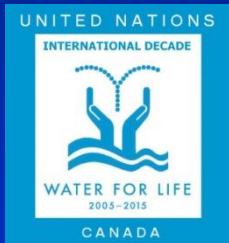
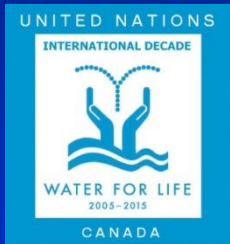


Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



R.W. Sandford
EPCOR Chair,
Canadian Partnership Initiative
United Nations Water for Life Decade

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

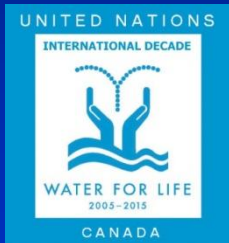


**How we know what we know, or
think we know, about dinosaurs.**

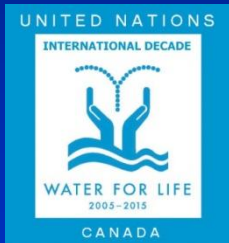
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There was not enough food on Isla Nublar to support that many dinosaurs.

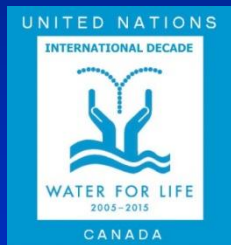


Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



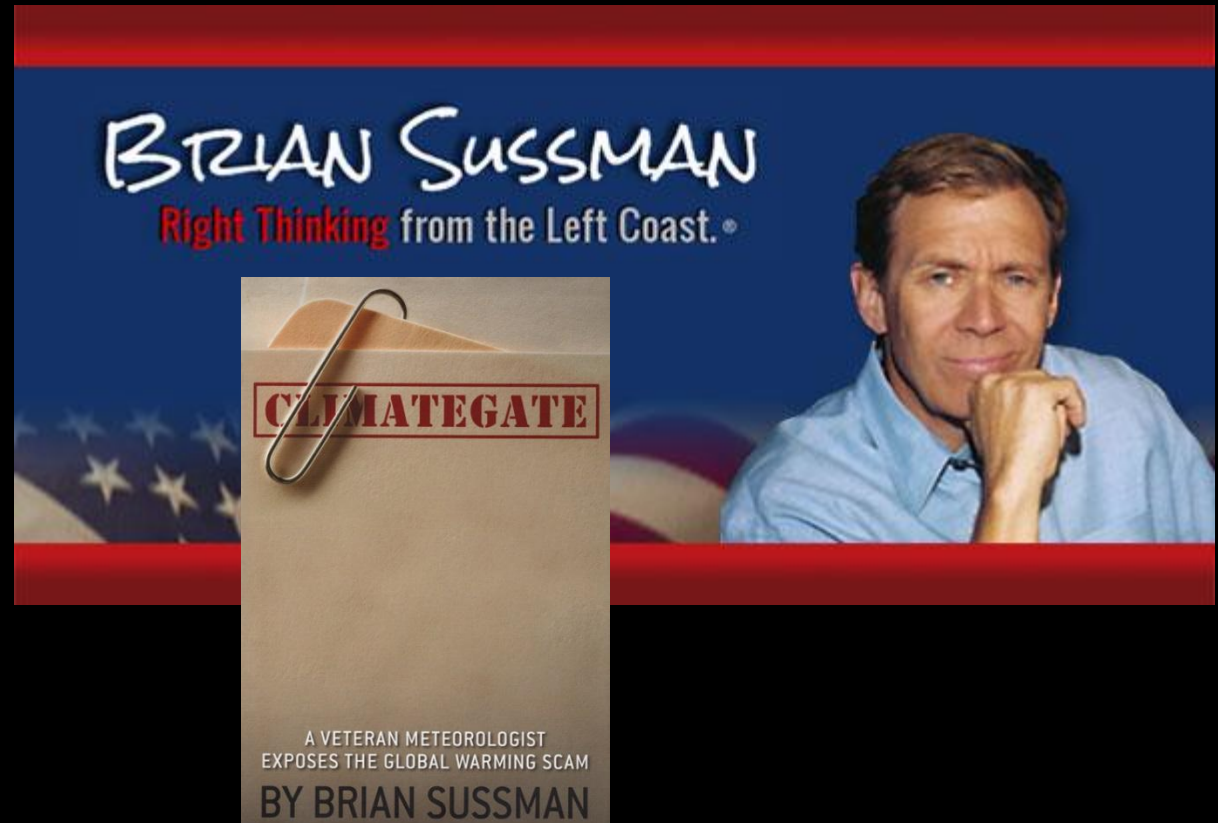
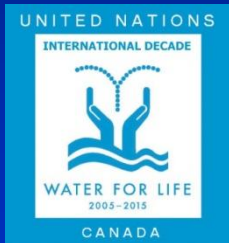
**All that remain from the Jurassic
are remnants.**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



**Debate over climate issues has
fueled a denial industry.**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

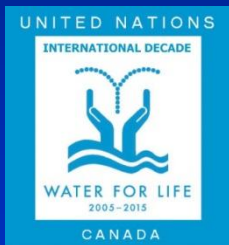


**Debate over climate issues has
fueled a denial industry.**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

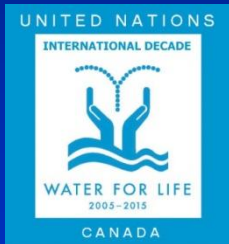
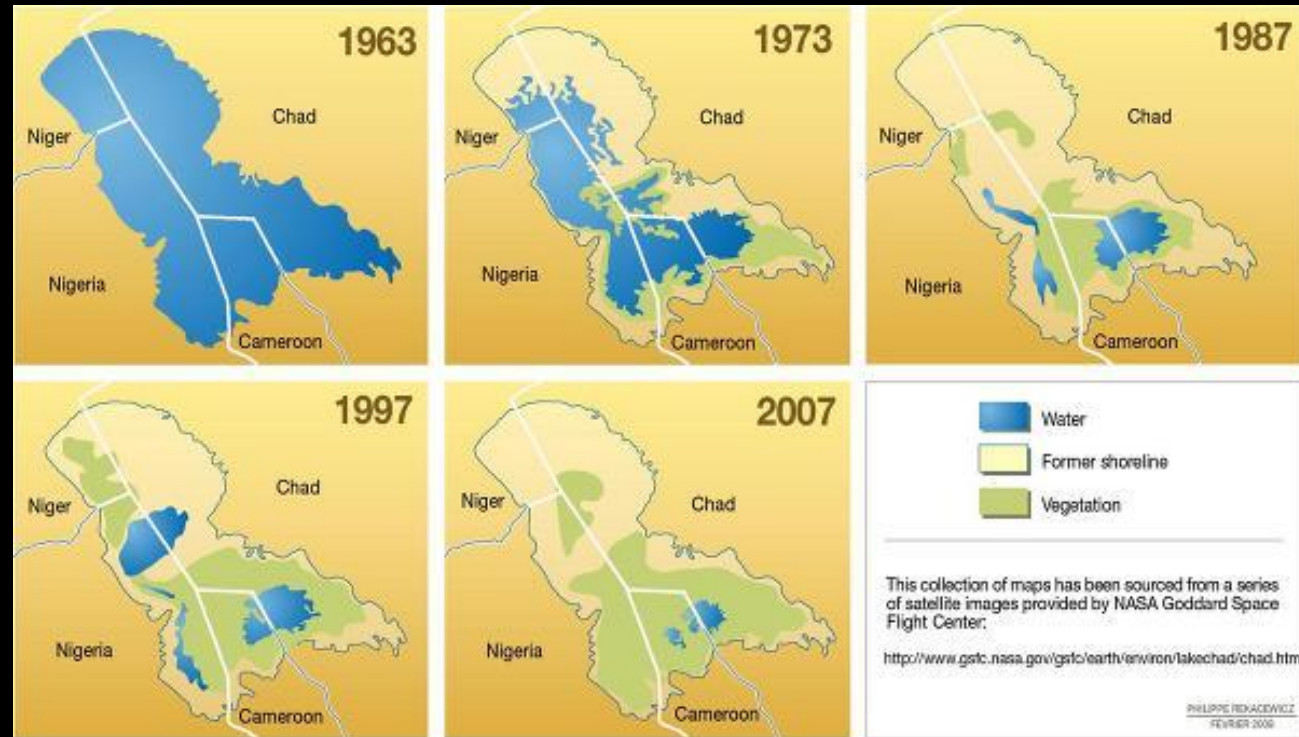


**Common ground between science
and the denial industry.**



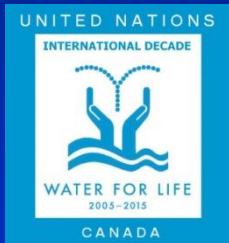
Come Hell & High Water:

Scientific Truth and Economic Consequences In Hollywood Disaster Movies



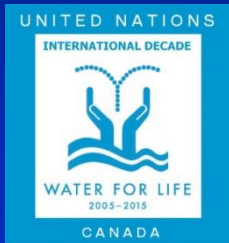
**Common ground between science
and the denial industry.**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



**Common ground between science
and the denial industry.**

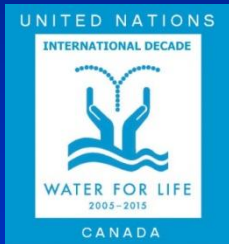
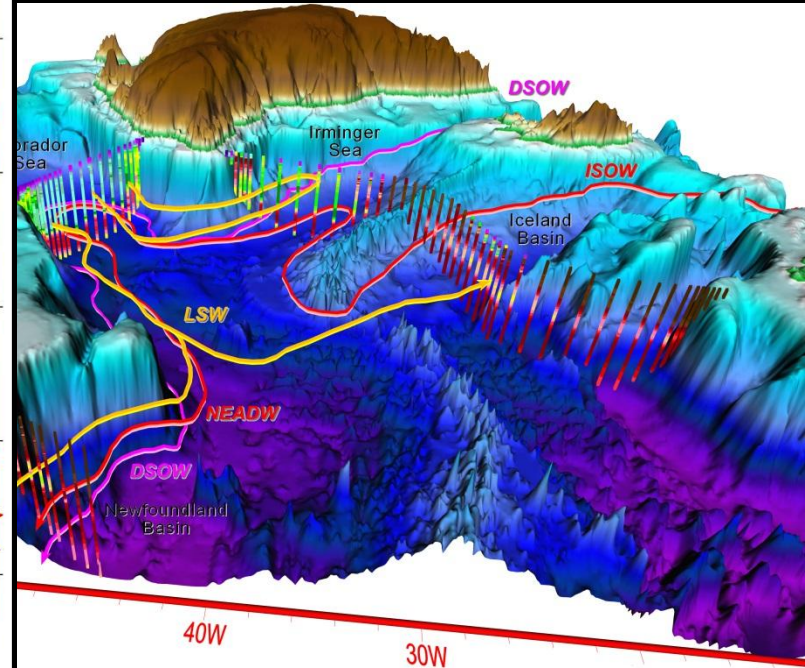
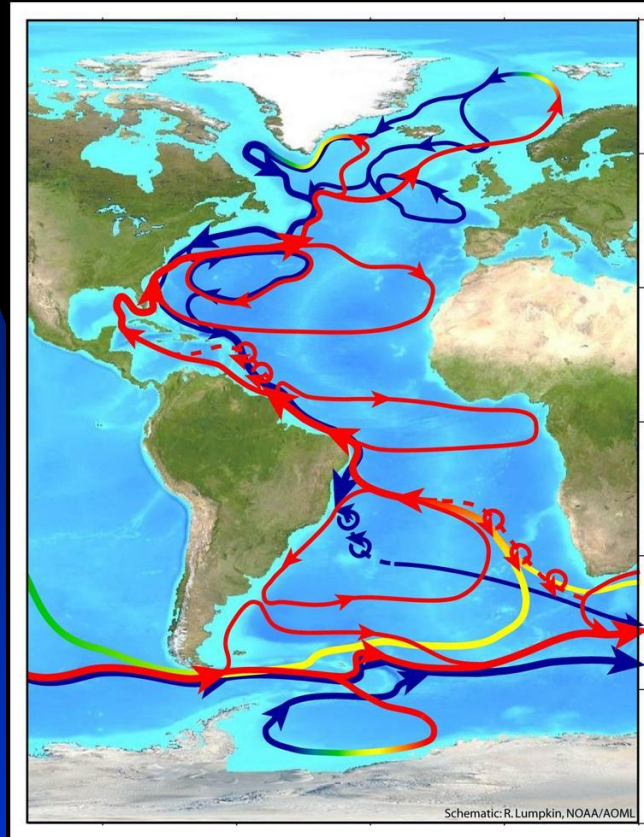
Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



Could what happened in the *Day After Tomorrow* really happen?

