





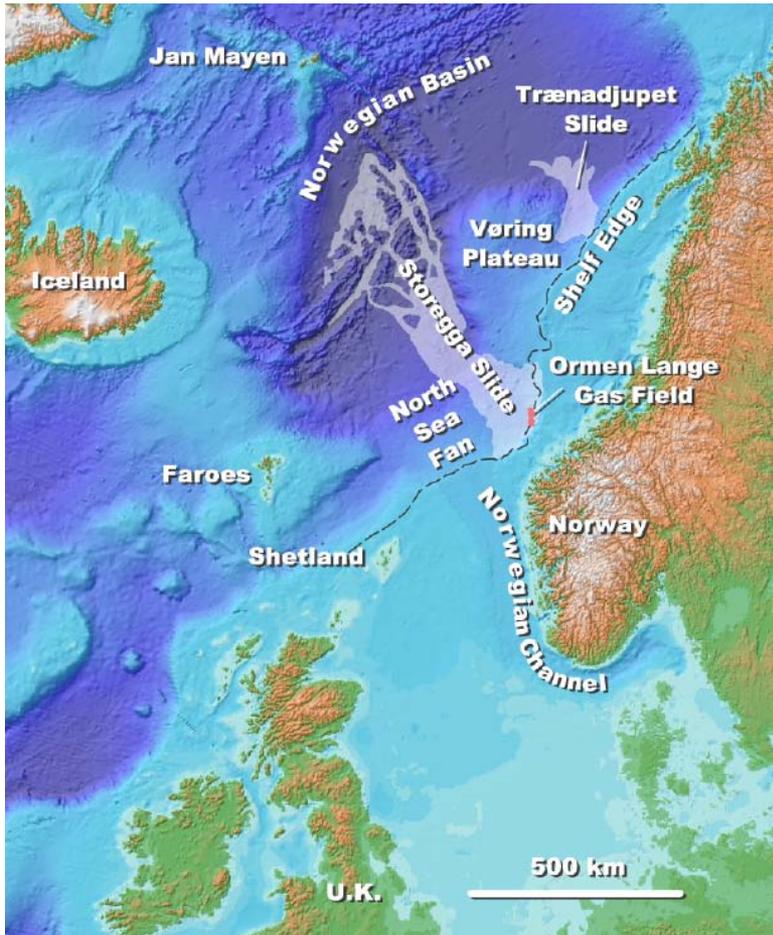
SCANDPOWER

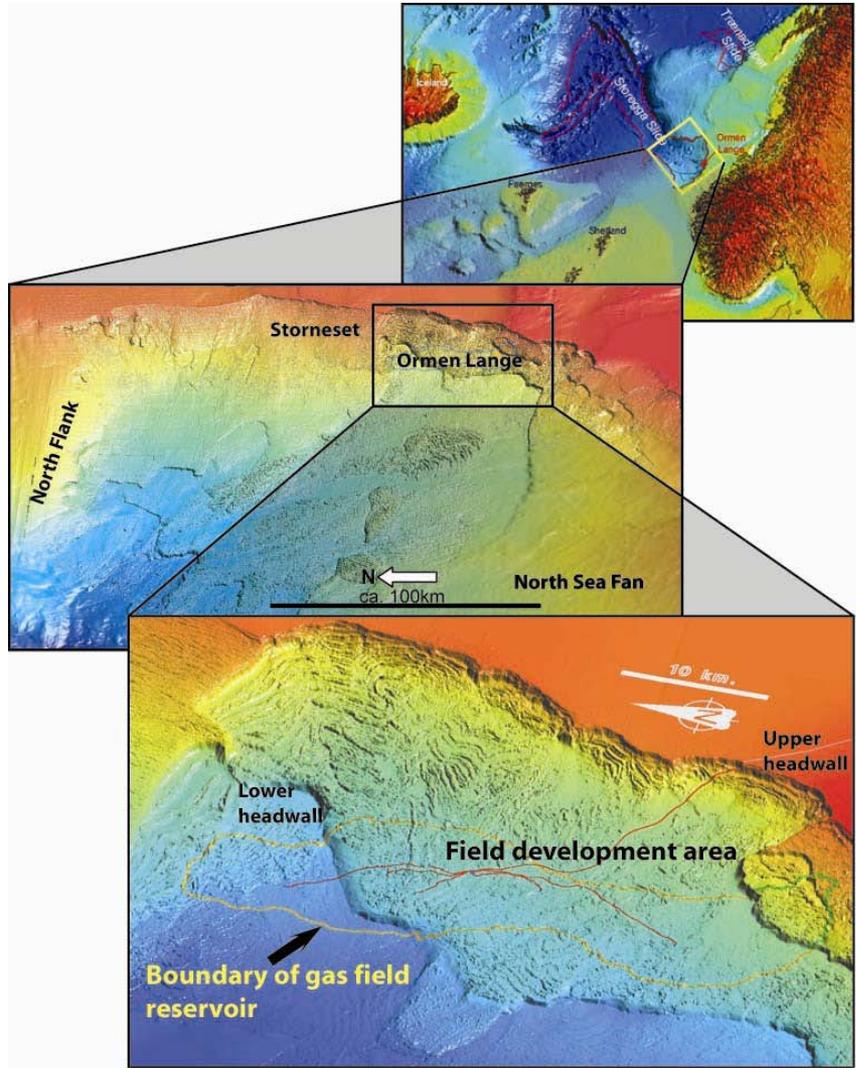


# Slide Risk Assessment in the Ormen Lange Field Development Area

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# Location Map showing the Storegga Submarine Slide on the Mid-Norway Margin



