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**Joint ICTP-IAEA Workshop on Vulnerability of Energy Systems to
Climate Change and Extreme Events**

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**Scientific uncertainties about the changes in the nature, magnitude and frequency of
extreme events triggered by anthropogenic climate change, their formulation for use
in impact and risk assessments for energy system**

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**Scientific uncertainties about the changes in the nature,
magnitude and frequency of extreme events triggered by
anthropogenic climate change, their formulation for use in
impact and risk assessments for energy system
particularly Pakistan**

Presentation to:

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Scientific Uncertainties

- **Uncertainty** is a term used in subtly different ways in a number of fields, including philosophy, physics, statistics, economics, finance, insurance, psychology, sociology, engineering, and information science. It applies to predictions of future events, to physical measurements already made, or to the unknown.
- Decision-makers use uncertainty as an excuse for inaction, when in fact it should be a stimulus for creativity and progress

(Book: *Uncertain Science... Uncertain World*, Henry Pollack)




The background is a soft, green-tinted composition. In the center, a large, semi-transparent globe shows the continents. To the right, a tree trunk and branches are visible, also semi-transparent. Numerous green leaves are scattered throughout, some appearing to fall or drift. The overall mood is natural and serene.

What is scientific Knowledge and Scientific uncertainty?

Where Human being stands?

- some people think of scientific knowledge as a house of cards – if one piece is taken away, the whole house comes down. That is, one uncertainty about climate change means none of the science can be trusted.
- Some people feel that if scientists aren't 100 percent certain about something, there's no need to take action – even when there is a 90 percent chance that inaction will lead to catastrophe. Why?
- So...




The background is a dark green gradient. On the left side, there is a small, semi-transparent globe showing the Earth's continents and oceans. Several green leaves are scattered around the globe, appearing to float or drift. The text is centered on the right side of the image.

Scientific uncertainty can be defined as when
doubt is a sure thing

and

Scientific certainty as being 95% sure that cause
and effect have been correctly identified.

(<http://www.psrast.org/precaut2.htm>)

The background is a dark green gradient. On the left side, there is a small, detailed globe of the Earth showing continents and oceans. Several green leaves are scattered around the globe, appearing to float or drift. The overall aesthetic is clean and environmental.

Is man Responsible for climate change?
What is role of Human being?

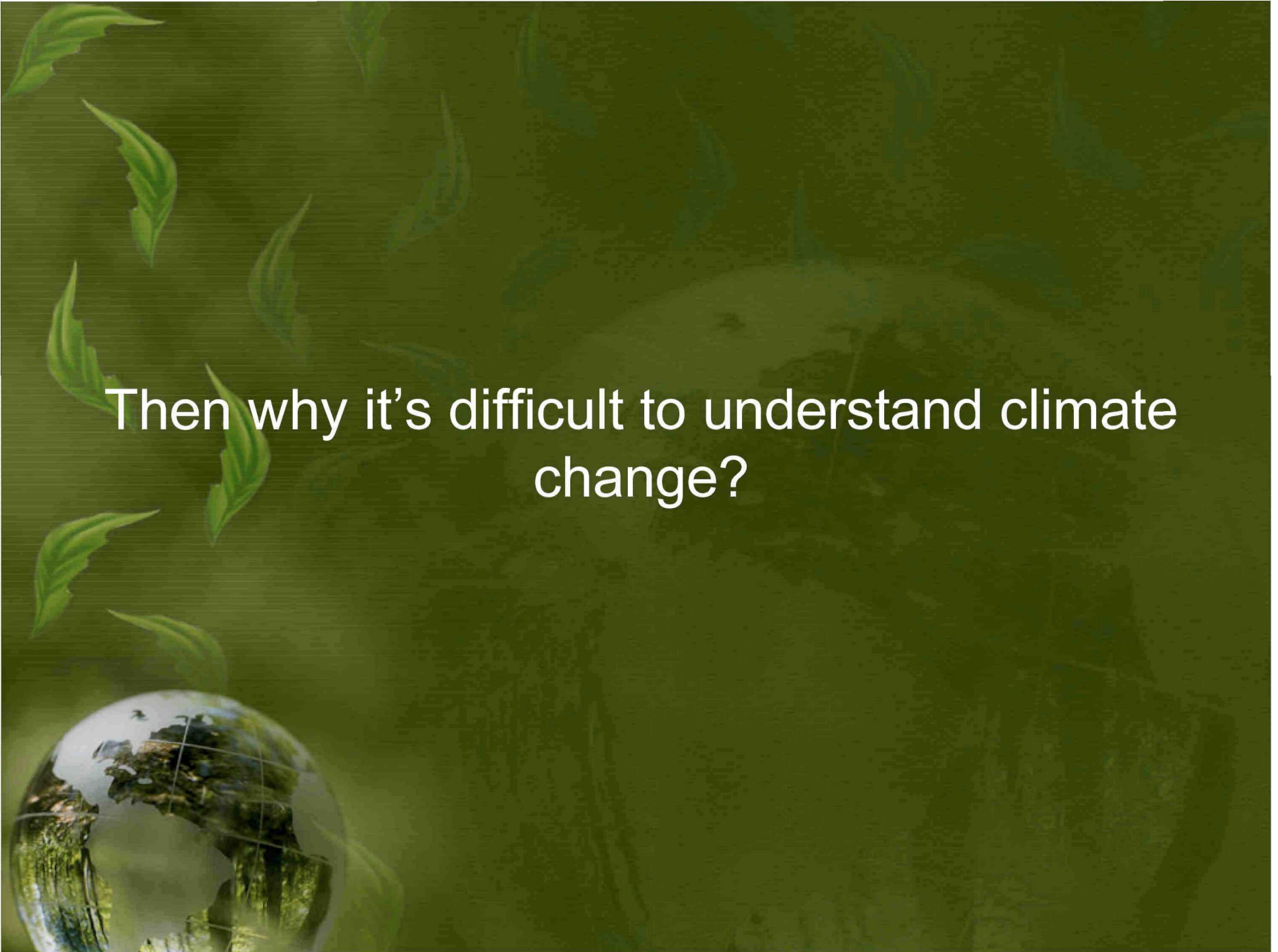
Significant and enduring anthropogenic impact on climate is not a peculiarity of our time. Man is part of the biosphere and as such always did and always will influence the climate system


