Imperial College London

Event-based risk management: An aid to decision-making in oil and gas developments

Craig Smalley

Imperial College London

Benchmarks Consulting

Benchmarks

30-May-2017

Outline

- Background: “Only 22% of oil industry megaprojects could reasonably be called successful” – Merrow (2012)*
- Thesis of this talk:
  - We could make better decisions, and enjoy better business outcomes, if we were better at defining risks and managing them effectively
- The interplay between decisions, uncertainties and risks in oil and gas projects and producing fields
- Event-based risk management for subsurface risks
  - How it works
  - Results: analysis of a large risk database
- Implications for decision making

**Merrow (2012) Oil industry megaprojects: Our recent track record. SPE paper 153695*

Typical life of an oil or gas field

DECISIONS

← Many design and operating decisions →

Drill? — Appraise? — Commit? — Sanction?

Explore → Appraise → Select → Define → Execute → Operate

"RISKS"

- Dry hole
- Subeconomic

- Appraise the wrong field

- Commit to the wrong project

- Non-delivery of project objectives

- Non-delivery of field performance objectives

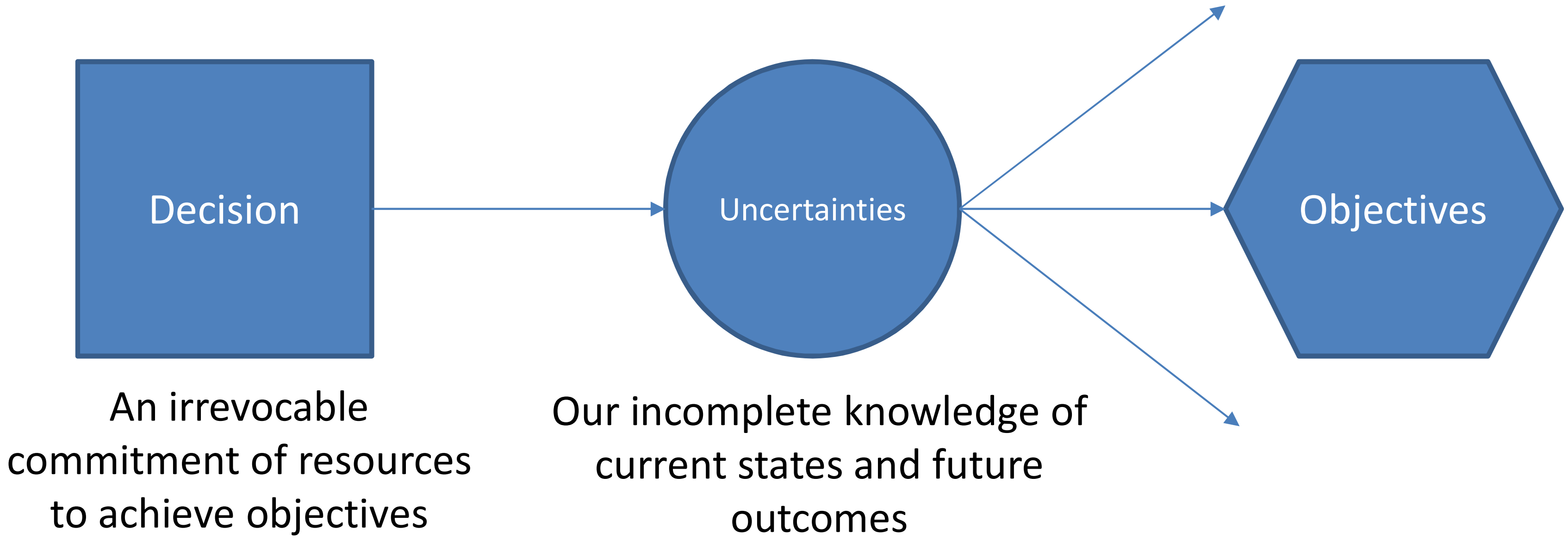
Can be managed as a portfolio

Decisions revolve around selecting the best prospects/projects from a portfolio

One shot to get it right

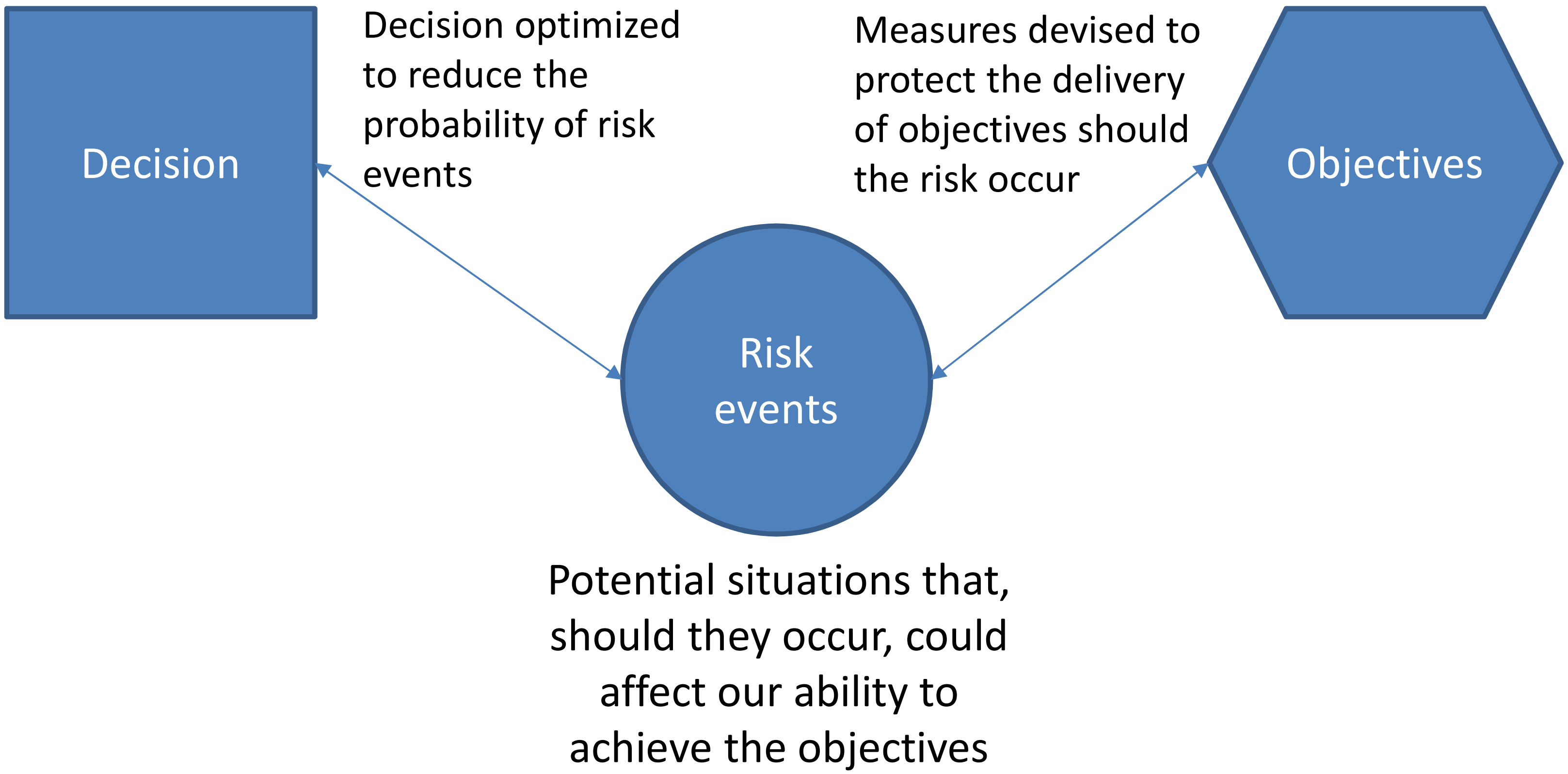
Decisions revolve around optimising the project and operating plan to maximize the chance of achieving objectives