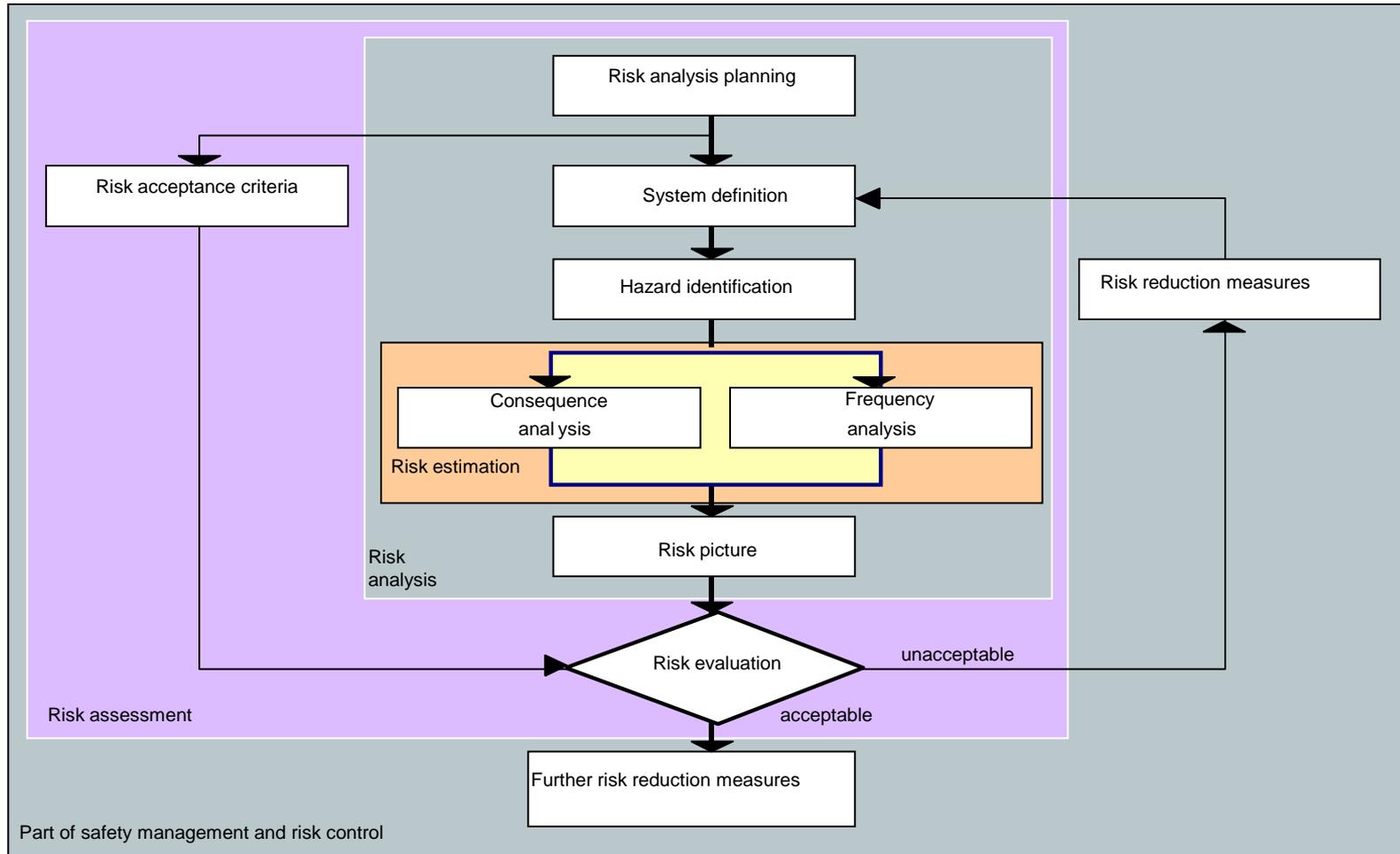


## Main Issues

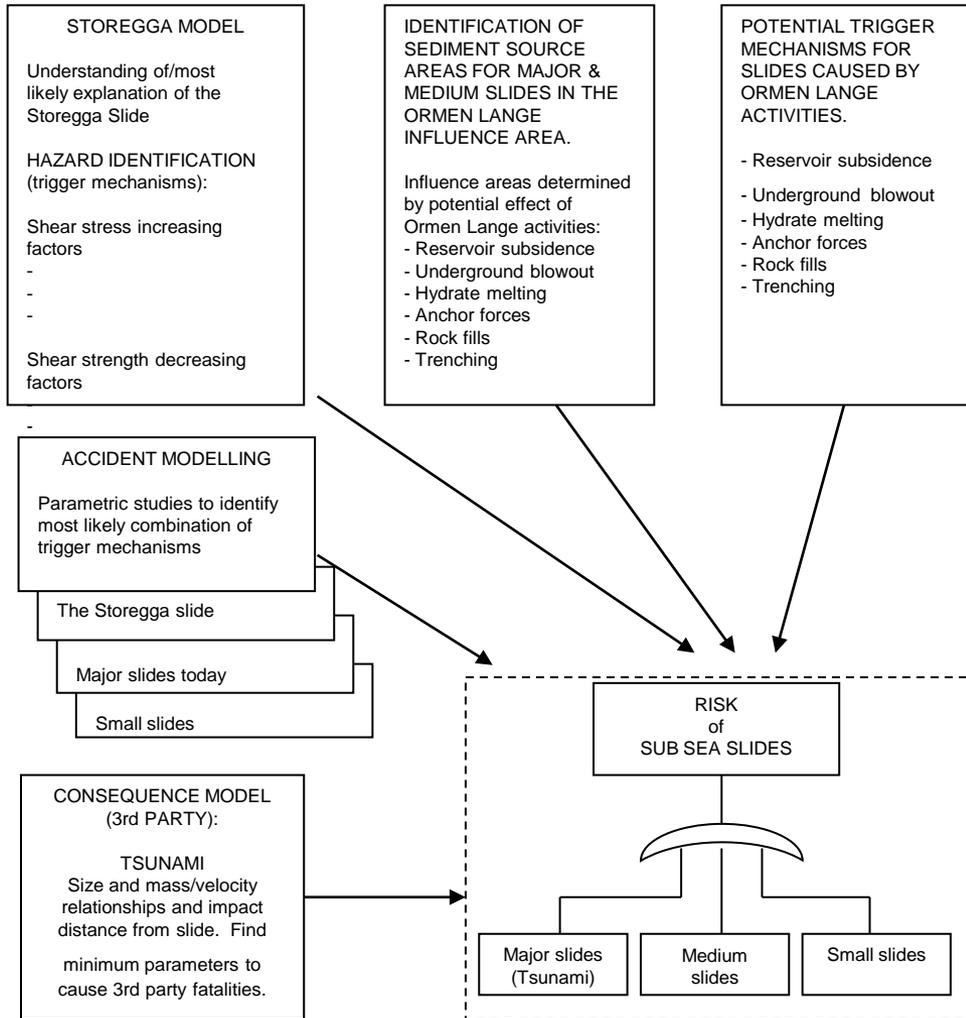
- **Is this area still prone to submarine slides?**
- **How were slides triggered in this area?**
- **Is there still a possibility for new slides in the area, which can threaten the Ormen Lange installations?**
- **Can the Ormen Lange activities alone or in combination with natural causes, trigger a new submarine slide with 3rd party consequences?**



