

# A bout B ehavioural science and C ompliance



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1. Compliance in context
2. Case studies
  - Chemicals management
  - Climate change
  - Occupational safety
3. Behaviour under uncertainty
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5. Conclusions

# Typical Risk Type examples



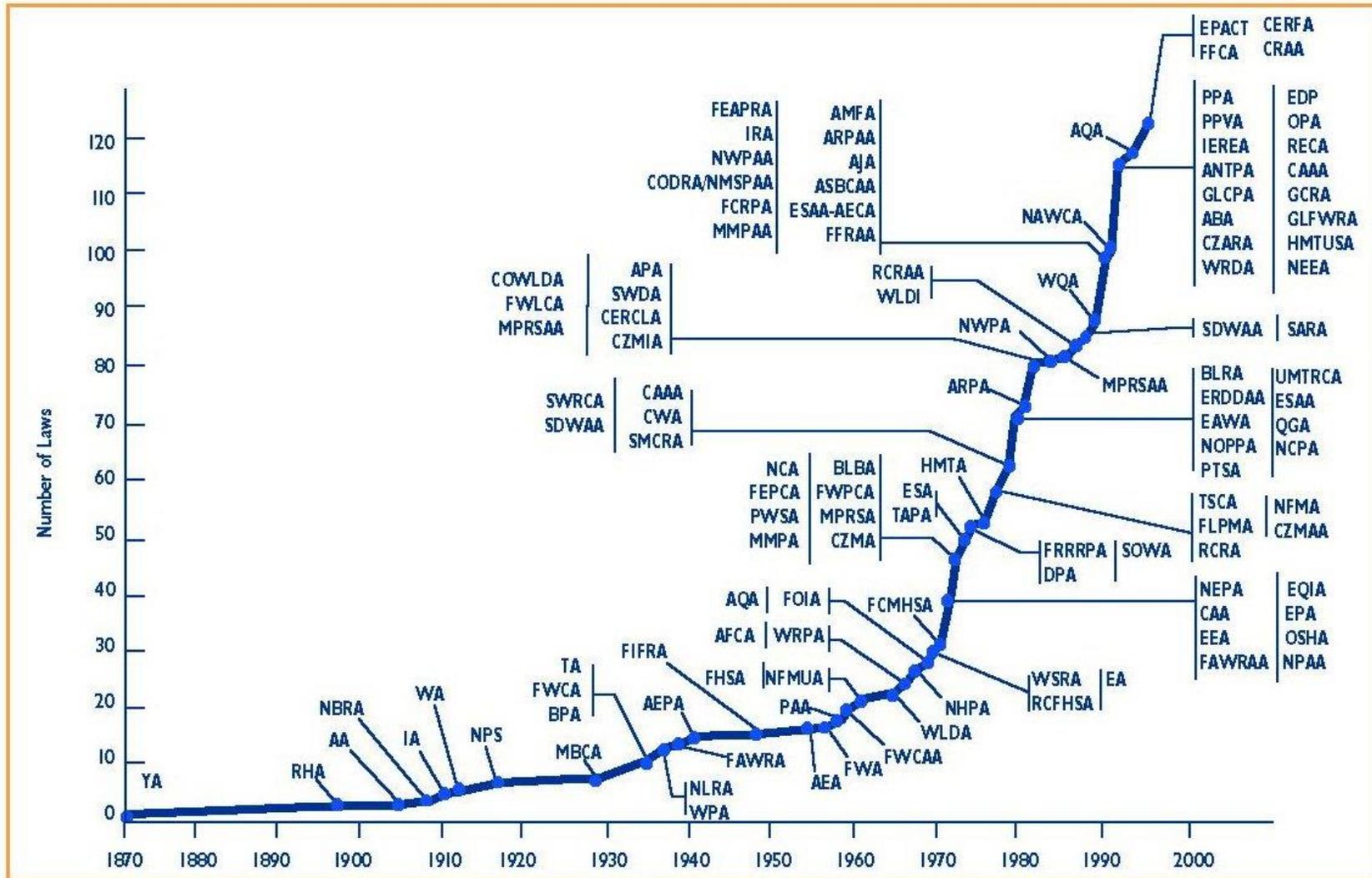
# Global development goals (2015-2030)

UN Sustainable Development summit 25-27 Sep 2015



World Leaders have committed to 17 Global Goals to achieve 3 extraordinary things in the next 15 years. **End extreme poverty.** **Fight inequality & injustice.** **Fix climate change.** The Global Goals for sustainable development could get these things done. In all countries. For all people.

