

PANEL #2

THE HUMANITARIAN IMPACT OF NUCLEAR WEAPONS: WHAT HAPPENS IF THE BOMB IS USED?

Climate Effects of Limited Nuclear War

by

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MCKINZIE: Setsuko, thank you so much. Thank you so much for your words, they are seared on our minds and your stories and your wisdom are a gift for us, thank you very much.

We'll have the opportunity to ask question of Setsuko after the next two presentations. As a teenager, one of my first memories of thinking about nuclear weapons was seeing Carl Sagan on public television talking about the concept of nuclear winter, that a nuclear war could so thoroughly change our global ecosystem. And it struck me how that cuts at the basic underpinning of nuclear deterrence, so with that I will turn the podium over to Dr. Helfand and Dr. Robock to provide the introduction to some of the global and societal impacts of nuclear war.

HELFAND: Thanks. I just wanted to start by saying a further thanks to Setsuko for what she's done. You know, having lived through what was undoubtedly the worst day in human history, I think many people would have just tried to forget about all this and get on with their life. And instead Setsuko has made a fundamentally different decision. She has made herself relive that horror over and over and over again in the hopes that we will not have to go through that. And this is an act of I believe incredible courage and dedication of which I'm sure we all are incredibly grateful. Thank you Setsuko.

Having said that, I need to also say that the incredible imagery of Hiroshima which many of us have seen in pictures in which Setsuko has shared with us some words today. As horrible as it is, we need to understand this does not begin to describe what we're going to face if nuclear weapons are used again. Hiroshima, Nagasaki one bomb, one city; one bomb, one city. If nuclear weapons are used again, the chances are overwhelming, there will be many bombs on many cities, all at the same time.

And so in the remainder of this section, Alan and I are going to try to describe to you what that's going to look like and the full extent of the destruction and humanitarian catastrophe that we're facing today.

ROBOCK: Thanks very much for inviting me here. First of all, I'm going to talk about the climatic disruption from a limited nuclear war. This is our beautiful planet but after a nuclear war, it might look like this with a cloud of smoke covering the earth, blocking it out of the sun, making it cold and dark at the earth's surface. By the way, these pictures were drawn by NRDC in the 1980s when they were involved in nuclear winter.

There are two types of targets of nuclear weapons, air bursts over cities that would cause them to burn, but also ground bursts over missile

silos which will produce a lot of dust. In one case the smoke would absorb the sunlight and prevent it from reaching the surface and the other case the sunlight would be reflected. But in both cases very little sunlight would reach the ground and that would cause rapid drops in the surface temperature and devastation to our global agriculture.

The heating of the atmosphere by the smoke would also destroy ozone which would then let a lot more ultraviolet radiation reach the surface. Again, it would be devastating.

So we could have a nuclear winter, temperatures could get below freezing even in the summer time, it would be cold, dry, dark, there would be more ultra violet and depending on the amount of smoke it could kill all of our crops and lead to global famine. Here's a graph of the total number of nuclear weapons in the world. There are actually, as you know, nine countries, but the total includes the other seven, but they don't have very many compared to the U.S. and Russia.

In 1982 a paper by Christen and Burkes pointed out that there would be fires from nuclear war and nobody had thought about that before. And then next year, two groups, one in Russia, Alexander Stenchikov, and one in the U.S., Turko Toon, Ackermen, Pollock and Sagan calculated how the climate would change, and they came up with nuclear winter. And the next year I did a paper and Coviet did a paper looking at the long term effects and then the nuclear arms race ended and the cold war ended.

The scientists presented this information to policy makers and this was part of the reason why the arms race ended. As a scientist, I study things by doing computer models, analyzing data. But historians, how can I prove my assertion? Historians did their research by asking people, so it wasn't the Soviet Union, the Soviet Union ended five years later, long after the arms race has ended.

And I also like to point out that the total now today is not zero, there are still about 5,000 nuclear weapons on the planet. So that's not the end and as I'll show you, we're still not safe even with that number of weapons.

