RISING TEMPS AND EMERGING THREATS: THE INTERSECTION OF CLIMATE CHANGE AND NATIONAL SECURITY IN THE 21ST CENTURY
KEYNOTE ADDRESS

By John Steinbruner*

Thank you for having this meeting. I'm sure the reason I've been invited [here today] is to talk about the National Academy of Sciences report "Climate and Social Stress: Implications for Security Analysis." The thing I want to say, though, is that you cannot blame the National Academy of Sciences for what I'm about to say. The report is the result of [work done by] fourteen members of the committee and then vetted by eleven other people, and everything said in it is extremely cautious. I'm going to extend a little bit beyond the details of the report. I'll give you my personal take on the situation, having gone through the result of the report.

If you're in Washington and dealing with climate issues, you hear a lot about uncertainty, and indeed, there are a lot of uncertainties associated [with climate issues]. But let me begin with things that are not at all uncertain. [First], the main determinants of anthropogenic thermal impulse are known with confidence. We know these things as well as we know anything: the radiative forcing effect of the CO_2 molecule; the atmospheric dwell time of that molecule (more than a century); and CO_2 concentrations over time (they've been increasing . . .).

The rate of change, at the moment, of CO_2 concentration and resulting radiative forcing is currently ten times greater than at any point in the last 400,000 years (we can measure [this change] with some certainty [because] we have annual data from the Vostock ice cores). [The current rate of change is] ten times greater than [the] *entire* [400,000 year period]. And if you go back to the point at which the temperature on Earth was recently, the greatest the rate [of change] is 20,000 times greater than the process that generated [the most recent] thermal peak (admittedly, that went on over a longer period of time). All of which is to say, "we are exceeding

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the speed limit." We are outside the bounds of the entire paleoclimate record in terms of what we can change . . . .

We know that the current sea levels—compared with a couple of obvious historical reference points—are four to six meters below levels that occurred during the Eemean Period (about 130,000 years ago) when the temperature was roughly equal to current conditions. And [sea levels] are twenty-five meters below the Pliocene Period (a couple million years ago) when estimated deep ocean temperatures were only one degree warmer than current conditions. We're almost certainly going to hit that one degree increase. [CO_2 concentration and sea level changes] are about as well-known as anything is well-known.

So what are the global implications? Well, there will ultimately be an energy balance. We know basic physics says "when you put this kind of thermal impulse into the system, it will be balanced in some way." So, either we're looking at sea level rise more rapid than currently projected and possibly in a nonlinear sequence, or there is some other combination of processes that we do not yet know that is going to balance it. In other words, we're running behind the schedule for the historical balancing mechanism, which is sea level rise.

The consequences [of global climate change] will certainly be substantial. There's no question about that. Apparently, [the consequences will be] unprecedented, given the rate at which we're adding [greenhouse gases] to the atmosphere. But there is a problem with this: the scientists can say with certainty [that consequences will be substantial, but] they cannot tell us the character, magnitude, timing, or location of what the consequences actually will be. There's a lot of uncertainty about how, in detail, this is going to work out . . . .

We're also outside the bounds of what our sea ice models will tell us. The arctic ice, over summer, is disappearing much more rapidly than anybody can give an account for. And that's a pretty stark warning of the consequences of where we are.

Decisive mitigation of the thermal impulse is technically feasible. We can, in principle, hold global warming to a prudent standard that would, if you will, presumably preserve the operating conditions of human society as we currently know it. But we're not remotely doing that; it would take several decades to accomplish [decisive mitigation], and we're not on that path. Therefore we have to anticipate, when you get to the security issues, the extraordinary and severe burdens of adaptation [that will occur] with increasing frequency over the next three decades.

And here's where I am really departing from the National Academy Report. Let me give you what that might mean. The Report says what I just said: there will be severely increasing burdens of adaptation, and in some

societies [the burdens] will exceed [the societies'] ability to cope . . . . My favorite example is Pakistan. As we all know, [Pakistan] is an internally fragile society. It has a prominent agricultural sector . . . , [and] it is highly dependent on hydrology in the Indus River Watershed. It is a pretty predominantly semi-arid area, and the water dependency is substantial: 30 [to] 40% of their water availability comes from the Indus River, and 30 [to] 40% of the Indus River water flow derives from glacier and snow melt.

