

GEORISK Project

WP 2.2 Risk Assessment
Ferid Seyidov

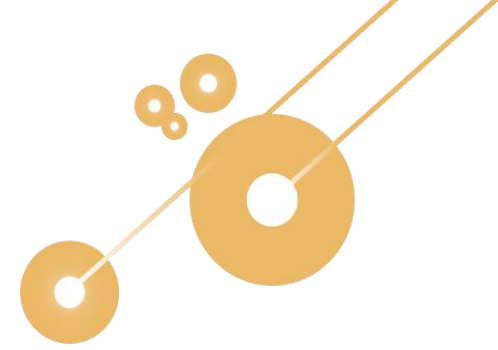
September 2019

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2 /



WP 2: RISK ASSESSMENT

MONTHS 1-15, Leader: BRGM

1) Context and Identification of potential risks (BRGM) (months 1-6)

Geothermal Risks register

2) **Risk Assessment (GEC-CO) (months 5 to 12)**

Geothermal Risk Matrix

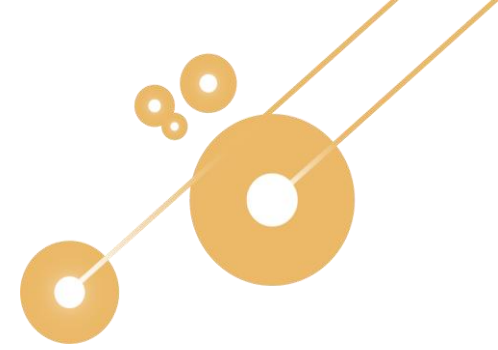
3) Tools to assess the risks (BRGM) (months 5 to 15)

Development of an online tool for developers globally

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3/

Strategy and Methodology

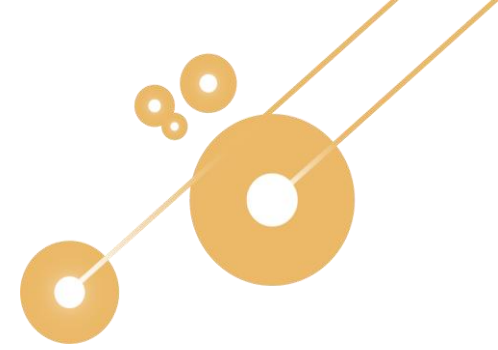


- The objective here was to create the risk portfolio for each country, geological system.
- The Risk Register was taken as a basis for evaluation matrix.
- Qualitative survey was set as a task goal to maximize the value of received data
- Objective was to make the list of stake holders and send 20 enquiries with expected 25% response rate.

5/

Questionnaire

- The questionnaire sheet is divided on 3 categories of risks
 - Socio Economical
 - Geology and Operational
 - Drilling
- The evaluation is based on real data from the active projects and project developers
- The risk index(RI) of each entry is evaluated based on the specified Frequency and Damage
- Each given risk have attributed Risk Index and Relevance.



6/

Representation of the Risk Matrix

Where Likelihood (a) is taken as

- (0,001; 0,01; 0,1; 1)

Where Damage (b) is taken as

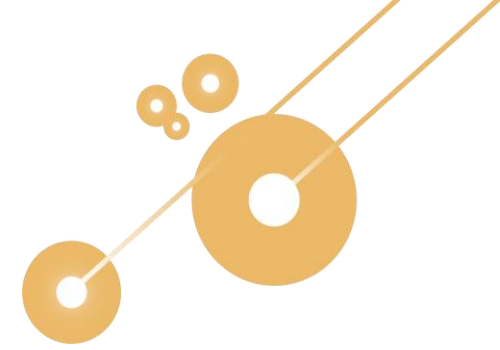
- (1.000; 10.000; 100.000; 1.000.000)

RI is Calculated as a sum of powers:

$$10^a \times 10^b = 10^{(a+b)}$$

Here the values are interpreted as following:

- 2-4 – Low level of Risk
- 5-6 – Medium level of Risk
- 7-8 – Critical levels of Risk



