into the less-turbulent and higher free troposphere. The aerosols can remain concentrated there for long periods and also be transported great distances. One of the project's goals is to generate data based on actual observations of biomass burning emissions from wildfires that can be used in global atmospheric models. The frequency of wildfires has increased over the past few decades, and such fires may be even more common in a future, warmer climate. Predicting the effects of climate change on air quality requires the ability to accurately model smoke injection and long-range transport. Even tiny, easily overlooked events can completely change the behaviour of a complex system, to the point where there is no apparent order to most natural systems we deal with in everyday life. Scientists who study "chaos" - which they define as extreme sensitivity to infinitesimally small tweaks in the initial conditions - have observed this kind of behaviour only in the deterministic world described by classical physics. The weather is one familiar case.

Science, however, has made tremendous progress by trying to break things down into their component parts. Frequently, these studies are carried out by separate scientists, in separate institutions under separate grants and with separate goals. While this has led to a great deal of insight, it has also tended to divorce the science from policy. Because of scientists' focus on single-factor experiments we have not historically provided enough information for policymakers to properly weigh up these different effects. Neither have we clearly identified the key sectors around the world that might provide win-win-win scenarios for people worried about climate, air quality and ecosystems. However, scientific and computational advances in climate modelling and validation over the last few years now mean that we can do a much better job. We can therefore now start to directly answer the questions that policymakers are raising – and some of the results may be surprising. a recognition of the net climate impact may help bridge the current gaps in the international negotiations on a climate treaty. Like a full life-cycle analysis for judging the impact on net emissions of a switch in energygeneration technologies, a full Earth-system analysis should become the new standard in judging climate-policy proposals. All climate models are wrong, but some of them are useful, and by working more closely to answer the questions that are actually being posed by policymakers, we can make them more useful still.

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