# Proliferation of US laws (graph lists environment laws only!)



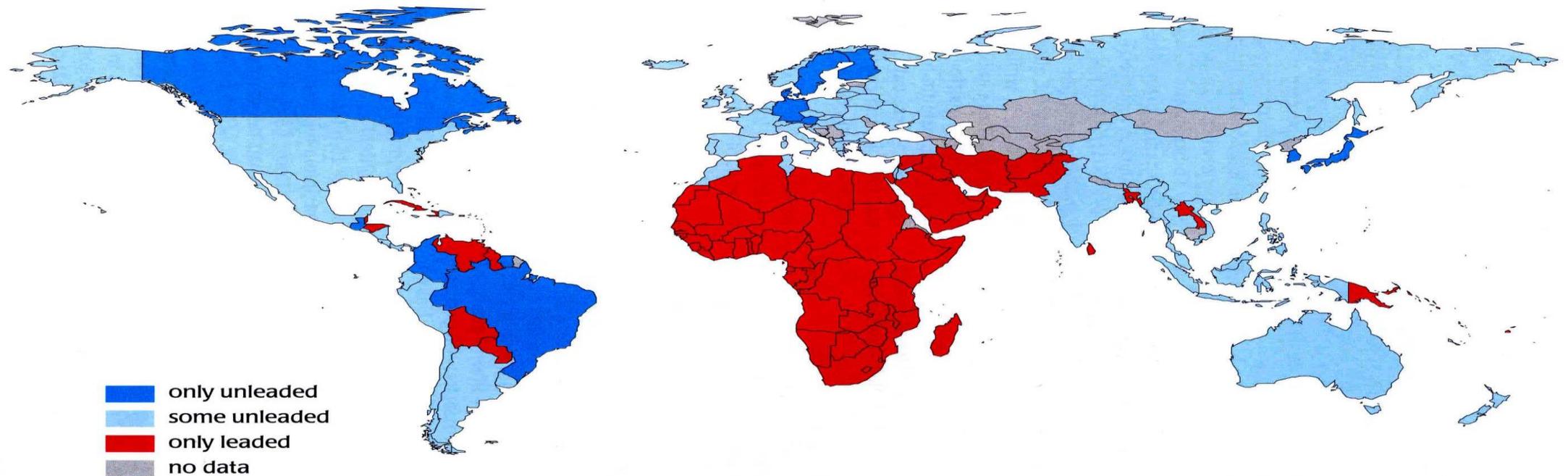
## Some case studies in chemicals

| <b>CHEMICAL SUBSTANCE</b>         | <b>ENVIRONMENTAL ISSUES</b>                           |
|-----------------------------------|---|
| Tetraethyl lead (TEL)             | Cumulative neurotoxin and accumulates in air and soil |
| Chloro-Fluoro-Carbons (CFC)       | Ozone depleting chemical and greenhouse gas           |
| Carbon dioxide (CO <sub>2</sub> ) | Climate change impacts                                |

Law and legal compliance was not always the solution towards solving these problems

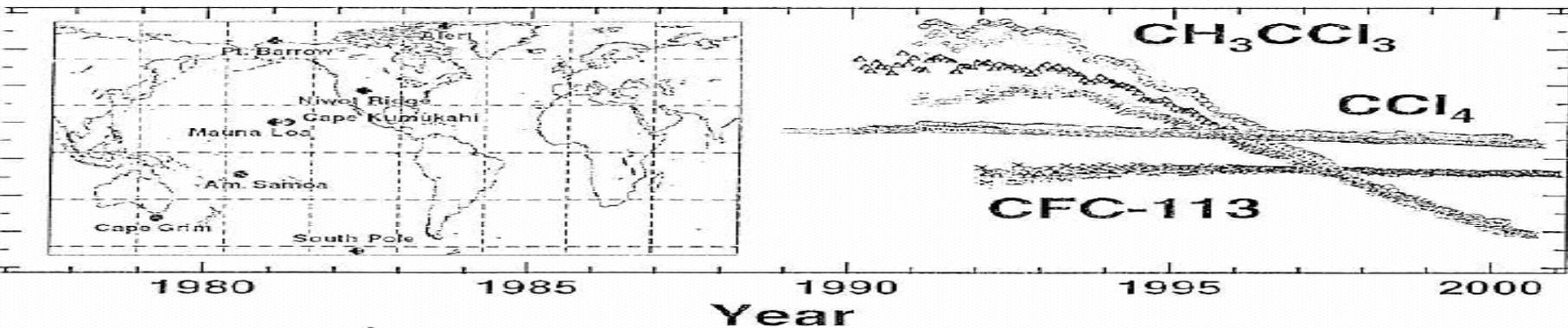
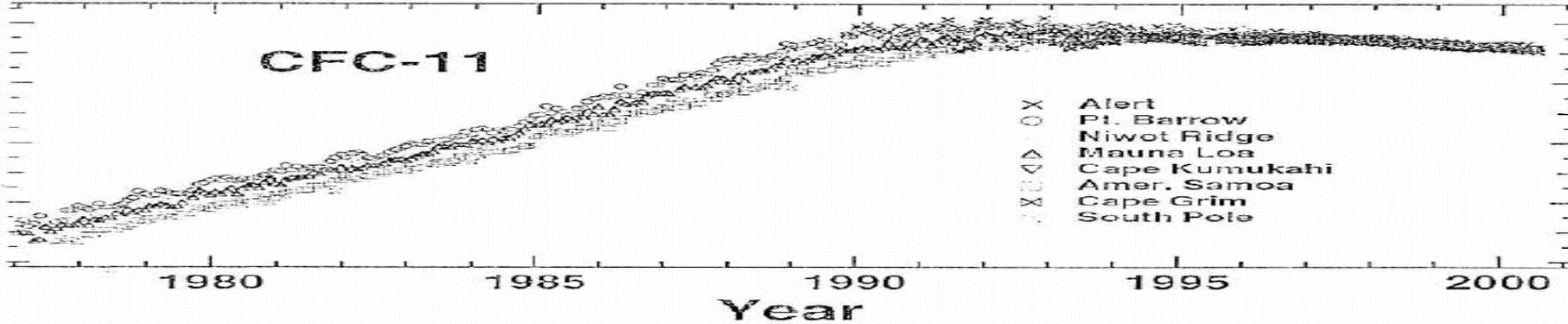
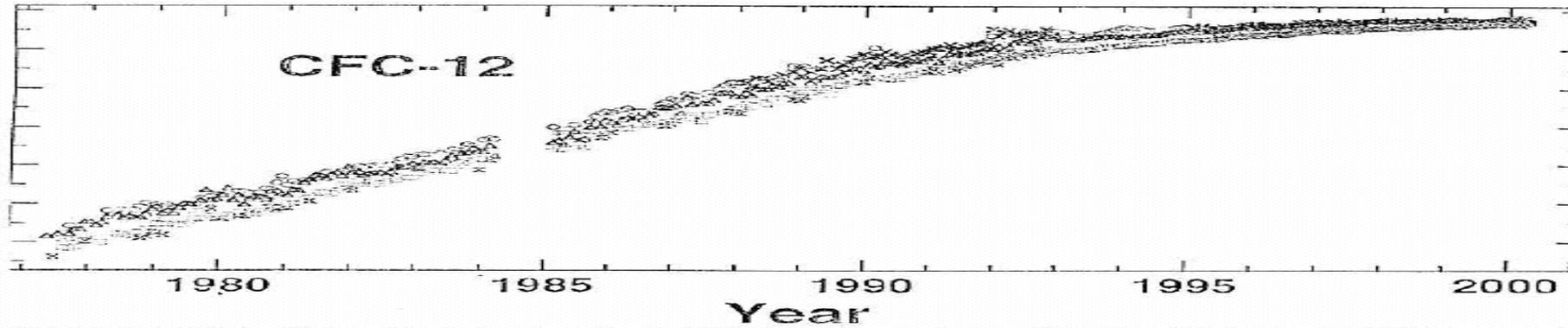
# Global reduction of use of Leaded Gasoline – what's wrong with this picture of 1998?

