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Drilling Hazards Inventory: the Key to Safer -and Cheaper- Wells

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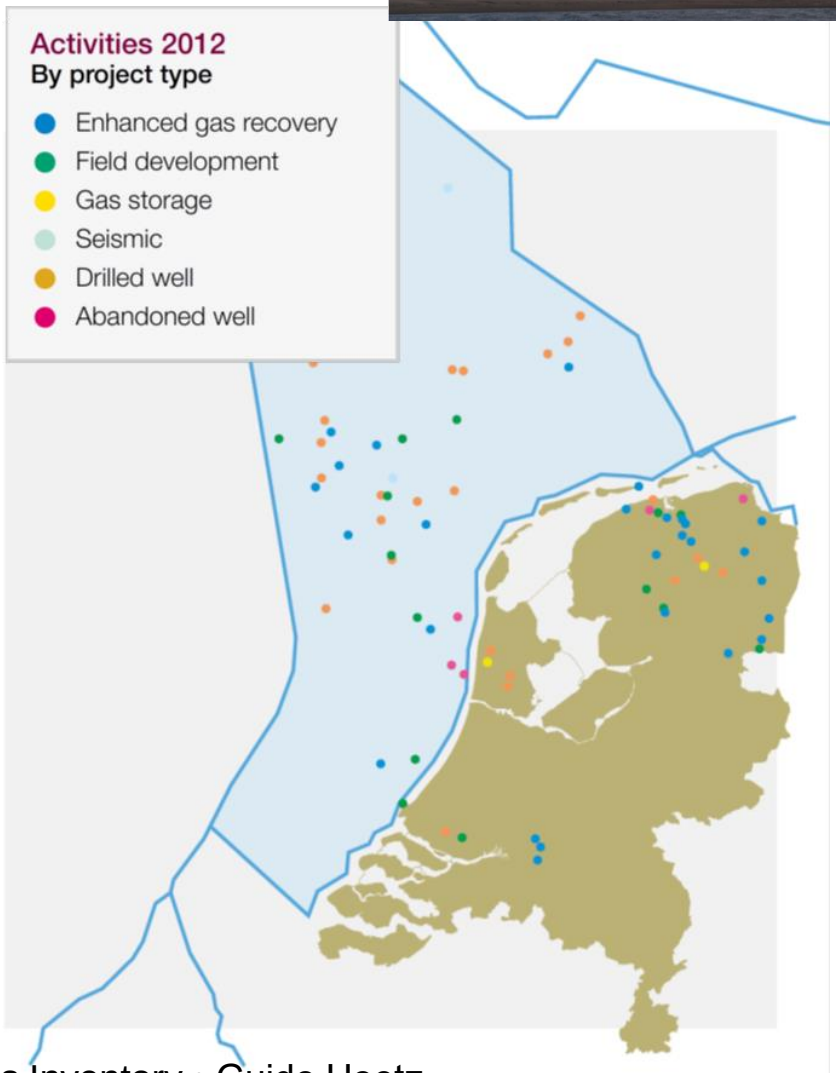
Outline: Drilling Hazards Inventory

- Background
- Defining Geo-Drilling Hazards
- The Drilling Incidents Triangle
- Vision
- Pilot for Joint Industry Project: GeoDHAPS
- Conclusions

EBN: who, what, where?

- Large E&P player in NL via NOV's
- 100% owned by ministry of Economic Affairs
- Focus on oil & gas exploration & production
- Optimise use of assets & knowledge
- Involved in most NL wells as 40% partner

Total NL well capex: > $1 mrd p.a.