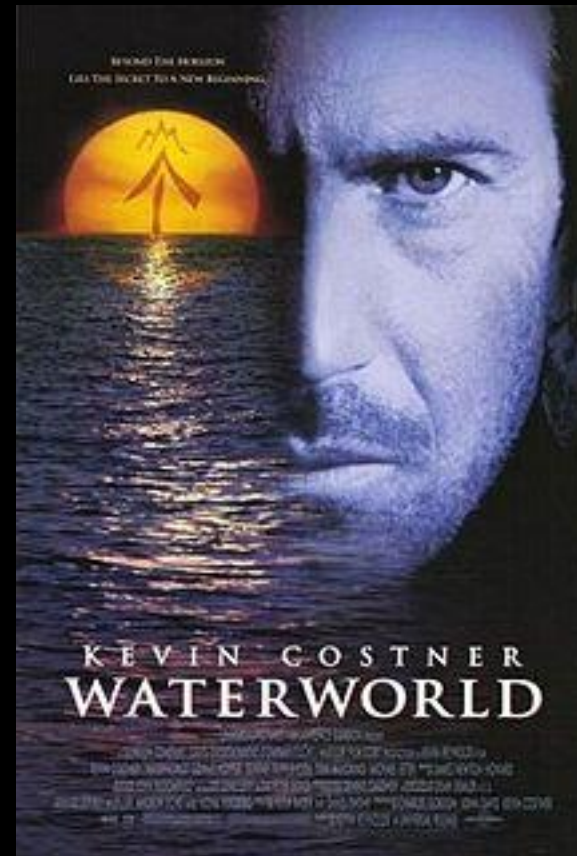
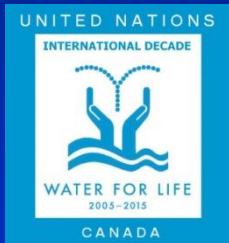
Come Hell & High Water:

Scientific Truth and Economic Consequences In Hollywood Disaster Movies



**The global ocean conveyor belt is
not likely to stop soon.**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



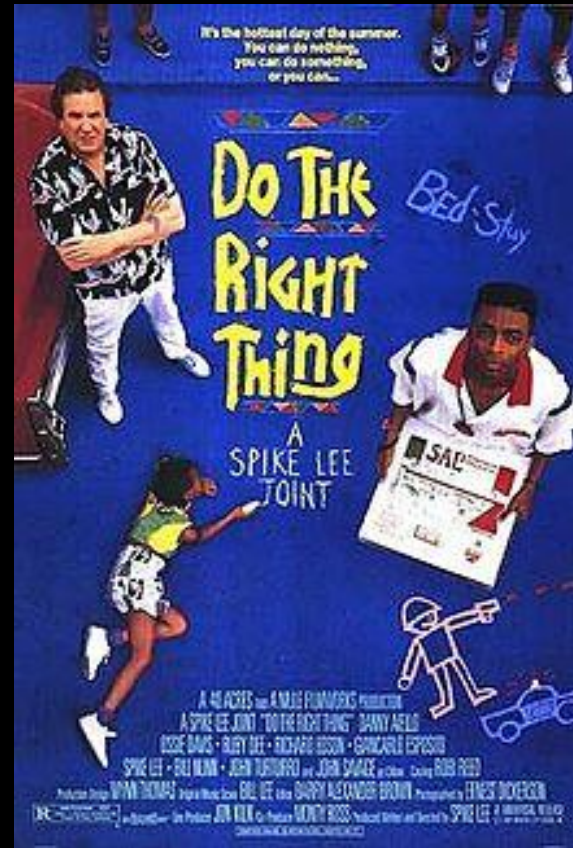
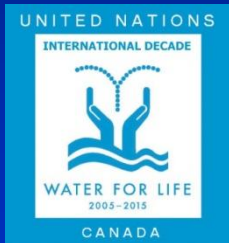
**What are the chances of
catastrophic sea level rise?**



North America

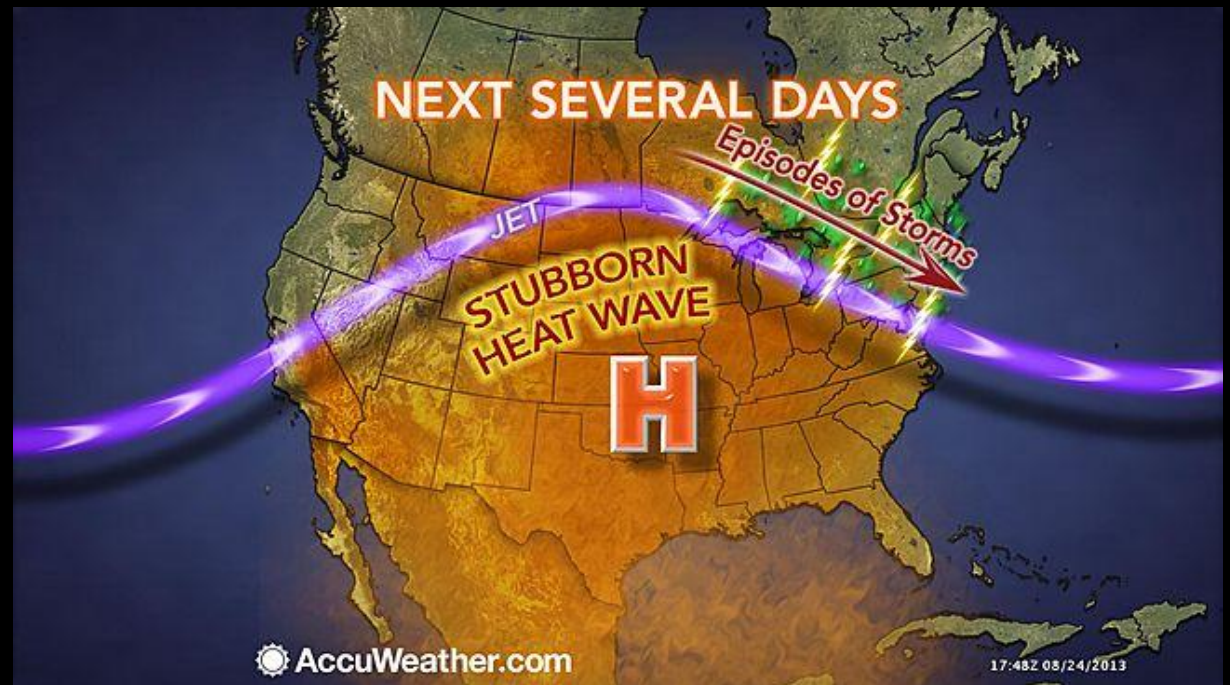
The entire Atlantic seaboard would vanish, along with Florida and the Gulf Coast. In California, San Francisco's hills would become a cluster of islands and the Central Valley a giant bay. The Gulf of California would stretch north past the latitude of San Diego—not that there'd be a San Diego.

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

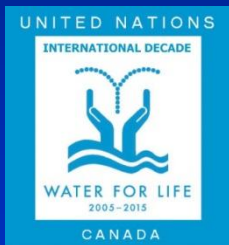


**Will there be an abrupt increase in
heat waves?**

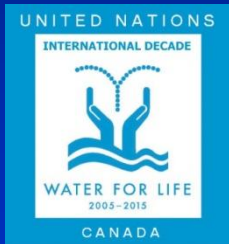
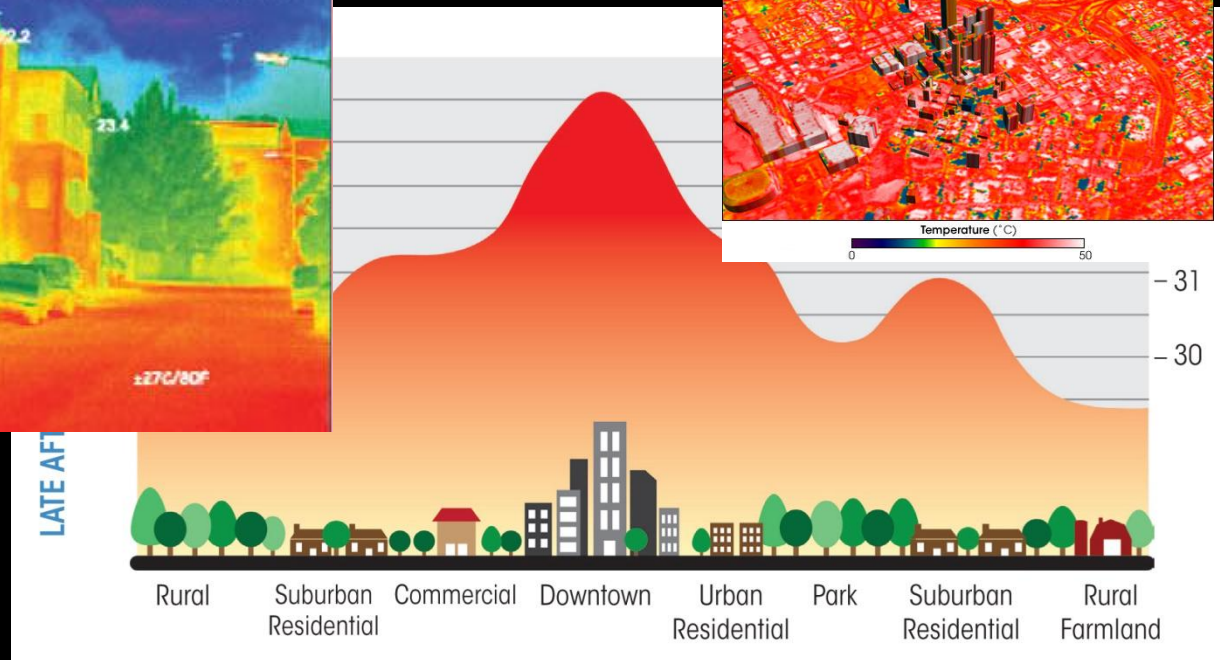
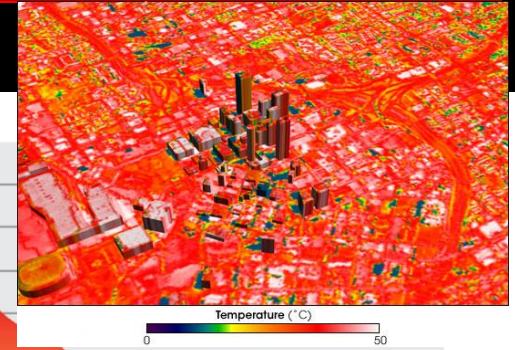
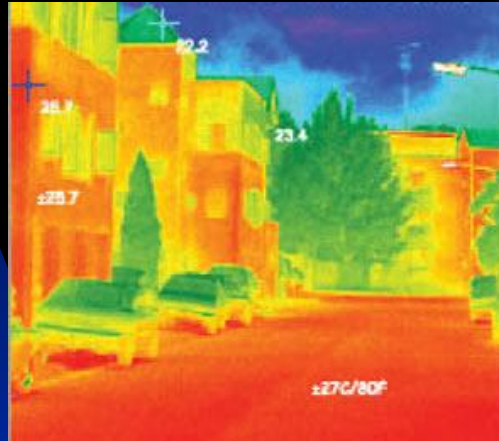
Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