Countries Using Only Unleaded, Some Unleaded, Only Leaded Gasoline



# Montreal Protocol worked quickly for CFC product phase-out...

Trends of Controlled Ozone-Depleting Substances

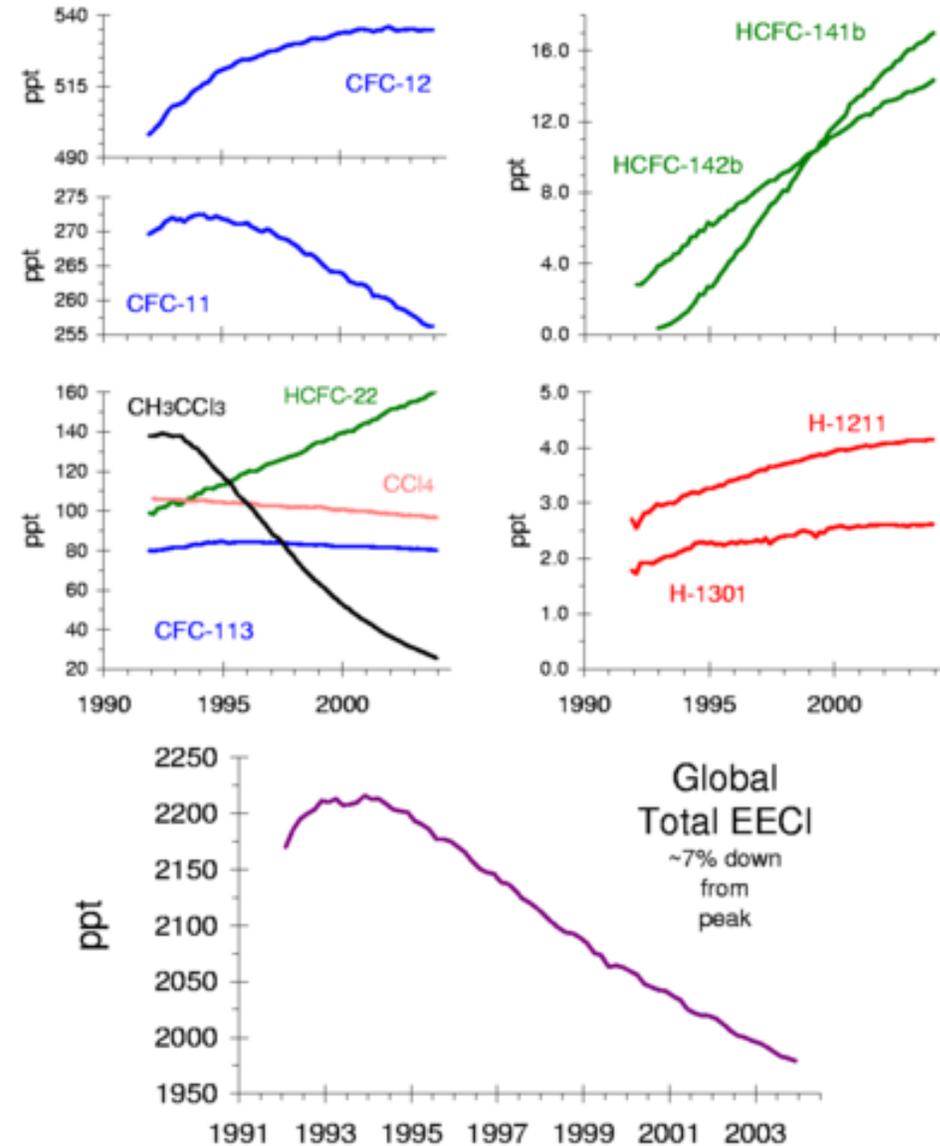


# Montreal Protocol worked...

The Montreal Protocol worked within 10 years to reduce CFCs...

