Networking for the future

addressing climate change effects on slope instability

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structure

1. CLIFF*s* – an introduction
2. UK climate change forecasts
3. climate signals and slope instability
4. networking and the future – key research needs

what is CLIFF*S*?

Climate Impact Forecasting For Slopes

- EPSRC-funded ‘dating service’ for academics, R&D agencies, stakeholders, consultants and climate specialists
- Aim - to stimulate an integrated research response to address the intricately linked problem of forecasting, monitoring, design, management and remediation of climate change induced variations in slope instability

CLIFFS

members

Core

British Geological Survey
British Geotechnical Association
British Waterways
CF Skanska Ltd
Geotechnical Consulting Group
Halcrow Group Ltd
Highways Agency
Imperial College London
Isle of Wight Council
Loughborough University
Mott MacDonald
Nottingham Trent University
Queen's University Belfast
UKCIP
University of Bristol
University of Birmingham
University of Newcastle
Kingston University

+ more than 140 members

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what does CLIFF*S* do?

multi-disciplinary themed workshops

- risk and uncertainty
- responses of constructed slopes to changes in climate
- responses of natural slopes to changes in climate
- mitigation, remediation and dissemination (3rd July 2007)

international symposium (2008)

web-based information

- details of the network at cliffs.lboro.ac.uk

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key questions

- Will the climate change predicted for the UK influence the mechanism and frequency of slope failures?
- Do stakeholders need to take any action?
- If they do, what is required and when?

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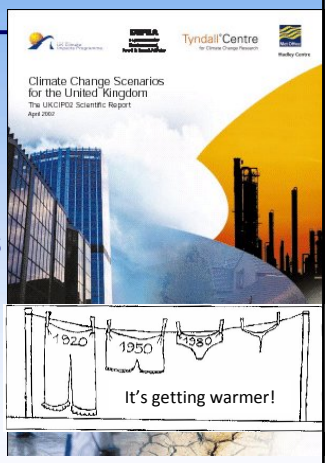
climate change forecasts

UKCIP02 - UK slopes will experience

- higher temperatures
- changing precipitation patterns
- changes in sea level
- other changes such as extreme events
- relative likelihoods unknown



UKCIP08

- ensemble of different models and derived probability distributions

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an unstable slope – contributing factors

hydrological triggering

- pore pressures on slip surface control stability
- shallow → deep slip surfaces

climate variables

- rainfall, temperature, evapotranspiration

other factors

- including geometry, stress history, vegetation, land use, engineering works, etc.

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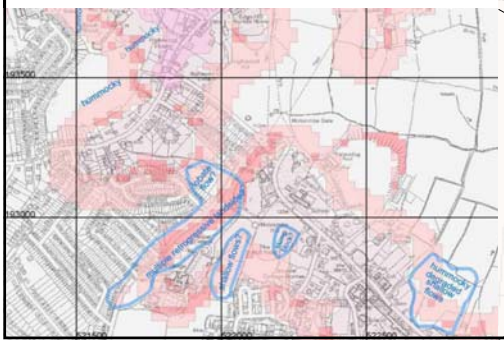
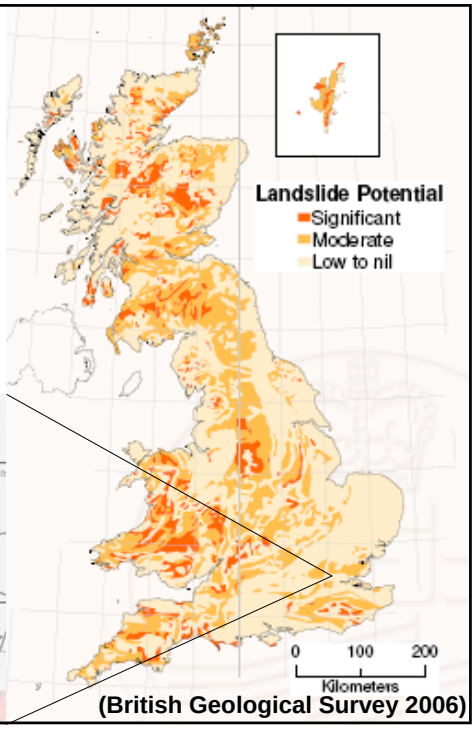
BGS National Geohazard Assessment identified some 90,000 properties (c. £20B asset) on sites with a 'significant potential' for slope failure.