Decisions and uncertainties



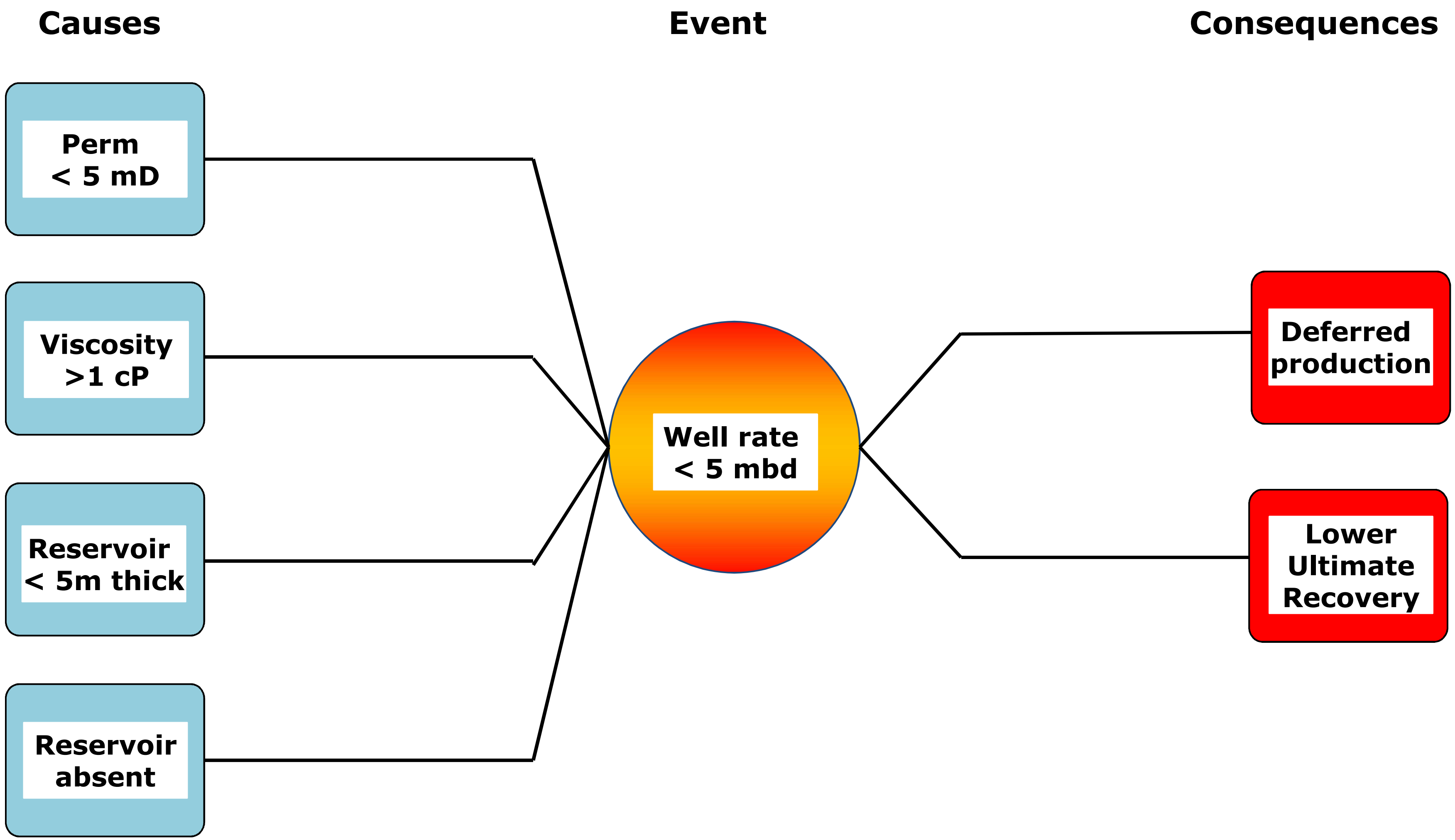
- In decision analysis, the decision is optimised to give the best chance of achieving the objectives, given the uncertainties
- But things can still go wrong

Decision and risks



- Event-based risk management focuses on relevant uncertainties and helps devise ways of managing them