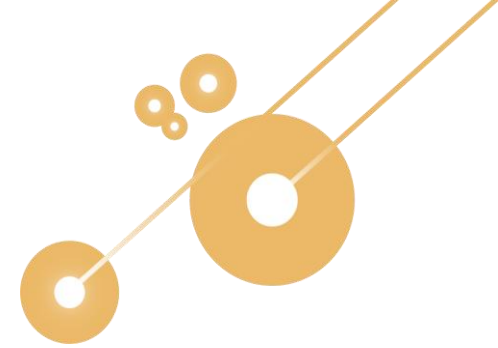
Likelihood

	1	2	3	4
1	2	3	4	5
2	3	4	5	6
3	4	5	6	7
4	5	6	7	8

Damage

7/

Questionnaire

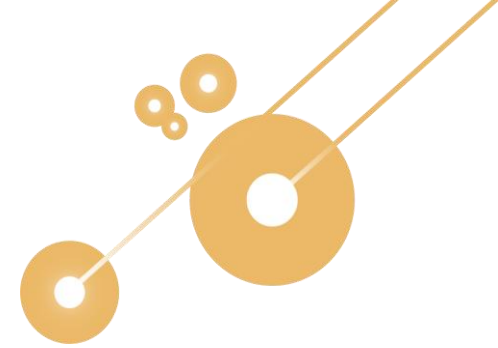


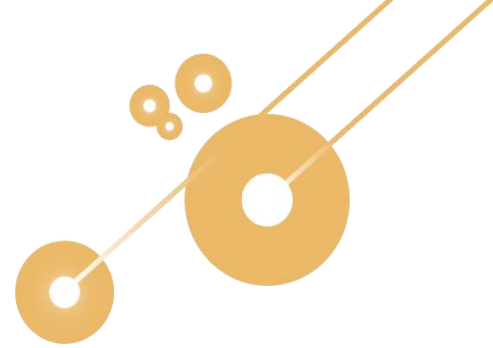
Output*		General Information			Level of Experience*		Note					
		Reservoir Type*	County and Region*		Geology	Social/Economic	Drilling	Operation/Development				
Topic*	ID	Phases			Description	Consequences		Risk Evaluation				
		IE*	DT*	OD*		PC*	EPA*	HSE*	Likelihood*	Damage Level*	RI*	Relevance*
Managerial and Social-Economic	A.1	X	X	X	External natural hazards damaging the infrastructure	X	X					
	A.2	X	X	X	Anthropogenic hazard damaging the infrastructure	X	X					
	B.1	X	X	X	Changes in policies, laws, taxes and regulations put development/economy in jeopardy	X						
	B.2	X	X	X	Lack of financing for the next phases	X						
	B.3	X	X	X	Low social acceptance put barrier to development	X						
	B.4	X	X		Public opposition against nuisances from the exploitation	X						
	B.4	X	X	X	Lack or loss of clients	X						
	B.4	X	X	X	Significant changes of energy costs	X						
	C.1	X	X	X	Low financing for work leading to low safety standards		X					
	B5	X	X		Unanticipated delays and costs in operations (materials, services, maintenance)	X						
	C.2	X			Suboptimal design of well leads to reduced flow rate	X						
	C.3	X	X	X	Best practices not applied (data acquisition, modelling, decision making, design of wells / plants, construction)	X	X					
	C.4	X			Unsuitable contracts (roles and responsibility not clearly defined) leading to suboptimal performance or exploding costs	X	X					
	C.8	X	X		Organization is not experienced / financially robust enough for the challenge	X						
	B.9	X	X	X	The research or exploitation permit is changed in favor of another resource	X						
C.9	X	X		Demand analysis and forecast are inaccurate	X							
Operation and Geology	D.1	X			Flow rate lower than expected (reservoir)	X						
	D.2	X	X		Flow rate degrades over time	X						
	D.3	X			Temperature lower than expected (reservoir)	X						
	D.4	X	X		Temperature degrades too quickly	X						
	D.5	X			Pressure lower/higher than expected	X						
	D.6	X			Pressure is changing during the operation in an unexpected way	X						
	D.7	X	X	X	Neighbouring operators cause negative changes to the reservoir parameters.	X						
	D.7	X	X	X	Fluid chemistry/ gas content / physical properties are different from expected	X	X					
	F.6	X			NCG Production	X						
	C.5	X	X		Human error leading to failure during work (including either insufficient background and/or regulations)	X						
	D.8	X			Fluid chemistry/ gas content / physical properties change	X	X					
	D.9	X			Target formation is missing in the well (unexpected geology, insufficient exploration)	X						
	D.10	X			Target formation has no/insufficient fluid for commercial production	X						
	D.11	X			Geological lithology or stratigraphy is different than expected	X						
	D.12	X	X	X	Excessive scaling in the geothermal loop	X						
	D.13	X	X	X	Excessive corrosion in the geothermal loop	X						
	D.14	X			Particle production ("sanding")	X						
D.15	X			Hydraulic connectivity between wells is insufficient for commercial use	X							
D.16	X	X		Re-injection of the fluid is more difficult than expected	X							
D.17	X			Degradation of the reservoir (structure, properties, deteriorating whole-scale further commercial utilization)	X							
F.8	X	X	X	Loss of integrity of surface equipments (leakage from the tanks, pipeline, heat-exchanger, etc.)	X	X						
E.1	X			Fluid losses leading to severe technical issues	X	X						
C.7	X			Damage to the well/reservoir while drilling or testing	X	X						
E.2	X			Wellbore instability	X							
E.3	X			Trajectory issues (deviation from target)	X							
F.8	X			Loss of integrity of surface equipments (leakage from the mud mud pit; well head and etc.)	X	X						
F.7	X	X		Loss of integrity of the wellbore (connection of well fluid with surface; inter layer fluid connection; etc.)	X							
C.6	X			Wrong choice of stimulation fluids or techniques damaging the reservoir/well	X							
E.7	X	X		Issues in transporting/handling radioactive sources for logging	X	X						
E.8	X			Technical failure of the equipment	X							
E.9	X			Well casing collapse	X							
F.1	X	X	X	Blowouts	X	X						
F.2	X	X	X	Fluid communication between different formations due to ineffective isolation of the well	X	X						
F.3	X	X		Induced seismicity (above sensitivity level)	X	X						
F.4	X	X	X	Surface subsidence or uplift	X	X						
F.5	X	X		Toxic emissions due to gases and fluids produced in-situ	X	X						
C.5	X	X	X	Human error leading to failure during work (including either insufficient background and/or safety regulations)	X	X						
C.5	X	X	X	Technical failure/difficulties during drilling (due to any additional causes that were not mentioned)	X							
Additional Notes*												

