# *Additional risk, end–of–the–pipe geoengineering technologies*

## *Introduction*

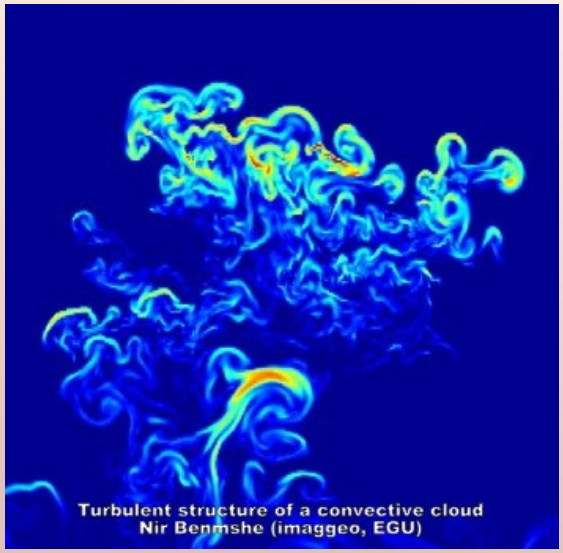
***Subject**: Cultural context of geo-engineering technologies, their acceptability to mitigate climate change and a related risk.*

**Dr. Martin Bohle,**
**Directorate General Research and Innovation**
**European Commission, 1049 Brussels, Belgium**

Credits: imaggeo (EGU)

Disclaimer: *And for the lawyers, I present here my views only and not those of my employer.*

## *Two scenes on stage…*




It's an intercontinental flight:

***The crew informs that the cooling system should be re-engineered, and that first experiments will be undertaken soon, also respecting the Oxford principles [a].***

It's Earth:

***The G8 informs that geoengineering should provide additional cooling for the planet, and that first experiments will be undertaken soon, also respecting the Oxford principles [a].***

# *Humans are engineers…*

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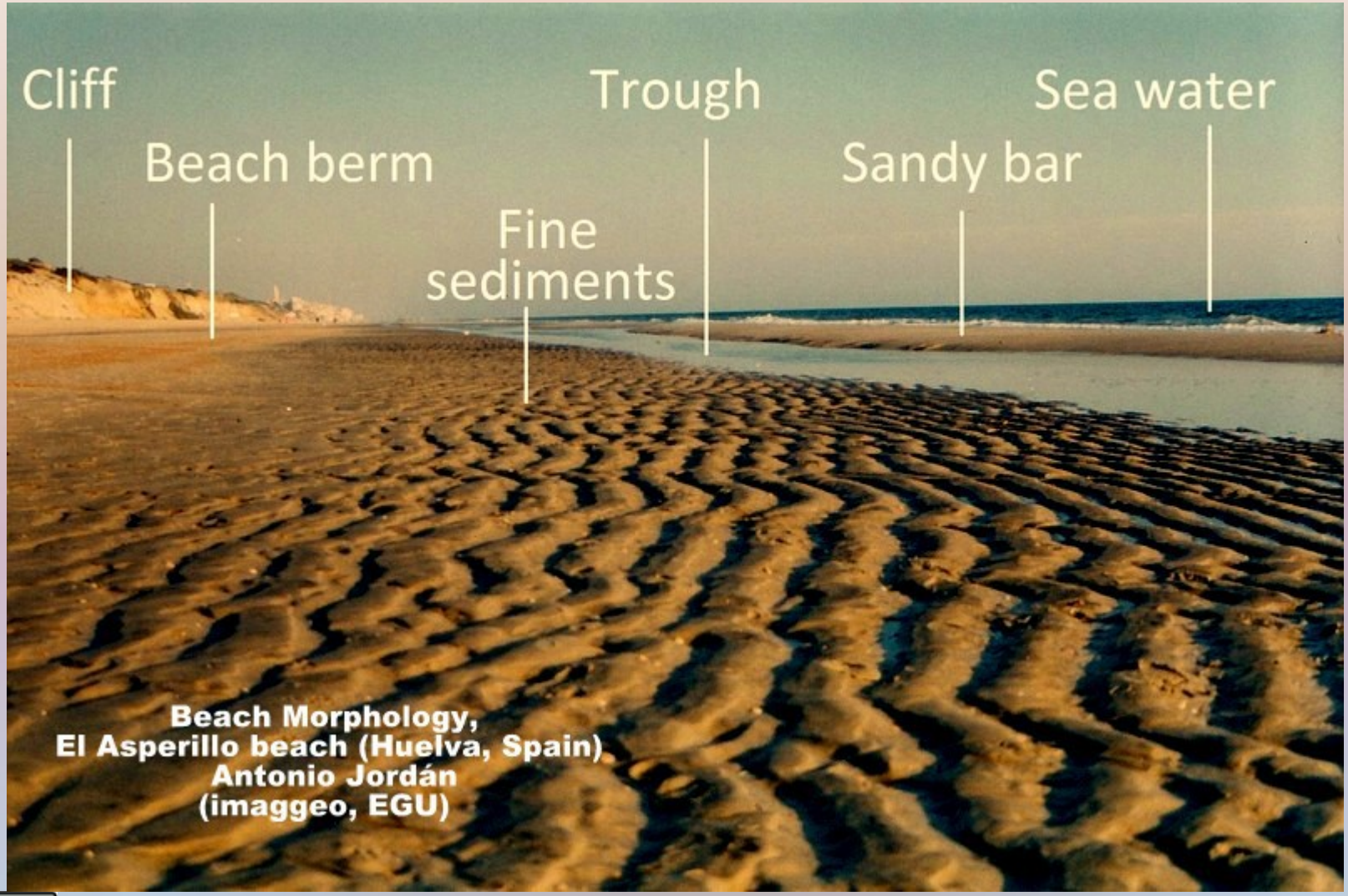
People live in environments, landscapes that they created.