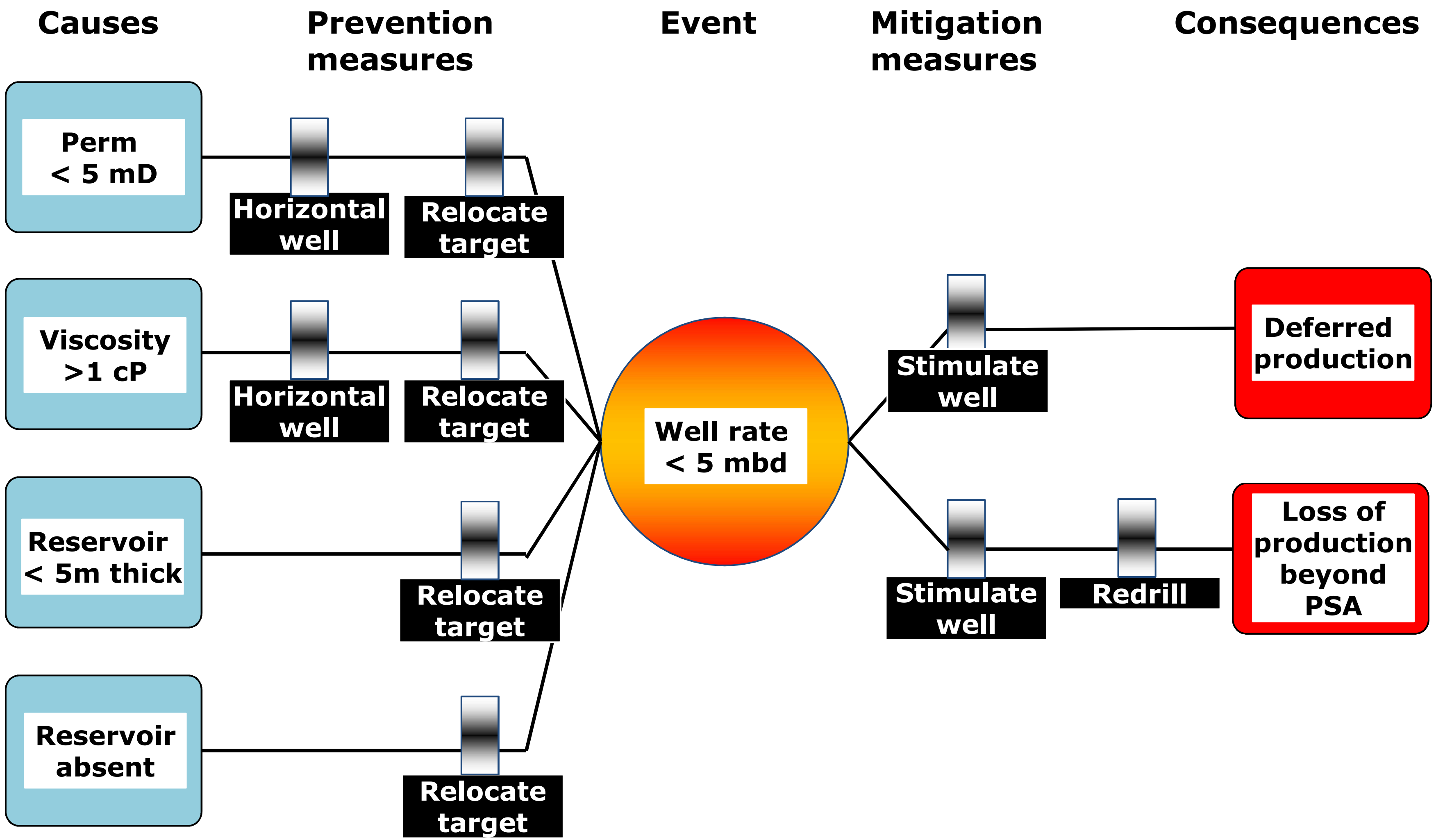
Anatomy of a risk: causes-event-consequences



Risk management measures

- Prevention measures
  - Reduce the probability of the causes precipitating the event
  - Often incorporated into project design decisions
- Mitigation measures
  - Reduce the probability and/or severity of consequences, should the risk event occur
  - Often incorporated into project execution and operation decisions

Risk management measures



Making good decisions

- Good project design and field management decisions require understanding of the relevant uncertainties ***and*** the relevant risks
- Will different decision choices activate or avoid risks?
  - Prevention measures can be built in to projects and field management by design decisions
- What can be done about the risks?
  - If the consequences can be mitigated, it is the cost of mitigation that needs to be factored in to the decision rather than the value loss of the unmitigated risk
- How can this be done in practice?