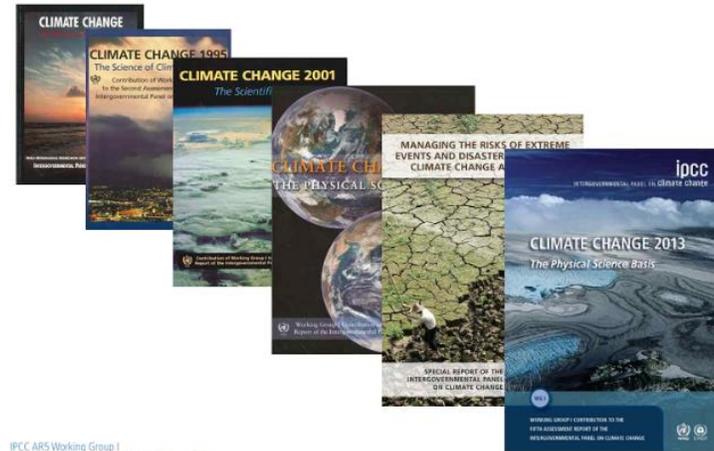
... but greenhouse gas reduction is a different matter

Global Mixing Ratios of Anthropogenic Halocarbons



# The Science and Politics of Climate Change

## IPCC Working Group I Reports Since 1990



IPCC AR5 Working Group I  
Climate Change 2013: The Physical Science Basis

## IPCC Working Group I Author Team



IPCC AR5 Working Group I  
Climate Change 2013: The Physical Science Basis



| Term*                  | Likelihood of the outcome |
|------------------------|---------------------------|
| Virtually certain      | 99-100% probability       |
| Very likely            | 90-100% probability       |
| Likely                 | 66-100% probability       |
| About as likely as not | 33-66% probability        |
| Unlikely               | 0-33% probability         |
| Very unlikely          | 0-10% probability         |
| Exceptionally unlikely | 0-1% probability          |

\* Additional terms may also be used – *extremely likely*: 95-100% probability, *more likely than not*: >50%-100% probability, *extremely unlikely*: 0-5% probability.

## Principles of IPCC (1998, 2003, 2006, 2011)

[...]

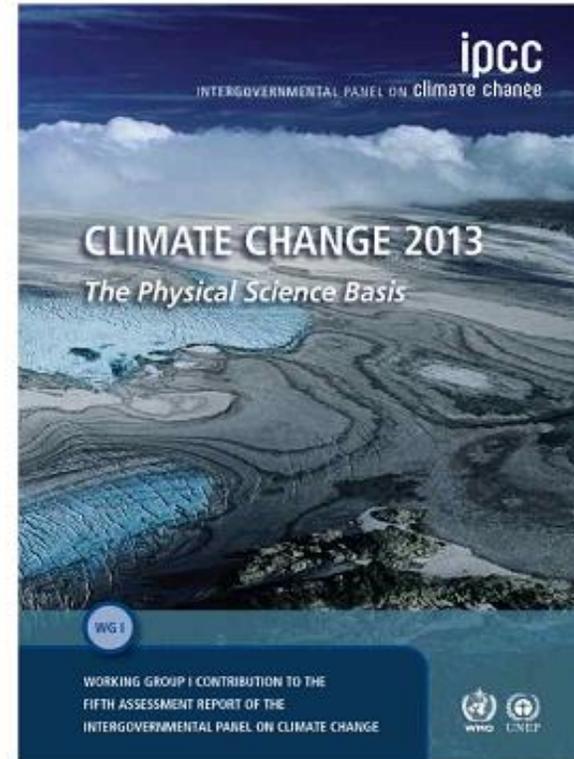
- The role of the IPCC is to **assess on a comprehensive, objective, open and transparent basis** the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. **IPCC reports should be neutral with respect to policy**, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies.
- Review is an essential part of the IPCC process. Since the IPCC is an intergovernmental body, review of IPCC documents should involve both peer review by experts and review by governments.

[...]

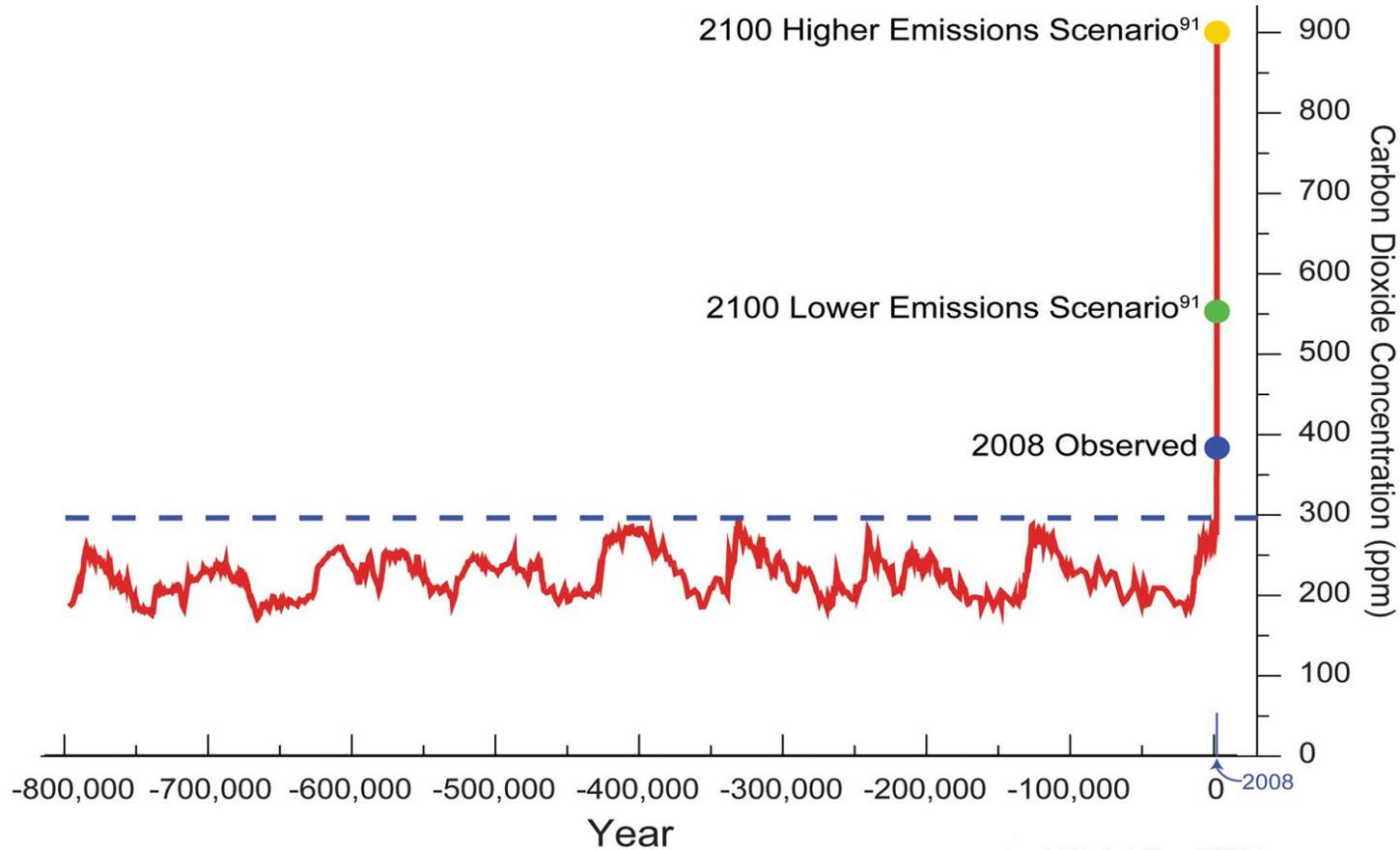
# IPCC WG1 AR5 is one example. Latest Report is BIG...