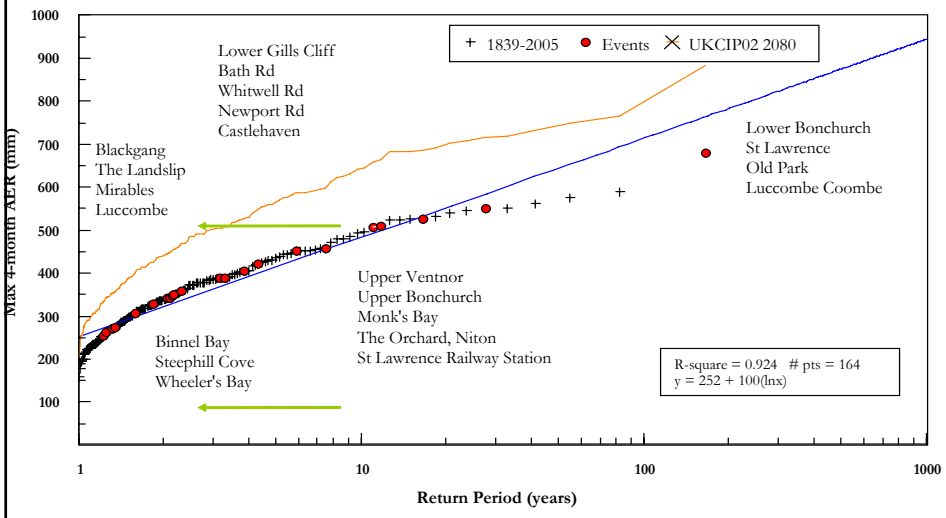
A significant proportion of the risk is from the reactivation of shallow relict landslides





(British Geological Survey 2006)

natural slopes



Present and forecasted (UKCIP02-2080, medium high) return periods of Isle of Wight's landslides. (Moore *et al.* 2006)

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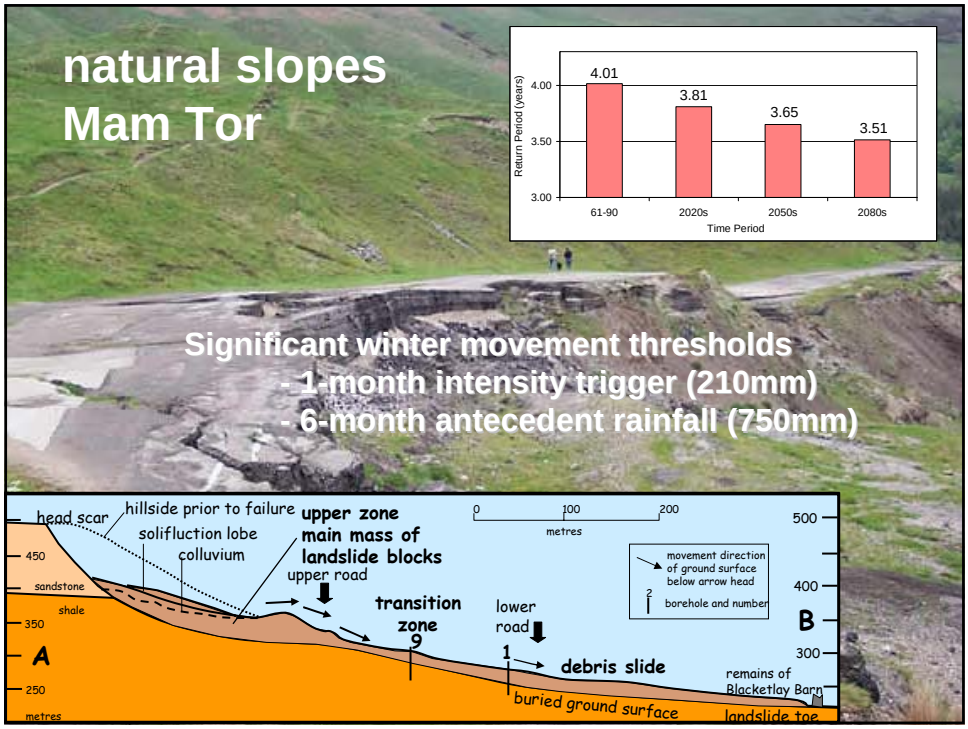

constructed slopes

- Ageing (>100 years old) poorly constructed fill slopes (e.g. London Underground)
- Recently constructed (>50 years old) highway cut and fill slopes with design based on historical climate and performance, (plus some arbitrary factors)
- Flood embankments with a range of ages
- Several studies are in progress to investigate the possible impact of climate change → ***BIONICS***

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4. **the need for networking and the future**

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networking

- At present, planning and design use relatively static information based on past behaviour (e.g. geological maps showing historical landslides).
- However, we operate in a dynamic system. What are the outcomes of this, how do we need to respond?
- Networking: stakeholders and research communities can interact – ask questions – find solutions

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networking - workshop outcomes

climate change → pore pressure → rates of movement

some fundamental questions

- how will climate change (in particular effective rainfall) affect slope stability?
- how well do we understand pore pressures in complex geological environments
- what happens when slides move?
- how do pore pressure variations lead to changes in landslide movement?
- how do changes in basic assumptions lead to changes in outcomes? – e.g. effect of fissure flow?

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what do we need to do?

- determine magnitude, frequency, impact of thresholds, in particular related to pore pressure changes on slip surfaces
- carefully (re-)consider assumptions about mechanisms and trigger events
- consider significance of changes in environmental conditions and uncertainty
- move from site specific assessments to broader understanding of slope responses

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what do we need to do?

- formulate plausible narratives of alternative futures (scenarios) for assessment of unstable slopes that relate to forecasted changes in climate.
- develop simple models that have flexibility to use different slope failure scenarios and integrate UKCIP08 probabilistic climate change information.
- analyse constructed and natural slopes (inland and coastal)
- develop engineering solutions and construction guidelines for the economic design and optimum management of slopes.

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