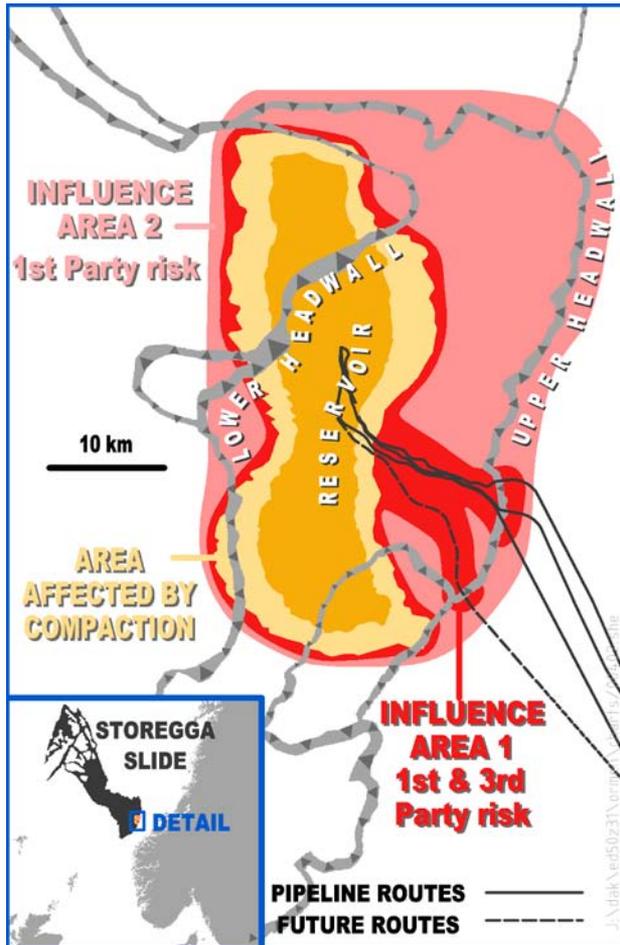
# Risk Analysis Framework (NORSOK Standard Z-013)



# Risk Analysis Planning



# Extent of Potential Influence Areas



## RAC (1st Party)

- **Conventional RAC applied by operators in the North Sea area**
  - Risk to personnel  
GIR <  $10^{-3}$  fat/yr
  - Risk to environment  
Duration of environmental damage to be insignificant compared to the expected time between such damages



## RAC (3rd Party Risk)

- **Normally not an issue for offshore activities**
- **Known formats**
  - Risk to most exposed person
  - Society risk

**not suited**

RAC

Chosen Criterion, 3rd Party

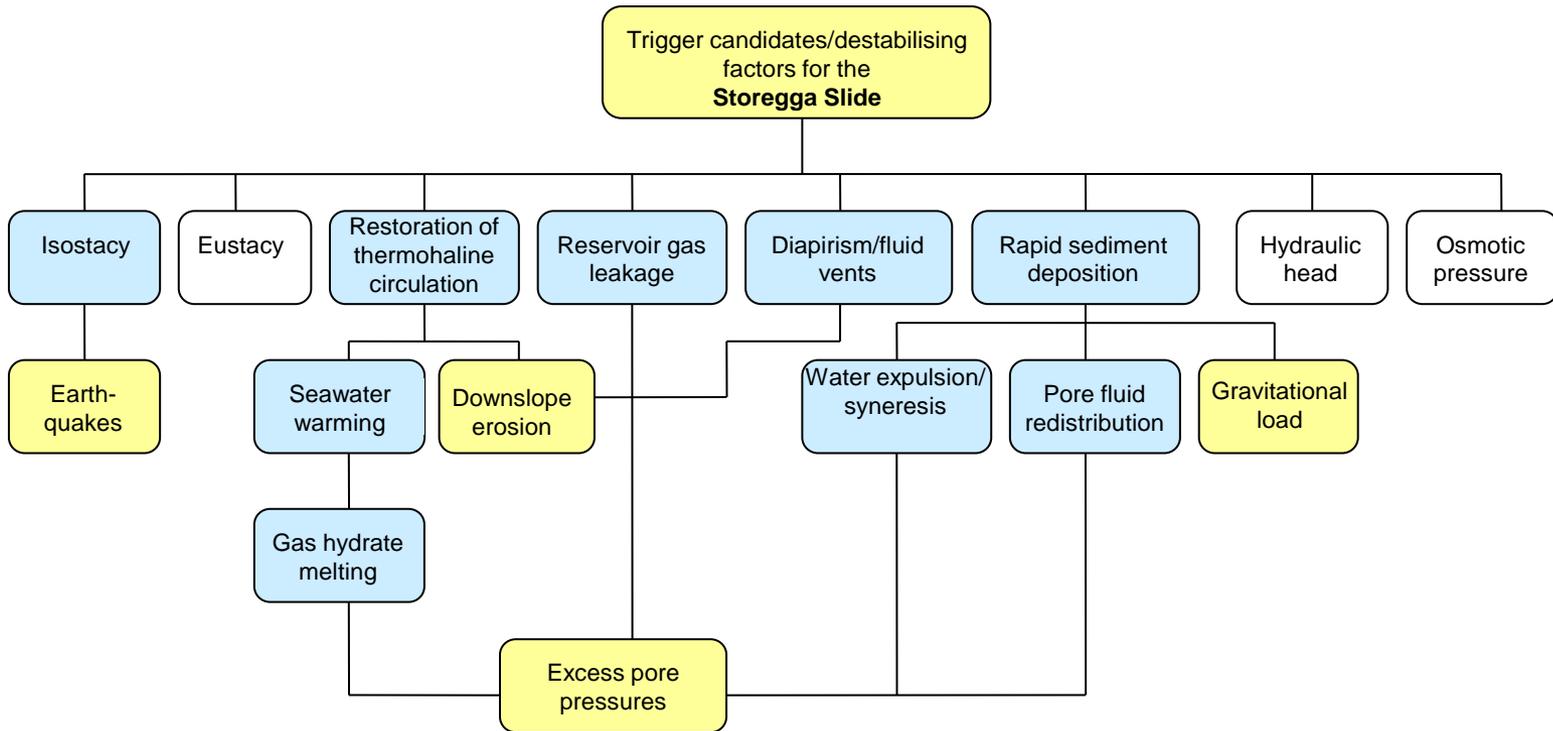
**Risk is intolerable if the frequency of a slide with "significant damage potential" generated by OL activities exceeds  $10^{-7}$  per year.**