## The four Elements of the Fifth WGI Assessment Report

- **14 Chapters**  
1'140'000 Words, ca. 2000 Pages  
1250 Figures und Diagrams
- **Atlas: Regional Projections**  
Maps for 35 Regions of the World, 2 Mio G Bytes
- **Technical Summary**  
55'000 Words, ca. 90 Pages
- **Summary for Policymakers**  
14'000 Words, 22 Pages, 10 Figures



# CO<sub>2</sub> concentrations within air bubbles of Antarctic ice cores



Lüthi *et al.*; Tans; IIASA<sup>2</sup>

Analysis of air bubbles trapped in an Antarctic ice core extending back 800,000 years documents the Earth's changing carbon dioxide concentration. Over this long period, natural factors have caused the atmospheric carbon dioxide concentration to vary within a range of about 170 to 300 parts per million (ppm). Temperature-related data make clear that these variations have played a central role in determining the global climate. As a result of human activities, the present carbon dioxide concentration of about 385 ppm is about 30 percent above its highest level over at least the last 800,000 years. In the absence of strong control measures, emissions projected for this century would result in the carbon dioxide concentration increasing to a level that is roughly 2 to 3 times the highest level occurring over the glacial-interglacial era that spans the last 800,000 or more years.



# Outcome of Science is Carefully Worded

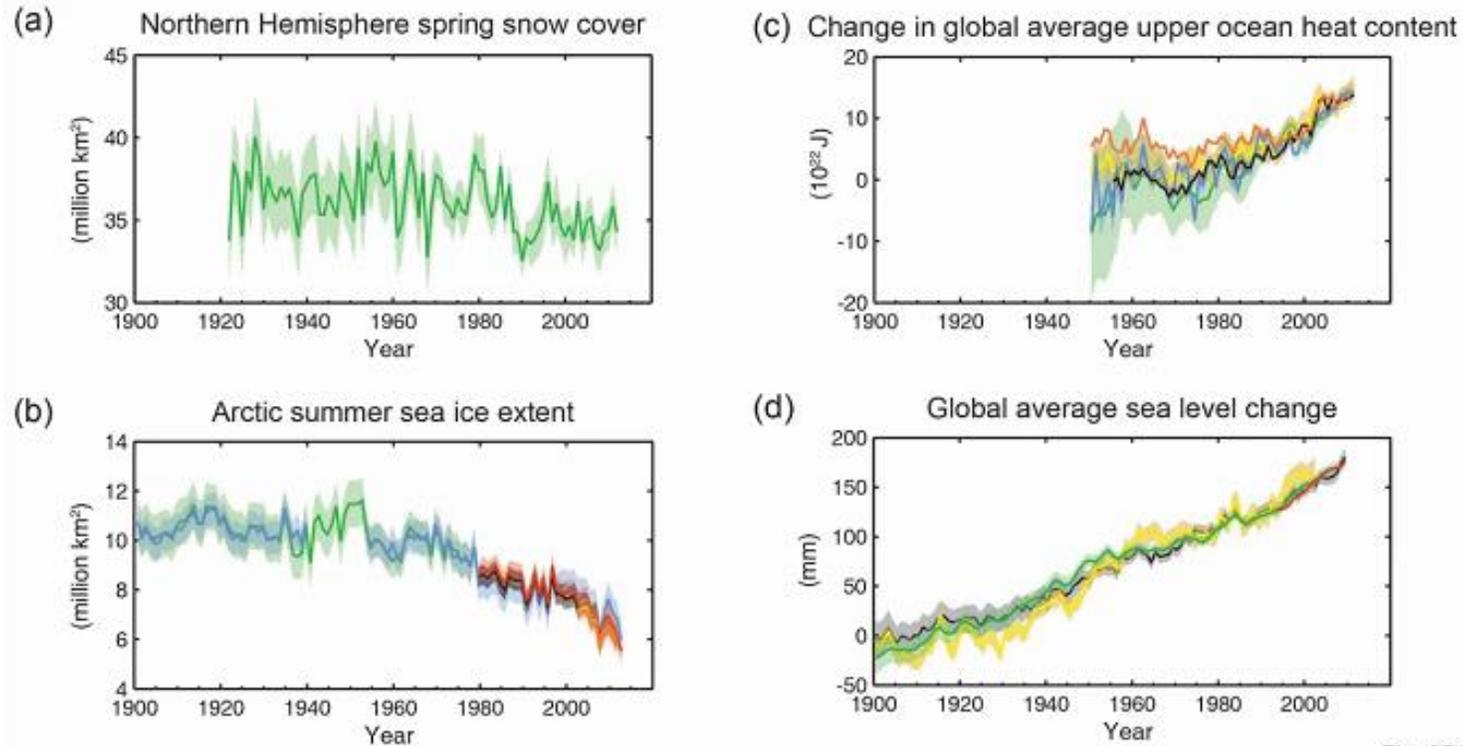


Fig. SPM.3

Warming in the climate system is unequivocal

# Yet, after 25 years of conferencing on climate risks, one day's coal consumption keeps growing and dwarfs the UN's HQ in New York

(Pic: WBCSD/Flickr)



# Options for stabilization at 550ppm CO<sub>2</sub> by 2050

(World Business Council for Sustainable Development, 2004!)

- 🌍 **Natural gas conversion (from oil and coal)**
- 🌍 **Mass transportation**
- 🌍 **Nuclear energy**
- 🌍 **Road transport - advanced diesel, hybrids, EV**
- 🌍 **Renewables – wind, solar, geothermal, hydro**
- 🌍 **Bio-products – replace non-renewable for cooking**
- 🌍 **Low energy appliances – lighting saving since 1970's 2-4 fold**
- 🌍 **Buildings – home energy use**
- 🌍 **Carbon capture and storage – unlimited?**