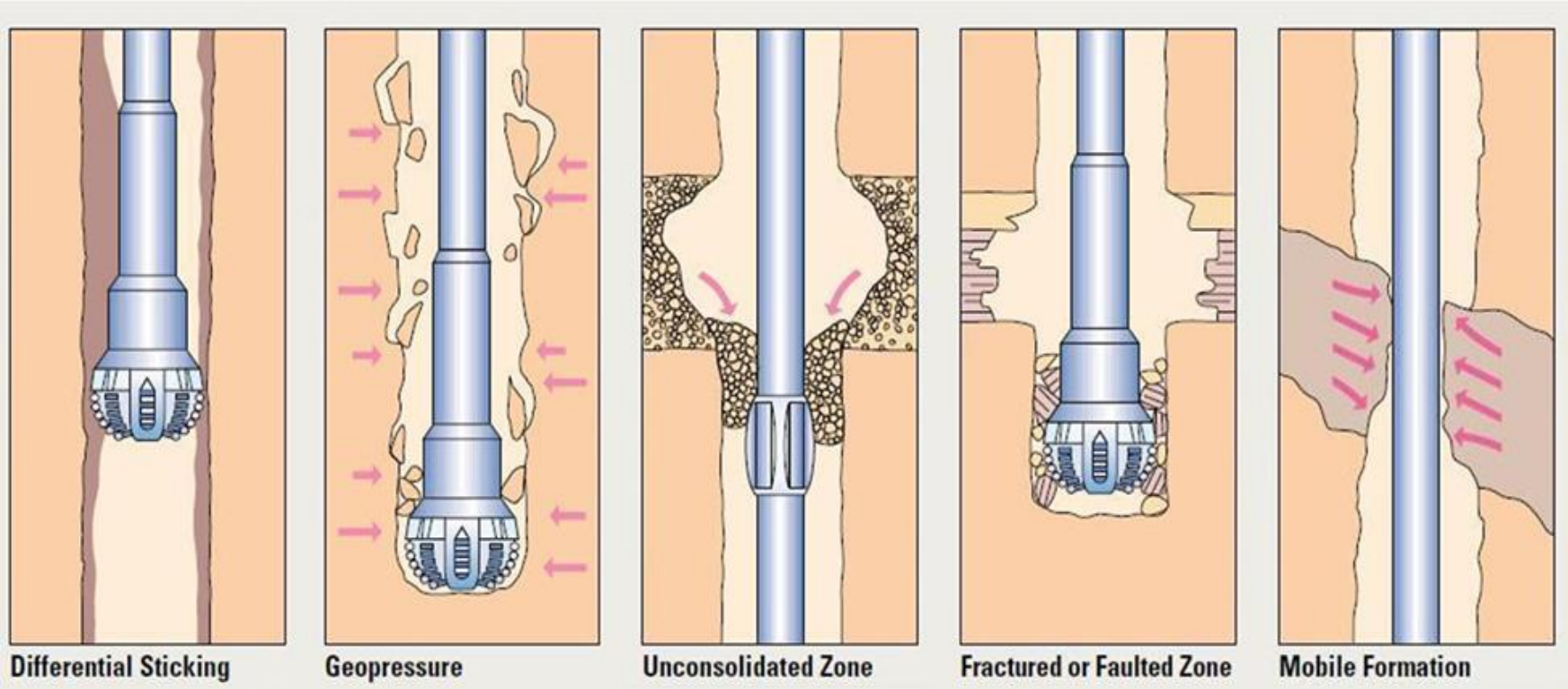


Background

- *Significant NPT** due to Drilling Hazards
- *Macondo incident*: renewed focus in NL
- *Drilling Hazards data* are currently not systematically shared amongst operators.
- *Drilling cost creep* to be addressed

** Non Productive Time*

Examples of Geo-Drilling Hazards



Definitions

Drilling Incident:

Unexpected event that hampers drilling progress

Geo Drilling Incident:

Unexpected event with geological cause that hampers drilling progress

Examples of Drilling Incidents : stuck pipe, kick, losses

Drilling Hazard:

Peril that potentially impacts drilling

Geo Drilling Hazard:

peril related to a particular geological subsurface situation (*geohazard*) that potentially impacts drilling

