PROCEEDINGS

From Floods to Drought: Practical Community Responses to Extreme Weather

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PRESENTATION OF ROBERT SANFORD

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I must say that it is an honour to be able to speak before such an experienced audience that obviously has considerable interest and passion for water issues. And I also find it very interesting to be in a province that actually has its own provincial department to deal with water issues. And also I would like to explain that I have a great deal of respect for groups in Manitoba, like Ducks Unlimited, for whom we owe a great deal of thanks on the Canadian prairies for their efforts in trying to restore semblance of earlier conditions.

Our UN initiative is aimed at being able to put Canadian water issues in a global context. And what we like to do is to compare what others have learned elsewhere about the types of issues that we are facing, so that we can do things that are going to be appropriate in terms of our response to growing populations, increased agricultural demand on water, greater industrial

withdrawals, and also changes in the amount of water that's available to us, especially on the western plains. And one of the things that we are most interested in is changing the notion of hydrological stationarity, the notion that the amount of water that we have presently available to us now will always be available to us in volumes that we are used to.

We have also created, as Glen mentioned, an institute that will deal specifically with issues related to climate change impacts on water availability and quality. And our central interest is in those rivers that have their origins in the Rocky Mountains, which includes, of course, the rivers that have so much influence on the Canadian prairies.

We are presently, in the context of that work, doing two very interesting studies. One is on the climate vulnerability of the North

Saskatchewan River. And, of course, you may understand clearly how important that is because so much pressure is being generated in Alberta for upgrader properties, et cetera, to allow tar sands exportation to continue at a relatively rapid rate and water is a limiting factor in that.

We are also working on a climate vulnerability assessment for the Bow River basin, which is part of the South Saskatchewan, in a very heavily intensely developed region, in the centre of which is Calgary.

So as you can see, we are very much involved in issues related to climate and historical climate issues such as drought and flood. And of all of the natural calamities that have plagued humanity since the birth of civilization, it is interesting to note, if you add up all the totals of the cost and the impacts, that drought has been the most devastating and the most costly. Drought causes more damage and costs the global economy far more than all of the impacts of tropical storms, hurricanes, tornadoes, earthquakes, volcanoes, landslides, tsunamis, avalanches, epidemics and famines combined.

Interestingly, only drought's diametric opposite, flood, even comes close to the devastating impacts that drought has had on humanity in the past.

It is interesting to note, when Glen introduced things this morning, you remember we have got people who have been evacuated from northern communities for fear of fire. And what you get in the absence of water clearly is fire. And then down here you have heavy rains. And I think everywhere I have been traveling lately, and also in Europe, we are faced with these two diametric opposites in greater extremes all of the time. It is a classic too little and too much scenario that we have often faced in Canada.

In Canada, clearly drought has had a very special place in the history of the west. And the dust bowl that emerged as a result of the ecological destruction of the Great Plains of North America is held to be one of the three greatest ecological disasters in history. Only deforestation of the uplands of China and the destruction of the Mediterranean eco-zone by livestock, livestock have been seen to have had a significant impact on the way we think about

ecosystems, as what happened with the North

American dust bowl.

And the lessons we learned, and interestingly enough didn't learn then, still haunt us I think today, and that's what I want to talk about by way of introduction to this conference.

For the purposes of examining what we learned and what we didn't learn from the North American dust bowl, we will define drought as a precipitation deficiency of 15 per cent or more over the course of a year or more. Now, I had to acknowledge, and many of you here will know this too, that there are probably 54 different definitions of drought and it depends on where you are and what the impacts are. You know too that it is very hard to determine when a drought actually begins and when it actually ends, because the implications often last much longer than the absence of the rain. So we will define it in that context.

Under this definition, the dust bowl drought lasted six years, from 1930 to 1936 in 20

U.S. States and three Canadian provinces. And what made the drought of the 1930s so remarkable was its intensity, its extent and duration. Temperatures on the Great Plains during the 1930s 10 sometimes reached 118 degrees Fahrenheit or 47 degrees Celsius. And what is forgotten about this is, by the time the drought ended, some 4500 people had died from the excessive heat. We forget that particular statistic, but it comes back later when we begin to realize that 35,000 people died in Europe during the heat wave of 2003. So you notice that these increased temperatures are part of a drought mortality. So what you also see is drought affects public health as well.

The biggest problem, of course, was that there was no water, and with water scarcity came other problems. There were clouds of grasshoppers that ate what little remained of many farmers' wheat and corn. Grasshopper plagues also ate the farmers' fence posts and ate the washing hanging on their clothes lines.

Now, all of us know people, and you, especially in this landscape, will know people who

lived through that period and have told you these
extraordinary stories. And I remember, I used to
hear as a kid and I was, yeah, yeah, right, and
you walked naked backwards up to school in six
feet of snow, I know. But what I find now in 11
really examining that history is that really was
an extraordinary event on this continent. And it
was the type of event that fashioned the
generation's psychology, and for good reasons as
we will see.

Now, drought is common on all prairie
landscapes. It defines it really. But no one was
prepared for this or for the weather phenomenon
that emerged after the heat had dried out the
millions of acres of plowed plains. The dust
storms that came in the wake of the drought were
of such violence that they made drought a
secondary problem in many areas. The story on
Donald Worster reports that in the United States
alone, this doesn't include the prairie provinces
of Canada, there were a total of 362 major dust
storms in less than a decade. Now, these aren't
dust storms of the order that we are used to here,
because the numbers don't even begin to belie the

story of the hardship that these dust storms caused. The impact of these storms was catastrophic.

During the dust bowl, some 408 tonnes of soil were lost from the average prairie acre. Some 10 million acres lost the upper five inches of top soil. Another 13 and a half million acres lost the top two and a half inches of top soil. And by 1938, the great plains were losing 850,000,000 tonnes of top soil through erosion a year.

Now, many of you work in agricultural areas, you can imagine what kind of impact that would have caused. The drought, like the recent collapse of the Atlantic cod and Pacific salmon fisheries, began really as an environmental disaster, but then it became an economic and social catastrophe, and then it became a political nightmare. And that is the habit that these things tend to have.

And once the magnitude of the disaster began to be realized, the first steps the Federal governments in both Canada and the United States took was to entice people off the most badly

damaged regions of the plains so that a
stabilization effect could begin. And that meant
removing people from marginal farmlands. And it
is really interesting that that had to be done,
because you would think that by that time many
people would have already left, and that was
certainly the case, but there were many people who
had no choice but to hang on. And it is
interesting to note that there was a positive side
to this relocation in both Canada and the United
States, but principally in the U.S., protected
areas, reserves, and in some cases even National
Parks were created which resulted later in
societal as well as environmental benefits on the
Great Plains. So, while it was a disaster, there
were certain activities which took place with
respect to moving people off marginal lands that
actually resulted in positive things later.

There were, however, limits to how
much land could be taken permanently out of
production. It was soon discovered that it wasn't
local family farms that were principally causing
the problem, it was the people who were profiting
from afar who were doing the most damage. And few

of these people were interested in the land as a home for themselves or for their children, they were outsiders, they were interested in the Great Plains as a means of making money. And it was these nonresident operators who comprised a third of farmers that bailed first, leaving those behind to deal with the problem.

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And for those who remained on the plains, mobility, as you can see here, in combination with the Great Depression, was greatly reduced. For them it became clear that recovery in human terms meant not just restoring the vegetation, but also saving their farms.

So the second step in the process of recovery was the creation of an economic relief structure. The term relief was meant to be a positive word that suggested the comforting of those overwhelmed by powerful outside forces. And in accepting relief, it was held that there was to be no confession of failure. Work was clearly preferable to the dole, relief meant it was only a temporary arrangement. And that didn't mean that the names of those on the dole weren't published in local papers for the edification of those who

were supporting them, but it was a trying and difficult, devastating and psychologically harmful period.

And once it was realized that the dust bowl was, in fact, caused by ecological breakdown and land misuse, the next step was to create an extensive and enduring program of soil conservation. In December of 1936, advisors put together a 194-page report for President Roosevelt 15 which proposed a new model for a regional land use planning, which would also serve as a blueprint for restoring environmental sustainability and stability on the Great Plains. The Future of the Great Plains, as the report was called, made a number of recommendations about the restoration of the Great Plains, which in my estimation, remain just as relevant today as they were in 1936.

Land destruction, the report argued, was basically the result of attitudes toward agriculture that had to be changed if the Great Plains were to be restored to any semblance of their former productivity. Interestingly enough, seven unproductive attitudes were identified in the report. The first on the list of attitudes

that the report argued needed to be changed was the ethic that claimed that people had the right to completely dominate nature. This attitude, the report objected, reduced the land to nothing more than a raw material to take advantage of and to exploit for private interests.

The second necessary attitudinal shift the report recommended was the realization that natural resources were not inexhaustible. The report argued that it was mainly this self-deception that prevented environmental adaptation and appropriate restraint on the Great Plains.

These are all fundamental tenets of ecology today, but it is interesting to note how often we have to be reminded of them.

The report also criticized the widely held notion that what was good for the individual was clearly good for everybody. The dust bowl had clearly proven this to be a false and destructive premise. What was good for you may not be good for the ecosystem or ultimately good for the productivity of the Great Plains and the sustainability of its economy.

The report also argued that the then widely held idea that an owner may do to his property whatever he likes was the foundation of unsustainable agricultural practices. In other words, you can't just do what you want and expect sustainability. You can't flaunt regulations or commonly held views on what ought to be done in common lands to protect their sustainability.

The fifth thing that this report in 1936 indicated was that markets will not grow indefinitely. In fact, the idea that markets should grow indefinitely was identified as a myth. Sustainability demands recognition of limits to growth in crops and markets, within the confines of sustainability of ecological systems. And whether those ecological systems were natural or agricultural made no difference.

The dust bowl also proved that the Great Plains could not be operated like a factory. And the notion at the time was that a transient exploitive corporate relationship to the land couldn't be sustained if people expected to create a permanent, settled existence on the Great Plains. So the point they wanted to make in 1936

is that you wanted to make sure that you had a
culture, a community on the Great Plains that
could sustain itself within the context of its
agricultural practices.