**Heat waves are becoming more
persistent and covering larger
areas of the Earth**

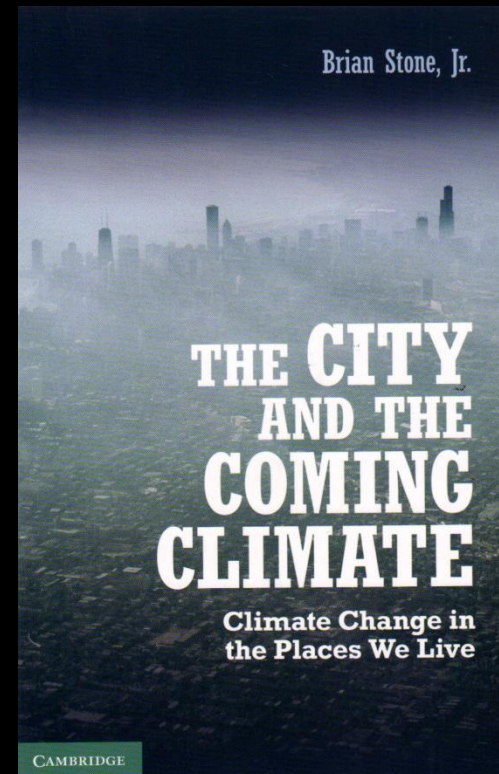
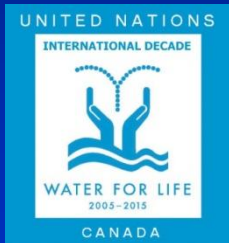


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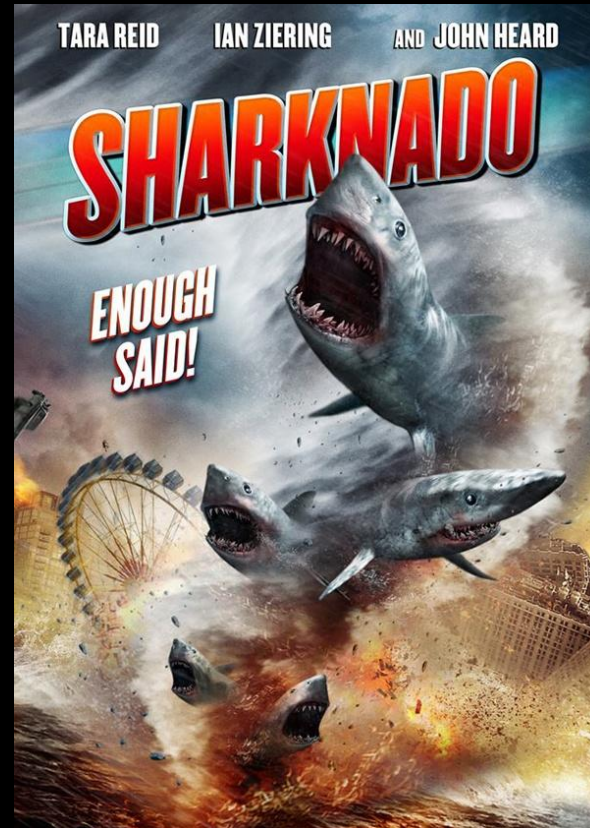
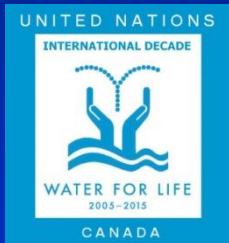
**Urban heat islands are causing
warming independent of
greenhouse emissions**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



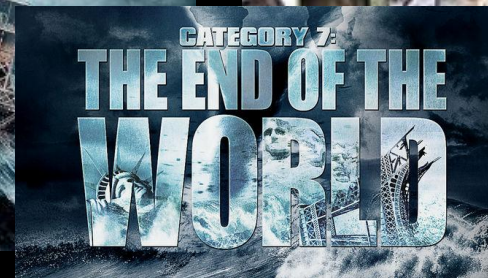
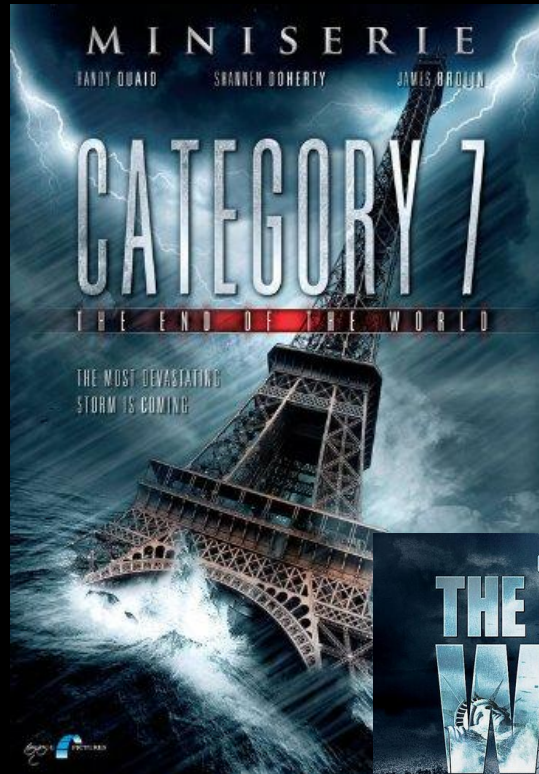
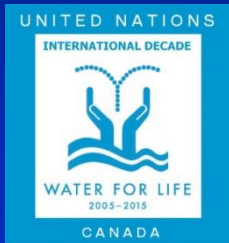
**Urban heat-island warming is
exacerbated by and exacerbates
greenhouse warming**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



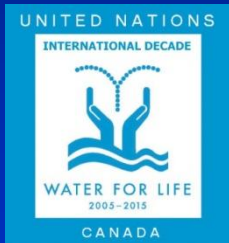
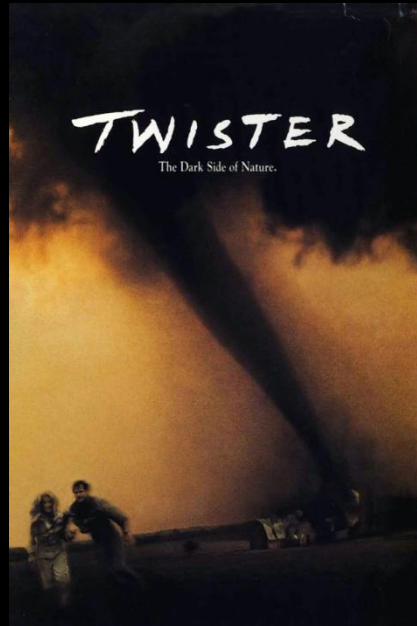
**Will there be an abrupt increase in
extreme weather events?**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



**Will there be an abrupt increase in
extreme weather events?**

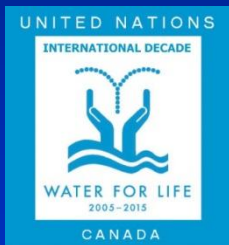
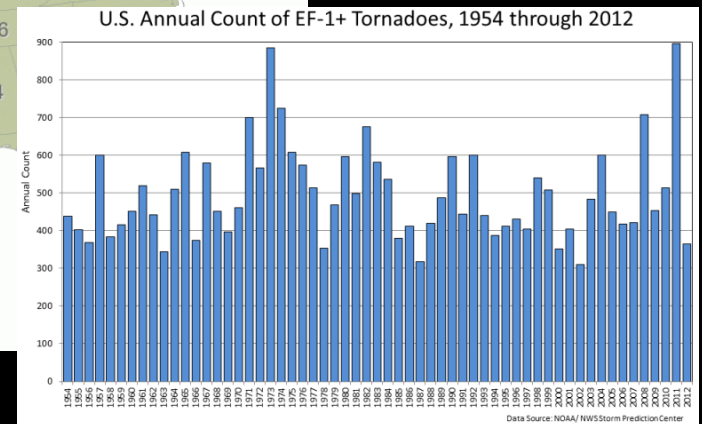
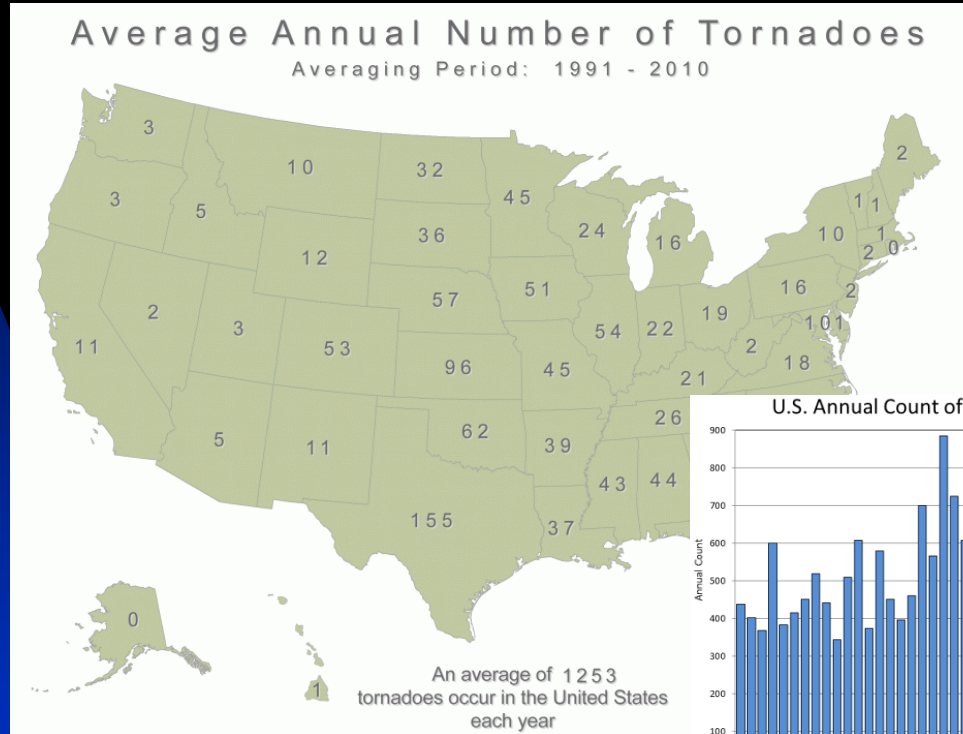
Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