Examples of geohazards: fault, brinepocket, H2S

Well Review analysis

Operational performance

Reservoir performance

well	operator	type	Target fmt	Summarized results	O	R
F		E	Volprie sst.	water bearing; P&A		
		E	ROSLU	ROSLU within range; ROSLL water bearing		
		E	ROSLL	delayed due to coring & high gas levels in Volprie; logged behind casing due to obstructed WL		
		E	Z3 Carb.	Z3 is tight; Z2 has over 500 ppm H2S; Vlieland is tight, but fraccable; SL column is small		
		E	ROSLL	small column; tight reservoir; P&A		
		E	ROSLL	severe mud losses in Volprie; high p		
		E	Bunter	small column; tight reservoir; P&A		
		E	Tersch.	reservoir within expectation range;		
		E	RO	results in low-mid case range		
		E	Bunter	total losses in Chalk; results around		
		A	Bunter	unforeseen casing mid NS; low pern		
		A	ROSLU	depleted reservoir: formation press		
		P	ROSLU	sidetracked 2X: [1] minor ST in NS. [kick off in NS; section drilled, expandable casing stuck; well suspended		
		P	ROSLU	water bearing; suspended for future sidetrack		
		P	ROSLU	results within expectation range		
		P	ROSLU	60 bar depletion; results within range		
		P	ROSLU	economic development; no H2S produced		
		P	ROSLU	sidetracked 3X in NS; unconsolidated formation; operational issues; disturbed drilling area; plugged		n.a.

confidential

traffic-light coding:

good

medium

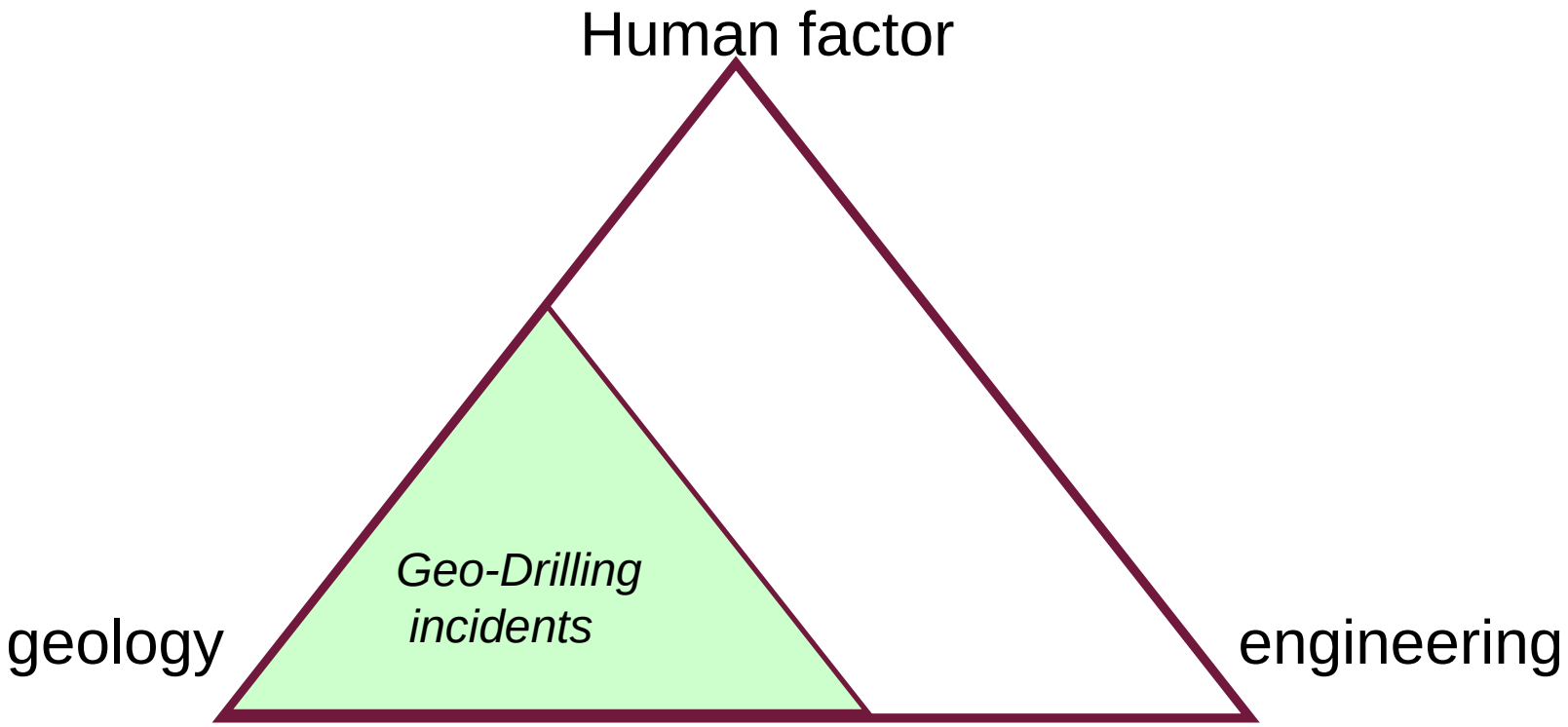
poor

Impact of Drilling Hazards: Results from internal review

- **56 wells with Geo Drilling Incidents were analysed.**
- **At least 25% of wells had significant Geo Drilling Incidents (damage: >200k €)**
- **Anticipating Drilling Hazards might cut costs by >10%**
- **Initiated *pilot Inventory* via Joint Industry Project**

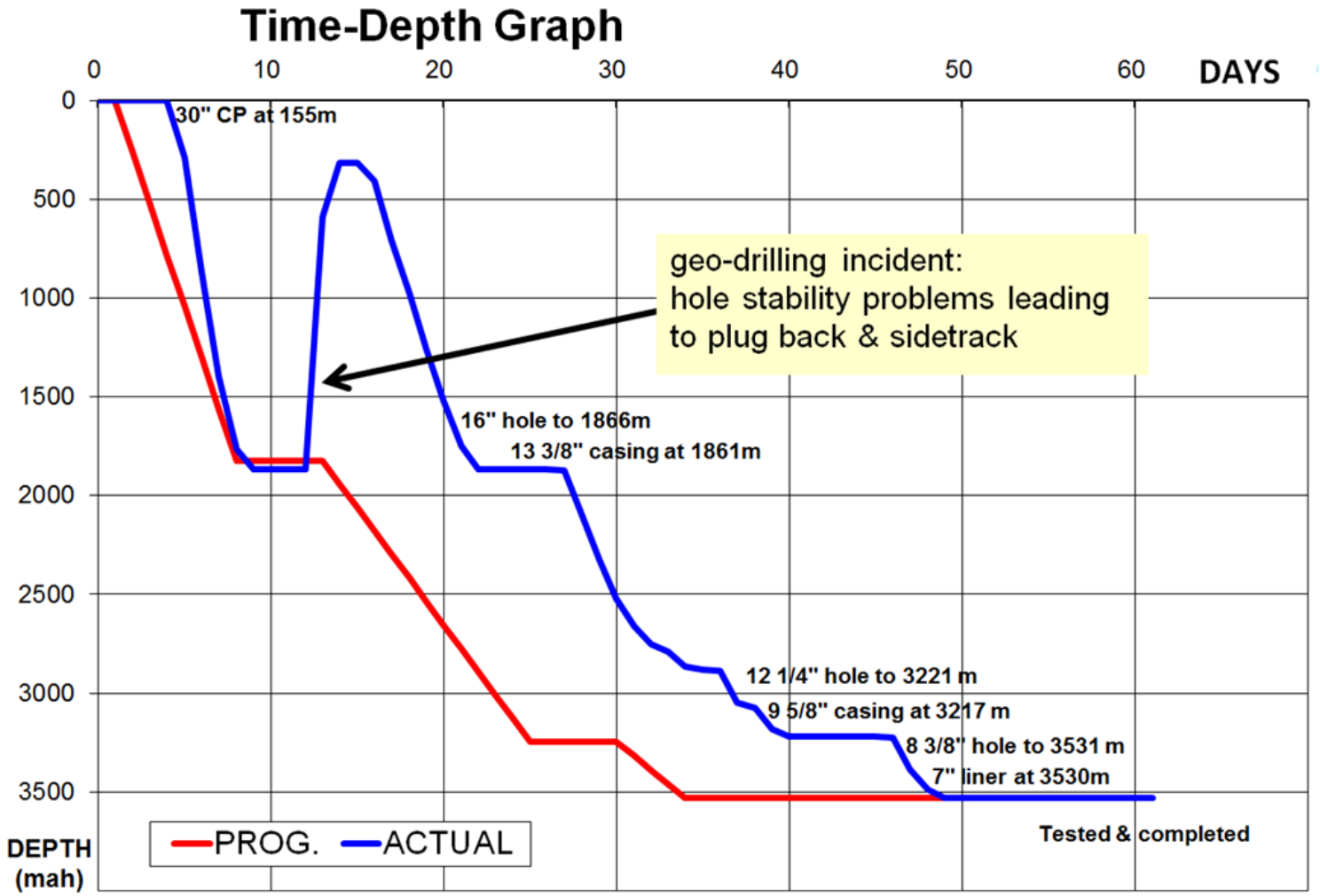
What Drilling Incidents to be captured?