Comparison of risks between projects

- To help make decisions, it would it would be valuable to access analogue data on the types and frequencies of risks likely to be relevant
- This would demand risk management learnings being captured and shared between different fields within a company, and potentially between project partners and more widely across the industry
- Problem: each risk description is unique to its own specific context
- Solution: use a standard way of classifying risks (taxonomy)
  - Each risks assigned to a class in the taxonomy scheme
  - Risk classes are then used as the basis for comparisons and statistics
- Here follows one way of doing it – there may be others

Taxonomy for subsurface risks

- "Subsurface risks" here means risks that we judge to:
  - Have a subsurface root cause
  - Belong to a technical area usually owned or managed by a subsurface team
  - Have consequences whose impact would normally need to be evaluated by the subsurface team
  - In this study we only include business risks; risks with HSE consequences are not covered
- Taxonomy based on:
  - Level 1: Area of consequence
  - Level 2: Style of risk event
  - Level 3: Type of cause

More information: Smalley & Chebotar (2017) Event-based risk management for subsurface risks: an approach to protect value generation from oil and gas fields. AAPG Bulletin, in press

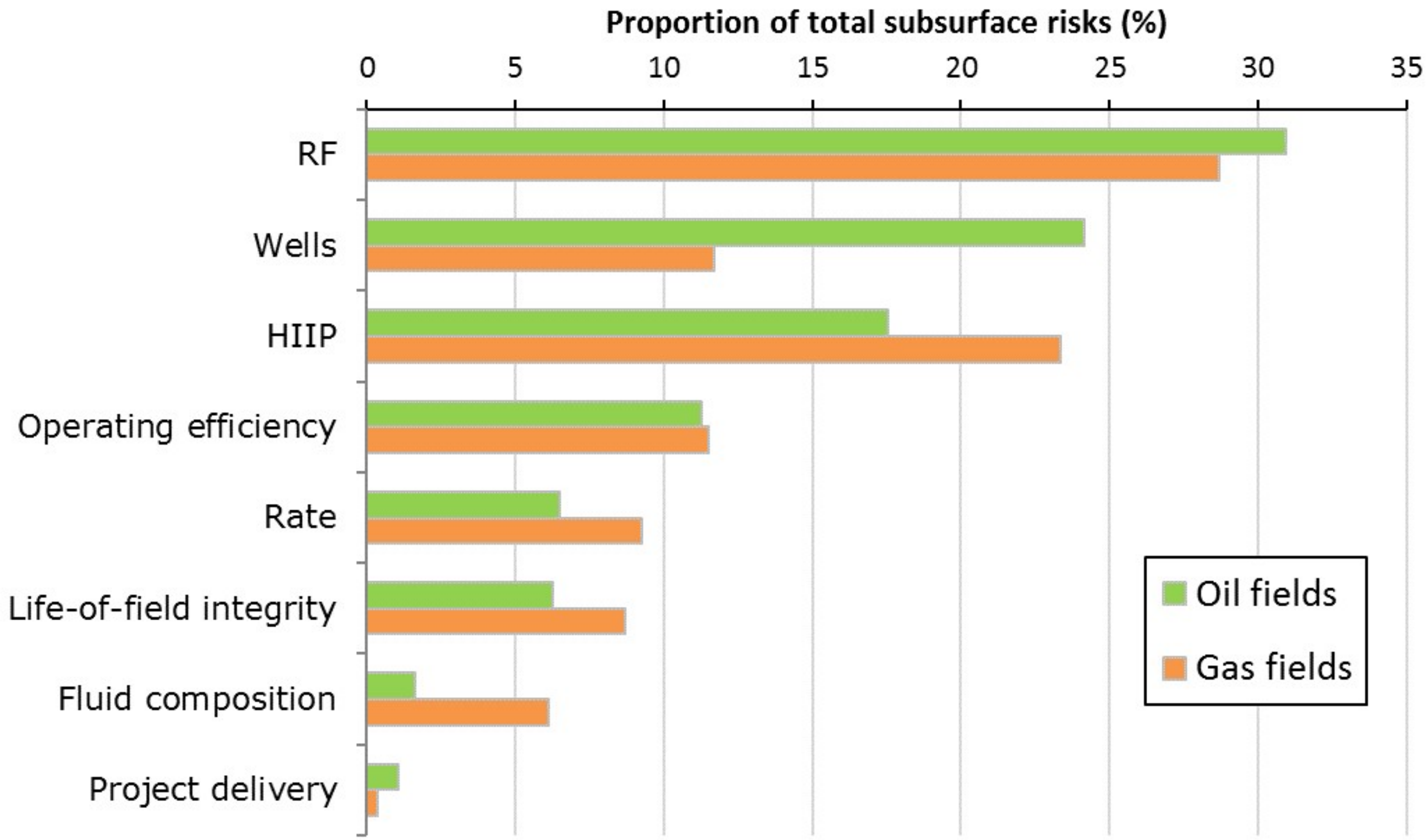
Risk classification examples

Risk category			
Level 1	**Level 2**	**Level 3**	**Risk Example: cause; event; consequence**
Fluid Composition	Oil Composition	API Gravity	Field segment X is more biodegraded (lower gravity) than expected; Oil composition depleted in lighter components; Fluid composition outside specification for intended refinery
HIIP	Hydrocarbon presence	Unexpected phase	Field segment X contains gas rather than oil; Oil in place less than threshold volume; Insufficient HIIP to maintain field plateau oil production rate
Life-of-field Integrity	Flowline integrity	Erosion	Reservoir strength less than expected causing sand production; Sand erodes flowlines compromising integrity; Extended shutdowns to replace flowlines defer production
Operating efficiency	Facility capacity	Gas Rate	Early breakthrough of injected gas to producers; Facility gas handling capacity reached; Oil production has to be cut back
Rate	Well decline rate	Water cut	Water coning from shallower than expected OWC; Rapid rise in water cut and decline in oil rate; Oil production targets not met
