IIIRM Risk Workshop
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1:00 p.m.
Todd Hinkley

Merv Tano: Good afternoon. We're going to start up again. What we're trying to deal with with the afternoon sessions are some of the more perhaps subtle or less well known kinds of risk. We all know about the problems of hazardous waste and radioactive waste and the clean-up of contaminated sites and the risk issues that are partial of those kinds of problems, but there are some longer term issues at stake as well. And what we have here are a couple of presentations. The first by Todd Hinkley of the U.S. Geological Survey. You can introduce yourself and start on.

Todd Hinkley: Thanks Mervin. I'm Todd Hinkley. I'm in the U.s. Geological Survey right down here at the federal center and I'm making this presentation with my colleague Margaret Hiza, who is passing our a couple of sheets to go with our talk. One's an outline of the talk and the other sheet is a list of some contacts which you might want to look over and keep in mind for future reference.

Our presentation is about climate variability and secondarily climate change and how they relate to various risks and how climate variability is really a risk in its own right. Clearly the climate does vary. It varies on different time scales. We know about some of that from our own lifespans. As we look farther back in the past we can see that the climate varies on longer time scales, perhaps more strongly. Here's a plot of a part of northeastern Arizona and just how much rainfall there was throughout this past century. It shows some details, it shows that quite lately we've had a period of rather high rainfall. A little farther back in the century there was a period of distinctly lower rainfall

followed by or proceeded by another period that was perhaps intermediate. So it does vary. Often we don't realize that the climate varies.

Al Young: Do we see a 100 year pattern there? That was a very interesting line that came down in 1990, somewhere in there. Do you know what's going on in Texas right now and Arizona?

Todd Hinkley: Well there's a lot of uncertainty because all you can see is the end of the line which is right now in the present moment. And if you could just get a little farther ahead in a couple of years you could say, aw, that was just a blip, or you can say, yes, that was really the start of something. So myself, I'm not very much of a climatologist, and I can only point out how things have varied for awhile in the past. And they have varied. Often we assume that they don't. Often we think of other environmental risk problems. We think about how contaminants move through the soil and through the water and that they'll always do it in the same way because the climate will hold steady, but it doesn't. That assumption is based on present conditions which tends to fill our minds. But the present conditions can and do change due to climate variability.

The big things about climate is that it varies, are the influence it has on the water budget, on the soils, and on soil erosion. We think it's the same as an assumption, but water and soils and the way they interact and the way they form a base for other life is not constant. It does vary. Perhaps according to a cycle, perhaps randomly, we don't understand the influences. But it certainly does happen.

We need to factor this possibility of climate variability and more broadly and less well known of climate change into the way we think about land use and the assessment of risks that we try to evaluate, whether it's contaminants from industrial processes or many other things.

Now, the way the climate may vary or systematically change in the future is not well known. The science of trying to do this is very much in its infancy but by intelligent study, intelligent measurement and monitoring we can make some reasonable estimates of what the possible futures are likely to be based on what has happened in the past, the ranges of the changes that had been seen in the past, the things that we should monitor are precipitation, the amount of moisture in the soils, and the way that wind processes can build up or more commonly erode soils. One of the approaches of the U.S. Geological Survey not in a regulatory way but strictly in a research way is to study the present land surface in certain regions and try to determine what are the factors climatic and others, that have produced the changes in the land surface.

Now this is a plot of a slightly different area, very much like the first slide that I showed. This is for the Mojave Desert. The previous one was for a part of northeastern Arizona. This is for rainfall or a parameter that's very much like rainfall for about the last 100 years. The lines vary a lot, but there's good reason to think that for certain periods of a few decades each, we can draw average lines through them and for those periods, the average lines vary a lot and they've strongly affected many of the systems on the land. They certainly affect the capacity of the earth to grow plants, they affect the changes in

plant communities, in modern years this especially has to do with the increasingly large problem of invasive exotic plants, especially perhaps in the western part of the United States. Indeed in Hawaii. Those new orchids are nice but when they start to take over everything and you realize they didn't use to be there, it can be quite impressive.