**Will there be an abrupt increase in
the number of tornadoes?**

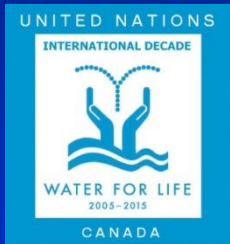
Come Hell & High Water:

Scientific Truth and Economic Consequences In Hollywood Disaster Movies



**Will there be an abrupt increase in
the number of tornadoes?**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

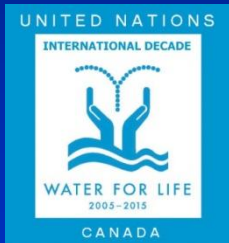


**Canada has its own Tornado Alley
and it is active.**

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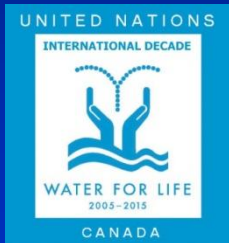
Canada			
Flight Vol	Arriving from Origin	Time Horaire	Status Etat
AC7247	KINGSTON, ON	12:53	DELAYED
AC8534	THUNDER BAY	13:14	DELAYED
AC7826	TIMMINS	13:18	DELAYED
AC7613	MONTREAL	13:20	DELAYED
AC7808	SUDBURY	13:22	DELAYED



**So what is really happening to our
weather & climate?**

Come Hell & High Water:

Scientific Truth and Economic Consequences In Hollywood Disaster Movies

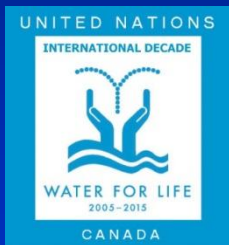
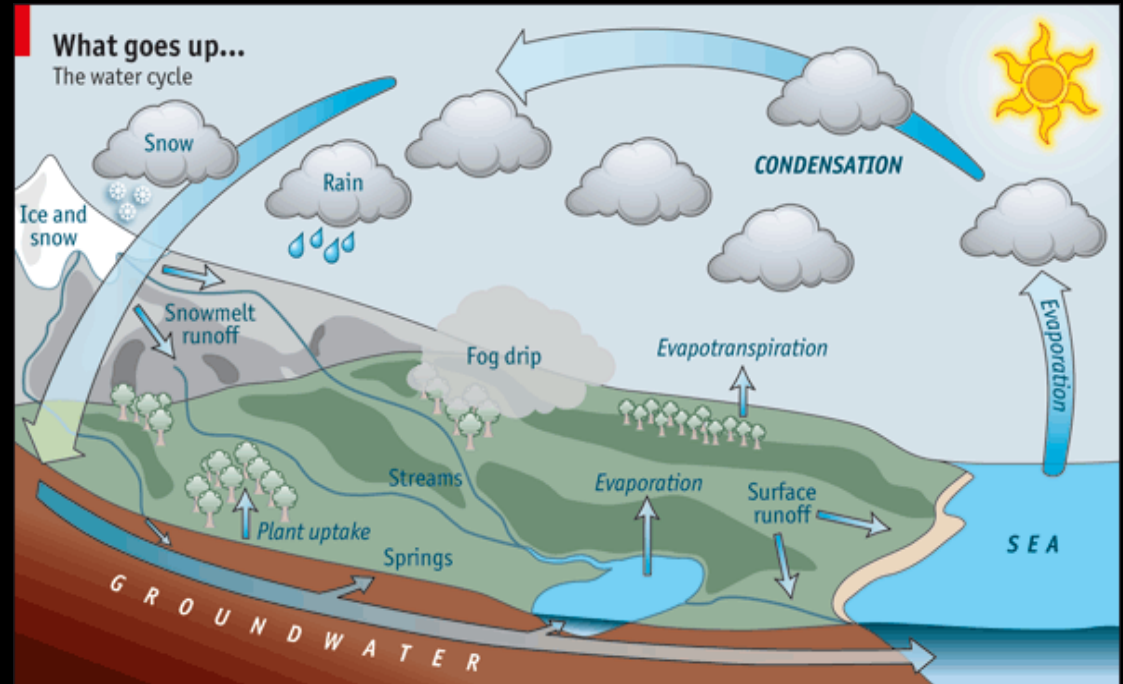


What we know scientifically:

Land-use changes can induce hydro-climatic change

Come Hell & High Water:

Scientific Truth and Economic Consequences In Hollywood Disaster Movies

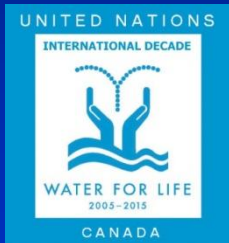
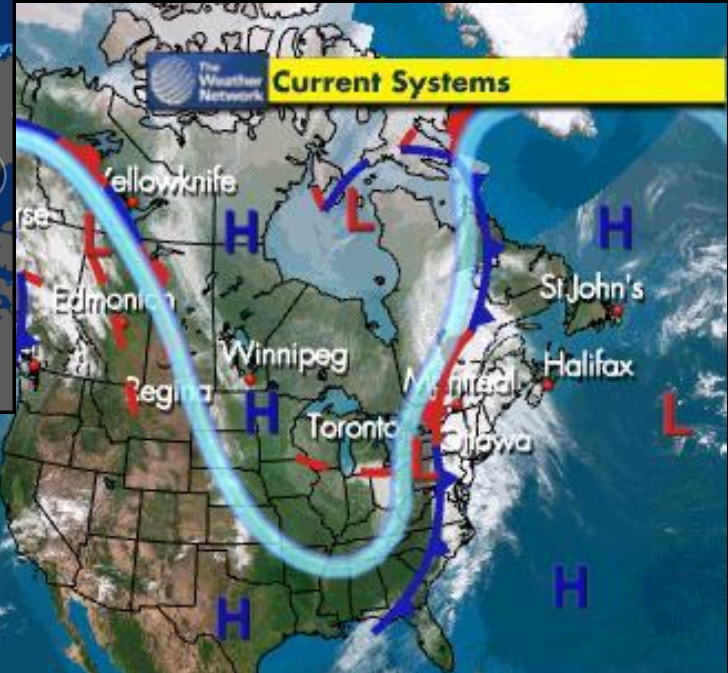
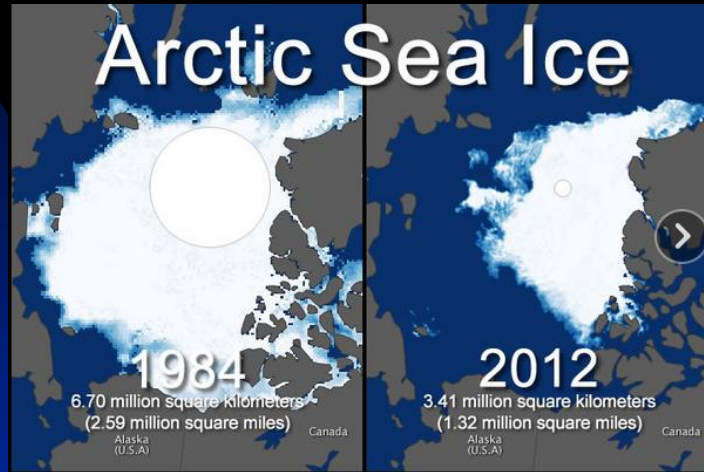


What we know scientifically:

*The real urgency resides in realizing
our nation's hydrology is changing.*

Come Hell & High Water:

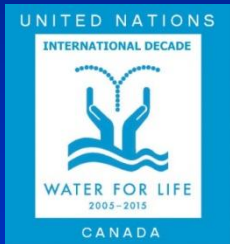
Scientific Truth and Economic Consequences In Hollywood Disaster Movies



What we know scientifically:

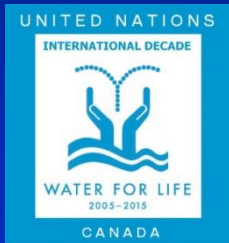
*The loss of polar ice appears to be
causing the jet stream to meander*

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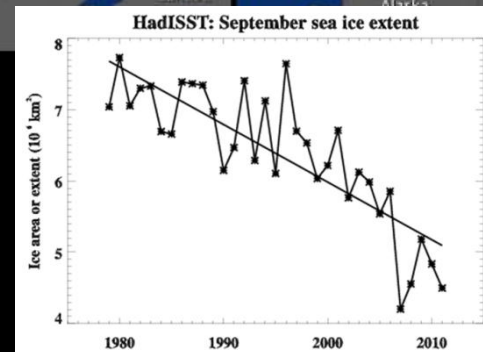
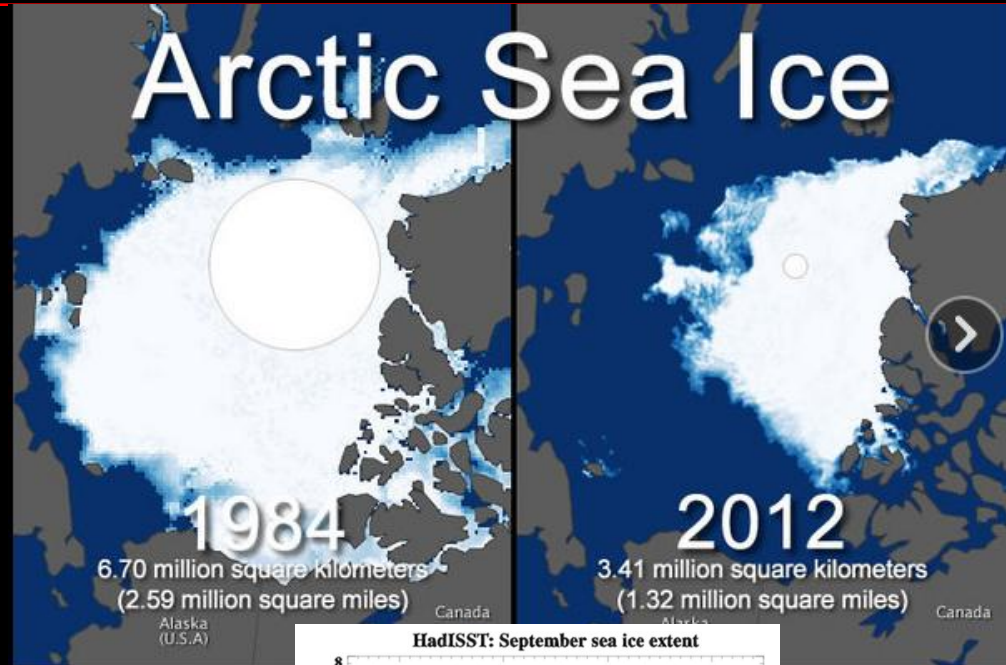
**Follow the water; but start with
polar ice.**