**Each option can replace 700 x 1GW Coal fired coal plants globally;  
combined saving 33 Gtpa CO<sub>2</sub>; which is equivalent to all CO<sub>2</sub> emission increase  
anticipated by 2050**

# Let's talk behaviour...

## enter Climate Critics, Sceptics, Denialists

- Politics - opposition parties differ in principle
  - e.g. when Democrats win, Republicans oppose climate action in the USA
- Popular writers - Bjorn Lomborg and others
  - The Sceptical Environmentalist, 2001 (<http://www.lomborg.com/>)
- Specialists (“Prof XYZ recently found that...”)
  - ...often with narrow field of specialization. Volcanoes, Cattle, Aviation,...etc
- Media and press
  - to stimulate debate and to get responses – it sells!

...these often delayed decision making and frustrated policymakers and scientists, but they also raise important debates helping awareness and highlight limits in knowledge

## How do Denialists influence progress?

- Creates a back door to do nothing
  - Consciously or subconsciously
  - What if climate change is not caused by us, not true?
  - What if the upsides outweigh the downsides?
    - A bit warmer Europe is nice
  - What if adaptation is cheaper than mitigation?
    - Benefits of two crops in one season, open arctic seaways?
- Bottom line – get the facts right
  - Forces rigorous check of all data and assumptions
  - Every 5 years the Assessment Reports are updated with the latest science
  - In democracies the majority rules- so whatever the science says, perceptions of the risk does count!

# What or who to blame for incidents?

## Technology

- Elimination (dangerous materials etc.)
- Engineering (monitors, conditions etc.)
- Administrative (procedures etc.)
- Mitigation (PPE etc.)

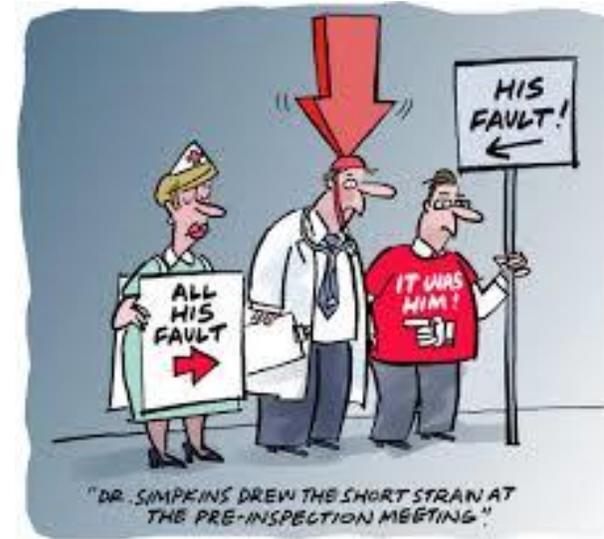


...unintended consequences:

- Regulations, ISO45001 & other standards, procedures, audits and training- too much?
- Alarms and signage, AI and automation overload?

## People

- Tone at the top
- Tone in the middle
- Operators on ground



...unintended consequences:

- Top: “Goal Zero”; ironically erodes practical skills– no small incidents allowed? Learning?
- Bottom: boredom of few ‘operators’ now mere ‘monitors’: gaming in control room?