And one of the great arguments was
that if you couldn't do that, then you couldn't
really have an economy on the plains. And it was
important that communities be viable, that they be
dynamic, and that they be responsible in the
context of their environment.

And finally the report criticized
irresponsible speculation, nonresident ownership
and land abusing tenantry that was common during
the two decades leading up to the 1930s.

The report in conclusion was very
clear in its main recommendations that far
reaching economic changes had to be made to
address the dust bowl emergency and to prevent it
from happening again.

It was recognized that it was
impossible and in many ways even undesirable to
restore the Great Plains to its pre-settlement
ecological climax order. The only practical
option was to create a completely new climax

equilibrium, a human designed steady state that would have to be carefully managed forever.

Now, what this suggests, however, is that there was a time when the door was open to addressing both soil conservation issues and the need for reform of the root economic short sightedness that caused the dust bowl disaster. So at that particular time, the crisis was such that it was possible to revolutionize the whole process by which people settled on the Great Plains and developed its agricultural economy, by doing two things; changing farming practices and also changing the intent and purpose of productivity.

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In the end that's not what happened. Soil conservation was addressed to a significant extent, but there was no fundamental change in the economic expectations that lead to the need for better agricultural practices. And when the rains returned, hard won conservation practices were often immediately abandoned. Advancements such as terracing were suddenly deemed to be inconvenient to construct, shelter belts were often seen to take up too much space, wetlands were seen to take

up too much land, and soil conservation practices were deemed to be too labour intensive and expensive to continue.

In the midst of the dust bowl several states and provinces passed soil conservation laws and tested them successfully in the courts, but when the national emergency passed, public conscience waned, the laws in many cases were repealed and established mechanisms of exploitation of the land were continued as they were practiced before the depression.

It is interesting to note from the historical point that dust bowl scientists and agronomists were absolutely horrified. We haven't

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stemmed the tide, said soil conservationist Howard Fennell in 1954, after the dust bowl returned to a large part of the North American plains. He said, we are heading into the same conditions that gave us the old dust bowl, only the next dust bowl is going to be a lot bigger.

Now, the lessons for us today are really quite interesting. We face today the same constant threat of drought, but that prospect has now expanded to encompass equally troubling

concerns about the growing frequency of floods and extreme weather events of all kinds that are a consequence of global warming. It is as if we have gone full circle, but the risks have been elevated by an order of magnitude from the 1930s to the present. The vulnerabilities that existed on the Great Plains at the outset of the dust bowl are also now problems that are facing us worldwide. And the question for us is this: What specific lessons can we learn from the dust bowl so that we do not repeat the mistakes that were made then in our time? And I must admit that I was stunned at how similar certain aspects of the dust bowl culture were to what our culture is like today. And this is what I would like to talk

about next.

The ultimate meaning of the dust storms that occurred in the 1930s was that the economic model employed in the agricultural development of the Great Plains was badly out of balance with the region's natural environment. But that was not something that many people wanted to hear. And it is very interesting -- sorry, I will just leave that on here.

Now, I will go to lesson one here. And this is what I have to say about denial, you know, and our capacity for spin. Because what happens is nobody wants to hear that kind of news, and they don't want to hear news that implicates that the practices that they were employing were inappropriate. It was very, very difficult for farmers and ranchers in the 1930s to admit that what they had learned and always been told was right could now be responsible for their terrible predicament. And it was quite natural, I think, for people in that situation to be defensive. They felt that they were being unfairly singled out for blame and criticism by many outsiders, when it was they who had to face the dust and to struggle hard to save farms that produced much of the nation's food. And how can you argue that? I mean, of course they would feel that way.

And masked by the tragedy is the fact that the dust bowl also puts into relief the human capacity for outright denial. And there were many, even in the midst of the worst of the disaster, who simply refused to believe what was happening. Many on the plains, including

businessmen in small towns, bitterly resented their growing dust bowl reputation, which had begun to affect property values, bank credit and business prospects in their region. They felt that the effects of the dust bowl had to somehow be minimized, discounted, evaded or ignored, and they set out to make sure that happened. Some communities and districts went so far as to form what were called "truth squads" whose work it was to get the facts straight for the rest of the nation. And those who do not conform to their optimism, embrace their boosterism, or that saw different messages in the blowing dust, were in for trouble.

By 1939, however, ready optimism and in your face public relations were no more effective against the wind than censorship. And in that year dust storms were covering as much as 100,000 acres at a time. Can you imagine that? And enough dirt was blowing around in the prairie sky to cover 5 million acres, one foot deep. Spin can no longer cut it. Something actually had to be done. And I think there is in this a very, very important lesson for us. It seems that we

are similarly awash today in spin that aims to equate simplicity with truth and self-interest with right action. And some of you here will know how hazardous it can be to work in situations that rely too heavily on spin. Certainly I know this.

The intent of spin, as everyone knows, is to shape the perceptions and actions of others around a vision of reality you and your colleagues have created to defend or advance singular interests. The risk, of course, is that over time and by way of much repetition you start believing your own spin. And it is at that moment that the unseen whale that is the larger truth invades.

Now, we recognize that spin and public relations and lobbying are part of how business is done in our contemporary market economy. But I would submit to you that there is a risk of being too good at it. And there is a risk of being too good at it without keeping an eye on larger truths and realities.

We have all seen, for example, how effective lobbying assured that North America automobile manufacturers remained exempt from legislation demanding more fuel efficient

vehicles. They have been so successful with their lobby that they have been permitted to keep producing inefficient cars and trucks, even though it has hurt their business and our economy to do so. Because of persistent self-interests with respect to fuel efficiency and productivity, North American automobile manufacturers lost world domination of the remaining markets. There are fears that none of what we used to call the big three, the unassailable car manufacturers in North America, may even survive.

The point that I'm trying to make here is that we simply cannot afford to let spin and other consequences, and similar consequences in any of our economic sectors affect our future. And especially, we can't allow this to happen to agriculture on the Great Plains. The relationship between water and food is becoming a global concern. Growing populations and climate change are colliding with unsustainable agricultural practices around the world to create fears of severe global food shortage. More and more of the burden for supplying food to the growing number of people who are going to occupy the world in the

future fall on just five countries; France, Argentina, Australia, the U.S. and Canada. We cannot deny our problems. If we fail over the long term to generate truly sustainable agricultural practices, then the whole world is going to be in trouble. And the lesson for us today, from the dust bowl, is that we can not let spin and denial stand in the way of real progress toward genuine sustainability.

So let's talk about lesson two that we might learn from the dust bowl, is that when it collapses we can expect exotic proposals to address everything but the real problem. When ecosystems fail, expect exotic bandaid solutions to be put forward that do everything but address the real problem. A great number of ideas were put forward to halt the dust storms. For many the solution was to cover the Great Plains over. A Chicago paper manufacturer proposed a tough water proof paper that would cover acres at a time. An asphalt emulsion spread over millions of acres was also proposed, as was wire netting. Someone else proposed to cover the Great Plains with cement with holes in it for planting seeds. Another

proposed moving rock from the western mountains to stabilize the prairie soil. It was also proposed, and you will like this one, that junk cars be sent from population centres in the east and they be used to anchor the blowing soil. Leaves from eastern forests were proposed as mulch that would bind humus to the soil. Building wind deflectors was also proposed. These deflectors would be made of cement slabs and board fences 250 feet in height, which would serve to direct the winds away from the Great Plains.

I thought it remarkable how similar the proposals that were put forward to address the dust bowl problem are to the proposals being put forward in this generation to address the climate change issue. And in both cases the proposals do everything but demand that we change our fundamental habits. Similar to the 1930s proposal of somehow covering the prairies to prevent them from blowing away, it has been proposed that we somehow capture all the world's errant carbon dioxide emissions and pump them to the bottom of the ocean, where very high pressures will keep it in liquid form stuck to the ocean floor forever.

Right.

Similar to the idea of bringing leaves from the east to cover the plains is the contemporary notion of dumping millions of tonnes of iron filings into the southern oceans as a way of extracting CO2 from the atmosphere. Similar to the dust bowl notion of constructing deflectors 250 feet in height to direct the winds from the plains is the contemporary idea of launching millions of mirrors into space to deflect the sun's rays away from the earth so as to reduce the amount of radiation reaching the surface.

None of these proposals gets to the fundamental cause of the problem. The fundamental North American ethic remains the same as it was in the 1930s, and that is the problem.

The third lesson that we can learn from the dust bowl is that we should not rely even on major disasters to facilitate wholesale attitudinal shifts. In the end -- and I get asked this all of the time, well, is it going to take a big disaster to make us change our fundamental

habits? And I don't think that's going to be the

case. In the end, even a calamity of the magnitude of the dust bowl did not elicit change in a fundamental level of the economy or culture of the Great Plains. The fundamental cultural trait that created the dust bowl in the Great Plains, and the one still getting us into trouble today is our relentless, unexamined devotion to growth as a priority. Newspaper advertisements published widely in the southern plains in 1930s clearly articulate the same bigger is better in systems that exists today. Listen to this 1933 ad. Wait until you hear this. There is no standing still, we must move forward or we move backward. A town that cannot be bigger until it is better and it can not be better until it is bigger, let us remember that it is natural and normal for a community to grow unless there is something wrong, something terribly lacking in it.

This is very interesting, because I hear this logic all of the time. I'm from Alberta, and to suggest that there might be restraints on anything like this, you are considered to be somewhat deranged. Now, even six years of dust bowl life was apparently not enough

to cause a change in the fundamental societal values that favoured the endless pursuit of increase over the health of the Great Plains ecosystem. And as soon as the rains returned, farmers set out to reproduce on a larger scale the very vulnerabilities that lead to the dust bowl in the first place.

And I worry that now in our time, we appear to be prepared to take the same risks with climate change we took in support of limitless growth in the 1930s. And I wonder if that isn't an important lesson.