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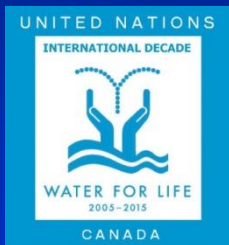


Arctic Sea Ice:
A Planetary Refrigerant

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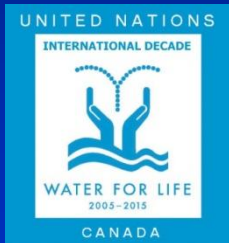
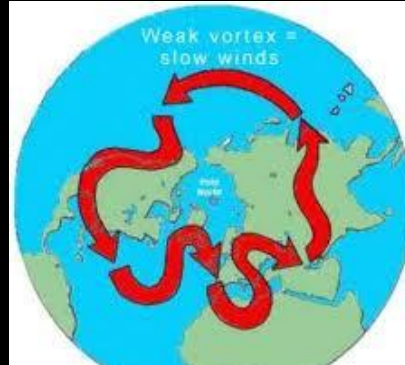


The loss of Arctic Sea Ice



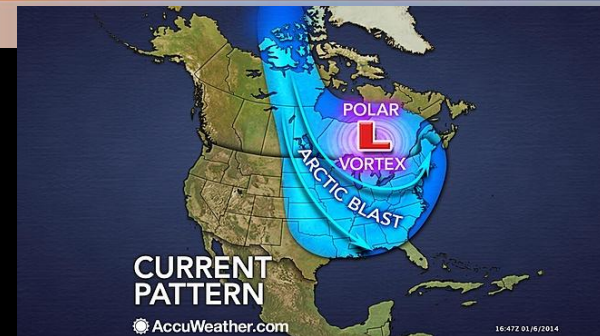
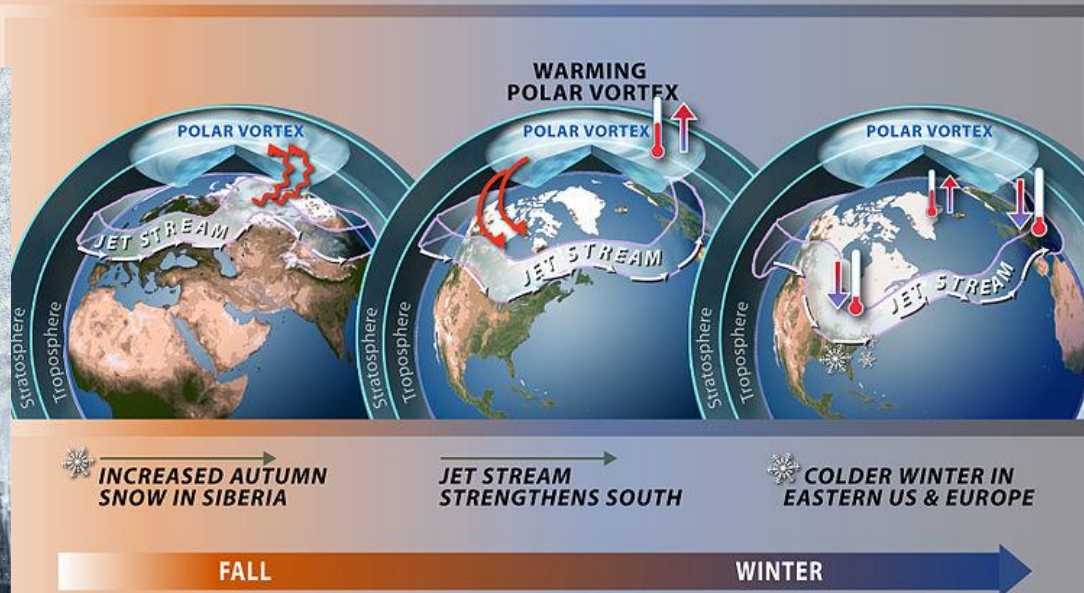
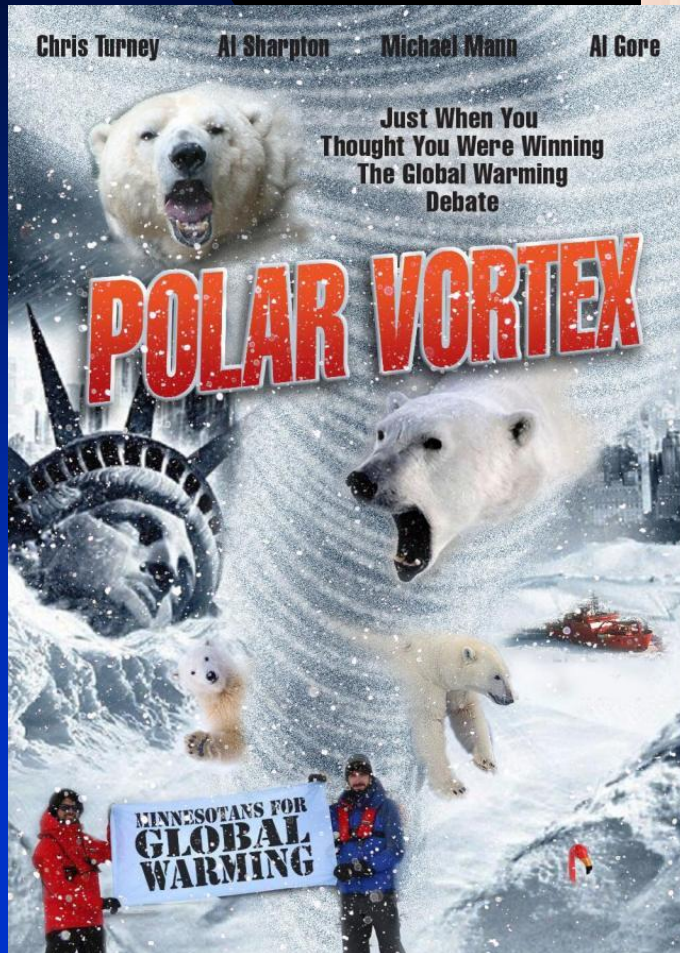
Come Hell & High Water:

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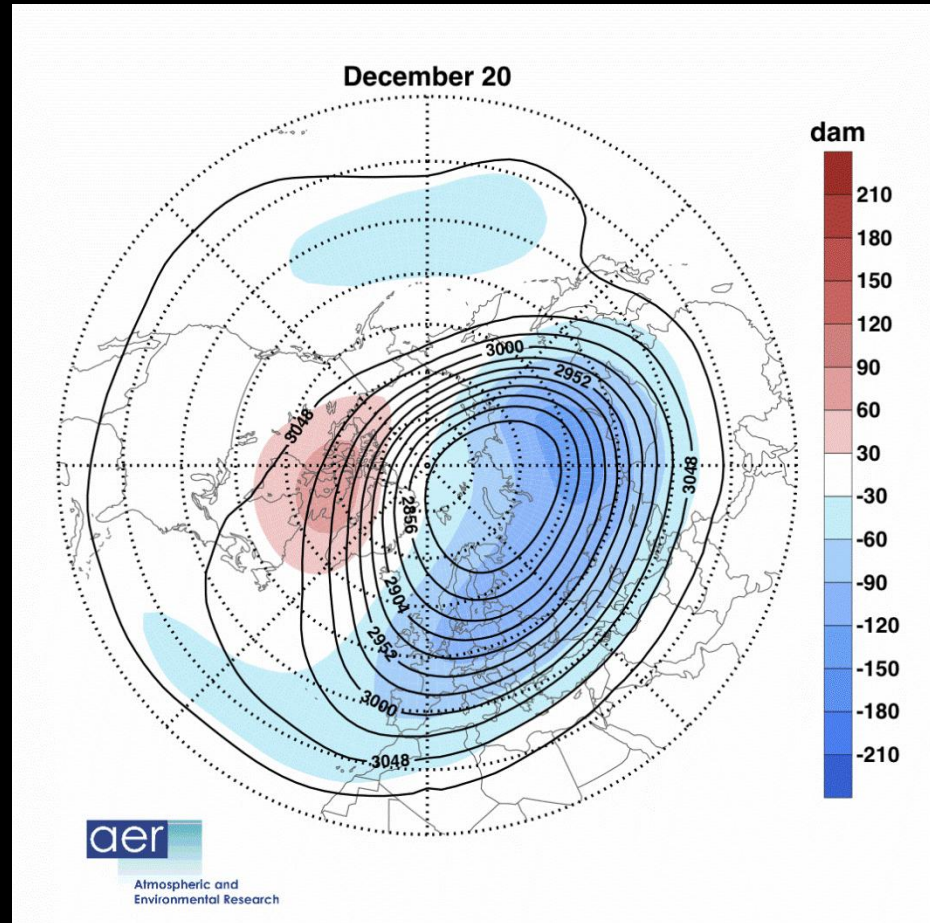
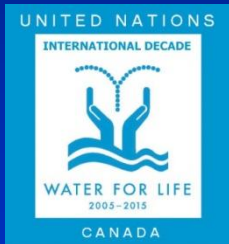
The Jet Stream

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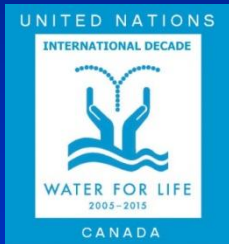
The Polar Vortex

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Our weather is all over the place.

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



Connecting the Dots:
Hydro-climatic change in the Arctic and in
the Mackenzie River Basin.

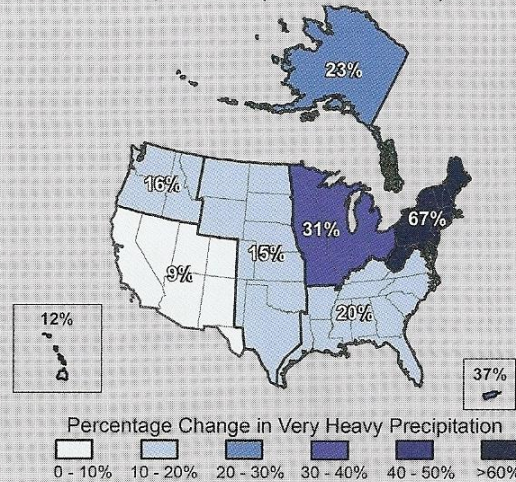
Come Hell & High Water:

Scientific Truth and Economic Consequences

In Hollywood Disaster Movies

U.S. Global Change Research Program

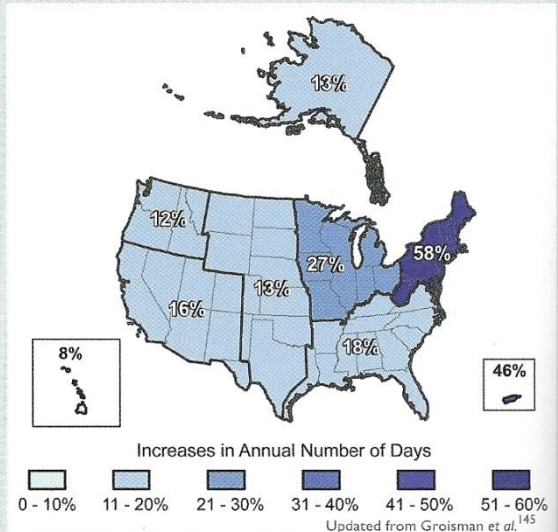
Increases in Amounts of Very Heavy Precipitation (1958 to 2007)



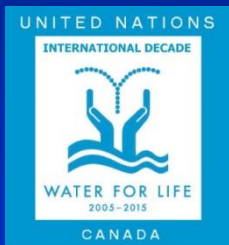
The map shows percent increases in the amount falling in very heavy precipitation events (defined as the heaviest 1 percent of all daily events) from 1958 to 2007 for each region. There are clear trends toward more very heavy precipitation for the nation as a whole, and particularly in the Northeast and Midwest.