**Significant damage potential:**

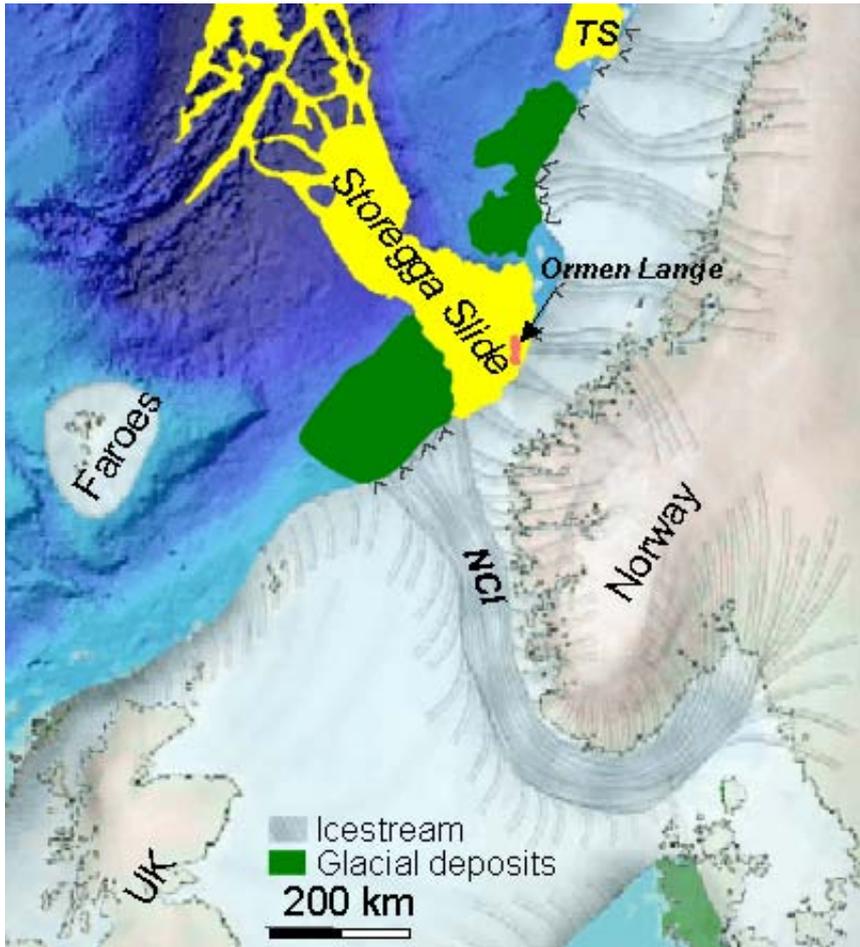
**A tsunami wave must be generated  
Vertical run-up must exceed 1.5 m in representative  
coastal areas**