Well engineered methods have shaped modern societies.

Environmental issues were successfully tackled by:

- ***Technological-fixes;***
- ***Combined with regulatory measures;***
  - ***Both, generally targeting the "start-of-the-pipe";***

# *Deus mare, Friso litora fecit [1]*



# *Deus mare, Friso litora fecit [1]*

Your ship has a leakage; what to do?

***Option*: You install pumps and command pumping duties.**

A Dutch experience: A substantial part of the Netherlands are below sea-level. To protect their country, the Dutch people use "pumping" since centuries. Evidently, the Dutch people plan to continue, at least for the next meter of sea-level rise. It's part of their culture.

- ***Does this kind of experience renders geoengineering acceptable in our culture, at least as an emergency-fix?***

# *Experiences – "start of the pipe"*

Experience:

# *Experiences – "start–of–the–pipe"*

## Experience :

Acid rain and ozone depletion (e.g.) have been addressed through a combination of a technological-fix and regulatory measures.

Threatening emission problems were targeted at their sources; thus at "start-of-the-pipe".

And to tackle these threats, our habitual consumption and current production patterns were not put into question.

***...this was a good experience, well fitting into our culture!***

# *Development trajectories… some "no–options" for nine billion people*

Option: Up-scale the global fluxes of resources so that nine billion people (2050) can live like European citizens;

- ***Comment*: Up-scaling by factor 20 is not sustainable for global systems; it is well beyond planetary boundaries [b].**

***p.m.: The "gross world product" increased ~20-fold in the period 1925-2000.***

Option: Proportional down-scaling of European-like production and consumption patterns to reduce resource intensity per capita;

Option: Keep current global imbalances of wealth and poverty;

# *Mitigating climate change… a dilemma*

Mitigating anthropogenic climate change is an essential part of a develop trajectory towards "global sustainability"; a trajectory that possibly comes at a substantial economic cost.

Mitigation anthropogenic climate change likely requires to engineer a ***disruptive change*** to our current production and consumption patterns.