Global Climate Change Impacts in the United States

Increases in the Number of Days with Very Heavy Precipitation (1958 to 2007)

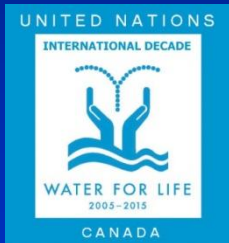
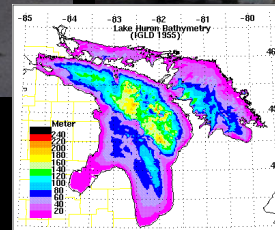


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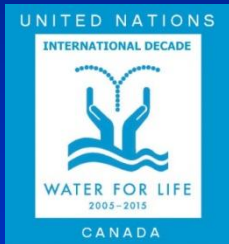
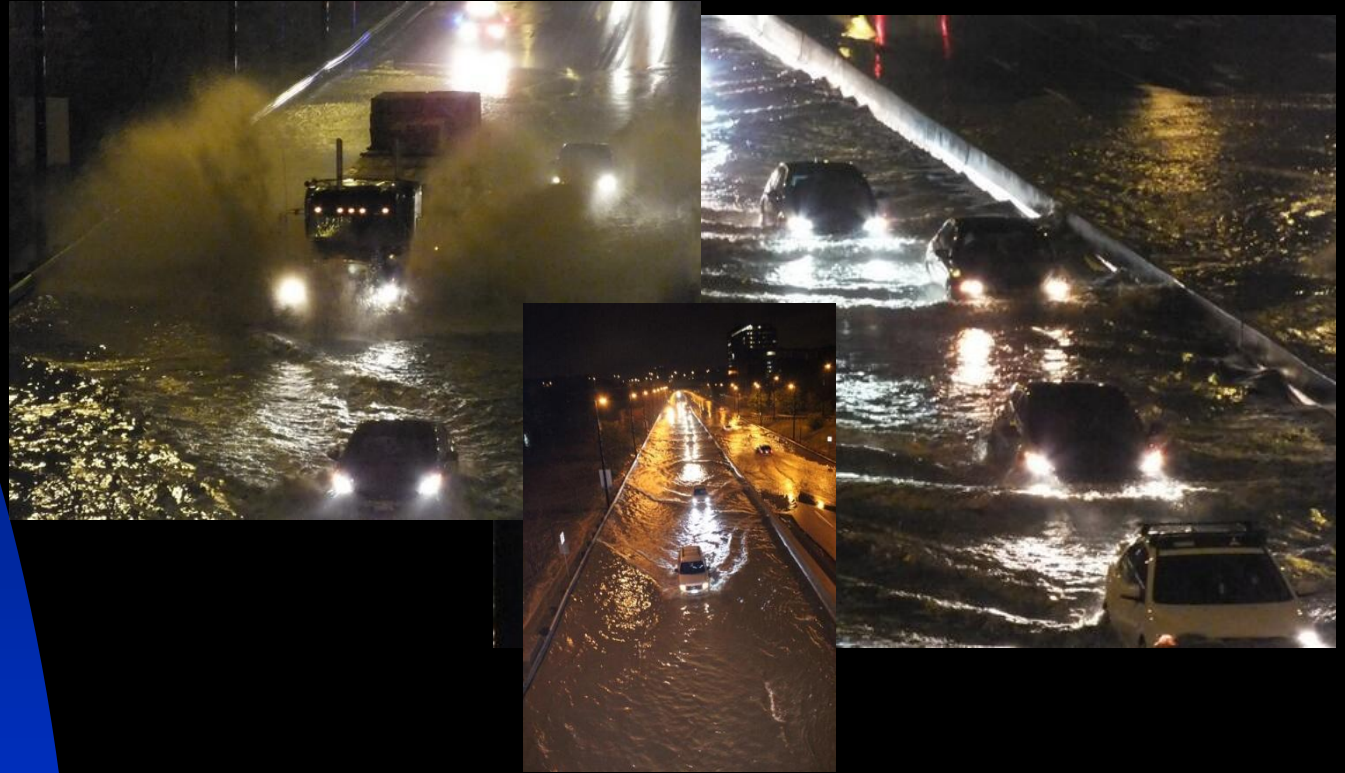
Increased rainfall days in the Red River Basin

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Connecting the Dots:
The Great Lakes

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Connecting the Dots:
Flooding of the Don Valley Parkway in
Toronto, May, 2013

Come Hell & High Water:

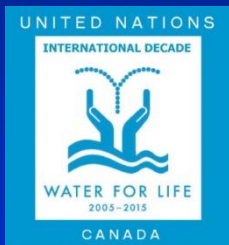
Scientific Truth and Economic Consequences In Hollywood Disaster Movies



Rudolf Clausius



Benoit Clapeyron

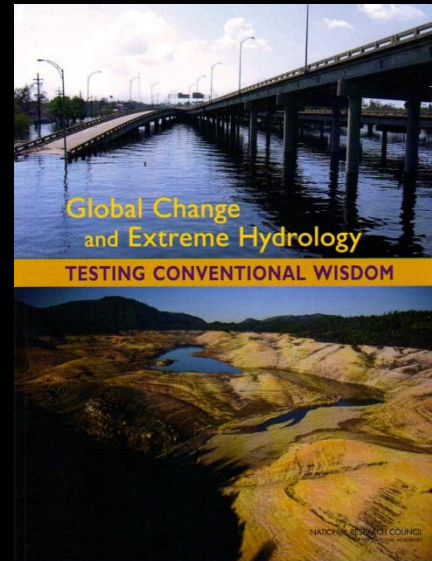


The Clausius – Clapeyron Relation

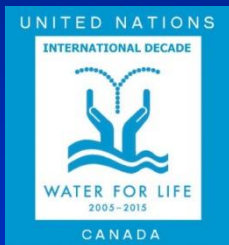
***The water-holding capacity of the
Earth's atmosphere increases by 7
per cent per degree Celsius***

Come Hell & High Water:

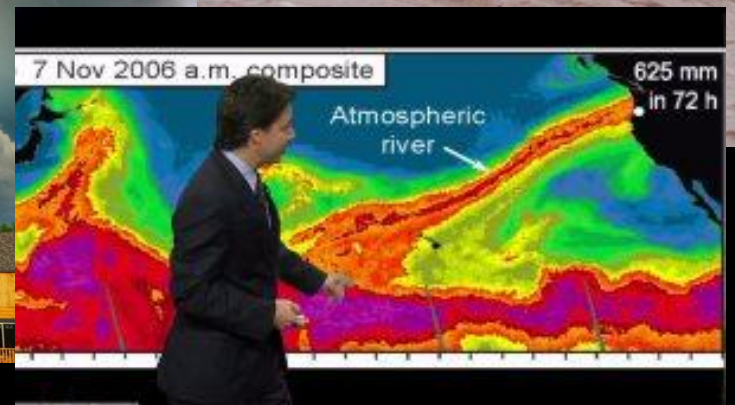
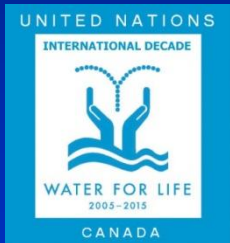
Scientific Truth and Economic Consequences In Hollywood Disaster Movies



"Continuing to use the assumption of stationarity in designing water management systems is, in fact, no longer practical or even defensible."

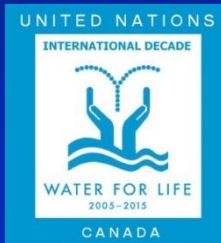
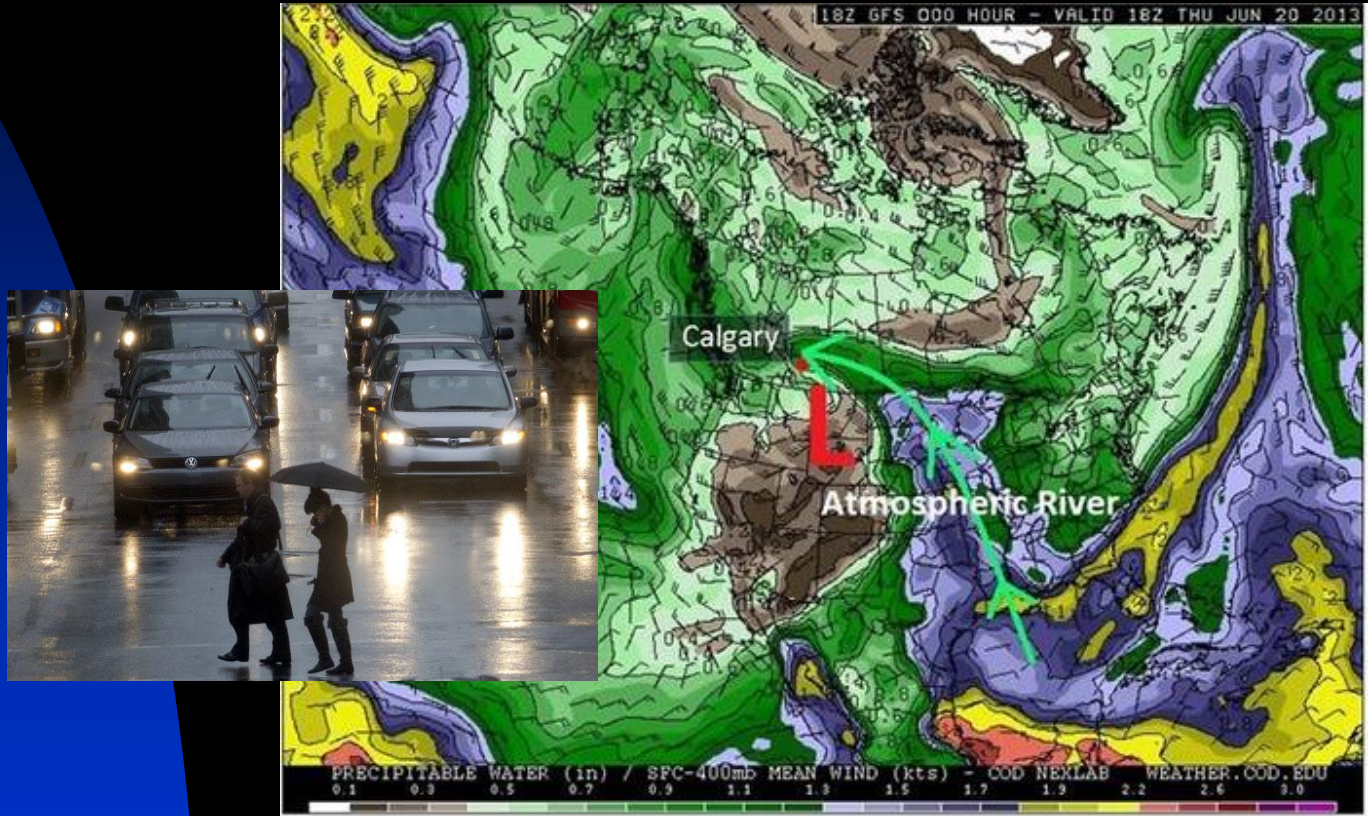


Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



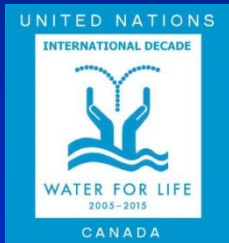
Atmospheric Rivers

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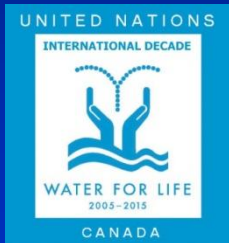
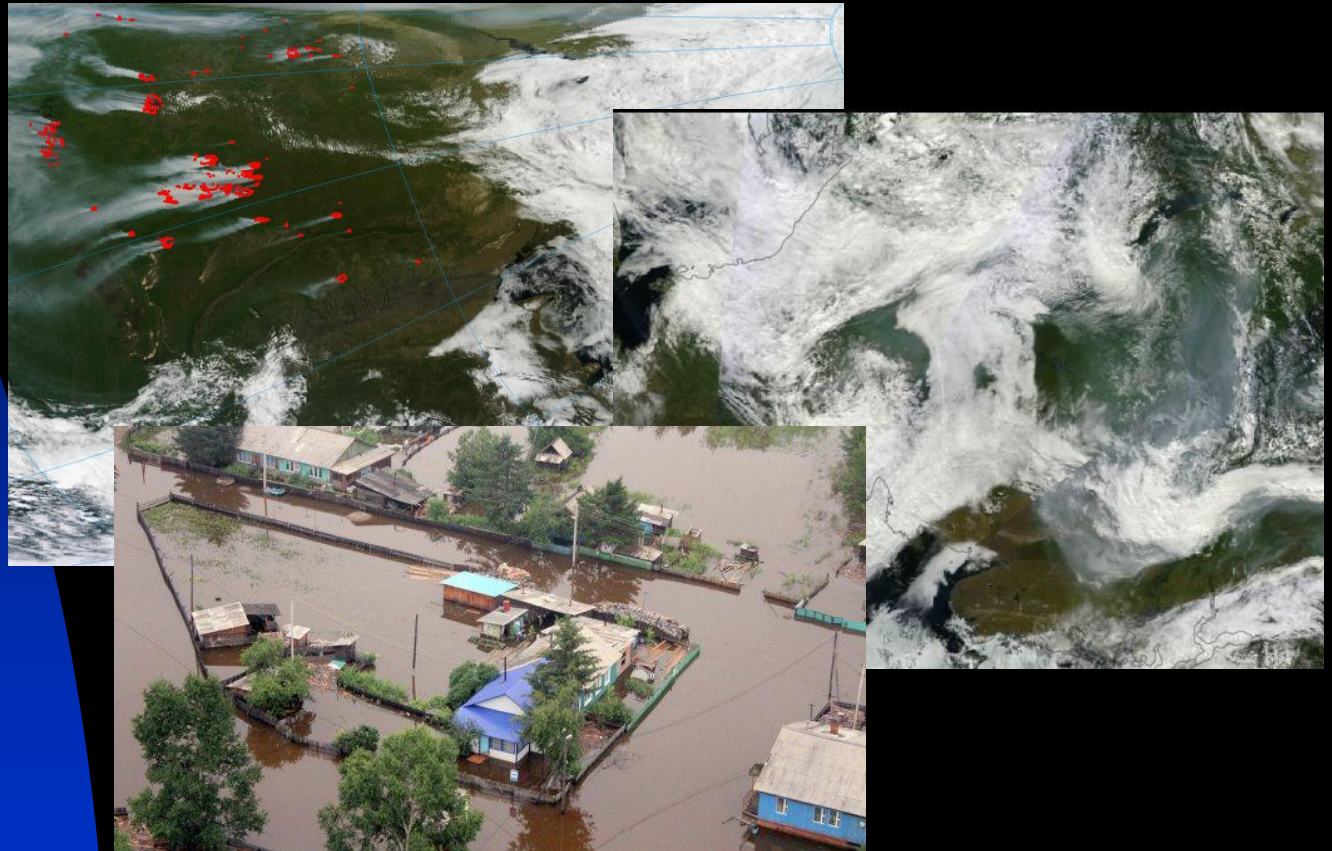
*Day one of the Alberta flood: the rain
begins to fall.*

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



Downtown Toronto:
July 8th, 2013

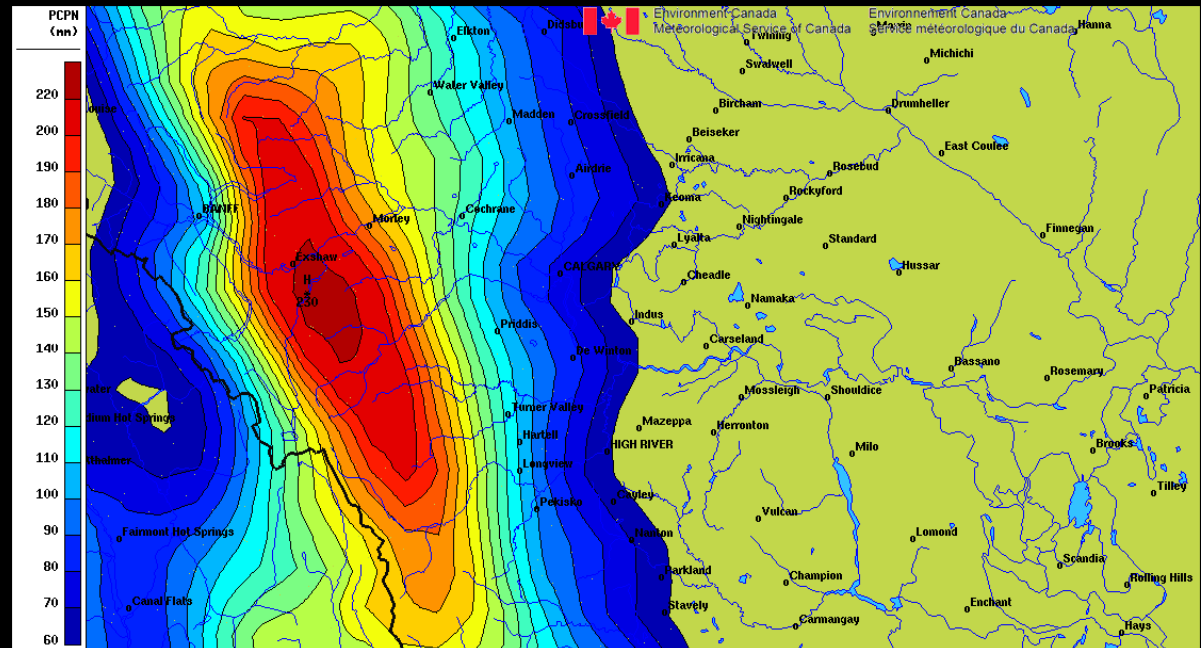
Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*



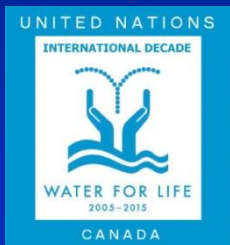
**A month after Alberta's floods:
firestorms & floods in Russia**

Come Hell & High Water:

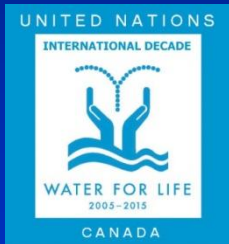
Scientific Truth and Economic Consequences In Hollywood Disaster Movies



**Storms in the future may be
different in character than what
we have experienced.**

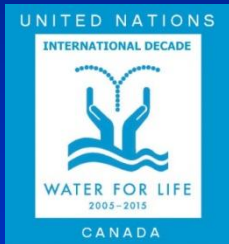


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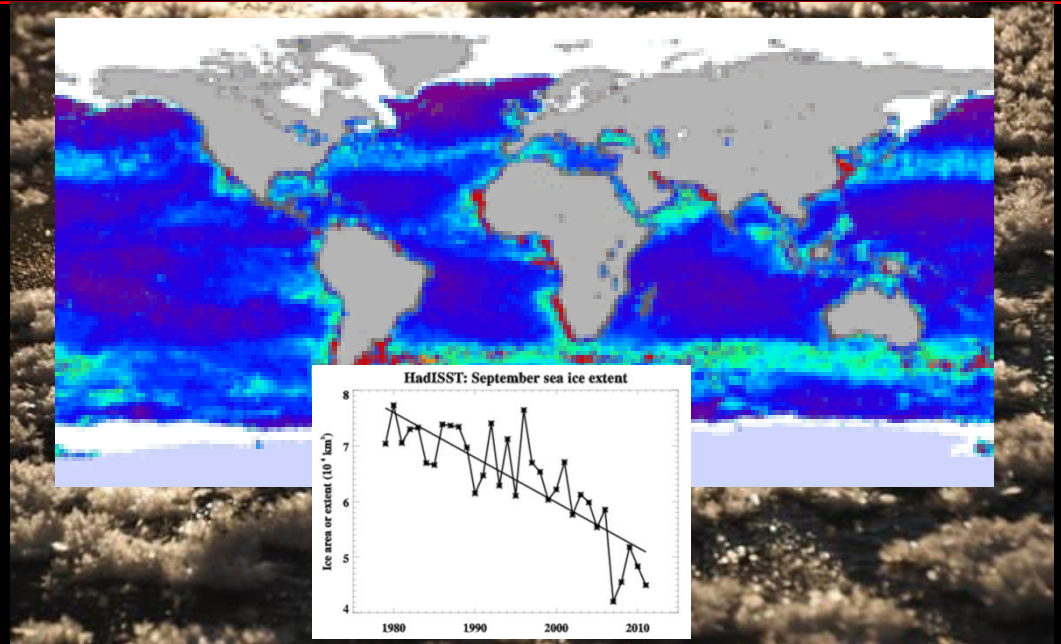
**Three months after Alberta's floods:
fires & floods in Colorado**

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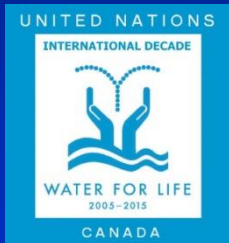
**What are the overarching lessons we
can learn from what is
happening?**

Come Hell & High Water: *Scientific Truth and Economic Consequences* *In Hollywood Disaster Movies*