- Deforestation for land and agriculture,
- changes in farming practices,
- building development

have modified the back-scattering of radiation by Earth's surface and the near surface atmospheric winds. The shift from nomadism to farming several thousands of years ago resulted in vast clearings and thus had a significant and sustained influence on regional climate.



Then why it's difficult to understand climate change?

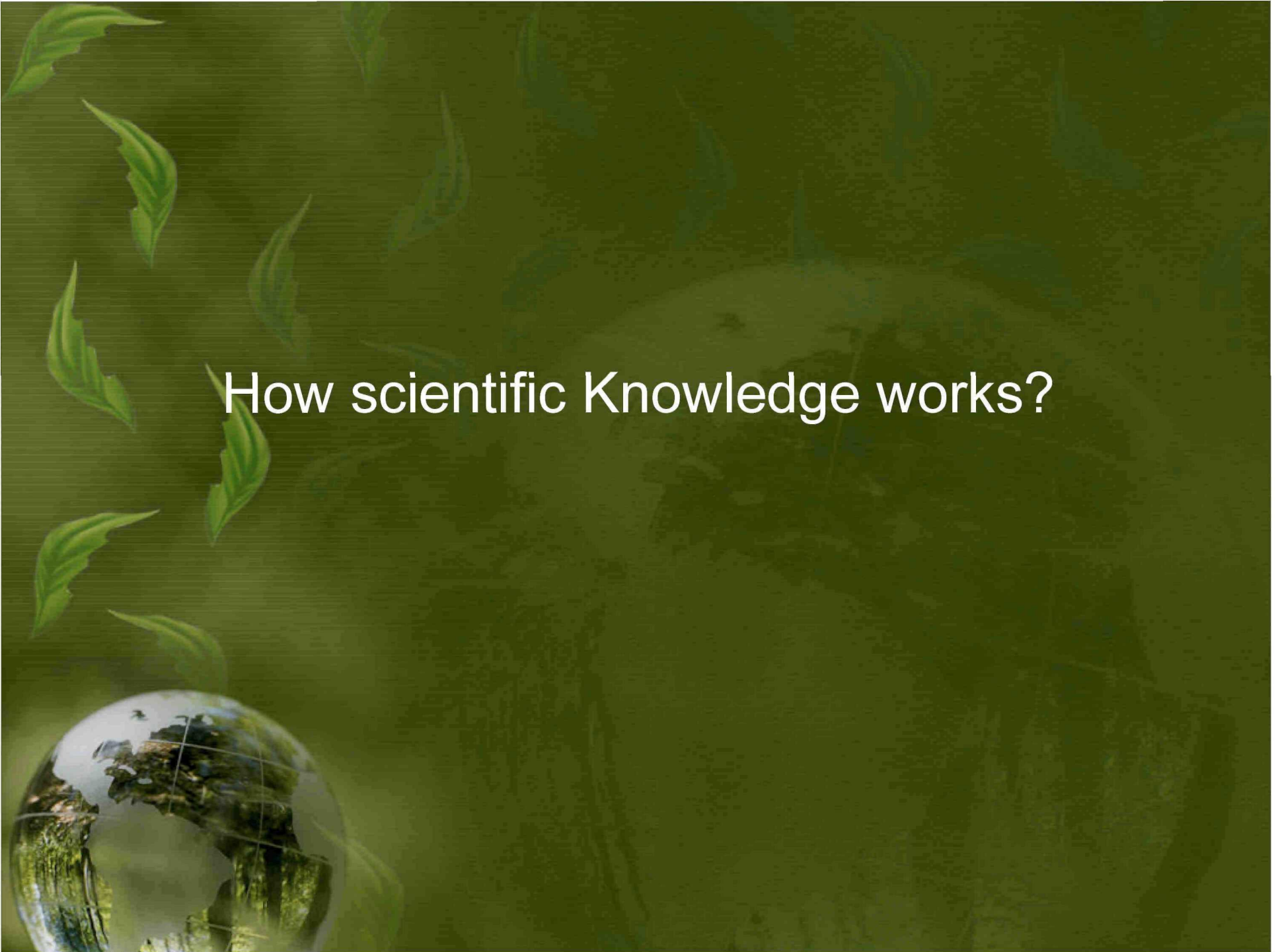




Among the factors that make climate change a difficult problem, the most important is

- uncertainty about the future
- course of climate change, and
- the effect of policies aimed at mitigating climate change.

How scientific Knowledge works?



Causes of Global Warming and Extreme events

Besides the greenhouse effect, there are three other heat sources that conceivably could explain global warming:

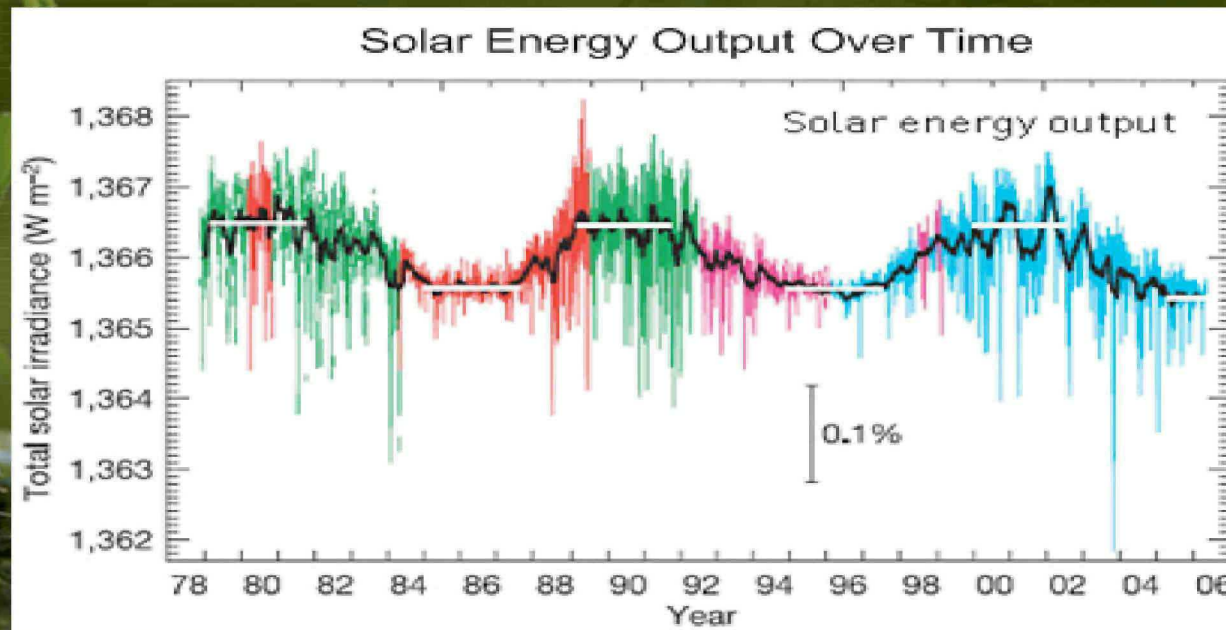
- Increased output from the sun.
- Increased absorption of heat from the sun due to a change in the Earth's reflectivity or "albedo".
- An internal variation in the climate system that transfers heat to the atmosphere from another part of the Earth.

