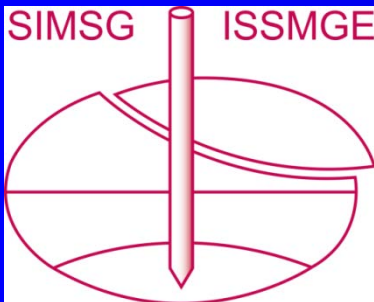


**3<sup>rd</sup> International Conference on  
Transportation Geotechnics**  
***1st YTGE Meeting***

**4-7 September 2016**  
**Guimarães, PORTUGAL**



**The future of geotechnical engineering  
(only some aspects or ideas for thought ...)**



**Roger Frank**  
**Ecole des Ponts ParisTech, Navier-CERMES**

# Outline

- The specificities of GE
- The general challenges of GE in this early 21st century
- ‘Methodological’ issues
- ‘Ethical’ issues. Conclusions

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- Nice profession !
- Each geot/CE work is a prototype
- Mixture of rational mechanics (and other sciences) with the art-of-the-engineer
- There is no 'truth'
- It is a science of observation

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# General ('Social') challenges

- Geohazards
- Environmental geotechnics
- Transportation geotechnics
- Production of renewable energies
- Existing structures. Cultural heritage...
- Safety, Health, Sustainability

# Geohazards

- Typhoons, tsunamis, storms
- Floods, mud flows, soil and rock slides, avalanches
- Volcanos (ashes and ... clouds), earthquakes (liquefaction and other damages...)
- « karsts », sinkholes, collapsible-swelling soils, subsidence (natural or anthropic)

# GEOHAZARDS, WHAT ARE THEY?

“Events caused by geological conditions or processes, which represent serious threats for human lives, property or the natural environment”

## Onshore

Volcanism

Earthquakes

Slides/debris flows

Floods

## Offshore

Slope instability

Tsunamis

Shallow gas/hydrates

Diapirism

Natural disasters are one of the main threats to improvement of the standard of living in many developing countries.

S. Lacasse, NGI, 2005

R Frank The future of geotech engng, Inaugural Lecture, 1st YGTE meeting, Guimaraes, 4-7/9/2016