8 /

Survey Results

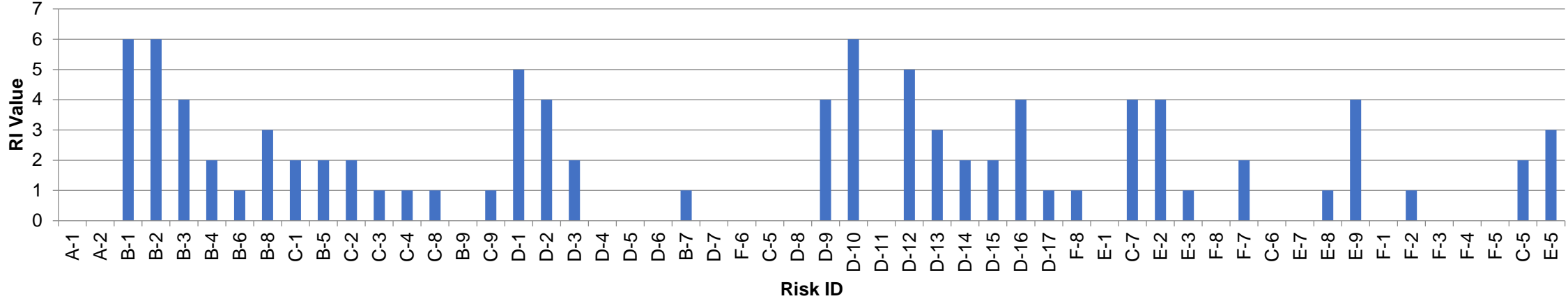
- France – 4 responses
Dogger Basin
- Germany – 4 responses
Molasse Basin
Upper Rhine Valley
- Greece – 7 responses
Shallow geothermal resources of Macedonia and Thrace
Deep Sedimentary Reservoirs
Aegean Volcanic Arc
- Hungary – 18 responses
Middle depth Pannonian Basin
Deep Panonian Basin
- Poland – 10 responses
European Intracratonic Basin and North German Basin
- Turkey – 6 respondents
Reservoirs in Western Turkey
- Switzerland – 4 respondents
Reservoirs in Eastern Switzerland