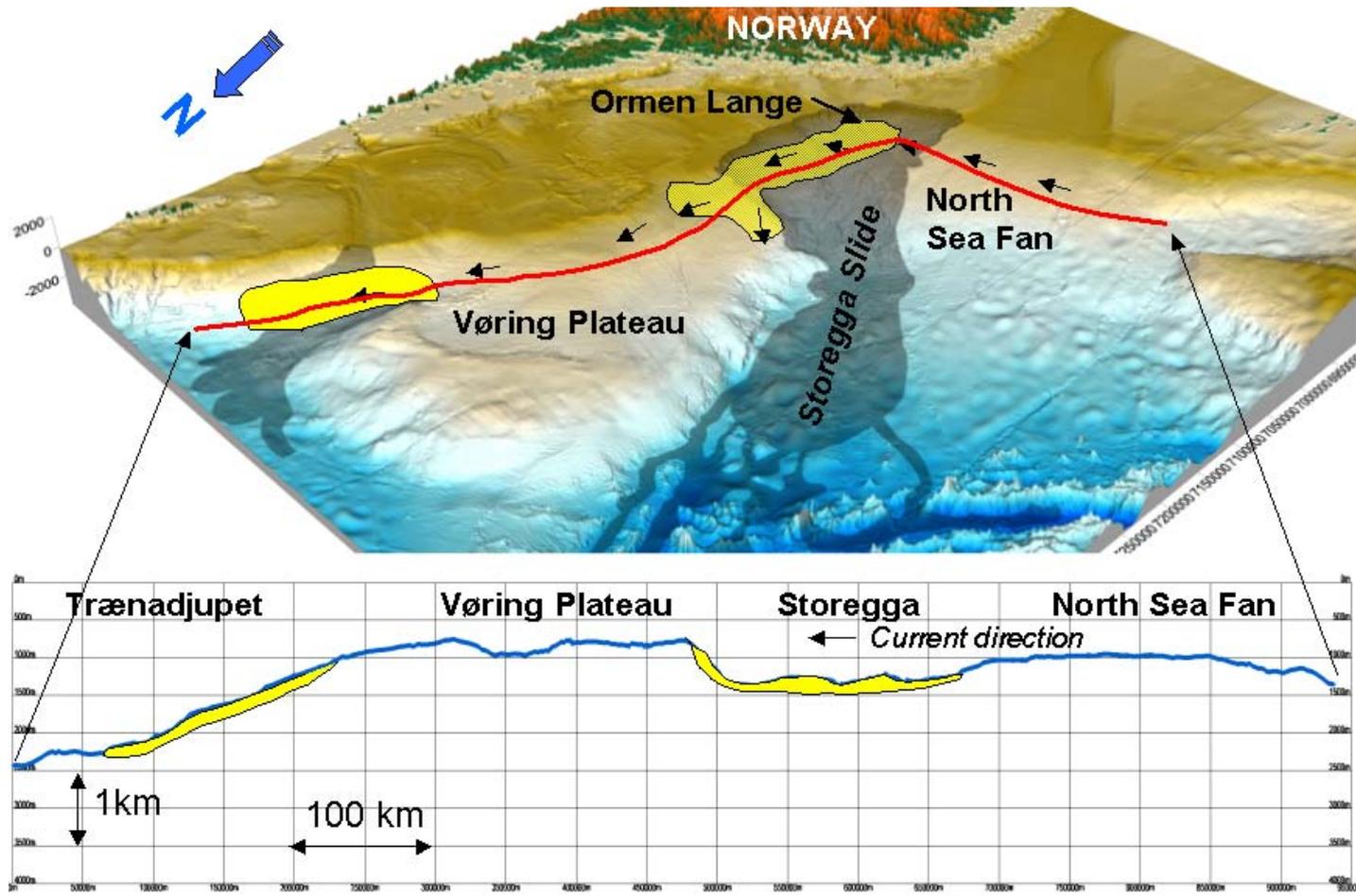
# HAZID: Storegga Slide



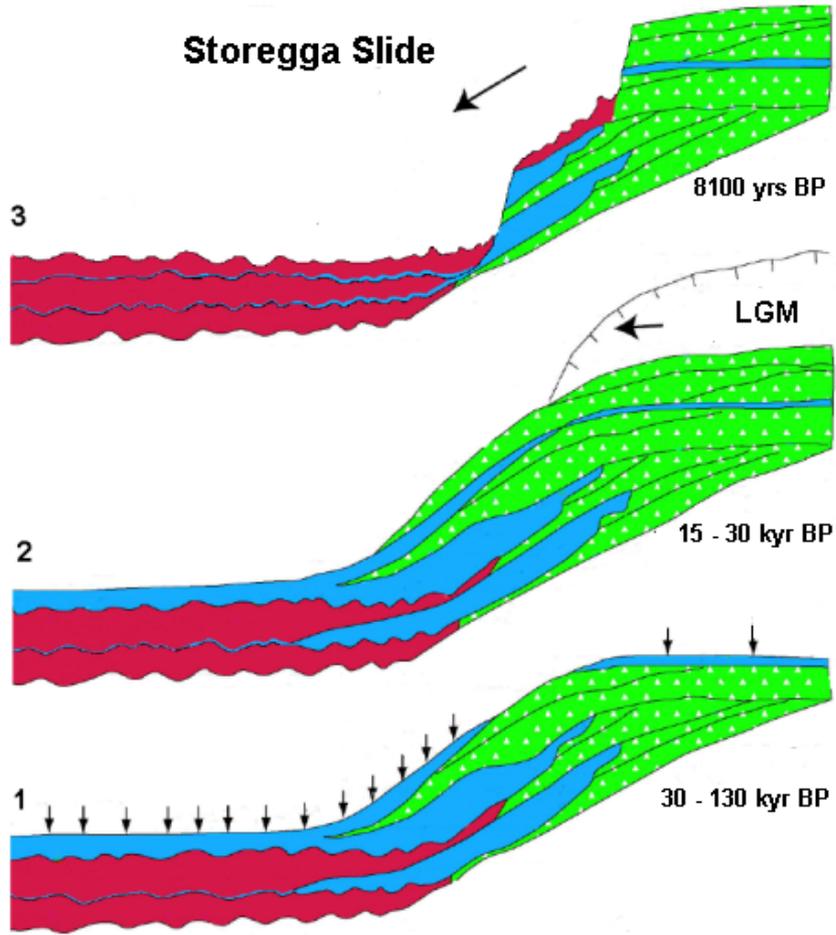
# Storegga Slide - Explanation Model