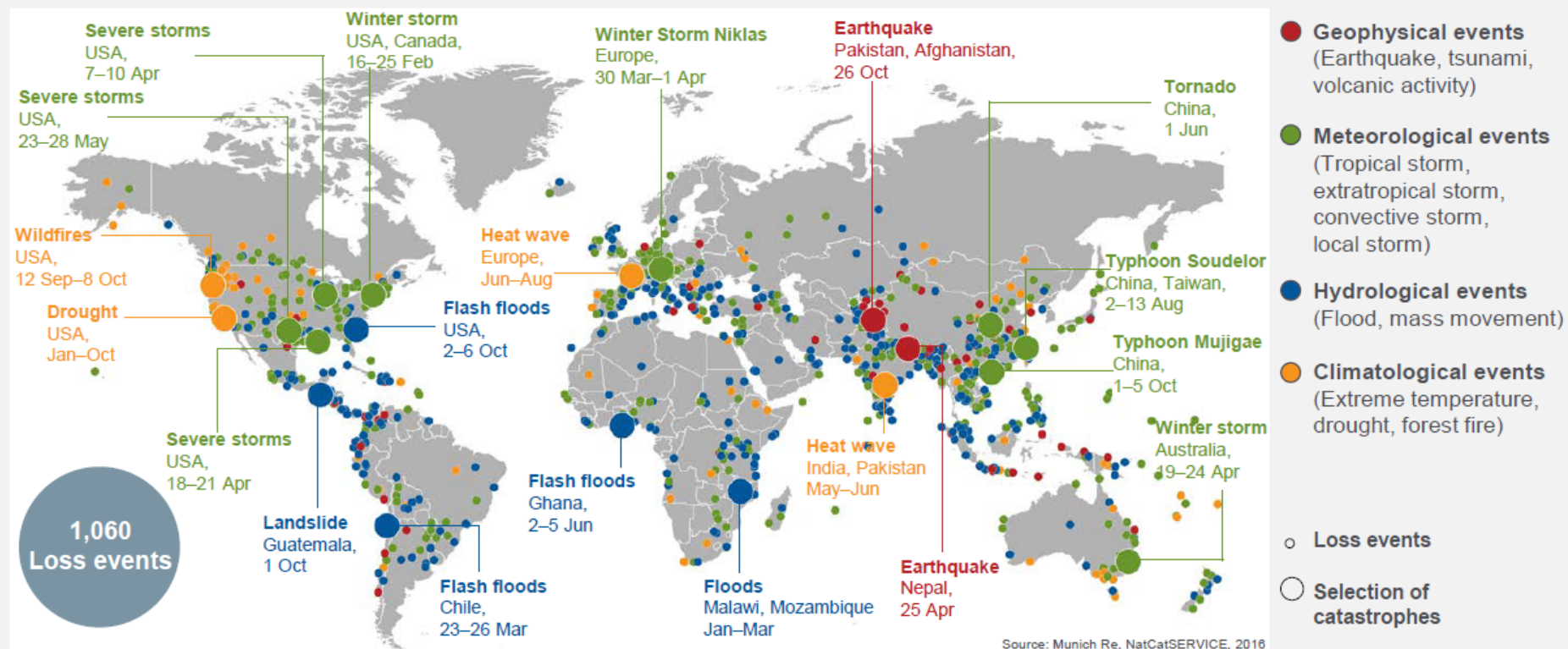


# Geohazards

- Unprecedented scales
- with... denser cities !
- Risks and reliability analyses
- No financial constraints on geot engnrs?
- Influence of climate change (melting of permafrost, zero level cities)
- Emotion is important

# Natural loss events worldwide 2015

## Geographical overview



# Influence of climate change : zero level cities



Origin: Government of the Netherlands, Delta Programme Commissioner

# Sea level rising more rapidly

News item | 11-05-2016 | 08:34

See also

→ [Delta Programme](#)

The media are focusing a great deal of attention on the publication by Nature magazine, in which scientists describe how the Antarctic ice sheet is melting faster than current data shows. According to the scientists, this is due to several processes that have previously not been recognised. The result may be that in the centuries ahead, the sea level will rise by more than is currently expected.



Origin: Government of the Netherlands, Delta Programme Commissioner

R Frank The future of geotech engng, Inaugural Lecture, 1st YGTE meeting, Guimaraes, 4-7/9/2016



In the Delta Programme, we are working with the latest insights that have been properly investigated. The new scientific insights regarding the melting Antarctic ice caps must be taken seriously. For that reason, it is important for the IPCC, the UN climate panel, to translate these new insights into a future sea level forecast. This is expected to be accomplished in 2018. The Royal Netherlands Meteorological Institute KNMI is currently examining the probability of such a scenario developing. For the time being, sand replenishments along the coast will enable the Netherlands to cope with the predicted +1 meter scenarios until 2100. The new IPCC analyses may be reason for the Netherlands to take even farther-reaching steps.

The essence of the Dutch approach is that we factor in multiple scenarios for 2100 and beyond, adapting them where appropriate. We adjust our course if need be, keeping level-headed and alert. The issue is urgent, yet not acute. We must continue to expend our best efforts on reducing the temperature rise by quickly making our country sustainable. However, the report on the Antarctic ice caps once more indicates that climate adaptation is an issue requiring continued and urgent effort, in the Netherlands as well as across the globe.

The Dutch approach sets an example for the world. We are collaborating with many nations, for example in the Delta Coalition initiated by Minister Schultz van Haegen. The Netherlands is well prepared. The law stipulates that water policy must be focused on disaster prevention. We have been working on that since 2010 in the Delta Programme, the Delta Plan for the 21st century - with a Delta Fund of an annual 1 billion euros and a dedicated government commissioner, the Delta Programme Commissioner, who draws up the plans together with all the parties involved. This is unique in the world. The Cabinet recognises the importance of this quite clearly and continues to allocate resources. We must not shirk our obligations. Upon a positive evaluation of the Delta Act – which is now being conducted, after 5 years – we must keep up the pace in our work on the delta.