We know that the increasing greenhouse gases are warming the atmosphere. What about these other possibilities?



It's not the sun

Scientists realized early on that increases in solar output could be the culprit, so launched satellites to monitor the sun. But the data has shown no appreciable change in solar output for the past three decades:



Source: Foukal et al. 2006. Variations in solar luminosity and their effect on the Earth's climate. Nature 443: 161-166.

It's not Earth's reflectivity

Satellite data reveal that the Earth's reflectivity increased (causing cooling instead of warming) from the 1960s to the early 1980s, and has decreased modestly since. The recent decrease in reflectivity is much too small to account for the current warming.

(Bill Chameides in Basic Science of Global Warming)

Then...



The Greenhouse Effect is the only explanation left

- it's a basic law of physics that if the globe is warming, the additional heat has to be coming from somewhere. So to end this detective story I'll quote from Sir Arthur Conan Doyle, creator of Sherlock Holmes: "When you have eliminated the impossible, whatever remains, however improbable, must be the truth."
- The only possible explanation for the global warming we're currently experiencing is the Greenhouse Effect, from burning fossil fuels and deforestation.





Scientific certainty: An example of
Pakistan and climate change

PAKISTAN

Population = 168 Million (2008)
GDP = \$410 billion at PPP (2007)
GDP per capita = \$2600 on PPP (2007)
Energy consumption = 2596 PJ (2005)
Energy use per capita = 20 GJ/year (2007)