Recovery Factor	Sweep	Water	Thief zones at base of channels cause early water breakthrough; Poor volumetric sweep of injected water; Recovery factor reduced below target
Projects	Schedule delays	Approvals	Different views of HIIP distribution between partners; Protracted equity negotiations and delays to partner approval; Late project and reduced value
Wells	Drilling cost	Non-productive time	Overpressured shale leads to drilling problems; Non-productive time increases well drilling cost; Wells budgets exceeded, impacting NPV

Risk frequencies

- A dataset of 1456 subsurface risks was extracted from a much larger global risk register database
- Each risk placed in the taxonomy
- Statistics derived for the frequency of risk categories identified in different situations
- Here we report patterns observed in the Level 1 risk categories
  - Of course, many other types and depths of analysis could be performed

Overall subsurface risk frequencies



Patterns of risk variation

- Clear logical trends in the relative frequency of high level risk groups with type of field, for example:
  - Risks related to HIIP more frequently identified in deep-water oilfields and gas fields feeding LNG plants, where resource volumes are critical to support the large project capital costs
- Trends also evident with field maturity, for example:
  - Risks related to HIIP are more frequently identified before the field sanction decision than afterwards
  - Operating efficiency risks more frequent in mature fields

Implications of risk frequency trends

- When making decisions, access to such risk data could:
  - Help to identify risks that could be relevant to the current decision
  - Help to identify potential risks that might arise later in field life, and could be avoided or minimized by the current decision
  - Give some indication of risk prioritization based on frequency of risk identification in analogous situations

Future directions

- This work hopefully illustrates the potential of the approach: identify risk events, classify them and generate statistics to provide analogue data to support decisions
- However, the current limitation is that the stats are based on frequency of risk *identification*

- More powerful would be stats on *actual risk occurrence*
  - Actual frequencies of events, causes and consequences
  - Comparison of actual v predicted risk probability and impact
  - Risk management measures used and their actual efficacy

- Planning research projects in this area at Imperial College