Origin: Government of the Netherlands, Delta Programme Commissioner

# Environmental geotechnics

- Cleaning of polluted soils
- Constructing on brownfields
- Waste disposal (including nuclear waste..)

# Main problems in Environmental Geotechnics (from I. Vaníček, GeoMos 2010)

- Waste deposition on surface
  - Landfills
  - Tailing dams
  - Spoil heaps
    - » impact on environment
    - » Utilization of surface for new construction
- Remediation of contaminated ground
- Construction on brownfields
- Utilization of different waste in CE
  - Ash
  - Material of spoil heaps => e.g. in Earth structures
  - Slag33

# Production of renewable energy

- Oil production
- Geothermy, energy piles
- Hydroelectric dams
- Foundations of electric pylons, wind generators
- etc.



# Existing structures. Cultural heritage...

- Ageing of geotechnical structures: foundations, earth structures (dams, etc.)
- Assessment of existing structures
- Maintenance, Repair

# Challenges at the level of geot engng

- serviceability of structures (predicting movements of foundations – eg see EC7)
- prediction of long duration movements
- soil movements; upper values of soil parameters
- **observational method**; compensation grouting, etc.
- **disturbance when retrofitting**

# Challenges at the level of geot engng (cntd)

- validity of continuum mechanics  
(development of micromechanics...)
- use of physical models (centrifuge, etc.)
- tunnelling in soft ground , **urban projects**

# Observational method or Interactive design – See EC 7

## 2.7 Observational method

(1) When prediction of geotechnical behaviour is difficult, it can be appropriate to apply the approach known as "the observational method", in which the design is reviewed during construction.

(2)P The following requirements shall be met before construction is started:

- acceptable limits of behaviour shall be established;
- the range of possible behaviour shall be assessed and it shall be shown that there is an acceptable probability that the actual behaviour will be within the acceptable limits;
- a plan of monitoring shall be devised, which will reveal whether the actual behaviour lies within the acceptable limits. The monitoring shall make this clear at a sufficiently early stage, and with sufficiently short intervals to allow contingency actions to be undertaken successfully;
- the response time of the instruments and the procedures for analysing the results shall be sufficiently rapid in relation to the possible evolution of the system;
- a plan of contingency actions shall be devised, which may be adopted if the monitoring reveals behaviour outside acceptable limits.