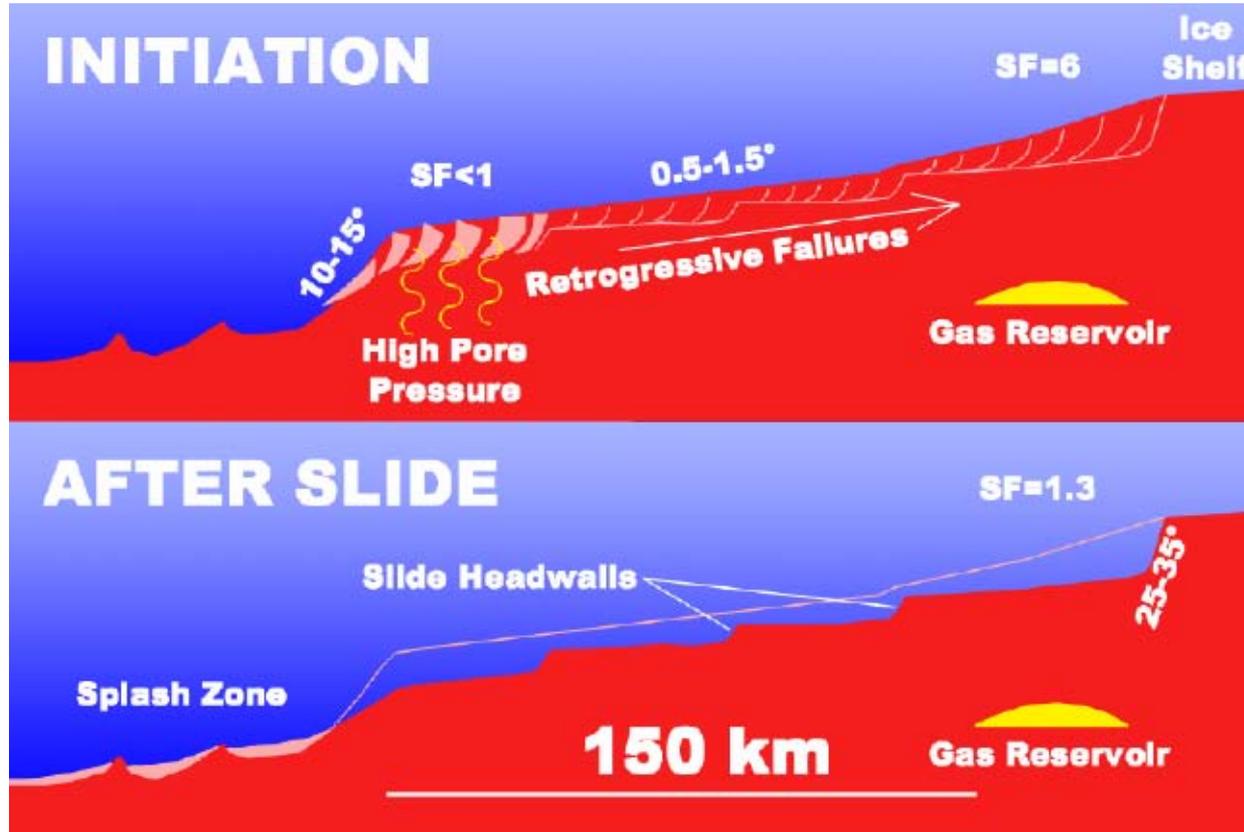
# Storegga Slide - Explanation Model



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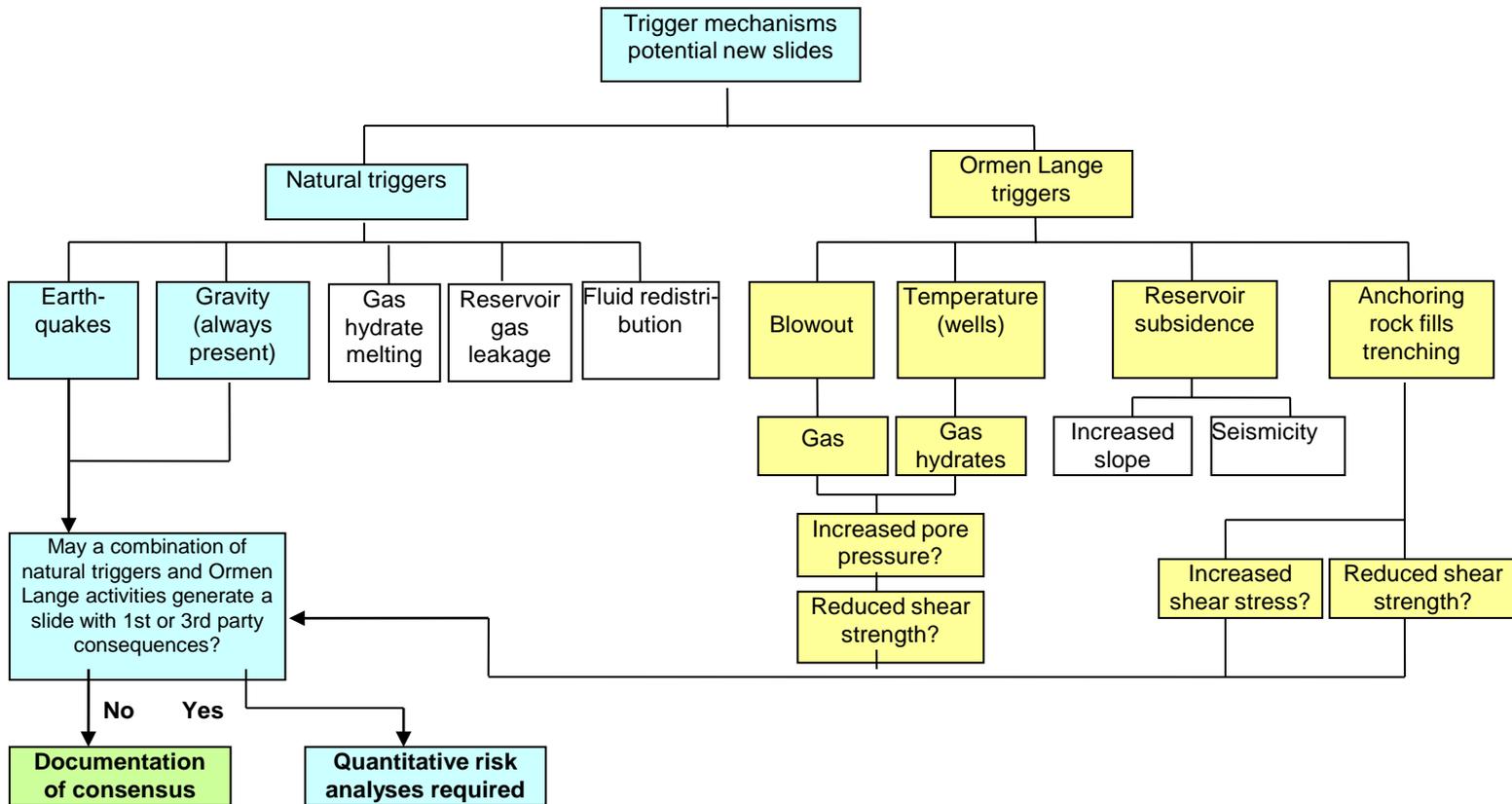