Though the dust bowl collapse was essentially agricultural, it affected everybody who depended one way or another on farming for their livelihood. And in Canada that is an enormous number of people. Abandoned in the dust were more than 10,000 empty homes, and more than 10 million abandoned acres of farmland. Like wildlife numbers after the fur trade, populations in many parts of the Great Plains have never returned to what they were before the dust bowl. And there are reasons agriculturally and industrially for that, but it also had to lot to

do with the disaster. And I would submit to you it is not something that we would want to repeat again in our time.

As the dust bowl persisted, its impacts accumulated. The financial cost of the drought in the U.S. alone, in the year 1934, amounted to half the money that the United States put into World War I. And that begins to give you an idea of what a drought costs. And as we have rationed it up, the investment in agriculture, we know our vulnerability. And I know from where I live, where we have proposed five-year drought plans, no one knows how to go after year two. All of the cooperative mechanisms that we have set up failed that. All of the trading of licences, all of the other ways of sharing water simply dry up with the drought.

By the time the dust bowl and its aftermath were over, at least 4 million North Americans were permanently displaced. Three generations later there are now more environmental refugees created in the world each year than political refugees. As global human impacts are further superimposed over a warming world,

populations on every continent will begin to move
in response to environmental change. And I would
submit to you, as difficult a thing as this is to
say, some of us could be among them. And I submit
this because of some of the models that we have
been able to create that suggest where the trends
that we have created now might take us in the
future. And I want to show you one of these. I
want you to watch this carefully. This is in
Glacier Park in the U.S., right on the
American/Canadian border, and this is showing the
recession of glacial ice over time.

The thing I want you to watch, besides
watching the decline of the glaciers, is what
happens to the vegetative circumstances that
follow in on behind the disappearing glacier.
What you see, first of all, is bush land, forest,
and then what you see here is grassland starting
to climb to the upper reaches of what were once
glaciated peaks. And watch it again. What I find
really interesting about this is that there is a
lot of people where I live who are taking the tact
that, well, the loss of a glacier is no big deal,
the recession has already taken place to such an

extent that the pulse of increased water availability is already passed, and what water we have got now is going to be the water that we are going to have in the future. This is the whole notion again of hydrological stationarity.

What you don't see until you watch a model like this is that long before global warming is finished wiping out our glaciers, it is going after our snow packs. And what you are seeing outside of the frame of this model is probably more important than what is happening, in terms of what we live like on the Great Plains. See how the glaciers disappear? What you are watching here is not just glacier recession, you are watching the operative advance of grasslands. And out of the frame of this, you are observing a projected model of desertification of the western plains. And this is really important, because you probably have all seen David Sashen's models of projected climate change on the Great Plains that show the extent of potential growth of semi-arid regions, and the upward northern advance of agricultural zones based on number of heat days and water availability. But one of the things

that is not being seen, that is clearly behind the science of these models, is that these dry conditions are moving north. And I have a friend who works with the Rosenberg International Forum on Water Policy, he is an American, and he keeps claiming, you know, Bob, you guys up there have got to stop pretending that there is this real line between Canada and the United States along the 49th parallel. The deserts of the American northwest are advancing northward, and the conditions that you are going to have on the Canadian west are going to be more and more similar to what we have, and you ought to be responding to that.

I think it is really interesting to note that these sorts of changes are going to have considerable impact on how much water is available, and ultimately they are going to torque the types of trans-boundary water agreements that we have between the provinces based on availability and proportion. And we have to see that coming, and we have to buy time. The lesson is that we know it, we didn't see these sorts of changes in the 30s, well, we can see them now and

we need to act in advance of those impacts in order to make sure that we are adaptable to the circumstances that will be created as a result of them.

The Great Plains committee that was set up to address the dust bowl problem was aware that new engineering technology, new agronomic processes and practices, new tax laws, et cetera, would prove inadequate over time without basic changes in the attitudes and functions of major institutions.

Unfortunately, the Great Plains group and similar organizations in Canada had neither the mandate nor the political support to make those changes happen. They did what you do when you are in trouble. Faced with a national emergency, they act to solve the problem in the immediate term. And we do exactly the same. You have to do what you have to do.

It is also important to note that not everybody was in favour of progressive change. The ecological ideas put forward in solution to the dust bowl problem were deemed to be threatening to corporate agricultural interests.

And the dust was hardly settled before these
interests mounted a counter charge. And this will
interest you because of the comparison between
what happened then and what is happening now. The
attack began with an assault on the science and
conservation programs put forward by the dust bowl

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researchers, conservationists and agronomists.
They attacked first on the grounds that the
scientific theories of ecological equilibrium and
climax made the grasslands too idealized a world.
And in an astounding preview of what would happen
two generations later in the climate change
debate, big agriculture hired professional deniers
who argued that the dust storms of the 1930s had
not in fact been as severe as many thought, and
certainly they did not have the lasting impact on
the Great Plains that many conservationists had
indicated. The attackers did everything possible
to paint conservationists as unprogressive
socialists who lacked faith in American ingenuity,
and the attacks grew more personal and vicious as
time passed.

In the end, I look at it as many
historians do, the government was kind of a

sitting duck in this. The main institutions responsible for resolving the problems that were created by the dust bowl were an easy target to such divisive criticism. Tensions grew between government departments that maintained that large sections of the Great Plains should be put back into natural grasses and those that vociferously opposed making any land off limits to the plow, and who put their trust in better farming techniques and technologies as the best solution to the dust bowl problem. And in the end it was the latter group that won out. The dust bowl example invites the question of whether our major institutions, which are just as fragmented in their function and purpose as they appear to have been in the 1930s, whether or not they are capable of addressing the problems we continue to create for ourselves in any different way. And I think that's an important question.

The seventh lesson that we might learn is that the dust storms of the 1930s can repeat themselves again. And, in fact, we look at the historical record, droughts of 20 years in duration are not uncommon on the Great Plains.

The dust storms of the 1930s meant that the Great Plains were close to death ecologically. And that invites comparisons with circumstances that we face presently in the west. And I'm not saying that they are equivalent, but it is a lot of things that you can look at and see what is happening now. Certainly, we are in a lot better shape in the Great Plains than we were in the 1930s. But we only have to look at our western rivers to see that we are still stressing, severely in some cases, our natural life support systems.

As I mentioned to you in our introduction, we like to work in the context of international example. And by way of international example, I like to think of the Saskatchewan River system kind of like the North American Danube. Now, in the context of where we live, we can look at the lesson of the Danube and what Europe discovered about itself and its future by examining its most important river system. Flowing through 18 different nations, the Danube is the world's most international water course. So because the Saskatchewan flows through many

jurisdictions and provinces, it is very similar.
The Danube is an engine that drives industrial and
agricultural prosperity in all of the
jurisdictions through which it flows in Europe.
As the European Union could never afford to
provide all the services itself, it is working to
ensure the health of the Black Sea and its
wetlands, and they are doing that because it is
into the Black Sea that everything that somehow

found its way into the Danube ultimately comes to
reside. So they are using the Black Sea as the
indicator of how well all of these 18 countries
are doing in managing the Danube River system.

Now, if the Saskatchewan is our
Danube, and I know that there are other systems
flowing into this, then Lake Winnipeg could be our
Black Sea. It is an indicator of how well we are
managing the water that flows through the centre
of the entire continent. Now, as you all know in
Manitoba, in the case of Lake Winnipeg, it is
being presently held in many international circles
that we have created the potential to have a fresh
water catastrophe of continental proportions here.
The question we might ask is, well, clearly, we

don't want Lake Winnipeg, what is happening now to it, to be an indicator of how our economic priorities function and how they are mirrored in the way we manage water resources in Canada.

What I'm saying to you is, there are indications that outside of the context of drought, that we are not doing things properly here. And in the end we might expect further decline unless we act.

Bitter and disillusioned dust bowl conservationists later articulated the reasons why agricultural conservation failed on the Great Plains. They offered farmers a technological panacea for ecological destructiveness, when the root cause of the problem was motivation and values. They fixed the short term landscape problem without altering the economic ethos that was at the root of the damage that had been and continued to be created. Technology was seen as the answer when it was only a partial solution.

And it is interesting to note that in response to the dust bowl disaster, we move briefly towards sustainability, but then we turn back. We got part way there, but we didn't get to

the roots. Instead we caved into interests that demand that we let the marketplace take care of the problem. But all the marketplace did was take care of itself. And until there is a better balance between market and ecosystem need, the fundamental problems that we are facing will not be resolved. And the problem will remain with us unsolved until we build a much better bridge between science and public understanding that leads to timely, effective and enduring policy that is evidence based and not just market based in character. And I think that is the lesson that we have got. And clearly we have all of the tools to do that. And that is one of the reasons why you are here today.

Unfortunately, one of the big lessons that still stands out today from the dust bowl is that ecological values and conservation practices are usually only accepted in North America where and in so far as they help business achieve its economic growth aims. Our enemy, I would submit to you, then and now, is the habit of continually delaying action on ecological decline until further growth is satisfied on what are perceived

to be more urgent agendas. As a consequence, we force ourselves to rely on more and more complex and environmentally damaging ways of meeting the same basic human needs. Until we change this fundamental circumstance, we are not going to achieve sustainability. Until the public knows why we must constantly invest more and more, in more and more expensive technologies that do what nature used to do for us for free, we are never going to be able to catch up with the problems that we are creating for ourselves with respect to ecological collapse, water supply and quality, and climate change. If we keep denying action on critical issues of ecosystem decline until everybody who is presently making a buck, or who will ever make a buck in the future by exploiting the circumstances that exist today is happy, we will not achieve the sustainability that we so desire and so desperately need. Ecological integrity will continue to decline until our economy, which happens to be a fully owned subsidiary of the environment, begins to fail. That is not what we want to happen.

Finally, in 1954 soil conservationist

Harold Carnel (ph) concluded that we didn't need any more laws, we didn't need any more incentive programs, we didn't need any more science. What we needed was will, the will to change. And I think that's true today. Droughts and floods will always be with us, only the will to conserve can prevent their impacts from becoming more devastating. The will to conserve can only flourish where people care about where and how they live and are prepared, when necessary, to put nature ahead of their own interests.