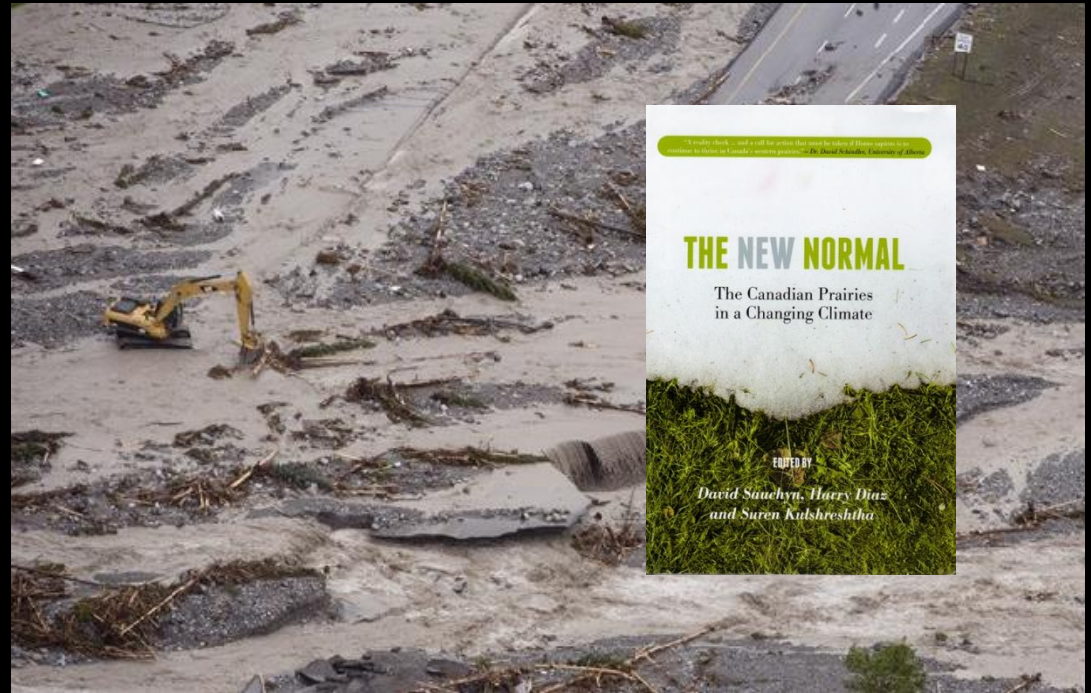
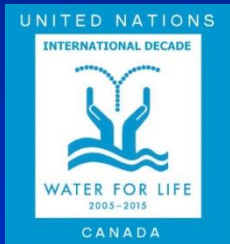


Game Change1.

*We need to begin to understand and
where possible manage the
hydrological cycle regionally and
globally*



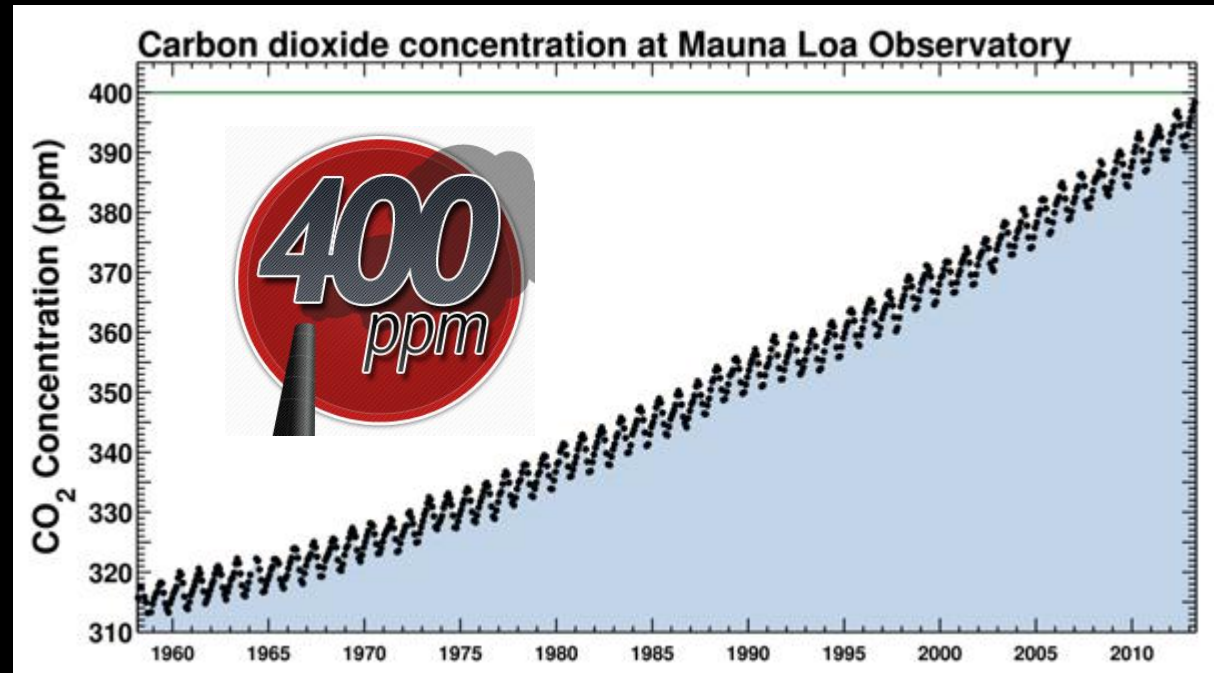
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Game Change 2.
What we have seen is what we are
going to get.

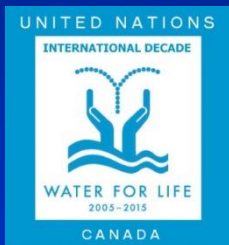
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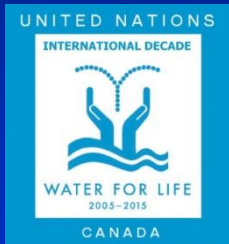
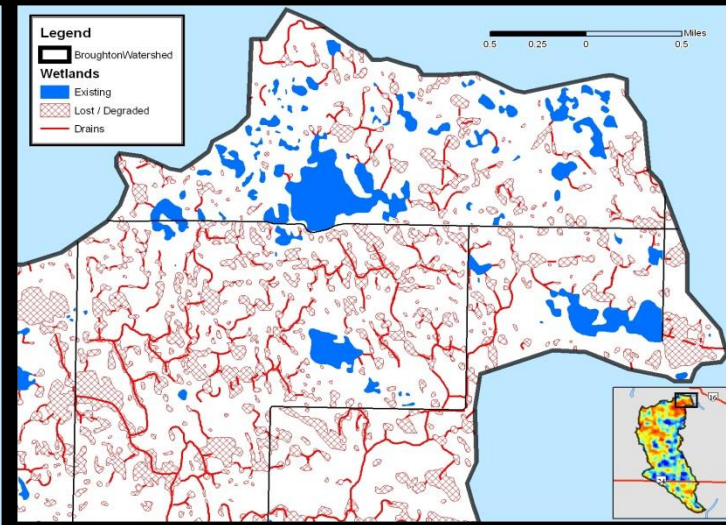
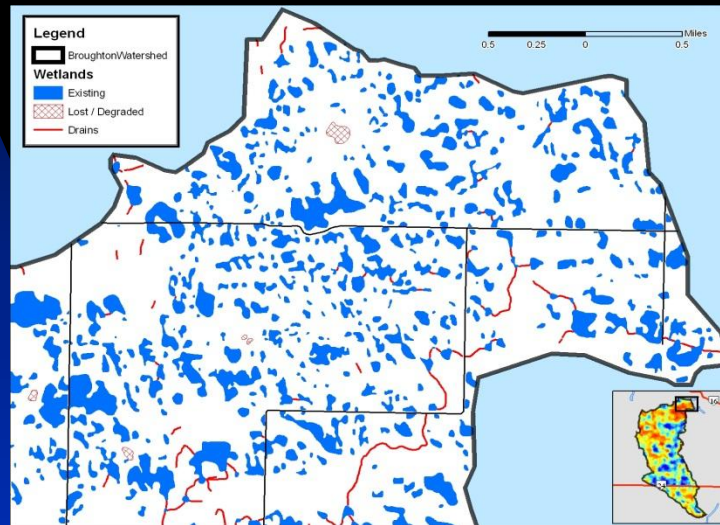
Game change 3.

*Sooner or later we are going to have
to take emissions cuts seriously*



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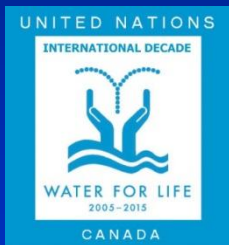


Game Change 4.

*We can't do this ourselves; we need
nature to help us*

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Game Change 5.
*Managing water on a basin scale is
no longer an option*

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***With Special Thanks
To Researchers***

Dr. John Pomeroy

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May Guan

Angus Duncan

Xing Fang

Dr. Keith Musselman

Dhiraj Pradhananga

Nicholas Leroux

Changing Cold Regions Network

Dr. Shawn Marshall

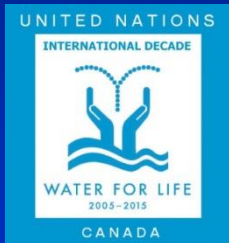
University of Calgary

Dr. Al Pietroniro

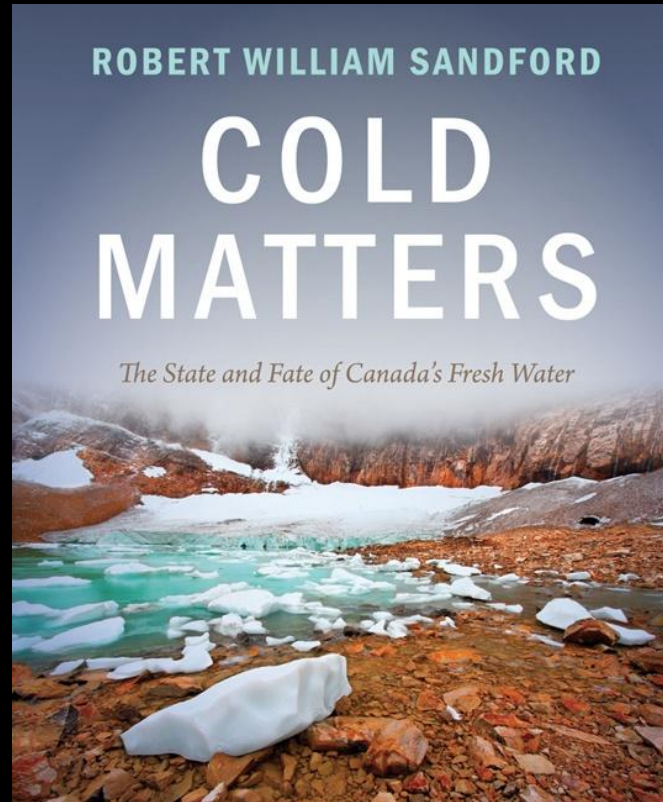
Water Survey of Canada

Michael Demuth

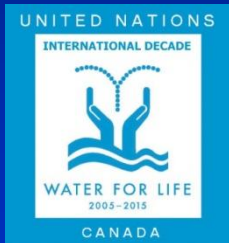
Geological Survey of Canada



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R.W. Sandford
EPCOR Chair,
Canadian Partnership Initiative
United Nations Water for Life Decade



Action Items

- Control the hydrological cycle regionally and globally
- Stop the Waste
- Enlist nature's help