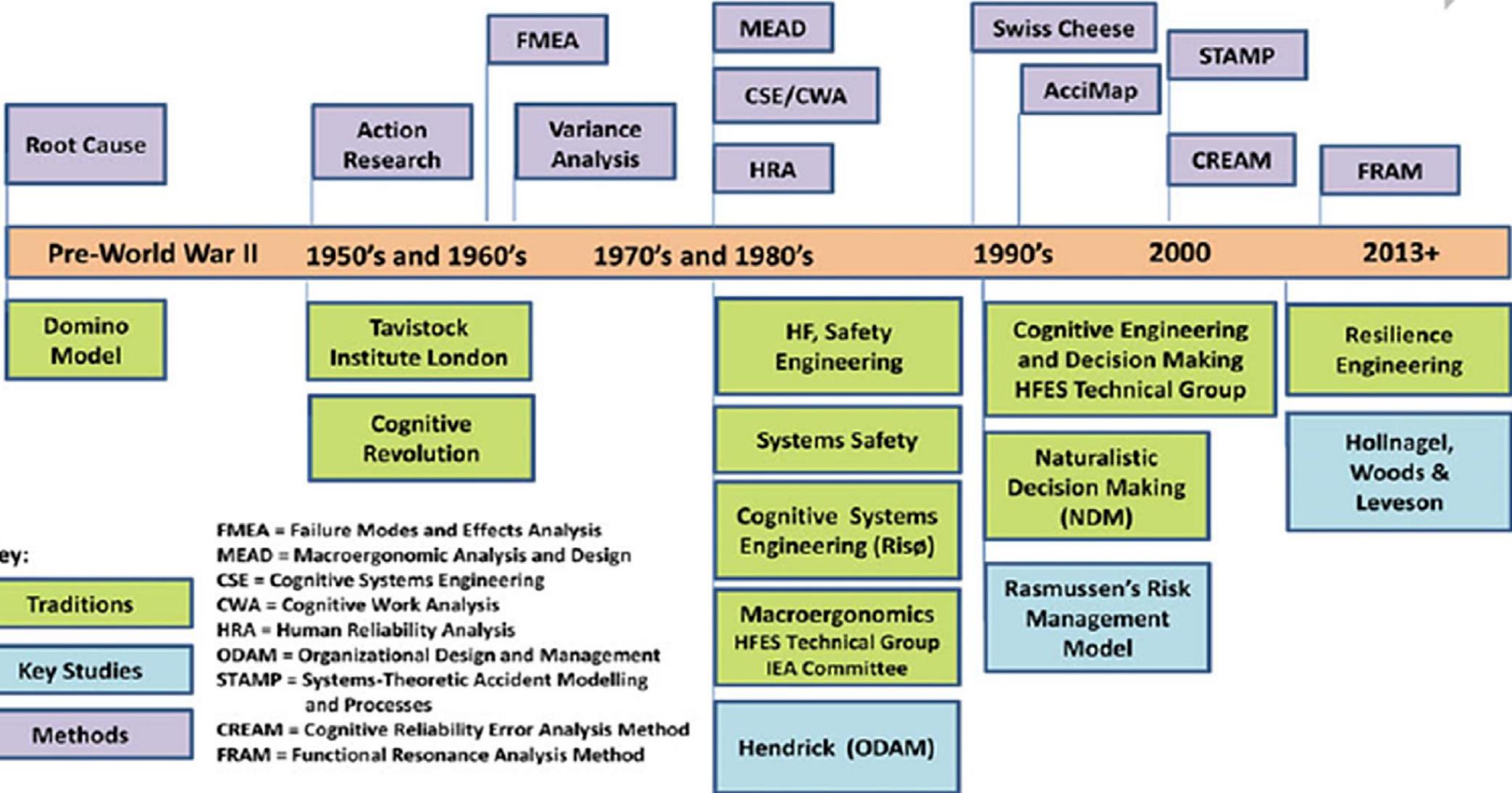
# Development of tools for sociotechnical systems and safety

(Waterson et. al 2017)

Age of Technology

Age of Human Factors

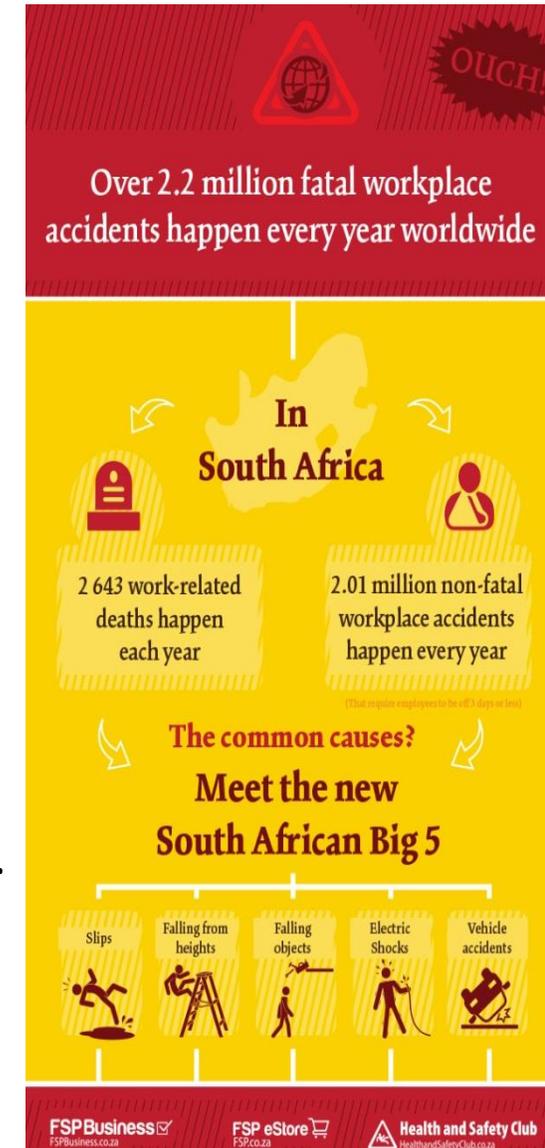
Age of Complex Sociotechnical Systems



“Sociotechnical systems are large, complex systems that generate electrical power, process chemicals, and transport people and cargo, among others”  
 - Strauch (2010)