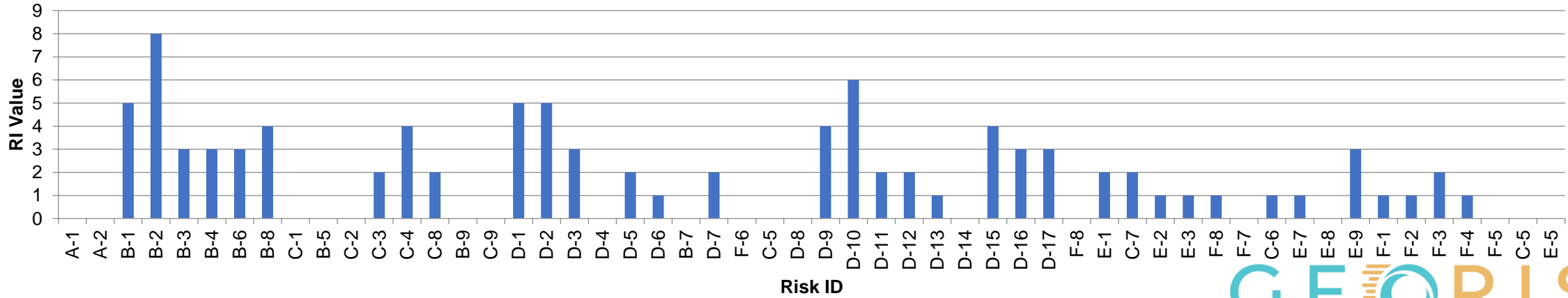


Highest Results Overview

Risk Index

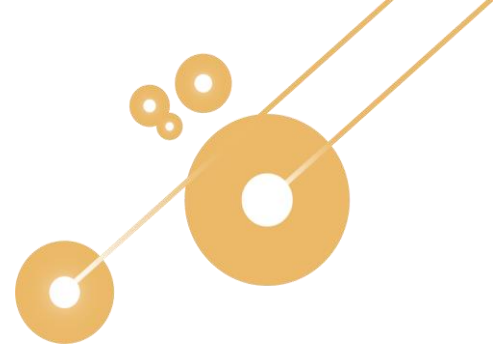
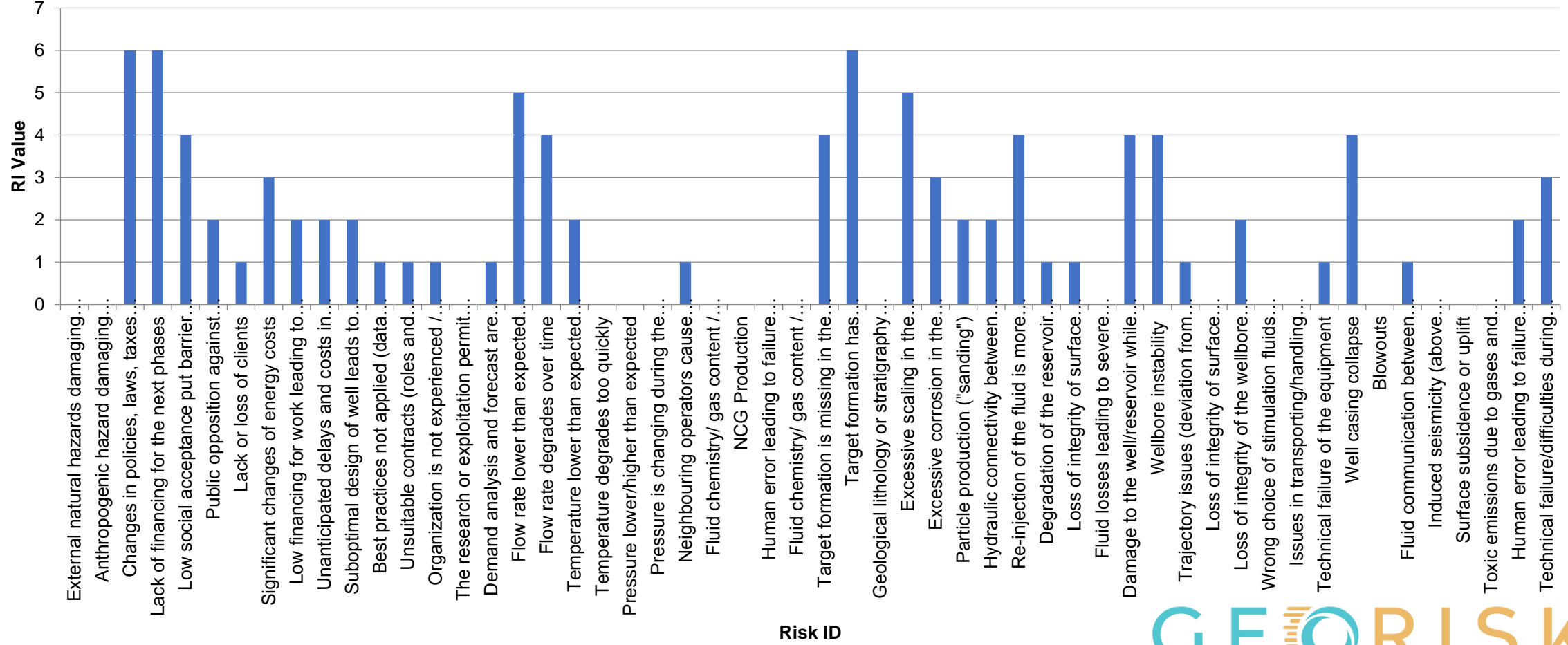