[Pakistan is] facing very sharp allocation tradeoffs among their water use, pinning irrigation versus power generation, and irrigation across provinces (Punjab and Sind, in particular). There [are] divisive water resource allocation rules favoring irrigation over power generation for, basically, internal political reasons. [Water allocation authorities are] favoring Punjab over Sind for the same reasons, even though the Sind is a much more arid territory. And [the] allocation pattern is based on unrealistically high estimates of water availability. Therefore, [water allocation authorities are] creating a division of interest between small and medium enterprises, which are dependent upon power and really provide. Any hope for viable generation of the economy depends on small and medium enterprises [who] depend on power generation. [And power generation] is being hurt and is in competition with agriculture—which depends on irrigation—and the growing urban areas depending upon water resources.

This situation, for whatever cruel reason, really is being severely exacerbated by one of the big climate effects going on at the moment: the accumulation in the Karakoram glaciers north of Pakistan at high altitude. Because of increased winter temperatures, it gets more snowfall up there, and the glaciers are actually increasing at high altitude and receding at low altitude. [Because of this,] the Indus River water flow is 30% below its normal pattern. [Pakistan is] also getting increased precipitation in some areas, and increasing drought in others. One of the apparent climate effects is increases in the extremes; and increasing ambient temperatures are interfering with the agricultural product cycle within Pakistan.

[The] bottom line is that this situation is already generating chronic protests within Pakistan. Most of the villages and many of the cities have, on average, power only half a day. So, one hour on, one hour off during the day, and one hour on and four hours off during the night—routinely. That is generating daily, or certainly many times a week, protest riots in the city. And the Taliban has discovered that the one thing less popular than the United States are the power stations; so they're beginning to organize against [the power stations]. All of which is to say, we're already seeing very severe internal pressure within Pakistan, and I don't have to tell you that Pakistan is an area of major concern.

What are the global and security implications of this situation? I think we have to anticipate adaptation failures in some societies, severe enough to induce an international reaction of unprecedented magnitude. We're going to look at cases that are far more serious than anything we've seen up to this point. In addition, globally we're going to have to prepare and manage what I will call "geo-engineering contingencies," because some societies subject to severe, immediate climate effects are going to be tempted to fiddle with the global temperature. And [temperature engineering], unfortunately, is technically possible to do. And then eventually we're going to have to, I think, anticipate a truly compelling mitigation effort. All of these things have security implications.

So again, deriving from the Academy report, and maybe being a little more venturesome about its implications, suggests some immediate practical steps that really are quite urgent. First of all, we need to develop a global monitoring system worthy of the problem. We are now watching social and environmental dynamics in high resolution the way we could, and the way we'll need to if we're going to be able to anticipate [from] where the trouble comes. Pakistan is a very good example of where to look, Egypt is another. I'll talk later about Syria, but [these nations are] not exclusive. There are [numerous] parts of the world where trouble could occur, and we're not watching with the kind of resolution that we need to.

[Developing a global monitoring system] will have to be a global process. We would have to establish a continuously managed database, prioritized for climate and social indicators, and we would have to learn how to do stress testing for areas of the world that aren't [already monitored]. All of this [technology] is far from the current state-of-the-art. We'll also, I believe, have to establish protocol for getting solar radiation management field trials and ultimate approval of any solar radiation operation.

If you see what's going on among the scientists at the moment, they are realizing: we're not on a course to mitigation; we are looking at severe trouble; and we may have to have [an] emergency reaction to reduce the average global temperature by interfering with the global climate system. And, whether it's fortunate or unfortunate, it is possible to [tinker with the climate]. With putting sulfate aerosols into the atmosphere at a cost of something like eight to ten billion dollars a year, we could reduce average surface temperature by five degrees centigrade per year. So, we could offset the underlying global warming effect, although we can't change it. Several countries are capable of doing this, and we have to worry about those [countries] that consider themselves to be severely burdened actually attempting to do it. I think that's the equivalent of heroin addiction really, if you do not accompany it with a mitigation effort. But [atmospheric

interference is] going to be a severe temptation. We're going to need rules about this, and we do not yet have them.