# Yet, safety culture concerns remain in the workplace

- Gulf of Mexico BP Deepwater Horizon oil drilling incident in 2010; Japanese Fukushima Dai-ichi nuclear plant tsunami incident in 2011 (Synolakis & Kânoğlu, 2015), Boeing 737 Max 8 in 2019, all happened despite regulations and systems in place
- South Africa is no exception- a few thousand work-related deaths happen each year (Hermanus, 2007). Add 14 000 road deaths (2017)...
- Design of most complex systems (e.g. nuclear power stations and refineries) is assuming rapid, transparent flow of factual information between team members and with technology. Wrong assumptions result in increased incident rates (Hodgson et al., 2013).
- Interventions have shown to be effective in strengthening safety culture (Grahn, Peacock, Larsson, & Lackman, 2001).



# Benefits to integrate the social system and technical system in IT (Piccoli, 2012)

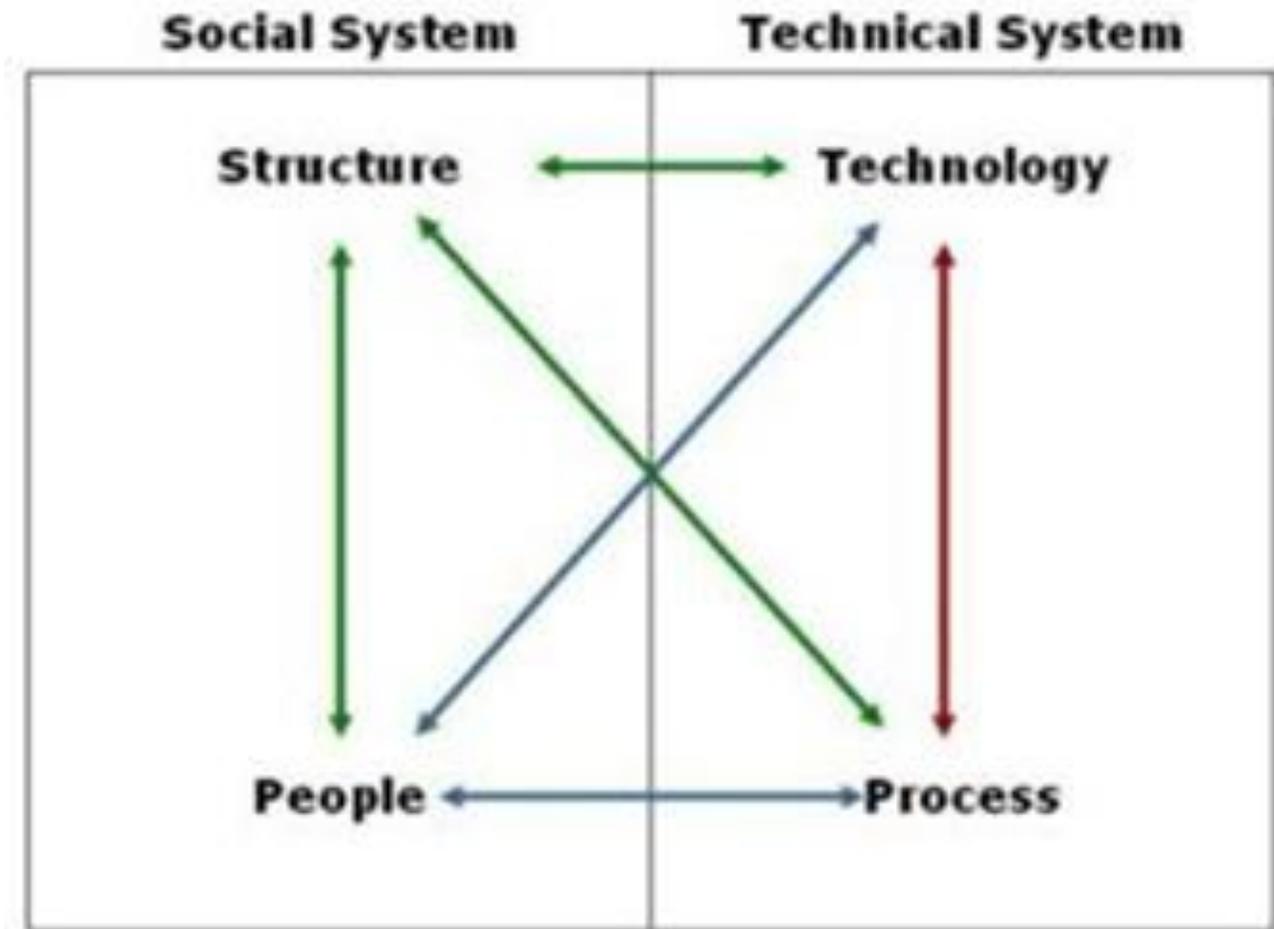
- Optimizing the technology or any other technical component individually fails
- Instead the system has to be managed as a whole, including the people (social) aspects
- The same diagram applies to how safety systems interact between people and technology:

*“I think we will find that this was an incredibly complicated set of events with individual decisions and equipment failures that led to a very complicated industrial accident”*

*Chairman of the Board,*

*British Airways,*

*2018*



## Conclusion



1. Changing from Blame culture to Learning culture
  - Technology → People → Both
2. Improvement opportunities exist to:
  - Integrate socio and technical systems
3. Balancing compliance with other mechanisms to effect change
  - Systems and technology, combined with understanding of people