I came today because I knew that there would be people in this room who understand that land, water and climate are reflections of one another. By managing one, we are in effect managing the others. We know that, for example, different types of landscapes and ecosystems retain, purify and release water at different rates. Though we sometimes pretend otherwise, we also know exactly which land use impacts to avoid. We know, for example, the enormous value of natural wetlands. We know that the destruction of aquatic ecosystem health of our rivers and streams through poorly considered land use is the

landscape equivalent of wiping out our
immunological capacity of our own blood streams.
When we destroy terrestrial and aquatic ecosystem
health, we wipe out the self-purifying capacity of
natural systems, the very capacity upon which we
rely to supply us with the air we breathe and the
water we need for drinking, for life, and for all
of our agriculture and everything else we do and
make.

So in the absence of ecosystem health,
we are left only with the engineering solutions,
engineering solutions that are often the
equivalent of putting all of nature and all of
humanity on dialysis. And I would submit to you
that if there is anything that we learned from the
dust bowl, it is that technology is a partial
solution to our problem. We can't make bandaids
fast enough, however, engineering and technology
are important, but we can not rely on them alone
to save us. To make even the best engineering
work, as needed, we have to support it with
changes in our collective habits and ideals.

And I believe that it is up to people
like us to find the language, to create the

images, and imagine the solutions that will allow us to break out of the vicious circle that threatens our sustainability by threatening the health of our landscapes and water sources. And I would submit that despite differences of opinion on how we ought to do it, that we are all in this together, and if the quality and diversity of the people attending this conference is any indication of intent, we can achieve this end. We can do it also, I would submit, with a certain amount of humour, we can do it with a little style, and we can do it with grace, but all that really matters is that we do it, and that's why this conference matters. Thank you very much.

MR. KOROLUK: Thanks, Bob. We have got some time for some questions from the floor. We don't have a mic that works on the other side of the room, but if you ask a question just talk loud. It is a small room here. Any questions?

SPEAKER: This morning I read in the paper, over my morning coffee, and I read an article that the Federal Cabinet has just overturned the Supreme Court decision to allow Imperial Oil to proceed with their tar sands

drilling. I don't know if you have read that.

MR. SANFORD: Did you drive off the road?

SPEAKER: Almost. And a couple of days ago I got a bit of encouraging news that after the Federal, after the Premiers met, the B.C. government had agreed to set out, form a water conservation secretariat among the four western provinces to manage the water flowing from the Rockies. So two developments; one negative and one positive. But it seems that the public interest, you know, is not getting served properly. And I know we are trying to make strides with our Provincial colleagues, with conservation groups, but policy seems to be just struck, you know, in a two or three year planning horizon that should be done in a 20 or 25 year. That's the real issue with departmental policy, it gets caught up in the whole political game and society suffers as a whole.

MR. SANFORD: I didn't know that. That's quite interesting. It is quite -- that's groundbreaking history that broke this morning, if that's the case that Cabinet did turn that around.

Now, you brought up a lot of things, but first of all I want to tell you how important I think PFRA has been to the history of the west. So I hope people in the west still appreciate that they were the signature organization that helped the plains recover from what happened during the dust bowl.

Now, with respect to that, I think that leads to the whole notion of who is accountable for what and who acts on what level to support the types of things that you are working to do here. If you don't mind a brief digression, I would like to suggest to you that North America is very different than the rest of the world in its attitude to a number of things, principally climate change impacts, and also increasingly environmental, reaction to environmental difficulties. Where once we were held to be world leaders, we are no longer so. And over the last two years it has been the first time in my life where I have travelled abroad and actually found myself having, not to defend, but to have to accept some of the things that we have done that are viewed very, very negatively on the

international stage.

And it is shocking because we have this notion about ourselves, and we have created in the world's imagination the idea that Canada really does have an excellent environmental record, and that our environments are in good shape and that this is part of our identity and our national image. I would submit to you that in travelling very widely in this country, that's not so. If you begin to see what is being done elsewhere in order to bring prosperity to our major cities, you begin to understand that we are moving in a direction that may cause permanent damage, and what we had in the past may no longer exist in the future.

Now, with respect to that, we have a number of levels of government that are responsible for that. And I would argue that I'm disappointed in the Federal Government's response to both water and climate and other related issues. Major reform in our water policy federally has not happened, as you would know, since 1985, and there doesn't appear to be any movement towards federal presence in the

relationship that we have with the province in defining higher standards for the way we manage water and the water quality, although there are some things that are occurring as a result of cooperation provincially. I know that Wayne can probably speak very directly to this.

Provincially, it varies very much across this country. Our initiative works widely, and you see what is happening, and you also see what you have just said. On one hand you might develop really excellent policy and programs, on the other hand you take it away by allowing growth and unrestrained development. So on one hand you create the opportunity and the possibility and the other -- and I think what our biggest problem is that what we are doing positively is being overwhelmed by what we are doing negatively. So the advances are always eaten away at. This is not a unique problem to Canada by any means. I just met the person who is responsible for managing water in Phoenix, Arizona. Can you imagine the headache that guy has got? He says the same thing, every time you ratchet up a successful policy of conservation practice, we

take it away by allowing growth to eat away at it, and we are constantly pushing up and ratcheting toward disaster. I think that is a common problem.

Now, there is two things that I want to say about where the real potential in my mind lies. And I think it is really important to tell you that I think it is at the municipal and municipal district level where most activity appears to be taking place that sticks, where people actually know the landscape well, know what can be done with it, can participate collaboratively with people they know to get things done, and it seems to me that that's where the activity is most promising.

Now, I have to also say one other thing about the positive aspects of where our future might go. Through our initiative we have, and I was explaining this to Sasha and Glen last night, we have a program where we offer the best

and brightest young people in a region an opportunity to meet water experts and to dialogue for two and a half days at our expense on water in

our future. And what I have seen is that the generation that's going to precede mine can be characterized by some extraordinary potential and capacity. And I see in this generation a tremendous enthusiasm for environmental issues, a very strong commitment to those issues, a willingness to make ritual and actual sacrifices to ensure that environmental futures fulfill themselves. And what I find most interesting about this generation is that problems that have dogged us and seemed insurmountable in my generation, don't seem to faze them at all. It is in that intergenerational sharing that I hold much promise in turning this around.

What you told me this morning, though, that's interesting, that that could lead to having quite interesting consequences.

SPEAKER: I'm sure it will be an issue of debate in today's question period.

MR. SANFORD: I would hope that it would get past that.

SPEAKER: I mean, another thing when you were talking, you mentioned magic bullets, another thing that government seems to be relying

on is carbon capture and storage as a means of cleaning up coal generating power stations. I mean, show me it hasn't been proven somewhere in the world that --

MR. SANFORD: Well, it has been practiced -- we also have a domain that works in looking at those technologies. Are we are going to talk about carbon sequestering? We can talk about this later, and I also have a document that I can give you on the state of that particular thing. It has been done in Texas to some extent. Everybody has got to realize that these technologies are really expensive. That's the other thing that has to be recognized. And they have impacts in their own right, and they lead you to further complications. So maybe we can leave that and I can talk to you later, if you like.

MR. KOROLUK: Is there a question in the back there?

SPEAKER: Well, the question I have is, do you think the vocabulary, you mentioned the importance of new language and new vocabulary to pose the problems and solutions in a new way, do you think the language of ecosystems services and

the monetization of ecosystems services, as a way to get across the message of water conservation, watershed protection to policy makers is a crucial development? Do you think that's a useful tool in the policy dialogue?

MR. SANFORD: There is a lot of people -- it is a divided view on that clearly, where I see it. On one hand you have people saying, well, if we have to reduce everything to the language of economics so that business can understand and accept that we need to save environments, what kind of future are we going to have? On the other hand it can be said that the value of ecosystem services is eight to ten times more than the value of our entire global economy, that we could never afford to provide those services ourselves, and in many cases we don't know how. So being able to put the value of ecosystem services in the context of what they provide for us on an economic basis begins to allow people who think in those terms to say why, yes.

I find it really surprising that we have not yet fully understood that our economies

really do harness ecosystem function, and that they rely heavily on them and borrow strongly from them to make them profitable, and we haven't quite figured that out. So if that language works to do that, that's fine.

Now, there is another group of people who say you should never use that kind of language and that you should insist that others begin to understand the language of ecosystems in its own right. The argument there is that when you stop using words to describe things, you run the risk of losing the things that the words describe. If you no longer use the names of places and functions and animals and other things that you see as important to you in an eco-cultural perspective, then those things will start to disappear, because you no longer name them and it is easier to lose them. So many people say that you should be up on economic language, but that you better make sure that it is clear that there are other priorities. And I think it resides somewhere in the middle.

Personally, I think we have to speak in economic terms. And I would recommend to you

Jeffrey Saxon's book Commonwealth for some of the language that you may wish to employ to work out how you think, and influence others on that domain.

SPEAKER: I was interested in that computer model of Rocky, but when I was watching it I was thinking, from a geographical perspective and geological perspective probably, that it wasn't that long ago, a blink of an eye probably, that they were sitting under half a mile of ice. And as I was watching the ice recede up the Rockies, I was thinking that in the early '70's I was out at some of the glaciers and you could see the sticks as they were going back, and I was, holy smokes, the ice is receding. This was long before anybody talked about carbon dioxide and global warming. So, what would you say when you attribute the recent recession of the glaciers before our current --

MR. SANFORD: Okay. Well, this gets into I think a very important argument with respect to climate change. And I know there has been a great deal of confusion about the accuracy of the science and the amount of agreement there

is within the scientific community regarding what is natural climate change and what is human induced climate change. We now know after 150 years of research that glacial advances and recessions are very much programmed to the nature of the axis tilt on the earth, its cycles of procession through the solar system, and a whole range of other orbital eccentricities that are an essential part of our relationship to the sun. And we have now over time been able to separate those influences from the anthropogenic influences that we have seen, particularly in the 20th century and early 21st century. And we know that cycles that we have seen historically and have been able to ascertain in the long earth record suggest that what has happened here is that we should, by virtue of a planetary and orbital eccentricity, be entering a cooling period, when we are not.