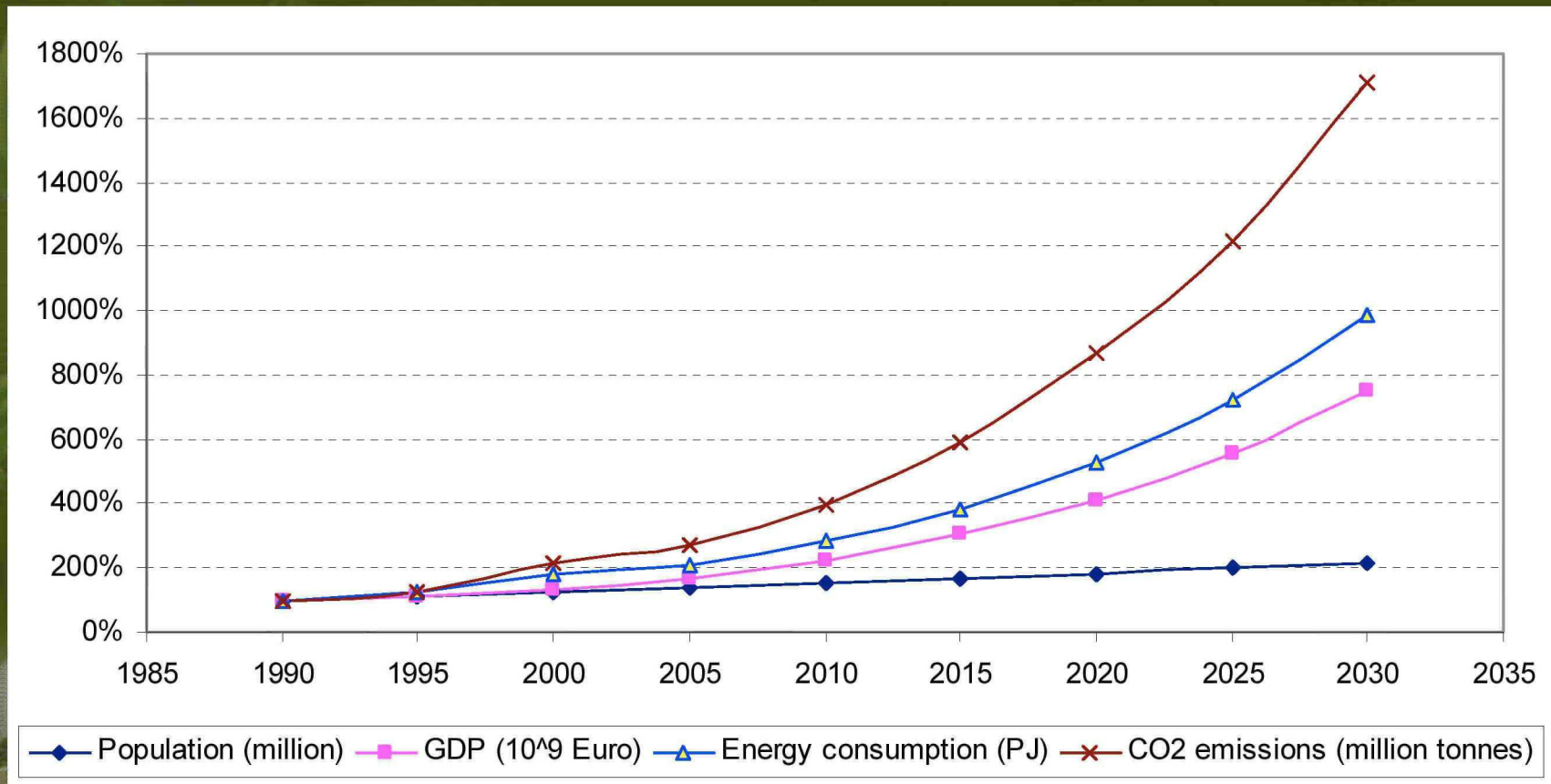


Source: IEA (2007)

Current Issues

- Growing use of fossil fuels
contributed to air pollution and High levels of SPM
- About 16.28 million Pakistanis are under risk of air pollution
40% of total urban population
- Air pollution is costing
Rs. 25.7 billion/year on account of health
- Air Pollution is effecting vegetation
rainfall patterns
ecosystems