There are droughts, there are floods, there's erosion of the land surface, there's control of what animals communities can live in certain areas and very certainly it affects the people. This is a picture of Quetzal in Arizona. Now the last slide I showed was rainfall over just about the last 100 years. But one a time span maybe about 5 or 10 times that long we realize that there were severe droughts in the last part of the 16th century and a very severe drought in the 13th century which I believe is the time that the settlement of Quetzal and other Pueblan communities were abandoned.

Now, the people certainly are affected by climate change. But it's the physical things that respond to climate that cause the effects on people. I mentioned that one of these is changes in the human health environment; the susceptibility of the land to harbor various diseases and the movement of the land itself. Another thing I can talk about is the climatic effect on sand dunes which are a feature of the southwestern United States. This is a picture of the Moan Kopi (?) Dunes. They're not the largest, not the most spectacular, but it's probably well known to many of you that the sand dunes shown here in green are concentrated especially common on tribal lands, especially throughout the southwestern United States. This is perhaps no accident. It could have been very much the result of political apportionment processes in the last century and early in the

20th century. Here's a little different scale showing the Four Corners region of Utah, Colorado, New Mexico and Arizona which the dunes that are concentrated right in there. You can see they're very much on tribal lands. They're very much influenced by certain wind directions. The people that have lived in this area for centuries or longer have used what are essentially sand dunes, perhaps stabilized sand dunes for subsistence agriculture and for grazing.

The behavior of sand dunes is very much related to the precipitation and wind regimes which are fundamental parameters of the climatic regime. The dunes are sensitive indicators of climate change. In fact, if we knew how sand dunes behaved in detail in the past, we could probably get new kinds of information about climate. To some extent we can do this. We can get information from dunes and dune type deposit, stabilized dunes, of what the wind regimes used to be in ancient regimes of climate. When the sand dunes change due to climatic effects, the degree of vegetation cover changes greatly on the sand dunes. It's vegetation that stabilizes them. They're very sensitive to general atmospheric circulation patterns. And as people who live in the areas well know, there are huge societal impacts, if presently stable dunes become unstable, if they begin to migrate to cover up other good agricultural lands and to become themselves unsuitable for agriculture and grazing use.

Here's a research plot done by one of our colleagues, Dan Mo, studying about sand dunes. Here's a plot starting from 1930 and going up to almost the present. It just shows how there's a directly opposite relationship between how much precipitation

there is in blue in the area of the sand dunes and how mobile the sand dunes are. And by mobile, I mean that they do not have stabilizing, vegetative surface covers and they're free to both migrate and to release sand to be blown elsewhere by wind processes. They're in the southwest. They're on native lands. They're very subject to climatic changes. In the more distant past, they've probably been subject to greater changes in their mobility than any of us have seen in our lifetimes and by study of the sand dunes and by monitoring, there are ways to find out what has happened in the past and to get some boundaries on the likelihoods of what the climate change and the change in sand dunes is likely to be in the foreseeable future.

Now, native people have lived in the southwestern area and other parts of North America, not to mention indigenous people in other continents, for many hundreds or thousands of years. During this period the climate has varied and changed. But the people have as expressed in their traditional knowledge, gained a great knowledge about how to adapt to and survive in conditions of changing climate. There's a tremendous wealth of knowledge about not only the conditions but how to change the way of life in response to them and survive. This is in oral traditions. In the past these kinds of knowledge have been used to solve the problems of climate change in the old days. It's quite possible that in the present and in the future, the same bodies of knowledge, and some of it perhaps secret knowledge, could be used not only for the same kinds of adaptation and survival, but could be used to apply to new challenges which come up. Challenges of new risk. Things like water retention, ground water

recharge and in the political sphere to bear on water rights and a portion of water in the future.