The thing that stands out, if you take everything out of it, the thing that seems to be changing the temperature and climate circumstances of the planet are the introduction of large scale carbon dioxide inputs and emissions.

So I think that's been fairly clearly defined. Now, I want to tell you that I understand why there is a lot of confusion about this, and we deal with this all of the time because we are, of course, linked to the U.N.'s climate program. What I find is it is really difficult for people who even want to know a great deal about this to fully do the kind of work that's necessary to grasp such a complicated subject. It takes work to understand this, but the research has been done. When you start looking at putting 875 billion barrels of fossil fuel emissions into the atmosphere, you start getting into things where you know that because of the nature of carbon dioxide, it is likely to have some sort of impact. And what we are seeing is that I am quite satisfied with the science now, and I have to admit that I went through a lot of doubt with this. And what I found where I live is there is some really interesting problems in coming to grips with climate change. And I really began to understand why that's the case. First of all, a lot of confusion about it, which makes you doubtful in the first place. And the other thing

that's happening is that for the most part climate
change impacts are happening in places where there
aren't very many people, in the north, in the
Arctic, and also in the high regions and

mountains. That's where the presence of climate
change is really being noticed and where it is
accelerating. Even where it is not happening in
non-populated places, even where it is happening
in places where there is a lot of people, it is a
very subtle thing, and the biggest differences are
the times when people are paying the least
attention; at night and in winter. So this is
where the temperature changes are most dramatic.

We are beginning to now see that this
is a bit of a perfect storm that's been created by
the way in which climate change imposes itself
upon a highly structured society with a great deal
of stable infrastructure. It does all of the
wrong things to be easily measurable, easily
addressable and easily adapted to.

So I have for you, if you are
interested in this, we did an annotated
bibliography of 80 of the most recent books on
climate change, and comments on where the science

was at the time that each of these were published. I will get it to you so you can see that. And also, we have a number of other things that are coming out that might be very useful for you to see where the evidence resides. And, of course, you always have to make yourself, your own decision. There is one book that I would recommend for all of you, it has just recently come out, it is Robert Strom, and it is about climate change and its impact on human societies. And it is called "Hot House," I think it is. I will get it to you, it is on that bibliography. If any of you want that bibliography, give me your cards and I will send it to you. It is digital. Okay. And that might be the best one, because it answers all of the questions that you might have and you have doubts about, because it has got them ordered, it shows you where the science is and allows you to make the decision yourself on whether or not you see the validity in it. That might be the single source that I would put you to.

MR. KOROLUK: One more question, I have think we have enough time for it, if there

is.

SPEAKER: One of the issues that is striking here is that it is not going to only affect Canada, it really is all of North America. My question is what mechanisms exist between the two countries, possibly a standard national joint commission, possibly not, to look at the issue of relativities in the sharing of the water and meeting the problem? I know certainly in the west the whole issue of the retreat of the glaciers, the ability to feed not only the North Saskatchewan, the St. Mary's River --

MR. SANFORD: And the Columbia.

SPEAKER: -- are an international issue, quid pro quo. Are there potential pitfalls there? I'm guessing there are. And secondly, what are the respective positions?

MR. SANFORD: Your question is of crucial significance. And you obviously know in asking it how complicated it is. First, let me say that you are completely correct in assessments about how changes in -- climate change impacts on snow packs are going to affect international relationships.

Let me give you one example, let's take the Columbia River, which is a very major river in British Columbia and central to the Pacific Northwest in an economic sense. We anticipate now that by 2050, there may be as much as a 34 per cent decrease in the snow pack in the southern part of the Columbia. In the northern part of the Columbia it is anticipated that the reduction in the snow pack may be 12 per cent. So what you are seeing then is that there will be less water available in the tributaries in the United States to the Columbia than there is further upstream, which will have impacts on the Columbia River Treaty, which is set for a potential reconsideration as early as 2014. So already political activities are happening on both sides of the border to anticipate what that treaty might look like in a changed hydrological regime altered by climate change impacts.

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You know that the Columbia River Treaty manages those relationships, but as you mentioned, the International Joint Commission is responsible for much of what happens with respect to disputes on water issues between the two

countries, on the other part of B.C. certainly
here. Now, they are aware of these problems, as
are many of the provincial governments. And I
know that there are deliberations on how those
things might happen in the future, but I don't
think there has been enough time or there has been
enough energy and mind applied to exactly what the
implications of those things might be. 60

I would submit that there is other
circumstances that are associated with what you
have talked about that we ought to be considering
also. For example, if climate change really does
manifest itself in higher storm surges, greater
storm activity, or more intense hurricanes, you
may find refugees moving from the 19 major coastal
cities in the United States that are vulnerable to
those sorts of impacts, they might be moving
inland. People on the Great Plains who are
pressed out because of lack of water resources
would be moving to communities and to provinces
where water availability is less an issue. And I
think you are going to see not just North American
movement towards places of water security, but you
are going to see that globally.

And what I see right now as happening in the western mountain communities, like the one that I live in, people call it amenity migration, but I think sometimes it is also a movement to places where the environment is likely to be most stable over the longest period of time, and water is likely to be available. And I think you are going to see industries moving in that way also.

So I think that we have built many of our institutions, including our urban infrastructure, but also our intellectual institutions such as treaties and agreements, public legislation and laws, they are all fundamentally predicated on hydrological stationarity that is not likely to exist for long, and which means that we are going to be living in a world that's very different, where there is going to have to be an enormous amount of work on building a bridge between scientific research outcomes and public policy decisions.

MR. KOROLUK: Thank you.

SPEAKER: Well, the notion that you just re-emphasized, that hydrological stationarity resonates, it should resonate with us here in

Manitoba, and it builds also on your point of Lake
Winnipeg being an indicator for sort of prairie
ecosystem help. Manitoba Hydro is, as you
probably know, contemplating a multi-billion
dollar construction agenda for new hydro power
plants on the Nelson River. This is a massive
risk of public capital, and it is all predicated
on stationary hydrology, on a reference hydrology
that may not be valid anymore. So I think it is
an interesting issue that we really have to

grapple with in Manitoba.

MR. SANFORD: Well, it is not just
Manitoba that you have to deal with that. Right
now, because of concerns about water scarcity, do
you know that in Alberta many of the southern
rivers are already fully, if not over allocated.
And they are not granting water licences anymore.
You can imagine what that means.

So, consequently, there is obviously a
concern about whether or not we ought to be
developing more storage. And a lot of people are
saying, well, just build more dams, that's going
to solve the problem. But with changes in the
stationarity, building expensive infrastructure

may not be the right answer until you know, or at least have some indication of what the hydrology is going to do. Right now -- and this affects Manitoba, please understand this, we do not monitor extensively above 1300 metres. We don't know what is happening to that snow pack. And we are trying now to build a hydrological, hydrometeorological model or observatory there that will give us more information on that. We are doing a lot of things in the dark here, without really fully understanding what the impacts of changed hydrology in the mountains will be.

Also, I think it is really important to recognize that things are going to change in the north too. While most of the water in Canada is in the north, as you know, things are changing there too. And with higher temperatures, you can expect greater evaporation on those shallow lakes and water bodies there. You can expect the drying up of wetlands and peat bogs. And you can expect when permafrost melts that you are going to get a new hydrology based on the fact that you are going to have a lot more groundwater activity than you

had previously. So the flows of northern rivers are already under study for changes that might be consequent of five or six degrees Celsius temperature change, which is already in the pike. So all of these things caught us, everything that we know, all of the structures that we define ourselves by need to be re-examined.

And again, we find ourselves back at the '30s again where there is a number of things that we can do. We can bandaid it, or we can go out and take what is going to be clearly an important and altering situation for our culture and reform our public policy and redefine ourselves along new attitudes, habits and economic models that will lead to sustainability. So we are back there again.

MR. KOROLUK: All right. Thanks, Bob.

(Concluded)

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PRESENTATION OF HANK VENEMA

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Now, I want to build on some of the key themes that Bob introduced, and I'm going to talk about climate change and soft paths in the context of climate change. And this is a variant of climate change -- soft paths thinking, mild variant, and we will get into that in a little bit. But we are interpreting the water soft path approach as a really useful paradigm for adaptation in the water sector. And I will go through the reasons why.

This is the instrumental record of temperature changes you see are part of North America as a climate change hot spot. Okay. This is not any projection, this is not any modeling result, this is the instrumental record. We are seeing a higher rate of warming in our part of the world. This is something called the Palmer

Drought Severity Index. This is kind of a rolling average of soil moisture deficits. And you can do it over a shorter term or you can do it over a longer term. In this case it is over the whole previous century. And you see that our part of the world is drying out. So is Australia, which is -- and the projections, the climate change projections expect more of this. And certainly what you are seeing in Australia is consistent with global climate modeling.

You also see a major band here, as the April 2008 issue of National Geographic, very good story on the Sahel region of Africa, and you see the rainfall isolines moving southward corresponding with this drying out, this intensification of the Palmer Drought Severity Index.

Just some more climate change modeling results. Too much detail, only the important thing is, whatever the time frame, be it in about 25 years or in about 90 years, our part of the world warms at a higher rate than the rest of the

world. Okay. So we are, it is accepted, we are
in a vulnerability hot spot. Our part of the
world, unfortunately, is a climate change 5
vulnerability hot spot.

This is reinforced by a recent report
from NRCan. This actually should have been
released before the Bali Climate Change
Conference, wasn't, it finally came out. It is a
very important document and it clarifies exactly
what we know about the science of the climate
change on the prairies. And I'm just going to --
there is probably too much text -- apologies --
I'm going to take you through some of the key
things. Both Bob and Glen have mentioned bits of
this.

Scarcity, this is our -- water
scarcity, our most serious climate risk. The
report was unambiguous about that. Droughts of
extreme severity or long duration, and
variability, variability that is likely to exceed
the coping capacity, the coping adaptive capacity
of communities and industries in the prairies.

And this is not -- what is interesting
is this is a Government of Canada document that's

saying this now. I think that's the significant thing here.