- De- glaciations of Northern Pakistan
will cause serious consequences for water availability in Indus basin
- Changes in winter and monsoon precipitation
- Irregular change in seasonal temperature
effecting crop growth and snow melt

Time-trend of population, GDP, energy use and associated CO₂ emissions in Pakistan



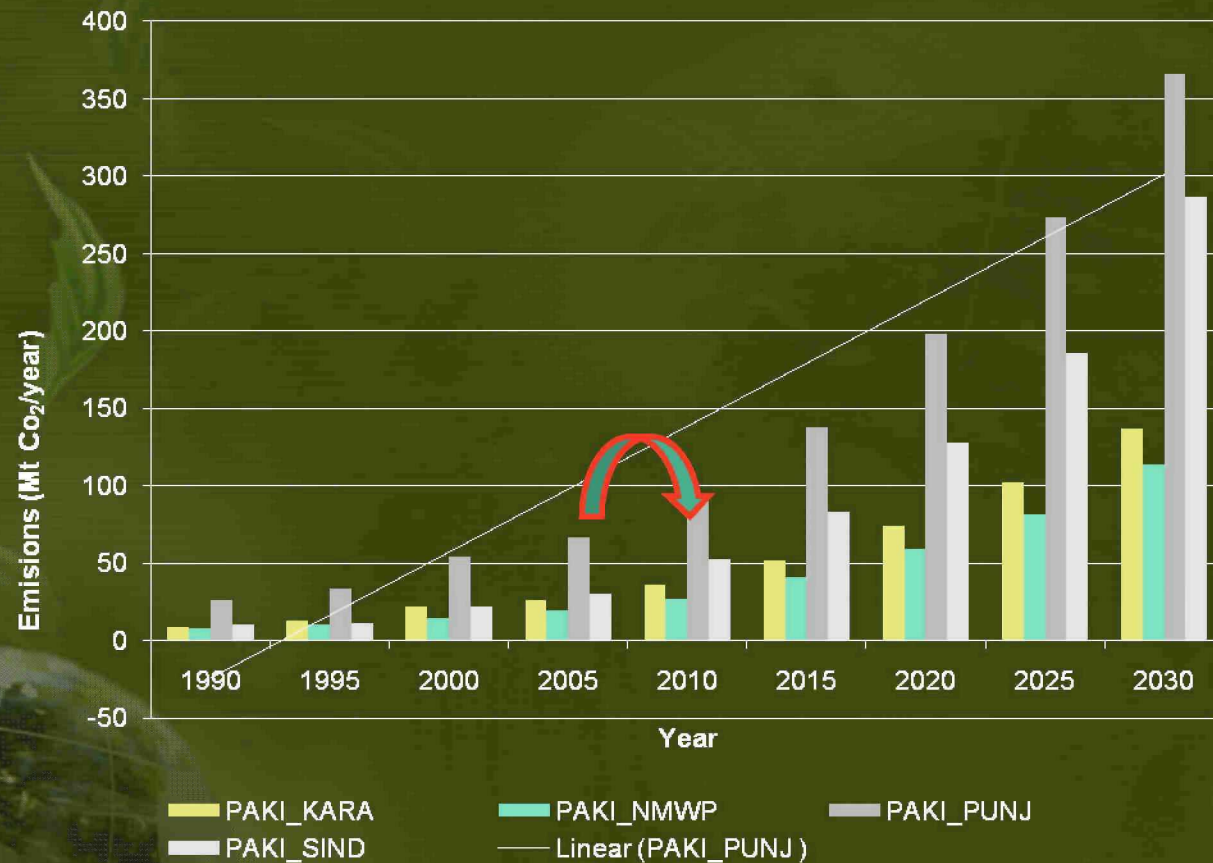
Source: GAINS-Asia (2008)

