A global database of subaqueous landslides:
A rallying call to the deep-water community

United Nations Educational, Scientific and Cultural Organization

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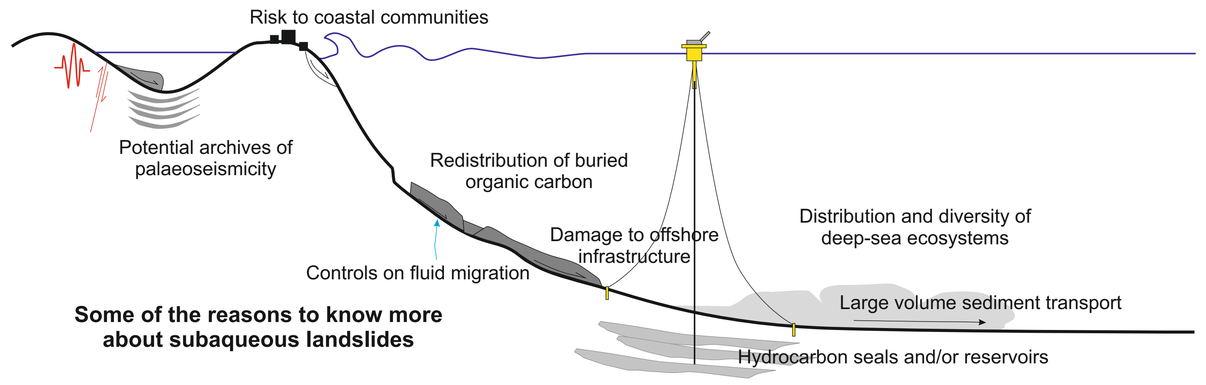
The global importance of submarine landslides

Subaquatic landslides are common in lacustrine and marine environments. They pose a risk to coastal communities and offshore infrastructure. They can play an important role in the distribution and diversity of deep-sea ecosystems. Furthermore, their deposits can have importance for hydrocarbon exploration and production activities, acting as potential seals, and in some cases reservoir units. During the past decades geoscientists have made many important contributions towards the improved understanding of submarine landslides. Efforts by the geo-modelling community have helped fill the gap between submarine landslide occurrence, dynamics and tsunami genesis.

However, our lack of understanding of the causal mechanisms and timing of submarine landslides has hampered progress in the development of deterministic and probabilistic assessment tools which are essential to implement appropriate mitigation measures.



Underlying rationale for a global database of subaqueous landslides:

Many developments have been made in the recent years on improving our understanding of subaqueous landslides in a number of different settings, in both modern and ancient timescales. The S4SLIDE community recognises, however, that there is still a large amount of valuable data that is underexploited and stored in many disparate databases. **We see much value in building a coherent and peer-curated global database of consistent subaqueous landslide data that can be made available to a large number of end-users**, to advance: 1) the understanding of subaqueous landslides, and 2) to support complementary research.

Anticipated Database End Users

Landslide researchers	*Seismologists*	*Oil and gas industry*
Marine geologists	*Seafloor surveying*	*Ore resources*
Basin analysts	*Tsunami specialists for identification of point-sources*	*Marine/geotechnical engineering*
Planetary scientists using submarine landslides as extraterrestrial analogues	*Geologists studying the link between climate change and gas hydrate dissociation*	*Marine geomorphologists*
Marine and lacustrine ecologists	*Geohazard research institutes e.g. exploring relationship with earthquakes*	*Blue energy*
Media	*Educators*	*NGOs*
Deep sea mining	*Cable/pipeline installers/operators*	*Government authorities*
Insurance / reinsurance companies		

What is S4SLIDE?

The **S4SLIDE** project builds upon the extremely successful E-MARSHAL and IGCP-511 proposals also known as the **Submarine Mass Movements and Their Consequences** project. As with its predecessors, the IGCP-640 project focuses on facilitating the interaction of scientists, engineers, industry and government representatives, and other parties interested in submarine mass movements and their geohazard potential, especially those from historically under-represented countries.

S⁴SLIDE — ***S***ignificance of Modern and Ancient ***S***ubmarine ***S***lope Land***SLIDE***s — IGCP-640

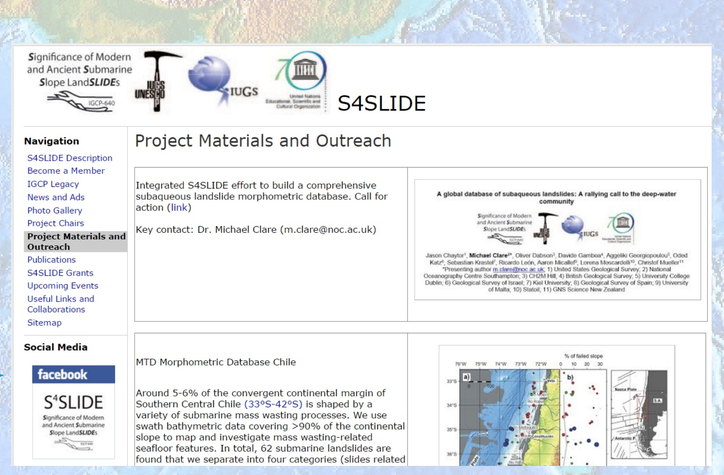
S4SLIDE seeks to create an international and multidisciplinary platform allowing geoscientists from academia, government, and industry to sustain a dialogue conducive to the integration of findings from different fields into a more cohesive understanding of submarine landslides.