Now as I said, these ancient technologies of which there are many and many fields, have worked in the past. They could work for new things now. They might have legal implications. One of the things about these . . . one of the illustrations of these ancient technologies is ancient agricultural practices and I'm going to go on emphasizing the southwestern part of the United States and typically Pueblan people.

Here is an aerial photograph showing the waffle grid gardens which are part of traditional agricultural practices of the Pueblos. You can see the pattern here on the ground. They're very extensive. They have covered large areas of land and they have also made lands appropriate for agriculture that would not be appropriate for agriculture according to European practices. Here's a picture of the same area where you can see the boundaries of this method known as the waffle grid method.

This next slide shows the location of some of those. Here is Santa Fe. Here's a scale of 20 miles or 30 kilometers. You can see the dots on this map which show the location of the pebble mulch method and the grid gardens of the northern Rio Grande River.

Here's a ground shot of the kinds of gardens and terraces that were used by the Zia people. The various technologies which are just one small illustration of the adaptive practices of native people in southwestern North America. The pebble mulch method of agriculture which allows retention of soil moisture as well as soil in ways where

European methods just wouldn't work. The cobble borders that have been used on the agricultural plots keep water from flowing down the slopes, or at least slow the speed of it and it redirects the flow of water toward channels where it's wanted. The terracing which is analogous to, but different in detail from old world in meso-American terracing patterns, are used to retain water and the movement of soils down slopes and to enlarge the planting surface by converting an intractable slope to usable horizontal agricultural plots. I was talking to Richard Pacheco at lunchtime and he told me about a system I hadn't heard of which is a system of spiral plots which he referred to as the nautilus method. So there's probably a great deal that I don't know about this and my use of the agricultural method as an illustration of broad past technologies is just one small aspect and there are probably many others which were used to solve problems of climate change, unfavorable climate in the past and might be used with variations to solve problems that come up in the present and future with various kinds of risks related to climate.

Another picture of the Zia grid gardens. Now, I gave the example of ancient people's adaptive technologies to climate change, to switch the subject a bit. One of the important past and modern things that has come from climate variability and climate change is the disease regime in local and regional areas. One of these diseases, very much related to climate is valley fever which is a fungal spore that's contained in the surfcial layers of soils. It's ideological agent is this name, coxcidial edomicosis (?). The reason it's related to climate is through the different regimes that wind and dust have under different climatic conditions. When there are dust storms in areas where coxcidial

mycosis or valley fever is endemic, the incidents can be greatly and episodically elevated. This is an example of the kind of dust storms that can occur, perhaps may in modern times be occurring more commonly in places like the Phoenix area of Arizona. It's something that perhaps the native peoples in these areas have evolved, developed some resistance to, but as migrations occur in the southwest, it finds new victims in populations, both native and European that perhaps do not have developed resistances to this valley fever fungal ideological agent. It's a sensitive thing. Often even people getting packages from areas where this is endemic can be affected. That's one of the examples of the disease. There are several others, some foreign invaders. Another one which has been well known to southwestern native peoples for a long time is the hantavirus or as it's now called medically the hantavirus pulmonary syndrome. This is as I'm sure most of you know, carried by certain kinds of rodents. The practices of hygiene, construction of dwelling and rituals of southwestern people have been extremely effective in minimizing the contract with the transmissive agents of this disease. And the cycles in the past of the high incidents of this disease have been well known in the oral traditions of native people. It's my understanding that European medical people begin to study this independently and found out that the history of outbreaks of it was very well known in great detail to tribal people in the areas where the incidence is highest. But of course, this is carried by rodents. I guess the rodent paramiscus, a kind of deer mouse, can have its populations just explode during short times and that's because it happens during wet years when there's a lot of vegetation. It's become apparent lately that the risk for this can be assessed somewhat in advance

by remote sensing techniques such as this full color satellite image here which shows basically on the development of springtime vegetation what the risks of hantavirus are likely to be during a particular part of the spring and projected forward. And these remote sensing and GIS technologies are increasingly available in being used by native people. It's a way to assess the risks of something that's very closely related to climate variability.