Some Recent Climate Extreme Events in Pakistan

2007 Record heat wave gripped Pakistan during June, 2007. **48°C temperature** was recorded on 9th June at **Lahore** (located in Punjab), a record repeated after 78 years. Earlier it was recorded on 8th June 1929 .

2003 During early June, a heat wave caused maximum temperature to reach **52°C** at Jacobabad (located in Sindh)on the 5th of June; normal highs in early June are around **44°C**.

CO2 emissions in different regions of Pakistan and Rise in Temperature



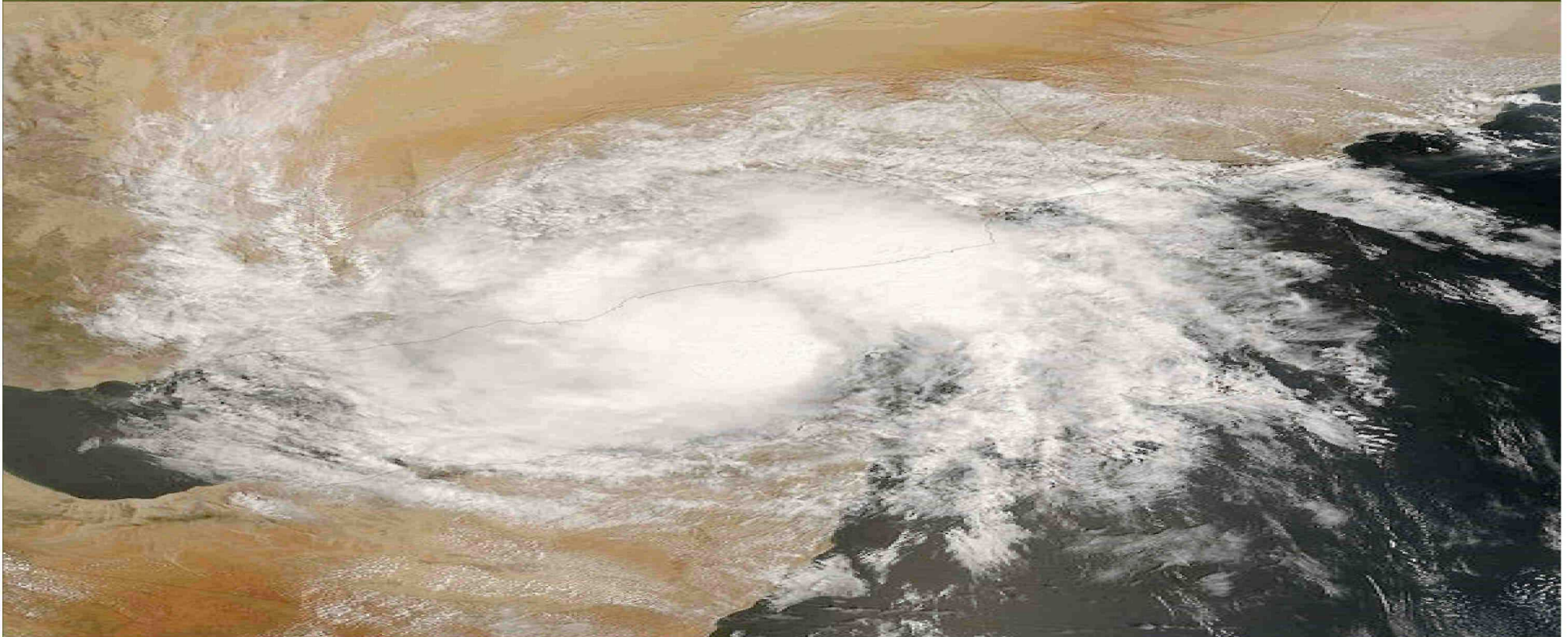
Source: GAINS-Asia(IIASA)

Extreme event and energy system in Pakistan (example of Yemyin)



Another extreme event hit Pakistan

2007 : Two super cyclones namely Gonu (02A) of Cat-5 and Yemyin of Cat-1 developed in the Arabian Sea during June, 2007 and hit Makran Coast and adjoining countries. The history of the Arabian Sea at least during the previous century shows no such events occurring twice in a month



Impacts of extreme event on energy system

Due to yemyin cyclone some 800,000 people hit by flooding in Pakistan's Balochistan province, with hundreds of thousands of homes destroyed, Many of them were **without electricity or drinking water** four days after a cyclone hit coastal districts.