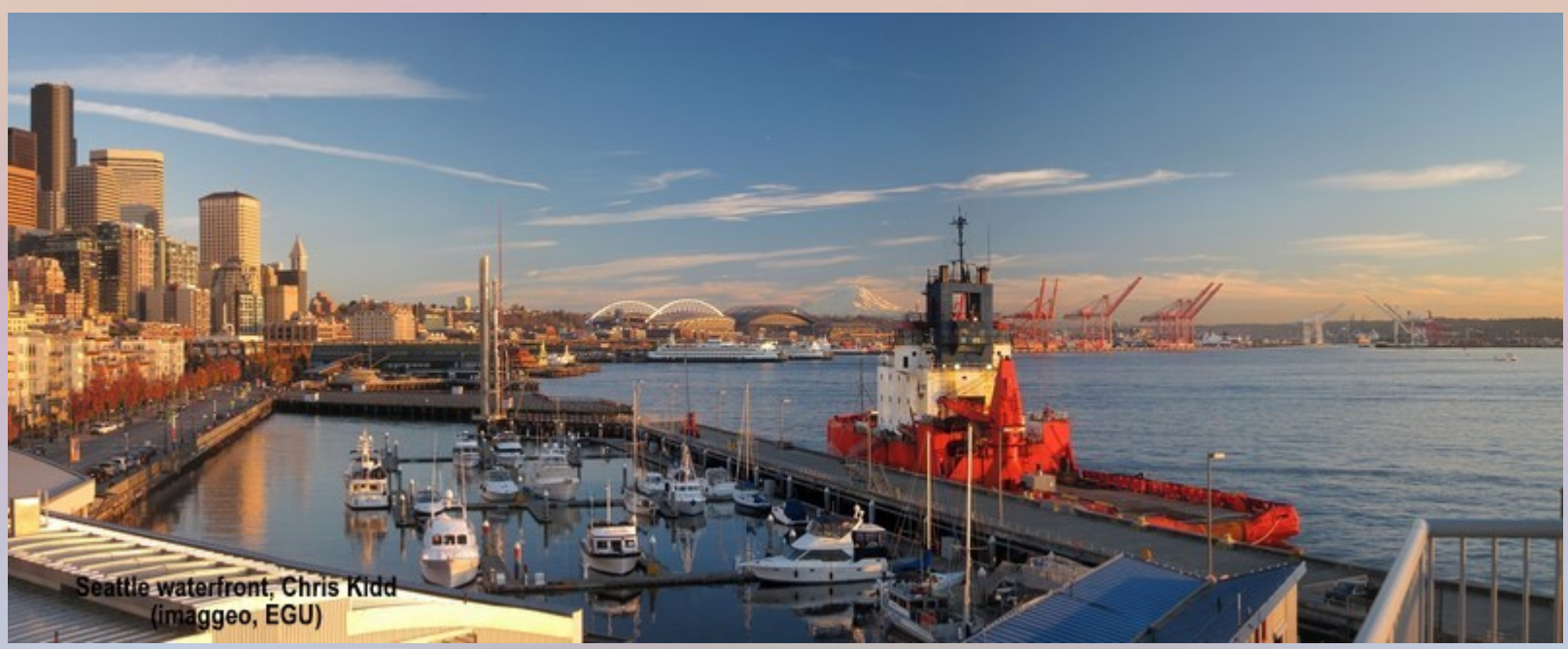
***Comment*: ...difficult to get accepted, difficult to manage,...**

The economic [*] and social costs [**] are quite high for a ***„business as usual scenario"*** of a non-mitigated anthropogenic climate change (without substantial sea-level rise).

[*] up to: ~ 3 % of the annual world gross product; [**] ?

# *Mitigating the dilemma, geoengineering a further option?*

..."Geoengineering" may look appealing: ***a "technology fix" without disruption of the current economic structures or the habitual consumption patterns…***


Seattle waterfront, Chris Kidd (imaggeo, EGU)

# *Geoengineering … a risk of perception*

Geoengineering technologies like reforestation, particle injection, carbon-dioxide scrubbing,... target:

- either the “end-of-the-pipe”
- or feedback loops of the climate system.