S4SLIDE Data Sharing Portal:

As the global database is not yet built, it is intended to make available published studies and results of subaqueous landslide studies (including morphometrics, recurrence etc.) via the S4SLIDE Outreach

https://sites.google.com/a/utexas.edu/s4slide/outreach

You are invited to share your findings to extend this online resource hub.



The overarching aim of the global database:

A number of existing compilations and databases exist (see below for a non-exhaustive set of examples). However, none of these are truly global and there are often large inconsistencies between them in terms of nomenclature and how key metrics are measured.

Thus, we aim to provide that consistency and links between existing studies such that comparative statistical analysis can be performed, scientific hypotheses can be tested in a robust manner, and to provide the basis for future scientific research and industrial endeavours.

To Address Outstanding Scientific Questions and Tackling Industry Issues

How do landslides vary from active to passive margins?

Provision of data for forward models (e.g. slope stability)

Which areas worldwide are under-represented with landslides (and is that real)?

Where are the point sources for tsunamis?

How do landslides affect subsurface fluid flow?

How do landslides interact with benthic communities?

What timescales of landslide occurrence are well/poorly constrained?

Do landslides scale from lakes to the deep sea?

Understanding triggers where this can be constrained

Can we be predictive in constraint of extent vs thickness with only 1D data points?

Guidance for future sampling strategies

How important are landslides for global sediment transport?

Can we determine volumes from 2D measurements?

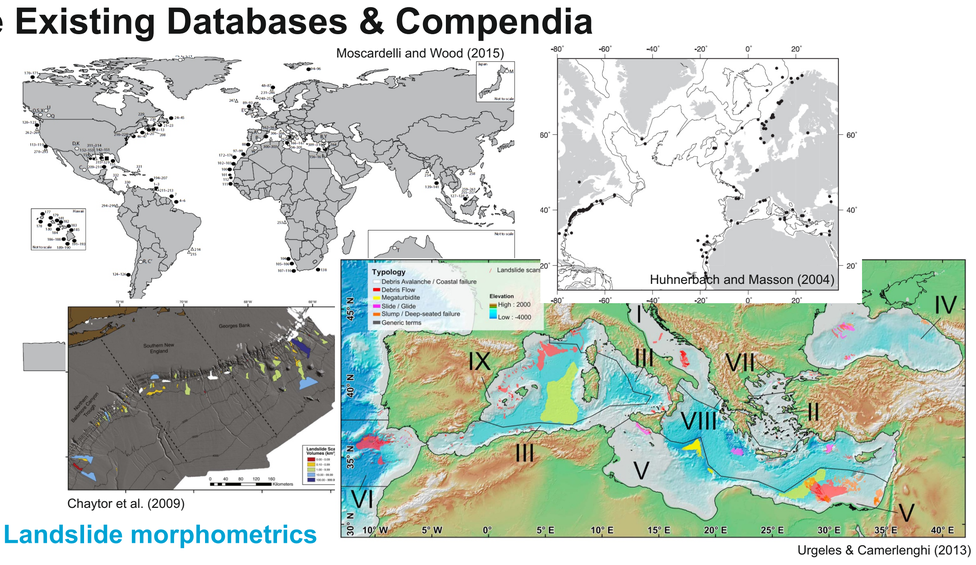
Tool for probabilistic industry risk assessments

Cross pollination between landslide and non-landslide communities

How important are landslides for organic carbon transport and re-burial?

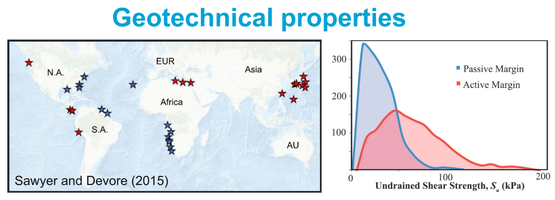
Political decisions (e.g. landslide run-out can inform UN Convention on Law of the Sea)