**When scientific uncertainty comes to
cause climate change???**

Example of volcanic eruption



Volcanic Eruptions and climate change

- For many years, climatologists have noticed a connection between large explosive **volcanic** eruptions and short term climatic change .
- For example, one of the coldest years in the last two centuries occurred the year following the Tambora volcanic eruption in 1815. Several other major volcanic events also show a pattern of cooler global temperatures lasting 1 to 3 years after their eruption



 USGS

USGS Photo by D. Harlow, June 12, 1991

Volcanic Eruptions and climate change

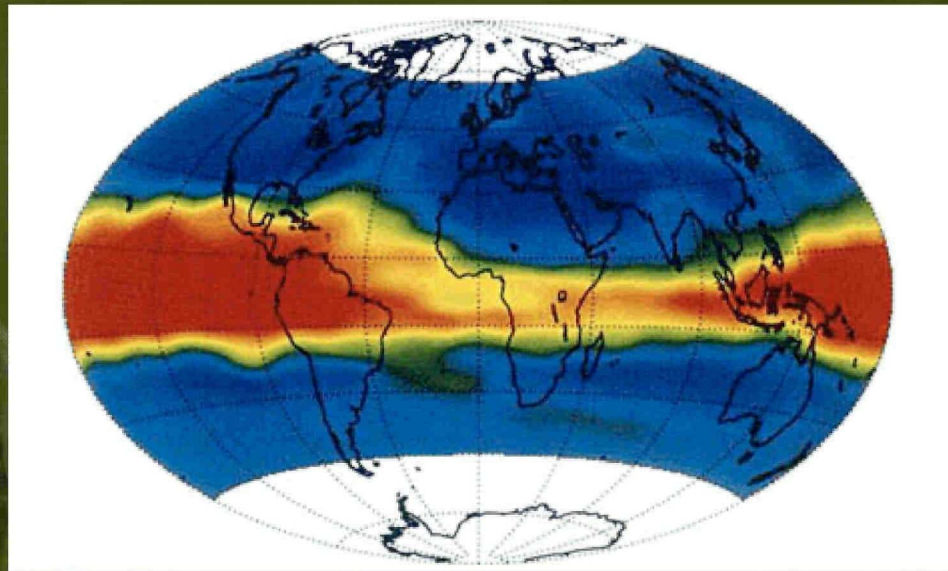
Explosive volcanic eruptions have been shown to have a short-term cooling effect on the atmosphere if they eject large quantities of sulfur dioxide into the stratosphere. This image shows the eruption of Mount St. Helens on May 18, 1980 which had a local effect on climate because of ash reducing the reception of solar radiation on the Earth's surface. Mount St. Helens had very minimal global effect on the climate because the eruption occurred at an oblique angle putting little sulfur dioxide into the stratosphere.



(Source: U.S. Geological Survey, photograph by Austin Post).