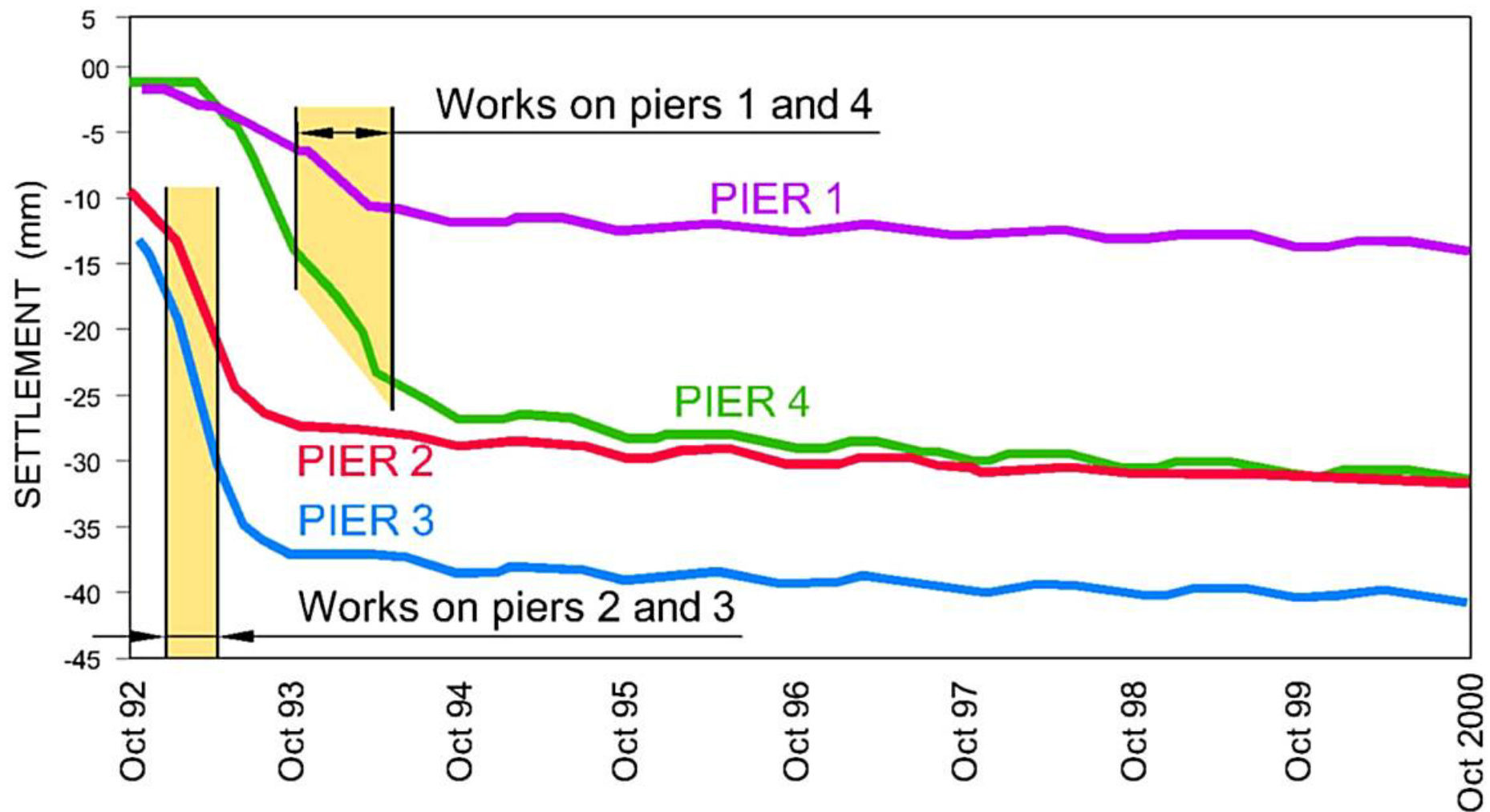
# Disturbance when retrofitting...

Pont de Pierre, Bordeaux



Origin: FOREVER, National Research Project on Micropiles, 2004

# STABILIZATION OF THE SETTLEMENTS AFTER MICROPILES INSTALLATION



Origin: FOREVER, National Research Project on Micropiles, 2004



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- Numerical results are not the reference
- The real 'judge' is the 'real' (full-scale) behaviour
- Interdisciplinary approach to many problems
- Understand what we do to/with the soil
- The investment into soil investigation should be severely increased (from ~1% to ~3%?)



to conclude on the challenges of geot engng :

- Eurocode 7: “It should be considered that knowledge of the ground conditions depends on **the extent and quality of the geotechnical investigations**. Such knowledge and the control of **workmanship** are usually more significant to fulfilling the fundamental requirements than is precision in the calculation models and partial factors.”

(Fundamental requirements : safe, economic, sustainable)

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# Civil Engineering : A People Serving Profession



Origin: <http://slideplayer.com/slide/10654726/#.WCHrnRqZewk.gmail> published by Emerald Harper

R Frank The future of geotech engng, Inaugural Lecture, 1st YGTE meeting, Guimaraes, 4-7/9/2016

# Civil Engineering

- In the beginning, Civil Engineering included all engineers that did not practice military engineering; said to have begun in 18th century France
- First “Civil Engineer” was an Englishman, John Smeaton in 1761
- Civil engineers have saved more lives than all the doctors in history --- development of clean water and sanitation systems

Origin: <http://slideplayer.com/slide/10654726/#.WCHrnRqZewk.gmail> published by Emerald Harper

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**Thank you for your attention!**  
**... and enjoy the conference!**  
**Enjoy your stay in Guimarães !**