Relevance

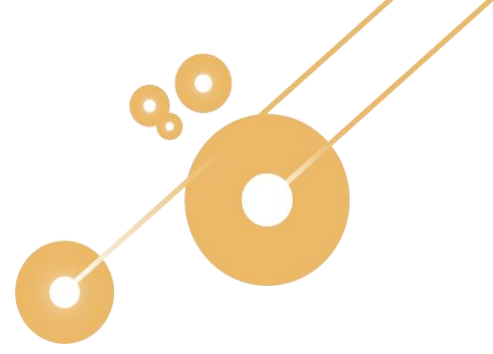


RI Results

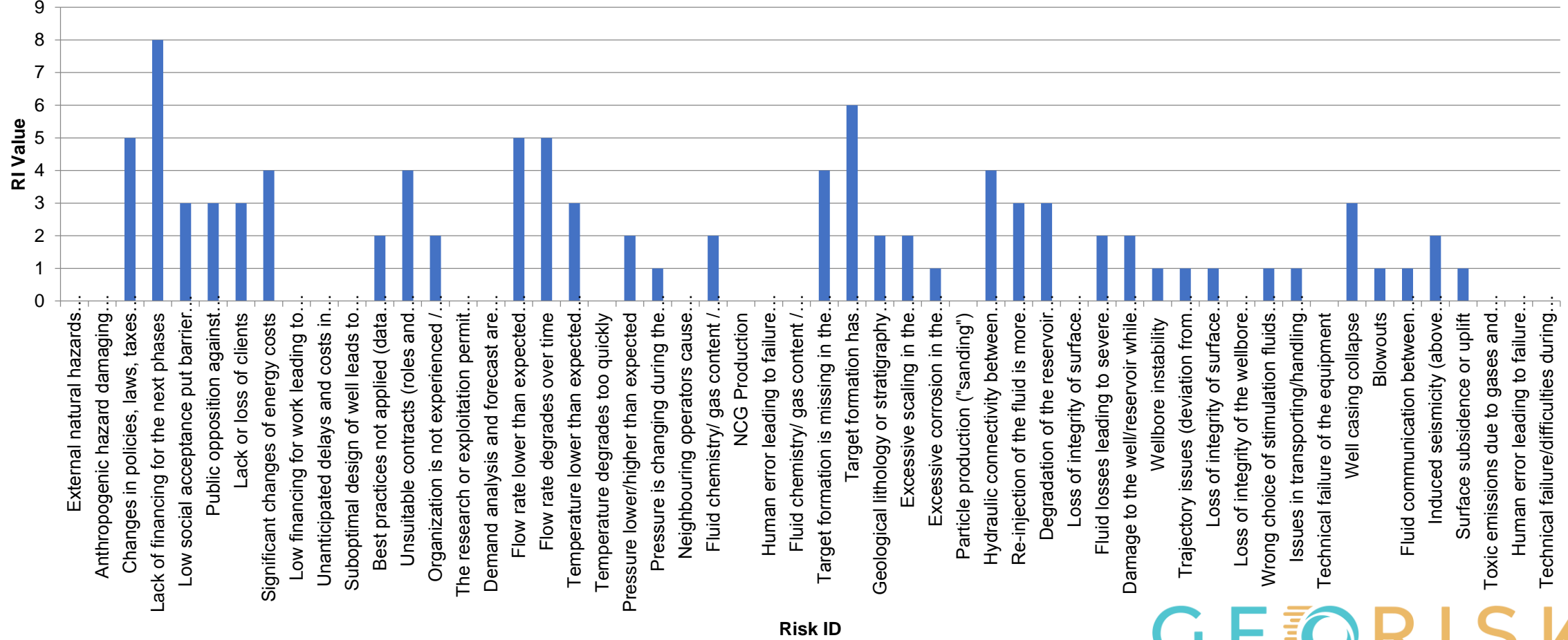
Risk Index



Relevance Results



Relevance





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