Ronald Reagan stated in a The New York Times interview, "A great many reputable scientists are telling us that such a work could end up in no victory for anyone because we would wipe out earth as we know it." And if you think back to national calamities, back in the last century, the 1800s volcanos, we saw that weather was so changed, there was snow in July in many temperate countries. They call it the year in which there was no summer.

Now when a volcano can do that, what are we talking about with a whole nuclear exchange, the nuclear winter that scientists have been talking about is possible. And Gorbachev the other person along with Reagan who ended the arms race, said, "Models made by Russian and American scientists showed that nuclear war would result in nuclear winter, that will be extremely destructive to all life on earth." The knowledge had a great stimulus to us to act in that situation.

Now that was you know, 35 years ago. Why am I even bringing it up? So I want to ask two questions. First, although the cold war is over, could the remaining nuclear arsenal still produce nuclear winter, could they produce so

much smoke that it would block out so much sunlight that it will still get below freezing in the summer time?

The second question is what about if there was a much smaller nuclear war, say between two of the new nuclear states, say India, and Pakistan, what would be the effects of that? So I'm going to tell you, the answers right now, then I'll show you how I got those answers. The answer is yes, we could still produce nuclear winter and it would last for more than a decade, much longer than we thought before.

And a war [between India and Pakistan] using say a 100 nuclear weapons or 80 nuclear weapons would not produce nuclear winter -- that is the temperatures wouldn't get below freezing -- but it would be a horrible catastrophe. The direct effects blast, fire, and radioactivity would kill millions of people. But the smoke would then still propagate around the world and have an effect on global agriculture for more than a decade.

What does a nuclear weapon do? This is one of the tests in the Nevada proving ground and it's like bringing a piece of the sun to the earth for a fraction of second, everything within a certain distance will burn. And here's a house they built and you see it catches on fire but then the blast wave hits and it might block the flames but it breaks the electric lines and gas mains and you can continue the fires.

Now this is what smoke looks like from burning material that's based on oil. The carpet here is probably oil based - plastic, and so it burns with this black city smoke. The wood burns with a lighter colored smoke. We've calculated the properties of the smoke and how they would affect the amount of sunlight.

Now we've heard about Hiroshima just now, this amazing testimony from Setsuko. It was a 15 kiloton nuclear weapon, that's 15,000 tons of explosive power of TNT. You might have heard about this mother of all bombs that was dropped a couple of weeks ago, the biggest -- that was 11 tons, so this is 15,000 tons, this Hiroshima bomb was more than a thousand times more powerful than that bomb. And even though we're down to 5,000 weapons, if we dropped one Hiroshima bomb every two hours starting on August 6, 1945 up until today, we still wouldn't use up our current arsenal.

This is the airplane that dropped it, the Boeing B-29 Superfortress, Enola Gay. I first saw it at the Paul Garber facility here, which is a storage place for the air and space museum. And that's a mockup of the bomb there. Enola Gay was the mother of the pilot, Paul Tibbets. It's now been put on display at the air and space museum up by the Dallas airport. And that's where the bomber would sit and this is a drawing of what it might have looked like. And as we just heard described, there were fires, Hiroshima burned. This is a drawing done by one of the survivors showing the fires and the smoke.

And it's as horrible as the direct effects are. The smoke, as it goes up into the atmosphere and gets blown around the world can have devastating effects on our food supply. This is what Hiroshima looked like afterwards, after the roads were cleaned up, all the buildings went up in smoke. This what Nagasaki looked like afterwards.

So we know that cities can burn unfortunately. In 1906 there was an earthquake in San Francisco, and the city burnt for three days, and Jack

London wrote an article about it for Colliers which was a big magazine at that time. And he said, "East, west, north and south, strong winds are blowing upon the doomed city. The heated air rising made an enormous suck. Thus did the fire of itself build its own colossal chimney through the atmosphere."

So these fire storms will just pump the smoke high up in the atmosphere where it can remain for a long time. This is what San Francisco looked like afterwards. Only a few of the strong buildings remained.