Water variability, more frequent drought and a shifting of the hydrologic budget, which is really interesting and really bears on how we manage water on the surface. There will be more precipitation in the winter and spring, and less in the summer, when crops need it the most and when temperature is highest. So that gives us some idea of the adaptation demands that will be placed on us in re-distributing that hydrologic budget.

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This is an important issue that the report identified as well. Our processes of adaptation are not well understood. We have the very compelling example of the dust bowl where adaptation was difficult and done not in any kind of sort of planned or coherent fashion until it was very well advanced. There was all kinds of recalcitrance wanting to avoid -- wanting to embrace the more wild-eyed proposals and not wanting to do the nuts and bolts of restoring the ecosystem services that PFRA eventually got around to doing, but it took a while.

The adapted capacity is only potential. Okay. We don't know exactly how we are going to mobilize it, but institutions and civil societies will play a key role, that much we know. 7

Just some comments about minimum tillage practice and crop diversification as being important elements of adaptation. Progressive water policy and water conservation programs as well will be a part of this adaptation agenda.

So, just to try and give a little bit of a visual here, this is a soil moisture deficit, the details don't matter, the red is the highest soil moisture deficit region for a supposed climate normal period. And then that's what the most severe soil moisture stress zone looks like around 2050 for an average climate change scenario. Okay.

Just a couple of points with respect to -- I should back up and show you -- I suppose many of you have seen this, this image that Bob spoke about. This is an algae bloom in the north basin of Lake Winnipeg. Well, we can anticipate that the stresses causing those algae blooms will

intensify with climate change, and that is dilution capacity will decrease as stream flows decrease and lake residence times increase. And as well the dessication of organic soils, because of climate change, the impact of higher frequency extreme events, which we have spoken about more extreme droughts, more extreme floods, will cause a flush of dessicated organic soils and will make the nutrification issues of Lake Winnipeg worse. That is the consensus science.

Now, I won't belabour this, but we know our past experience with extreme events, we know that was a picture from the dust bowl. This is a picture taken out side of Rosetown, Saskatchewan in 2002. So the important message here is that, despite our best efforts, our soil and water conservation practice can be undone and rather quickly. You can see the soil drifting here after the 2002 drought.

So I will just continue here. Some extreme events, recent extreme events, 2005 flooding in southern Manitoba. The floodway, the Red River Floodway flowing full in June of 2005, entirely unprecedented, so a little bit of

context.

So those are the risks and we should understand them clearly now.

Now, this is kind of cobbled together from some Environment Canada literature and the Intergovernmental Panel on Climate Change. The key message here is that an adaptation strategy in the rural agri ecosystem is going to have to focus on water use efficiency and integrated water resources management. We are going to have to crack this nut of integrated land and water management, and this jurisdictional fragmentation will be overcome or we will not succeed in the adaptation challenges out there. And that's clear from the international literature.

The IPCC says about integrated water resources management, there is no -- it is still something we are learning how to do, but unequivocally it will reduce climate change vulnerabilities. Okay. And there is a whole set of things about that that are important, basically, at a policy level of how we get land and water management linked.

And, you know, there is a bunch of

knock-on agricultural extension issues that we
have to tackle too, and sort of our ecological
goods and services programming agenda, which there
is much interest in, and integrating that on a
watershed basis and linking that with integrated
water resources management, those are critical
pathways going forward.

So I'm going to talk a little bit now
about the water soft path concept as adaptation.
Now, the water soft path concept, as recently
popularized in Canada by the Gordon Foundation and
David Brooks, who was working with this in our
Manitoba work, basically has a perspective of the
municipality or the city or kind of a -- it has
the perspective of a municipality oriented. What
we are talking about here is soft paths at a
Provincial level. And there is a difference.
When you are talking soft paths at a
jurisdictional level, you can imagine, you can
imagine cultural and behavioral changes focused on
water conservation and technology that will
dramatically reduce your water consumption from
something like business as usual to some desired
future position where you are very, very efficient

about the use of water.

Now, it is something else when we talk about water soft paths from a Provincial perspective. It means something different. And I will get into that in a moment and you will see why. I leave this out there as a claim right now, and you will see if I can back it up. But what we are talking about here, from the perspective of a province, from a large ecosystem, this idea of reducing, changing the way we think about water, changing the way we think about producing and using water is adaptation, is adaptation. So we are re-interpreting soft paths for adaptation for climate change adaptation.

So I will say a little bit about soft paths. It emerged, the idea comes from Amory Lovins, who was actually an energy analyst at the Rocky Mountain Institute in the '70's. And he said all of energy policy is focused on the supply side, let's look at the demand side and let's look at the way we use energy. And he advocated all kinds of hyper-efficient technologies and decentralized supply, as an alternative to thinking about big coal plants, big hydro plants

and no changes in the way we use energy.

Now, the analogue in water is the same. There are all kinds of things we can use to do, to use water efficiently. And it is very important from the perspective of a city or municipality. We can use water more efficiently and we can also generate it decentralized. We can generate it, not from huge dams, but we can increase our water supply from watersheds, okay.

So there is two aspects of the soft

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path, and it is hyper-intensive end-use efficiency and distributed supply. And whether it is water energy, the analogue is the same. Instead of big massive gigawatt scale coal plants, how about thousands and thousands of small micro turbines and wind turbines. Let's think about water the same way. Okay.

So I'm not going to belabour this, I think I have said enough, except that the soft path looks at water from an ecological perspective, and it does not attempt to solve water supply problems with massive infrastructure. It looks at the demand side and it looks at the distributed supply side. Okay. That's enough.

Now, the water soft paths study that we are doing in Manitoba focuses on the Manitoba agricultural zone. And this is the region, this is the portion of the province where there is significant human population and human activities, either on the landscape or in the direct use of water, have an influence on the hydrologic cycle. Okay. So our study is limited to that portion, essentially agri Manitoba.

Now, just, it is a technical study, we looked at 94 independent sub watersheds, we looked at a watershed budget model that's based on work done by the FAO. We used sort of a 30-year climate normal, and then we looked at climate change scenarios and, you know, your standard hydrologic inputs, temperature, precipitation, snow accumulation, land use, crop types, livestock populations, all of that kind of thing. And then we did some analysis. The outputs are soil water storage, water surplus, water deficit, run-off, this kind of thing. So it is kind of a global hydrologic analysis of the agricultural region of Manitoba.

Just some -- we had some land use

data, some crop type data, crop information, soil type information. This is a kind of characteristic Manitoba hydrologic profile. The precipitation peaks around now, around this part of the year, June and July. But we don't actually see that as runoff in our rivers. The runoff actually comes from spring freshets. And what is going to be interesting is that when climate change, we are predicting a shift in this, and we will have to capture more of that peak early in the year, and we may have less precipitation overall to contend with. But the important thing is, look, the volumes here are significant, the volume under this curb is the input to the system, if you will. The volume under that red curve is what we actually have to use for our human purposes more or less. So elaborate technical model constructed, generalized for the entire agricultural region of Manitoba, and some calibration, technically it is working fairly well. The important thing, this is the kicker, all of that just sets up this slide. Okay.

We use directly in Manitoba 0.15 per cent of the total water budget. Irrigation,

domestic use, livestock use are negligible. Okay.
And this is different from other jurisdictions.
The total human abstraction from the hydrologic
budget in Manitoba is tiny, the direct human
abstraction.

Agri agrological processes, watershed
based ecosystem processes control 99 per cent plus
of the total water budget in this province. There
are important issues here at a municipal level.
You can expend a lot more money building new water
plants if you are a municipality, or you can go
about trying to make your water use efficient.
That is important, this 0.5 per cent is important 15
and the water soft paths' perspective
traditionally is important in this domain.

In this domain it is all about
decentralized supply, because this is where our
major vulnerabilities lie, and this is what Bob
was talking about. If we want to buffer our
vulnerability to water supply interruption, we
have to focus on this 99 per cent that is
controlled by watershed based agri ecological
processes. Okay. If we want to buffer our
exposure to floods and droughts, this is where it

happens.

In terms of potable water supply, fair enough, we need to think about the traditional soft paths approach and human end-use efficiency. But if we are concerned about the overall vulnerability of water supply interruption, from a Provincial perspective, we need to be here.

Just a point on that, and this gets back to the ecosystem services valuation argument, point I should say, that I raised in my question to Bob, and the language we can use to make this point to policy makers. The value of ecosystem services around groundwater replenishment, flood mitigation and water quality control at a

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watershed perspective, watershed based ecosystem services, this is in the range of perhaps 50 or 60 to several thousand, perhaps $5,000 a year per hectare. Whereas -- and that's the adaptation, that's the climate change adaptation component here -- whereas the ecosystem services related to the climate mitigation, carbon trading, which you normally hear about, is probably an order or two -- an order of magnitude or two worth less. So, there is an enormous economic rationale to

re-building those ecosystem services in our
watersheds, primarily for flood and drought
protection and groundwater replenishment. So I
hope that's clear.

Again, the classic example of that,
and I have raised this in other fora in the
province, is the New York City example and their
water supply issues. We had actually someone here
last week from the New York Catskill's Watershed
Agency. The City of New York was confronted with
a $10 billion bill to buy a new treatment water
plant. Water had been sourced historically from
the Catskill Mountains just to the northwest of
the city. But unsustainable agricultural, if you
will, unsustainable agricultural practices had
degraded that water supply to the point that it
was no longer appropriate for human use.

So the City of New York was faced with
the choice of spending $10 billion on a new water
supply plant or re-building the ecosystem services
in the Catskill's watershed, and they chose the
later at one-tenth the cost. So the economic
rationale for rehabilitating watersheds for water
quality and water supply is enormous.

Just some more work we did on the technical side, we actually looked at climate change scenarios, which do not capture extreme events, they only capture -- there is only now starting to be some climate change modeling work that captures extreme events, and the higher frequency droughts and floods. We were limited to changes in averages, so that's what we modeled. And we modeled the influence of, you can see here, for a typical watershed, or an average runoff in 2020 and 2080, you see much reduced runoff for a particular case. So we have reasons to be concerned.