Well let me talk a little bit about what we in the research part of the U.S.G.S. are doing. There are two main things that come to mind. One is our participation in the national assessment of climate variability and change. It's got a slightly longer title, but this is a national program mandated by Congress. It's divided up into a lot of subjects and into a lot of regions around the country. The U.S.G.S. has got responsibility for one of the 6 subjects, namely water, strongly related to climate and we've got responsibility for 3 of the approximately 15 regions around the country evaluating the potential consequences to people of climate variability and change. All three of these that the U.S.G.S. has, the southwest, the Rocky Mountain great basins, and Alaska have a fairly strong emphasis on native issues. Some of the others do too, and some don't have very much. So I just wanted to quickly mention our involvement in the national assessment of climate variability.

I'll come back to that a little bit later, but let me talk to you a little bit specifically about our own research and monitoring project. The goal of which is looking at landscape response to climate variability and land use. Margaret and I are both research

members of this project, but there are a number of members throughout the U.S.G.S. organization that work on various aspects of this research project. One of our emphasis is what we call Aeolian processes. This means the processes to do with wind and the transport by wind of things like dusts and how these dusts build and erode soils. It's a specially well chosen thing to study we think in the southwestern United States. We're looking at the details of wind erosion and the deposition and emission of mineral dust.

Here's a dramatic picture of a cloud taken in the central valley of California. Very high winds. Lofting of the very dense cloud of dust to thousands of feet and distant transport of it and the effects that you might imagine on agricultural and wild lands.

Here's some details of some of the things we wish to accomplish in our research project. Basically we want to look at the past to a very large extent to see how in the past climate change has affected things about the land surface. Soil loss, stream erosion and sedimentation, sand dunes and they're effect on ecosystems. Now stream erosion may be something that you know about. Since the end of the Civil War throughout the southwestern United States, there's been a great acceleration of down cutting stream channels. This is well know, it's very dramatic. The causes of this are not well understood. Some people think it has to do with European agricultural practices. Some people think it has to do with the climate change that was delayed after the end of the last ice age 10,000 years ago and is a natural thing.

We're very interested in the ecosystems, especially things like invasive exotic plants. There's a big new problem with the plant cheap grass throughout the arid regions in the

southwestern United States. We're trying to see whether this is just because of mobile introduction of this plant or if it has to do with climate change and if so, which soil systems are susceptible to this kind of invasion, whether anything can be done about it. In general, we're looking at the interplay among climate, land use, and surfical processes very largely in areas where tribal lands are concentrated. In southern and eastern California, Arizona, New Mexico, parts of Utah. We're certainly interested on what this is going to do in the future. One of the things we've done is to establish a series of monitoring stations where we can keep continuous records in key places of the speed of the wind, the deposition of dust in various kinds of collection devices, the transport by strong winds of particles along the surface of the land. We catch those in low catchers, we monitor wind directions and we monitor precipitation. This one is at a place in Canyonlands National Park in Utah, a site called dugout ranch. It's partly grazed in a way maybe not so different from traditional Native American raising practices. We have other sites and lands that have never been grazed and at various elevations. The network of these is increasing. The data's building up and we hope it'll support some conclusions about the effect of climate and climate variability on the land surface.

Now that's a little bit about our research project in the geological survey. I mentioned a minute ago the national effort of the National Climate Change Assessment which has this longer title. It's to look at how the climate's varying, what it's doing to the people and the lands, and what people should think about it, and what kind of research is needed. Now, I said that this national study, mandated by Congress, run by a branch of

the White House called the Office of Science and Technology Policy, has taken 6 subjects. Here are the six. One of them is Native Peoples, Native Homelands. The leader of this whole national program, the National Climate Change Assessment, a man named Mike McCrackin, is one of the leaders of this Native Peoples, Native Homelands so-called sector, meaning subject. The draft of their report is at a fairly advanced stage. He asked if I would make it clear to this group that he would welcome contacts from people with native and tribal connections, native and tribal backgrounds to review that report and have input into the way it has been written at this early stage. I put contact information about that on the sheet that I think Margaret passed out before the talk started. The others are forest, coast, farms, water and health. Those all have probably some but not large components of native issues.