Drilling incidents can have one or more causes: Drilling Incident Triangle



Geo-Drilling incidents have a significant geology component in the cause
Geo-Drilling incidents require geoscientists for understanding
Geo-Drilling incidents can often be avoided by doing geological homework

Spotting Geo-Drilling Incidents (example)



Vision:

Geo Drilling Hazards Prediction System (GeoDHAPS)

Database with observed Geo-Drilling Incidents (GDI's) that allows improved design & reduced risk of future wells.

Expected results:

- *Safer wells*
- *Cheaper wells*

Drilling Incident and Hazards classification scheme

Drilling Incidents coding based on:

observation and interpretation

Category - Geological Drilling Incident

Type of Drilling Incident Based on observation:

DI_CODE	Type	Description
1	High Torque/Overpull	High torque or vertical resistance of the drill/casing string which ca reaming and/or significant hole cleaning.
2	Collapsed hole	After RIH again, drilled hole found to be too tight or completely col
3	Difficult Drilling	Excessive wear of the drill bit resulting in reduced rate of penetrat

Category - HAZARDS : Cause of Drilling Incident

Type of Drilling Hazard based on analysis:

HZ_CODE	Type	Description
A	Abrasive formation	Formation with abrasive effect on drill bit. The abrasive effect is caused by an high content of hard m chert.
B	Boulders	Large detached rocks in borehole. Typically originating from conglomerate. Can lead to trapped drills
S	Squeezing formation	Borehole formation deforming under the influence of drilling activity (e.g. ductile behaviour). Movem (undergauge hole), leading to stuck pipe, excessive bit wear/reaming/clayballing/gumbo etc.
W	Unconsolidated/weak formation	Unconsolidated formation, collapsing into the hole