We have done some work on where water stresses are likely to occur, and this is a strong function of land use and we need to do some more due diligence on this, but this work will be coming out shortly. I just want to point out some of the future directions for this work. There is a technical report and a policy overview that really emphasizes the implications of soft path thinking in the Manitoba Provincial context and distinguishes it from a municipal context. Our key water vulnerabilities, from a Provincial

context, are due to climate change and
interruption of those agri-ecological and
watershed processes that control 99 per cent of
our water budget. That's where our key
vulnerabilities lie, from a Provincial
perspective.

So we argue that it is essentially
synonymous with climate change adaptation. The
critical challenge is to buffer floods and
droughts using watershed based ecosystem services
to re-distribute available water. And this will
generally generate -- this will generate water
quality co-benefits. So the science is fairly
clear that we will see more water in winter and
spring, and we will need to reproduce that water.

So I guess the emphasis is here that
watershed based integrated water resources
management is the core of the adaptation agenda.
And this is -- the reasons to do this are clear
from the climate science. And as I say, the
intergovernmental panel on climate change is
absolutely clear that this watershed approach to
ecosystem services generation will reduce our
vulnerabilities.

The institutional capacity to do this is the critical question. In Manitoba -- and I want to a plug in for the Conservation Districts Association and that program which is extremely important in Manitoba to execute this. And we are pleased to see that that program is getting higher profile, but I'm going to make one further point about this and where we place our budgetary priorities.

This is an analysis of the prairie 20 provinces and where integrated water resources management sits as a budgetary priority, despite everything we know about the value of ecosystem health and resilience to climate change, we don't spend on it. You see the budgets approximately reflective of populations, and we see the total amount of spending on agri-environmental issues in its various silos, and in rural municipalities, it amounts to about 5 per cent of budgets across the provinces.

What we actually expend on the integration function that pulls it together and says this is the rational way to link environmental, agricultural, agri-ecological water

resources issues, the way to plan for it is
minuscule. Okay. And it varies a little bit
because there is some definitional issues when you
interpret the various Provincial budgets, but
fundamentally it is negligible. Okay. And this
is where our resilience lies and this is what we
have to start making a budgetary priority.

So I just thought I would leave you
with that as kind of, a sort of challenge, forward
challenge, to impress upon policy makers how we
are going to have to resource this watershed based
ecological agenda. So I will leave it with you.
I will leave that point with you. So thanks so
much for the invitation and your patience with me.
Apologies for the interruption.

THE CHAIRMAN: We have got maybe a
couple of questions, may be a couple of questions,
some questions before lunch. We have got a lot of
information in front of us for the afternoon. We
will look at some of the programs that we do have
working for us quite well in this part of the
world.

Are there a couple of quick questions
here?

MR. VENEMA:
There is a project that's -- the
water soft paths' work thus far has been largely a
policy and technical desk exercise. The second
phase of it, we anticipate, is the fully laying
out and adaptation program where we would do those
kinds of consultations. But this is the spade
work, laying the foundation, getting our heads
around the water budget analysis and its
implications. That's been the bulk of the first
phase of work.

As I say, the second phase we
anticipate that more consultative process working
with groups on what is working with respect to
adaptation.

We have done some work on that, and
that's the Prairie Climate Resilience Project done
for NRCan. I can talk to you about that more
because that's coming to an end now too in this
fiscal year. And that involved a lot of focus
groups and producer level discussions, basically,
at the farmer level. What is -- how are you
coping with extreme events now and weather shocks
and extreme weather shocks now as a proxy for what
you are going to experience in the future. The

logic being, the ability to cope and adapt with recent historical shocks is a necessary, perhaps not sufficient, but a necessary condition for future adaptation.

And then we kind of interrogated the policy constraints and drivers of farm level adaptation as experienced in the last ten years. That's a different study and results of that one are coming out this year as well, so I will be pleased to share that one with you as soon as it is ready. Yes, Greg?

SPEAKER: (Inaudible). Can you suggest which provincial jurisdiction is practicing soft path?

MR. VENEMA: They are municipalities, I guess, would be the short answer. And I think I would say the City of Victoria is doing some fairly interesting work right now. Other good -- well, other good examples would probably be in California, actually, various jurisdictions within California where they have really had to confront these issues.

I would say it hasn't -- I mean, there has been some work done in a very small scale

around agriculture, and that's been sort of
diverting water from lower value water intensive
crops to higher value less water intensive crops,
that kind of thinking, but it is done at a pretty
small scale. It hasn't been done yet -- that kind
of analysis really doesn't apply in Manitoba
because we use so little of the available water
budget directly. We have evapotranspired so much
of it, or it runs off. The combination of run-off
and evapotranspiration fully dominates our budget.
So that's where our vulnerabilities and our
opportunities lie. So that sort of more economic
interpretation of water soft paths doesn't apply
here. Where it has been done in agriculture -- I
believe David Brooks and the Gordon Foundation
people did some work in the Anapolis Valley in
Nova Scotia on sort of redirecting water between
crops. And that's essentially what has happened
in California too, they have re-diverted, they
have taken water now away from irrigators and put
it back to higher value uses. Anyway --

THE CHAIRMAN: One more question.

SPEAKER: I was wondering (inaudible.)

MR. VENEMA: Well, it is not, I mean,

this all doesn't happen in a regulatory vacuum

either, of course, right? I mean, the incentives,

the signals for watershed based water conservation

have to be there. And it doesn't mean, you

don't -- I don't think it follows logically that

you then have an open access resource. So there

is -- this happens within a regulatory framework.

So I don't think -- I mean, you are right, it is a

risk, but I think there are ways to -- I mean, we

have a licensing process for groundwater

extraction now. Could it be improved? Well, I'm

sure it could. Would it be, would it have to be

improved if we saw this decentralized water

capture? No doubt. But it doesn't happen in a

regulatory vacuum.

THE CHAIRMAN: Well, thanks, Hank.

MR. VENEMA: My pleasure, thank you.

(concluded)

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PRESENTATION OF DUCKS UNLIMITED

STACEY HAY AND GREG BRUCE

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MS. HAY: Okay. Thanks. I realized

after I titled this presentation that it might
sort of sounds like I am implying that humans are
not a part of nature, that's not what I was going
for, but I think that this title just really sort
of gets to the heart of my presentation, which is
that wetlands really are a solution, partial
solution to a lot of the environmental problems
that we are facing today. But we continue to lose
these valuable ecosystems. Up to 70 per cent of
our wetlands have been lost in settled areas of
Canada. And a little later on in my presentation,
I will talk about a specific local example of
wetland loss and degradation.

Okay. So just a quick outline for

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you. I'm going to talk first, just to start
things off, about what wetlands are exactly. I
know most of you are probably very familiar with
them. Then I'm going to talk a bit more -- I'm
going to expand on what Bob and Hank have sort of
started talking about today with the economic and
environmental importance of wetlands. And then
finally, as I mentioned a second ago, I'm going to
give you a specific example of wetland loss here
in Manitoba, at Broughtons Creek watershed, and

that is some research that we have been doing in
partnership with the University of Guelph. And
then Greg is going to come in and sort of wrap
things up and give you a perspective of where we
need to go from here to stop wetland loss here in
Manitoba.

So what are wetlands? As biologists,
we like to define things where we can and it
actually is a little tricky with wetlands. I
think part of the problem is that we have such a
wide diversity of wetlands across Canada. We have
got the coastal and boreal wetlands that are quite
different from what we have here on the prairies,
which is where I am going to focus my talk today.
But one definition that is quite often used is
this one that is taken from the Canadian Wetland
Classification System. And there are sort of
three common elements that it identifies that all
wetlands share. The first is that the land is
saturated with water, whether or not you see water
above ground. The second is that the soils are
poorly drained, or hydric we sometimes call them.
And then finally, wetlands have vegetation that's
adapted to the wet conditions.

When we think of wetlands, I am sure most of us probably think of the wetlands that we are showing down in the bottom left-hand corner and sort of in the centre of the screen; body of water present throughout the year, cattails usually is what you will see, sort of the bigger wetlands. But I just wanted to start off by pointing out that wetlands come in a lot of different forms here on the prairies. The screen only applies to what you see sort of in the prairie region. You have ephemeral or sheet water wetlands up in the top left, and they are -- sort of just have them as the snow is melting in the spring, they go away pretty quickly. Temporary wetlands and seasonal wetlands are other ones that tend to dry up throughout the course of the year.

So, I'm just going to talk a bit about temporary and seasonal wetlands because they are pretty relevant to the discussion that we are having today around adapting to flooding and droughts. These wetlands, as I mentioned, disappear over the course of the summer and fall, or periodically they will retain shallow surface water. And these ones actually have the greatest

capacity of all wetlands types to return water back to the soil. Water sort of percolates through the wetlands down into the ground below and into the atmosphere. They are very significant when we look at reducing the impacts of flood. They are small on the landscape, but collectively they are quite significant.

A couple of other points about these types of wetlands, they have the highest amphibian diversity of all wetlands types and they are crucial to the water foul lifecycle.

These wetlands, as valuable as they are, often are subject to draining and consolidation on agricultural lands, and that happens through process of sort of draining several smaller basins into one larger basin, consolidating.

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It is important to note we often think of bigger as being better in life, and when it comes to these temporary and seasonal wetlands, that really isn't the case. If we just look from a water foul perspective here, if you were to consolidate one hectare of wetlands into a single ten hectare wetland, we are actually reducing the

breeding capability for water foul by 66 per cent.

So I have already sort of touched on the concepts of natural capital and ecological goods and services today, as have our other speakers, but I thought I would just throw up some definitions that are sort of common definitions. When we are talking about natural capital, such as a wetland, it is really just the stock of natural resources, environmental and ecosystem resources and land. And ecological goods and services then are the things that flow from this natural capital. It is really all of the economic, ecological and social benefits that we are deriving from the land.

This screen just shows that we have got maybe five or six different types of natural capital here. If we take a look at wetlands on the screen, it lists some of the goods and services that they provide, things like nutrient retention, flood control, wildlife habitat.