Finally, we need to develop prototypes for small modular nuclear reactors with passively safe and sealed fuel design features. Simply because if you go look at the basic numbers of the alternative technologies available (non-carbon emitting technologies), and the amounts that we have to produce in order to achieve a reasonable global standard, there is no way you can get there without a dramatic expansion of nuclear power. Now that is not a message that anybody finds welcome, but if you look at the numbers it is unavoidable. Wind, solar, biomass, and some degree of carbon sequestration all make some contribution, but without a dramatic expansion of nuclear power, we're not going to be able to do mitigation. At the moment, currently accurate designs, current fuel cycle management practices, and current security relationships simply will not support an expansion of the sort required. So we've got a big transformation that we need to go through.

There are conceptual designs of reactors that would be far more appropriate than the current ones. [These designs are inherently safe and much more resistant to proliferation [than current designs]. I'm just going to go through a series of them. I'm not going to dwell on this, but there are conceptual designs that are basically paper designs that people are thinking about, and there are another four designs that are being undertaken by various commercial ventures at the moment. But if you go through these figures, . . . you'll notice none of them have all the properties that we need. You need a sealed fuel feature such that, in providing a large number of reactors, we do not spread access to nuclear fuel and ultimately nuclear explosive isotopes. You want to concentrate [the process], [by managing] the reactors that are manufactured in a central location, [and are then] sent out, plugged in, and brought back with no access to the fuel in between. So, you need the seal fuel feature that has to last for twenty to forty years for this concept to work. None of the [existing] prototypes yet have [the seal fuel] feature, but you can definitely create small reactors that have [it].

Arguably, in order to prepare [for the increase in nuclear technology]we need an investment program to develop a couple of prototype reactor designs to the point that we could actually use them. [Development] would probably take about ten years, and about a billion dollars. That's small change considering the magnitude of this problem. Nobody is currently making those investments. We're not even creating the technical design that we know we're going to need. So [creating investment programs for the proper technology is] the first step that [must] happen.

In addition to [an investment program], we'll also need to develop an institutional design for global management of nuclear reactor and fuel cycle

services. If we are going to expand nuclear power, and therefore the fissionable isotopes that are generated (which also can be used for nuclear weapons), we're going to [need] an accounting system far more accurate than the one we currently have. We need to aspire to be able to keep track of all nuclear explosive isotopes, down to the weapons equivalent unit. We are decades away from [this] aspiration.

There's a dispute about whether we'll ever get [an effective system in place], given uncertainties about historical production. But the point is, we do not even have the *design* for a system that would [accurately account for nuclear materials], and it's going to have to operate over several decades before we'd have much confidence in it. So we need to get going on that. For sure, it is technically feasible, given the information technology we currently have, to keep track of all nuclear explosive isotopes and fissionable isotopes, down to [an acceptable] degree of accuracy. But we haven't been [keeping track of these materials] that way, and [we] haven't played catch up. It's going to be decades to catch it up.

We also should realize that we have to prepare for the transformation of current security relationships among the U.S., the E.U., Russia, China, and India, at a minimum. Those are the key players of the global warming problem; China and India are the key venues. If we do not achieve mitigation in those two societies, we're not going to do it globally. They have 40% of the world population between them, and much of the economic growth projected to come. So we either win or lose on global warming in those two places.

So, in order to [achieve mitigation in China and India], we're going to have to elevate interest in mutually protective collaboration over the rather contentious assumptions that currently dominate our security relationships. We'll have to develop institutional arrangements for financing and technical support of energy transformation, which will have to be the main event between us, and it will have to subordinate residual military confrontation to that purpose. A big change in attitude and a big change in institutional arrangements will be driven eventually by the global warming problem.

In general, it is prudent to expect that the social effects of climate change will be as extensive and as consequential as the ecological effects. What's going on here is a very complicated interaction between climate change and social dynamics. In principle, these social effects can be constructively shaped. There's a surmountable danger here that offers inherent opportunity, but as we're already realizing, it remains to be seen how this will work out.

But the students of your generation have a lot to accomplish. We've given you a legacy that [presents] big challenges out there. But the good

news is it's not impossible. It's not impossible to do this. It's technically feasible. The barriers are largely attitude and institutional arrangements.