Some Existing Databases & Compendia

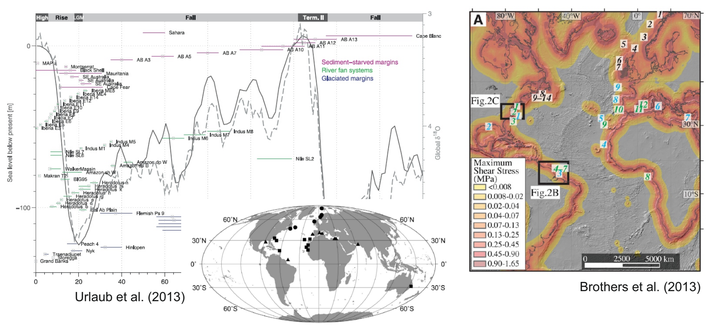


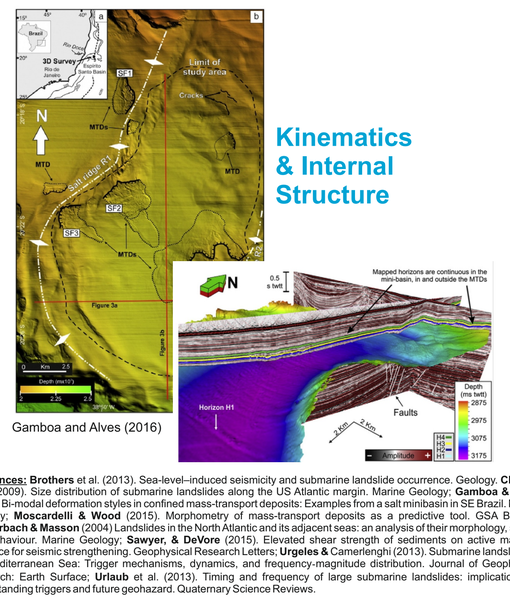
Landslide morphometrics

Geotechnical properties



Landslide recurrence and forcing factors





Kinematics & Internal Structure

References: **Brothers** et al. (2013). Sea-level–induced seismicity and submarine landslide occurrence. Geology. **Chaytor** et al. (2009). Size distribution of submarine landslides along the US Atlantic margin. Marine Geology; **Gamboa & Alves** (2016). Bi-modal deformation styles in confined mass-transport deposits: Examples from a salt minibasin in SE Brazil. Marine Geology; **Moscardelli & Wood** (2015). Morphometry of mass-transport deposits as a predictive tool. GSA Bulletin; **Hühnerbach & Masson** (2004) Landslides in the North Atlantic and its adjacent seas: an analysis of their morphology, setting and behaviour. Marine Geology; **Sawyer, & DeVore** (2015). Elevated shear strength of sediments on active margins: Evidence for seismic strengthening. Geophysical Research Letters; **Urgeles &** Camerlenghi (2013). Submarine landslides of the Mediterranean Sea: Trigger mechanisms, dynamics, and frequency-magnitude distribution. Journal of Geophysical Research: Earth Surface; **Urlaub** et al. (2013). Timing and frequency of large submarine landslides: implications for understanding triggers and future geohazard. Quaternary Science Reviews.

Success Criteria:

- Stepping stone/accepted standard for uniform methodology for subaqeuous landslide data collection
- Record of landslide occurrence (geographically and also temporally)
- Hierarchical record of landslide metrics
- Provide data beyond just morphometrics such as seismic, geotechnical, geochronological data etc.
- Source of consistent data for morphological/statistical analysis and site/parameter comparison(s)
- Share existing data in a more open and efficient way than is currently done hence this can become a bridging database to other harder to find data
- Accessible and useful database to wide range of users

What will be included in the database?

- Both **submarine** and other **subaqueous** (e.g. lake) data
- Metrics on **"recent"** (mappable on the surface) **mass movements**
- **Broader information** that may be acquired from cores or other vertically resolved, but not laterally resolved sources (e.g. longer term recurrence of landslides at one point location or for a region)
- **Sub-surface geophysical information** (e.g. 2D/3D exploration seismic) that can provide valuable data on ancient landslides or that is not possible from high resolution seismic or core data
- **Geotechnical data** – e.g. IODP physical properties, available classification/index testing, in situ cone penetration testing etc. This will ideally also include "background" conditions of unfailed material to enable region specific slope stability assessment or address why MTDs may be different in different places…

Specific metrics to be included: ID – database identifier; Map data; Name – published name (s); Data Source; Quality Flag; Region – Ocean/Sea/Margin; Tectonic/Geologic Environment; Age; Morphology/Failure style/mechanics; Dimensions of source (area, volume, length, width; headwall/sidewall heights); Dimensions of deposit (area, volume, run out); References; Thickness; Volume; Composition/lithology; Basal erosion surface style; Incision magnitude; Information on top and basal surface relief; Internal kinematics; Metadata that can capture a wide range of information such as data source, limitations, uncertainties, errors, cruise reference, etc

Get Involved!

Interested parties, from data sharing through to end users are encouraged to get in touch to discuss future directions. We are very keen to hear from anyone that would find this a useful initiative

What data could you contribute?

What science and/or industry questions do you want to answer about subaqueous landslides?

Are you aware of existing useful databases?

Please get in touch! Twitter @S4SLIDE or email m.clare@noc.ac.uk