The other part of this national assessment is geographic regions. As I mentioned there are about 15 of them. U.S.G.S. has Alaska, the Southwest, substantial components of native issues. One I might mention in particular the northern Great Plains, has a particular emphasis on native issues and there is information available about that and contact would be welcome.

Mostly these separate investigations, whether they're about sectors or about regions or run through universities, the one in the southwest is run through the University of Arizona in cooperation with the U.S. Geological Survey. The coordinator there, William Sprig at the University of Arizona, asked if I would particularly mention in talking to you, that he would be eager to have contact from tribal people about research projects on

health issues as they relate to conditions of climate change. If there's direct interest in becoming involved in that, I could help you make the contact but this is eagerly sought.

Merv Tano: Excuse me, Todd. We have a representative from the National Indian Health Board that just walked in and I think she'll probably want to talk with your right afterwards.

Todd Hinkley: That'd be great. Let me go on a little bit to the general matter of remote sensing which according to my understanding is increasingly available to and increasingly exploited by native people for use on their native and tribal lands. It's air photos, satellite images, and GIS processing of the information that comes from that. The strength of it is that various conceptual layers can be put together, used together for synergistic effect, for planning of land use, finding out about land changes. In this rather simple illustration, it just shows how the geology, what's under the geology, the vegetation, the conditions of the soil moisture, the wind directions and the deposition by dust can all be separated out, combined at will to use for assessments of the conditions of land and how it changes into models of what's likely to happen under various climatic conditions.

Here I'll show you a series of three images from the landsat thematic mapper. This is a picture of the Mojave Desert taken in a wet season of a wet year. This is late April of 1992. It's false color. The red here is areas most strongly covered by vegetation. The exact same area was taken in a drier season of a drier year in 1997. The colors change. The comparison can be made either by looking at the two pictures in

sequence, or it can be made by artificially combining the two colors as in the third picture here where the bright white areas are the areas where there's been the greatest change in the two preceding images of the two times. Now what this means here where it's bright white here means this is where there was a lot of vegetation in one picture, very little vegetation, or at least a big change in the other picture in the dry season and it identifies parts of the landscape, not only where plants can grow, but it also means this is an area which is covered by fine grained soils and it's kind of a double edged thing. Plants can grow there, but it's also the kind of material that can be picked up and blown away by wind processes and the extent to which this happens varies greatly with climate change.

So, I tried to give you a general overview of how climate is an important thing to put into your thinking and your methods as you consider other kinds of risks, such as the flow of contaminants by water, through soils, and the changes in soils with time as climate changes. I would invite you to take with you a video which is there on the back table which is about the National Assessment of Climate Change and how it got started. It's a little out of date now, but it shows the foundation of the process. There are also two other books back there on the table related to the same thing, related to both changing climate and specifically the national assessment, some of which has strong native and tribal issue interests. One of them's, . . . I can't remember which is which. They're both blue. One's little and one's big and those are two titles. Please also look at the sheet of additional websites for further information and for contact which is strongly invited about various research projects around the country and at universities. There are other things

I could mention such as global modeling, of possible future climate change under human influence situations, a thing that's in its infancy, but I don't think I'll go into that. I think I'll leave it with talking about conceptually how climate is a risk, it relates to other risks. To tell you a little bit about what we're doing in our modest research project at the U.S.G.S. and to give you an idea that there is something bigger and more national called the National Assessment of Climate Change. Thank you for your attention.

(applause)

Merv Tano: Any questions for Todd? Alright.

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