Now, this is an estimate of the number weapons on the planet, nuclear weapons, 15,000 as of June last year. And this is the United States, this is Russia and these are all the other countries. And so India has a hundred or so, Pakistan 130 and so we said, "What would happen if there was a war between these new countries?" So what if India and Pakistan had a nuclear war?

So I guess Zia has left but he described to you very clearly different scenarios that could start a nuclear war between India and Pakistan along the Kashmir border. The thing he described I read about in New York Times -- 19 were killed along the border in November 2016, it did not start a nuclear war fortunately. Remember the terrorist attack on Mumbai also did not start a nuclear war.

What about this? Imagine your Pakistani air defense and the stealth part of these invading force didn't work quite right and you see this, you're being invaded. Who would you think was invading you? Did this risk the possibility of a Pakistan-India Nuclear war, everybody in America was so happy we killed Osama Bin Laden.

We decided to say, what would happen if 50 nuclear weapons were dropped on 50 targets -- 50 were dropped on targets in different countries. And we used 15 kiloton bombs which are pretty small by today's standard, but we figured, I think Bruce mentioned that that's about the size of the Pakistani or Indian weapons. We know that they can build on that size. You would get in India, 3.5 million tons of smoke from the fires. In Pakistan 3 million tons. 6.5 million tons of smoke total.

So what if India and Pakistan each used half of their arsenals? So we decided to be conservative, we took 5 million tons instead of 6.5 million tons. And we put it in the atmosphere over this region, and into a climate model the same ones were used for global warming and other studies, and calculated how the climate would respond. It would be horrible, 20 million people could die but it would produce 5 million tons of smoke.

There's a movie of where the smoke would go and the graph on the left shows the vertical distribution, the black line is the troposphere, so everything below there it is where there's rain to wash it up, but it would be heated by the sun and lock up high up in the atmosphere where it would remain for more than 10 years. We did this with a modern computer and a modern computer model, that wasn't available in 1980s, the fastest computer, the Cray computer that was used for doing the calculations was much slower than your iPhone and so they could only do a 20-day simulation, only parts of the climate system.

So we discovered this, and then I plotted on here how the global average temperature would change. The blue is the global warming. The red is

the global climate change. Instant climate change, it would be global climate change unprecedented in recorded human history. Using much less than 1 percent of the global arsenal.

So two other climate modeling groups did the same experiment to make sure that our model was right and got the same results. This is a fancier graph from the one up at the National Center for Atmospheric Research. It gets heated up into the stratosphere and lasts for more than a decade where there's no rain to wash it up, blown around the world.

We calculated how much the temperature would change. For instance, over 10 years, global temperatures would go down 1 to 1.5 degree Celsius, 2 to 3 degrees Fahrenheit, precipitation will go down maybe 10 percent, sunlight would go down. And it wouldn't be a nuclear winter. The temperature wouldn't get below freezing. How would it affect agriculture?

So the upper atmosphere will be heated more than 50 degree Celsius, a 100 degree Fahrenheit warmer. And that would destroy ozone, producing ozone depletion globally. Now we have an ozone hole around Antarctica. This would be a global ozone hole with more ultra violet radiation.

What would the severe ozone loss do? It would affect human health, it would produce sunburn, increase skin cancer, it would really be damaging for crops over land and for fisheries. We haven't calculated those effects here, we're just starting a project to do that. Agricultural effects would include reduction of temperature, less precipitation, less sunlight, a shorter growing season by 10 or 20 days and more ultra violet radiation. And we calculated with an agricultural model how this would affect agriculture in the two countries that grow the most food, China and the United States.

And we took the changed climate from these climate models and put them on to these agricultural models and you would have a 20 to 40 percent reduction of the food supply for five years. And 10 to 20 percent reduction for another five years. So you can imagine how disruptive that would be.

There was a drought and heat wave in Russia in the year 2010 and they stopped exporting wheat because they didn't have enough. That doubled the price of wheat and that was the trigger for the Arab Spring and so you can imagine all kinds of disruptions. And now, Ira is going to talk about how it might affect people who can go to the grocery store and spend a little bit more money.