# Storegga Slide - Explanation Model

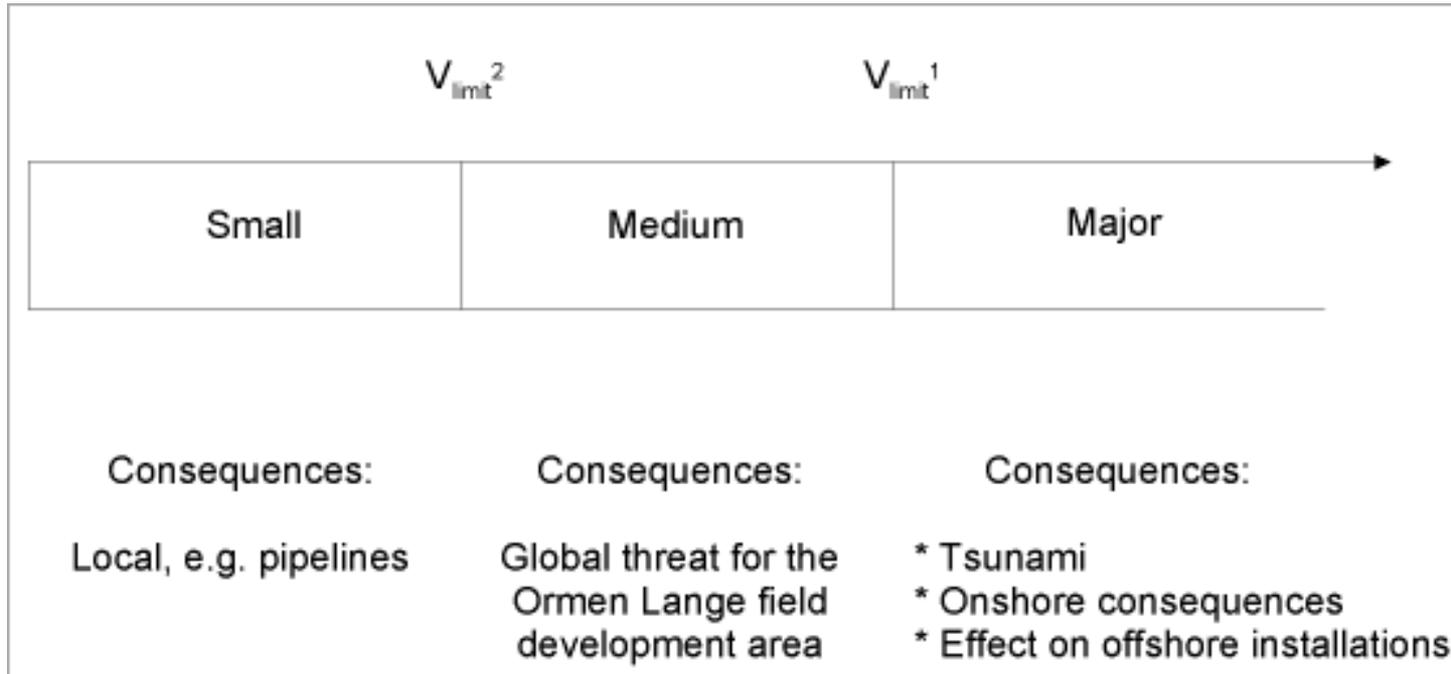


# Risk under Present Conditions

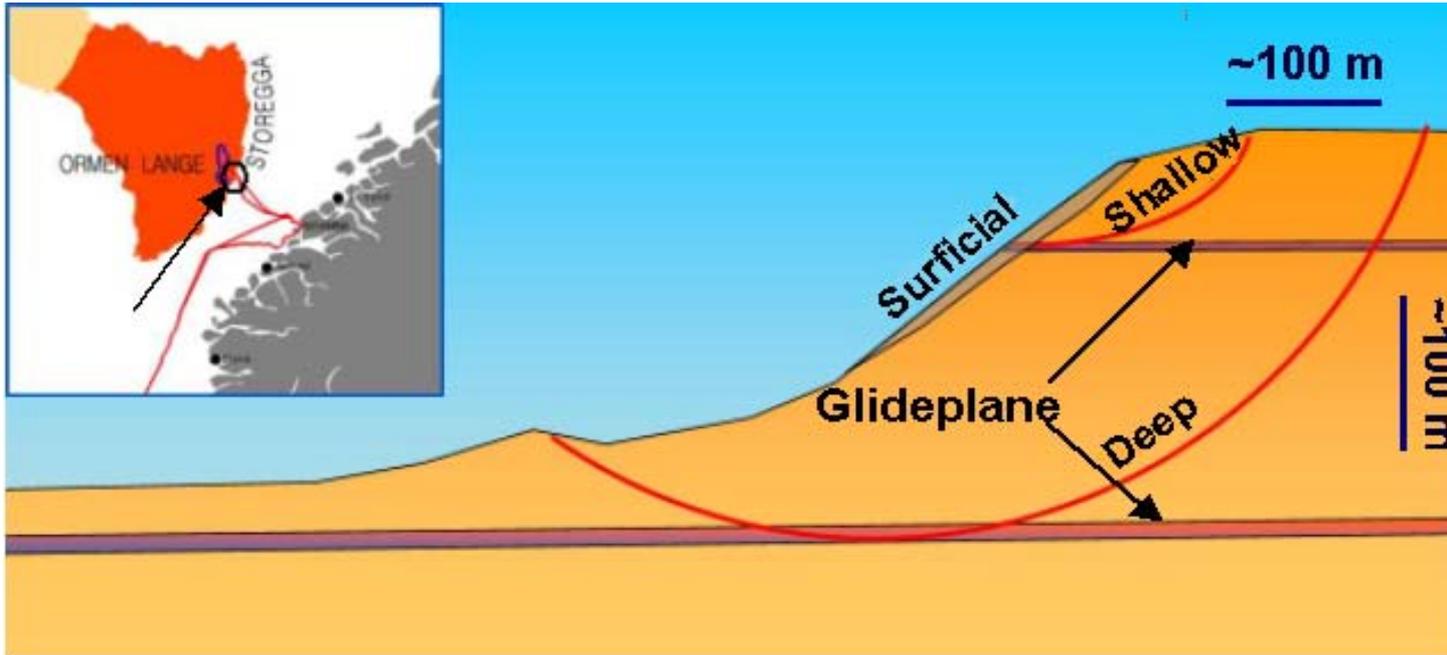
# HAZID: Present Situation with Ormen Lange