Geoengineering does not offer “start-of-the-pipe technologies”. This makes them different from the engineering success stories like mitigating of ozone depletion or acid rain.

Geoengineering appeals to our culture because it offers a regulated technology-fix for a dilemma that is difficult to tackle.

Thus, "geoengineering" is loaded with the risk of being accepted because ***it fits well into our culture*** **-** humans are engineers.

# *Experiences with particle injection – two events*

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A cancelled project:

- ***SPICE, a project for "stratospheric particle injection for climate change" has been cancelled [2, c].***

An executed project:

- ***Injection of volcanic ash into the atmosphere to test an aircraft sensor for volcanic ash-hazards [3] has been executed.***

***p.m.:*** *Who has the authority to evaluate and regulate the testing of geoengineering technologies?*

# *Regarding acceptability… a comment:*

Some cost estimates:

- ***economic cost of "carbon capture at combustion" 18 to 49 $/tonne $CO_2$ [4]; economic cost of climate change 12 to 64 $/tonne $CO_2$ [5]; …***

If – then:

- ***if "social, legal and political issues as well as scientific and technical factors to be considered" [6]...then:***
  - ***experiences advices use of "start-of-the-pipe" technologies;***
  - ***cost are still moderate (0.9% – 2.2% world gross product);***
  - ***no "emergency technology-fix" seems to be needed ;***

# *Geoengineering… a cultural risk ?*

Geoengineering technologies fit into our culture, because they offer a regulated "technology-fix" to mitigate climate change.

Public perception of geoengineering will vary, likely from ***„No, to in-flight re-engineering"*** to ***„Yes, to an emergency-fix".*** However what is the level of "emergency" that would render geoengineering an acceptable option and who would regulate it?

Our experience with acceptable political / social choices for technology-fix / regulatory measures show one key-feature:
***They have been an affordable start-of-the-pipe approach.***

Thus to mitigate anthropogenic climate change, an acceptable engineering option would be:
***"Carbon capture at combustion"***.

# *Thank you for your attention*

# *References*


**[1] Robert J. Nicholls (2011), Planning for the Impacts of Sea Level Rise, Oceanography 24(2):144–157,**

**[2] David Kramer (2013). Geoengineering researchers ponder ethical and regulatory issues. Physics Today vol. 66 (11).**

**[3] Alexandra Witze (2013). Volcanic-ash sensor to take flight. Nature, vol. 502.**

**[4] Jeremy David and Howard Herzog (2001),The Cost of Carbon Capture (http://sequestration.mit.edu/ )**

**[5] Richard L. Revesz (2014) Improve economic models of climate change., Nature 508, pp. 173-175**

**[6] Adam Corner and Nick Pidgeon (2010). Geoengineering the climate: The social and ethical implications. Environment, vol. 52.**


**[a] http://www.geoengineering.ox.ac.uk/oxford-principles/principles/ In December 2009, the Oxford principles, initially drafted by scholars were endorsed by the to UK House of Commons Science and Technology Select Committee on "The Regulation of Geoengineering" making them a national-level policy statement on responsibly executed geoengineering research.**

**[b] http://www.planetunderpressure2012.net/pdf/state_of_planet_declaration.pdf, "State of the Planet Declaration" adopted by the conference "Planet under Pressure" 26th-29th March 2012 in London.**

**[c] The injection height of 1.000m foreseen in SPICE, following habitual definition, would be much below the stratosphere habitually having a lower limit around 10.000 m. However, "SPICE" is not a misname of the project. The cancelled experiment was part of a much wider undertaking that apparently also run into difficulties because of a dispute about patent rights for geoengineering techniques (see: D. Cressy 2012, Geoengineering experiment cancelled amid patent row, Nature, Vol. (485): http://www.nature.com/news/cancelled-project-spurs-debate-over-geoengineering-patents-1.1069).**