GeoDHAPS features

1. **Database to be populated with info on GDI's from operators.**

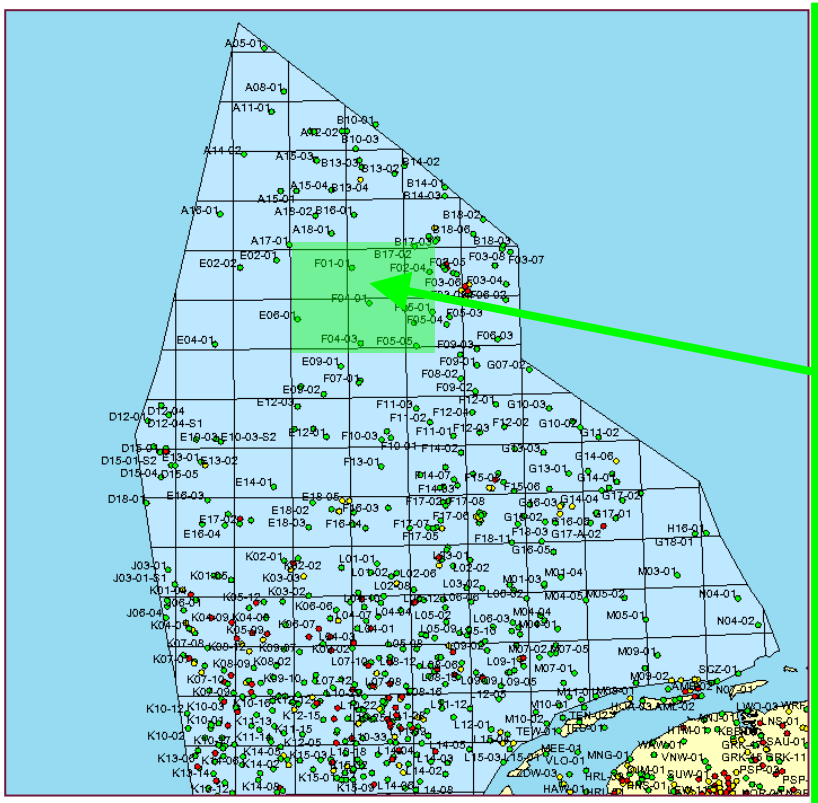
2. **Database (online) accessible by operators.**

3. **Database contains info on many (all?) wells: basin-wide (nation-wide).**

4. **Dataformat flexible.**

GeoDHAPS:

Quick access to incidents of Geo- Drilling Hazards



GIS interface to database

Recorded incidents
(table format summary for selected AOI and/or stratigraphic interval)

Strat unit	F19-1	F19-2	F19-4	F19-5	F20-2
N S	1C (fault mappable)	No problems reported	unknown	No problems reported	No problems reported
Chalk	No problems reported	No problems reported	unknown	2A chert	2A Massive chert
Triassic	No problems reported	6A Gasshows in RBMVL (not tested)	unknown	No problems reported	No problems reported
Zechstein	3A Squeezing salts cause csg collapse	No problems reported	unknown	3B	3A Floater gas kick remedied with MW 1.9 sg
Rot-liegend	No problems reported	1A Depleted reservoir	8 Sand problems During production	5A Hole at wrong side of fault (migration problem)	1A Differentia-lly stuck (reservoir depleted)

example

GeoDHAPS Pilot

1. Capture Geo-Drilling Incidents in small subset of wells.
2. Design GDI classification scheme.
3. Determine key parameters for GDI datacapture
4. Design GDI data access (GIS interface)
5. Report out & test support for follow-up (JIP)

GeoDHAPS pilot results

A. 11 out of 12 operators provided input as requested

B. Value of GeoDHAPS acknowledged

C. Key challenges:

1. Workload (2-8 h analysis per well)
2. Lack of experienced staff
3. Translation from well files to incident codes
4. Confidentiallity
5. Sensitivity (*what actually went wrong?)*
6. Who will obtain access?

Conclusions

1. Not anticipated geo-drilling hazards have massive impact on cost and safety.
2. Understanding drilling hazards starts with knowing what happened in offset wells.
3. GDI classification scheme helpful in analysis.
4. Sharing Drilling Hazard knowledge via Joint Industry Project (GeoDHAPS) piloted successfully.
5. Full GeoDHAPS currently proposed to NL industry.