And Ducks Unlimited Canada has done a lot of work in recent years to sort of promote these concepts of natural capital and ecological goods and services. And these are some of the

documents that we have produced over the past few years. The first in the top left corner is the value of natural capital in settled areas of Canada. And that's a document that an economist at Simon Fraser produced for us, Dr. Nancy Olewiler. What she did was basically take a look at what was the economic sort of dollar figure attached to retaining natural lands. And I think it was four different case studies across the country.

Next we had our natural values report that came out after the Walkerton Inquiry. And that report really took a look at the benefits of riparian areas, wetlands and upland management practices for water quality and quantity on the landscape.

And these last two documents on the right are fact sheet series that I have been working on for the past two or three years now I

think it is. What we tried to do with the first
one is take a look at a wide variety of natural
capital, I think we had about 18 fact sheets in
that series, but we really tried to drill down and
identify what the ecological and economic benefits
were for each of those.

Then finally, we are just halfway
through the next series now, and it is taking a
look at exactly what we do from sort of a program
and policy perspective to conserve natural
capital.

If you are interested in any of these,
they are all available on our website, ducks.ca,
and a lot of the information that I will be
presenting in the next few slides are sort of
contained within here.

So I'm just going to sort of address
the theme of today's workshop for the next few
slides. Wetlands are incredibly valuable for
storing surface water and for reducing flood water
peak discharges. And I will just show you a
couple of case studies next that sort of

illustrate that.

In the Mississippi River Valley, there were pretty damaging floods in 1993 and 1995, and they were attributed to wetlands loss at the end of the day. Other studies showed that restoration of about 7 per cent of the watershed was needed to sort of alleviate even the most extreme floods in the future, or mitigate them.

So then another study also followed up and took a look at the cost of wetland loss, if we know that wetland loss is what is causing the problem, what is the cost of replacing those wetlands that we are losing in Minnesota each year? And they figured 5,000 acres of wetlands are being lost each year in Minnesota at a cost of about $1.5 million. This information is more than ten years old now too, so you can expect that cost to be quite a bit higher in today's dollars.

Another case study here, in New England, the Charles River Basin Authority acquired and preserved 3,400 acres of wetlands as a natural means of controlling flooding. The alternative, to construct dams and levies, would have been about $100 million, so quite the cost

savings there.

Wetlands also recharge our groundwater supplies, as I touched on briefly earlier. The water percolates from the wetlands through to

underground aquifers, and the ability of wetlands to move water back down underground sort of varies with a whole bunch of things such as their location in the landscape, but they are quite valuable from that perspective.

They also help to prevent erosion. When water comes into the wetland, the vegetation sort of disperses it and reduces the flow, reduces the velocity of the water coming through.

From a water quality perspective, nutrients are -- wetlands retain sediment as they come in to the wetland itself. You can see here I'm showing in the right-hand column that up to 70 per cent of the sediment is retained in wetlands.

Wetlands, they are also incredibly productive ecosystems and they are able to actually take in pollutants, things like excess nutrients, pesticides and coliforms and basically render them harmless. What we are showing here then is that up to 95 per cent of nitrogen is

retained in wetlands, 92 per cent for phosphorous, and then coliform is up to 90 per cent. And pesticides, basically what we are showing here is that it takes from less than a day to months to degrade the pesticides in wetlands.

We will switch gears here a little bit and just talk about some of the research that we have done around carbon, sequestration of wetlands, it is an area that we have been involved in for, I am not exactly sure, probably at least the last five years or so, a little bit longer than that I think. A lot of this research is still going on, but basically what we are trying to get at is what is the carbon sequestration potential of wetlands.

So some preliminary findings then from this work are that greenhouse gas emissions are generally low from wetlands, wetlands are natural emitters of greenhouse gases. Things like methane have always come out of wetlands. It has nothing to do with the enhanced greenhouse effect that we have seen in recent years. But now we also know that the overall balance, they are taking in far more carbon that they are emitting into the

atmosphere.

The second point here, carbon storage in grasslands and wetlands is generally higher than in annually cropped lands that surround them. So we have found that now. We are doing a little bit more work to sort of narrow down exactly how much greenhouse gases they are taking in. So we can say now we are fairly confident that they are quite valuable in fighting climate change.

And then also, so they are sequestering the greenhouse gases, but as we start to see more effects of climate change in the future, and increases in extreme weather events such as flooding, wetlands are going to be increasingly valuable in adapting to those conditions.

So the economic value of wetlands, touched on this a bit in the some of the studies that I have shown you so far. But for certain ecosystem goods and services, or ecological goods and services, we have been able to attach a bit of a dollar figure to those services. And these are just some examples. For instance, here a local example in Manitoba in the upper Assiniboine River

delta, hunting generates a revenue of $10.71 per hectare per year, wildlife viewing and other, $4.61 per hectare per year. Carbon storage, which I just mentioned, if you take a look at what is happening in the boreal forest, the carbon that those boreal wetlands are sequestering, the value there has been estimated at $349 billion. And then other EG&S provided by those wetlands and boreal have been valued at 80.4 billion, so extremely significant dollar figures here.

Then again just another, a lot of studies have sort of placed the value of all of the ecological goods and services that wetlands produce at somewhere between about $5,700 to $24,000 per hectare per year.

So we know that these wetlands are extremely valuable, both from an ecological and an economic perspective, and we can start to attach some dollar figures to those goods and services, but we also face cost of wetland loss. They are not apparent necessarily, you don't get a bill at the end of the day every year when we lose more wetlands, but you can start to see these costs come in with things like water treatment. If we

lose our wetlands, we are losing filters on the landscape, and those nutrients, for example, have to be pulled out by water treatment plants, so increases in water treatment costs, increased insurance costs due to flooding that we are seeing on the landscape due to wetland loss. Property value can be decreased because of a lack of sort of esthetic values. Decreased revenues from

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things like tourism, wildlife viewing, hunting, that are associated with healthy ecosystems.

So now I am just going to talk a little bit about some of the work that we are doing in the Broughtons Creek watershed here in Manitoba. This is research we have been doing in conjunction with the University of Guelph. And the real question was what sort of changes have there been to wetlands between 1968 and 2005, and what has this meant for water quality and quantity in Manitoba.

We are just sort of on the cusp of releasing all of the results from this study. But what I am really going to show you today is just sort of the front end of this work, which is what changes have we seen to the wetlands so far.

So just some background on Broughtons Creek watershed, I'm sure a lot of you are familiar with it, but it is located within the RM of Blanshard in southwestern Manitoba, it is about 25,000 hectares in size, and there we are showing sort of the landscape composition there, 74 per cent of the watershed is used for agriculture. It is important too to keep in mind that this does have an application to the Lake Winnipeg watershed, it is a part of the Lake Winnipeg watershed. The Broughtons Creek watershed itself empties into the Town of Rivers reservoir, it is quite an important water source for Rivers. Ultimately it flows into the Assiniboine River and the Red River, which empties into Lake Winnipeg. So that's something to keep in mind as we are sort of going through this.

This is a snapshot of what the northern part of the watershed looked like in 1968. You can see here is just the little box sort of showing you exactly what we are looking at. Here we have got wetlands shown in blue, we have got lost and degraded wetlands in 1968 shown with sort of red cross-hatching. Then we have got

the drainage infrastructure shown in red. So this is 1968.

This is what that area looked like in 2005. Dramatic increase in drainage, you have got some of the larger wetlands that weren't present before, and that's because of the consolidation that I mentioned at the front end of my talk. Really dramatic change in what we are seeing.

This is an aerial photo, it just shows some of the work process that was sort of done to get at this information. This is what this little section of the watershed looked like in 1968. You can see there is a fair number of wetlands there. This is the drainage infrastructure that was already present in 1968.

Now, if we go forward to 2005, this is still a 1968 photo underneath, but we have got now the drainage infrastructure from 2005 on the landscape.

Here is the 2005 photo. Very few wetlands left, actually virtually nothing there now.

So here is sort of an overall snapshot of the entire watershed. Again, we have our

existing wetlands shown in blue. You can see that they were quite a bit more abundant in 1968. Lost and degraded wetlands are shown in the cross-hatching, and I don't think it is showing up too great here, but you can see there is a lot more red on the right-hand side of the photo. And another thing to kind of take a look at here is the warmer, the reds and the yellows, are really showing where the loss and degradation of wetlands has been greatest.

What we found at the end of the day 18
was that just between 1968 and 2005, 70 per cent of the wetlands had either been lost or degraded in that watershed. It is important to note here too, we weren't able to take a look at what had happened prior to 1968. There was likely a bit of drainage going on before then too, and this loss continues today.

This just shows sort of what has happened as far as drainage area goes. The 1968 is on the left-hand side of the screen here again. The blue areas are showing you that those areas would have drained into wetlands which would have then filtered that water that came into them. The

beige is showing that that land basically drained directly into streams.

So when you take a look at what is going on in 2005, there has been a great increase in sort of the beige areas that are draining directly to streams without having passed through wetlands first.

What does all this mean for Broughtons Creek and for the rest of Manitoba as well? Well, still early days, we haven't put out all of our results yet, but we can say that increased peak flow and average annual flow in the watershed has increased, and that's accordingly increased the risk of flooding.

We have also seen an increase in the amount of water that directly enters streams, as I was just mentioning, lakes, and other water bodies without being filtered. So this water doesn't have a chance, or there is no opportunity for wetlands to retain those nutrients and other pollutants before it goes into our streams or rivers.

We are seeing also an increase in sedimentation and increases in the amount of

phosphorous and nitrogen that are leaving the watershed. And again, that increase in the drainage infrastructure which you saw in the photos has basically facilitated the movement of soluble phosphorous, phosphorous that's in the water to downstream water bodies.

So I'm going to let Greg come up now and sort of run you through where we need to go in the future.

GREG: Well, good news and bad news, good news, I have two slides, the bad news is I can speak for half an hour to each one of them, but I won't.

Stacey has done a really good job of outlining the implications of, I guess of the anthropogenic influences basically of our ability to withdraw from our bank of natural capital. And we haven't done a very good job, frankly, of redepositing into that bank. I know when I first got married, I had some financial problems and my wife solved it very quickly, she took out the scissors and got rid of the cards. It is going to be more difficult with our natural ecosystems.

One of the things we need to do as we