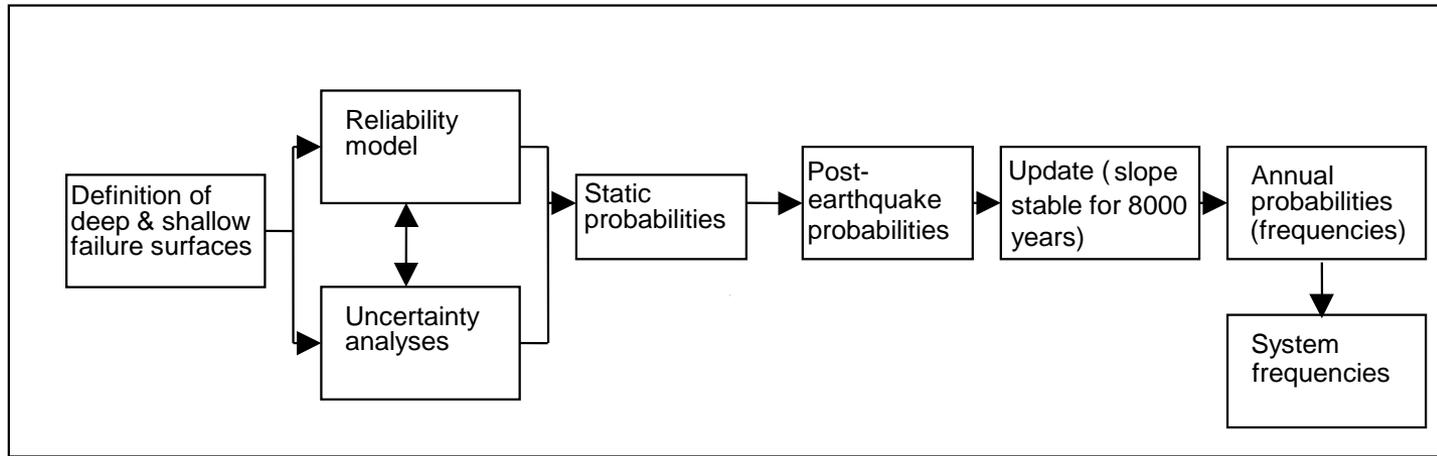
# Consequence Model



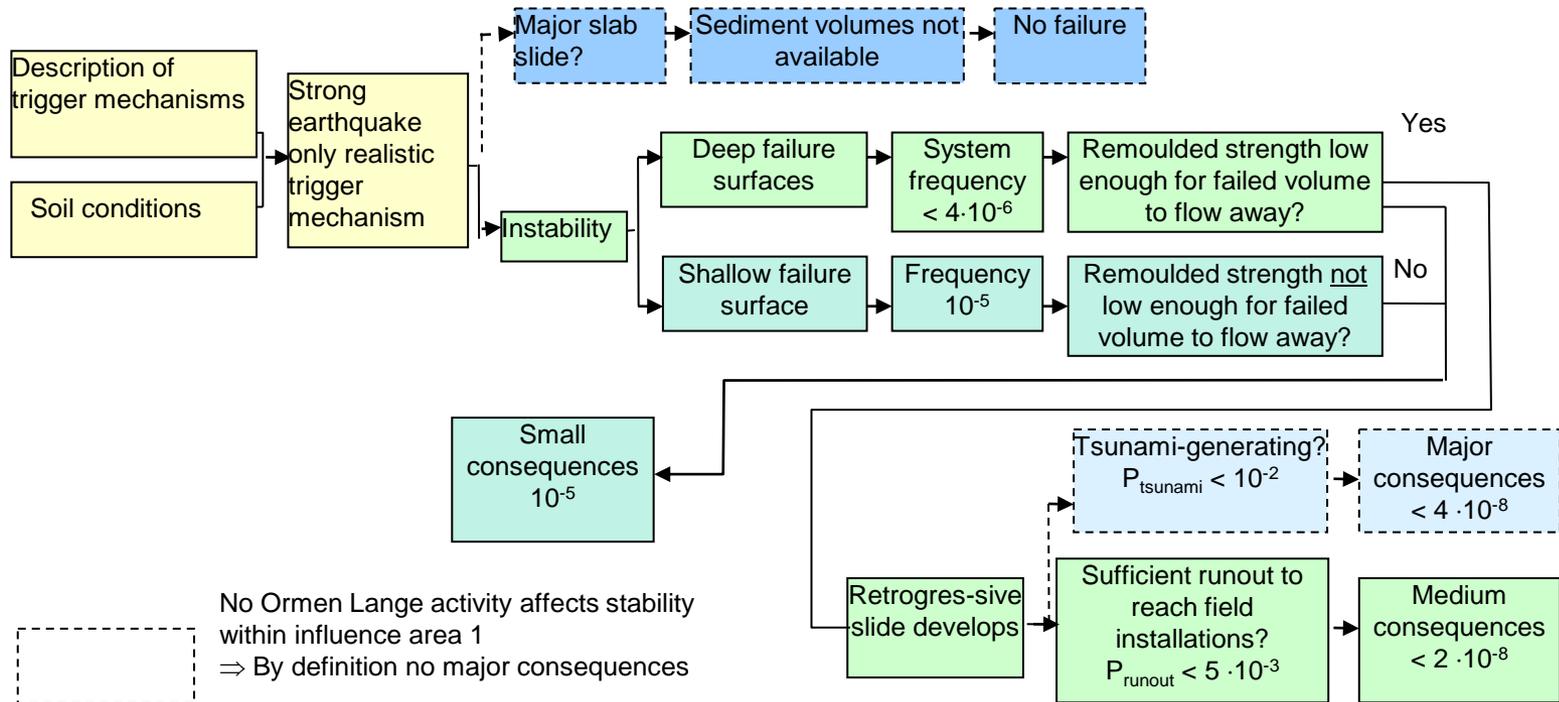
# Type of Slides



# Calculation of Frequencies - Main Steps



# Risk Estimation

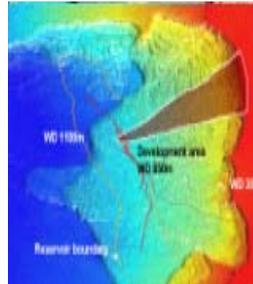


# Risk Summary



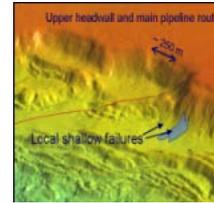
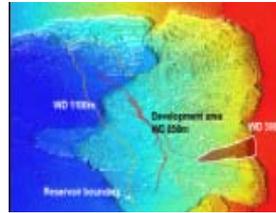
Slide consequence class	Description of slide	Risk results (frequency per year)		Comments
		1st party or environment	3rd party	
<b>Major:</b> Slide generates tsunami that causes damage along the coast. (3rd party, 1st party risk and environmental risk)	Large regional slides related to the glacial/ interglacial cycles. (Volume range 100 - 3000 km <sup>3</sup> )	Not relevant	Not relevant	The prehistoric Storegga slide removed all soft sediments
	Slides from the back walls of the Storegga slide scar; retrogressive process		< 4·10 <sup>-8</sup>	Only natural causes (extremely strong earthquakes). No project generated risk

# Risk Summary



Slide consequence class	Description of slide	Risk results (frequency per year)		Comments
		1st party or environment	3rd party	
<b>Medium:</b> <b>Global threat to field installations</b> <b>1st party risk and environmental risk</b>	Slides from the back walls of the Storegga slide scar; retrogressive process	$< 2 \cdot 10^{-8}$	No risk	Far below Ormen Lange risk acceptance criteria

# Risk Summary



Slide consequence class	Description of slide	Risk results (frequency per year)		Comments
		1st party or environment	3rd party	
<b>Small:</b> Local threat to pipe-lines and umbilicals 1st party risk and environmental risk	Slide from back wall shallow slip surface	$10^{-5}$	No risk	Far below Ormen Lange risk acceptance criteria
	Surficial slide in back wall	$< 2 \cdot 10^{-2}$	No risk	Risk is acceptable, but detailed evaluations of technical solutions are ongoing
	Clay drape failures (in steep areas)	To be evaluated	No risk	

## Summary

- **General risk analysis framework can be applied**
- **Ormen Lange field development activities have negligible effects on stability (deep failure) and will not trigger Tsunami-generating slides**
- **The annual probability of a slide with run out to the field development area is almost zero and negligible compared with RAC**
- **Shallow slide events and surficial slides can threaten pipelines, but the risk is acceptable**



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