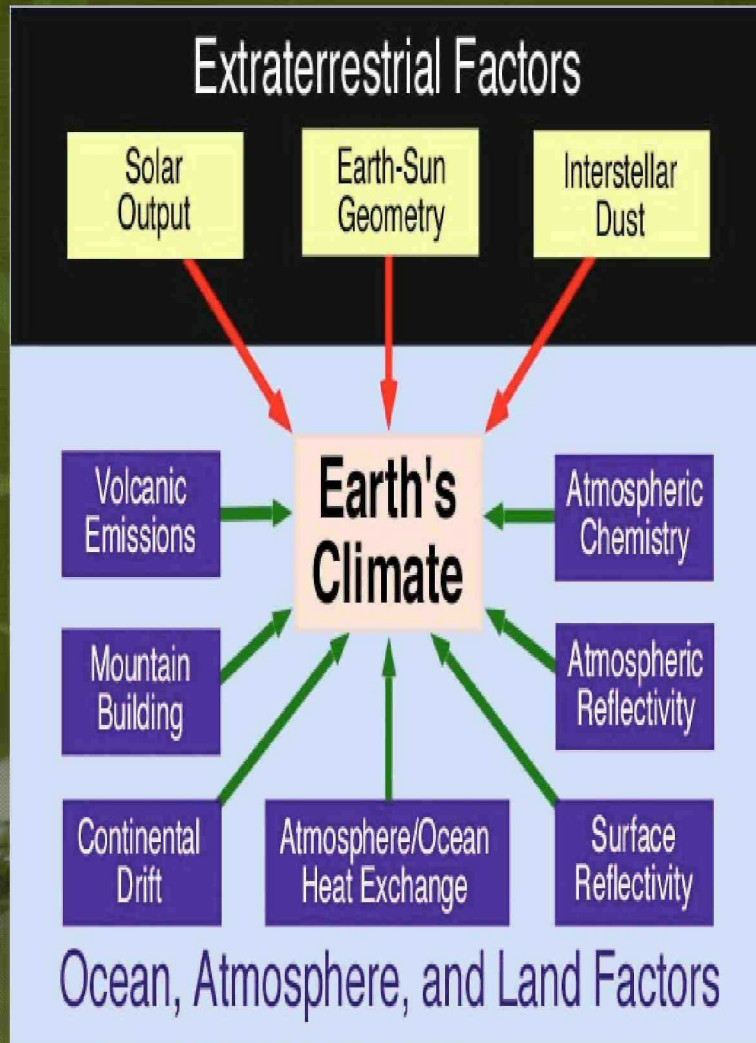
Volcanic Eruptions and climate change

The following satellite image shows the distribution of Mount Pinatubo's sulfur dioxide and dust aerosol plume (red and yellow areas) between June 14 and July 26, 1991. Approximately 45 days after the eruption, the aerosol plume completely circled the Earth around the equator forming a band 20 to 50° of latitude wide. These observed patterns of aerosol movement suggest that tropical explosive volcanic eruptions probably have the greatest effect on the Earth's climate.

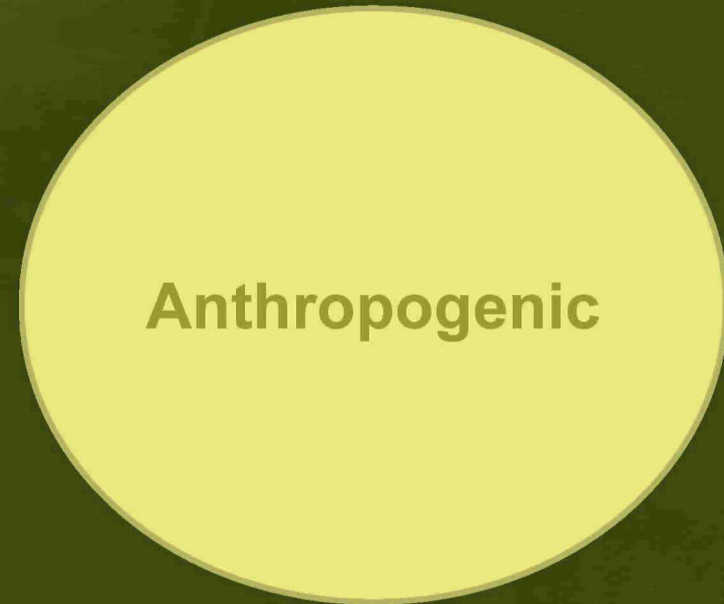


(Source: SAGE II Satellite Project - NASA).

Factors that influence the Earth's climate



+



Conclusions

- Climate change is always uncertain (example of volcanic eruption)
- Anthropogenic interference acts as contributing factor for climate change
- Apart from scientific uncertainties one must trust scientific knowledge as In our everyday lives we act based on incomplete information as a matter of course – to the point that we don't even think about it. But for scientists, uncertainty is top of mind.
- The next generation IA models must begin to incorporate the extreme events evident in climate change study, as well as those events interact with the energy system and resulting emissions
- There is need to develop techniques for uncertainty reduction at the output stage enabling the communication of risk assessment to the user community and its use by that community
- A framework should be developed for incorporating fine scale climate and energy relationships into model

Conclusions

- To reduce uncertainty there must be IA models and also there is need to identify improvements in model initialization, data assimilation and the processing of forecast and sample outputs across model community
- Unlike a car accident, which is serious but unlikely, global warming is both serious and likely. In fact, the clear picture that has emerged from decades of research is that it's already happening. We must act now to reduce greenhouse gas emissions. The challenge facing us can seem overwhelming, but we can turn this around
- So the next time someone tells you that global warming isn't a certainty so there's no reason to act, ask them what the probability of an accident has to be before they'll wear a seat belt.
- So finally there is need to develop present relationships between weather extremes and energy systems sensitivity at fine space/time scales

THANKS

