remote sensing across the oil and gas lifecycle

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GRSG Conference 2017
overview

• The oil and gas project lifecycle
• Remote sensing applications across the project lifecycle
• Remote sensing technology trends
• Implications + challenges for oil and gas remote sensing applications
• GRSG Oil and Gas Workshop Boulder 2018
the oil and gas project lifecycle

<table>
<thead>
<tr>
<th>1-5 years</th>
<th>4-10 years</th>
<th>4-10 years</th>
<th>20-50 years</th>
<th>2-10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration</td>
<td>Appraisal</td>
<td>Development</td>
<td>Production / Operations</td>
<td>Decommission / Rehabilitation</td>
</tr>
</tbody>
</table>

- **Exploration**
  - Searching for prospects
  - Bidding for exploration licenses

- **Appraisal**
  - Collection and interpretation of seismic data
  - Exploration + appraisal drilling
  - Determine resource potential + feasibility

- **Development**
  - Planning of facilities with consideration of environmental, social, economic, and operational issues
  - Construction of facilities

- **Production / Operations**
  - Produce hydrocarbons
  - Redevelopment: EOR
  - Maintain installation and facilities

- **Decommission / Rehabilitation**
  - Removal, disposal or re-use of infrastructure
  - Remediation + reclamation of site to pre-development state

Wide diversity of applications of remote sensing across the project lifecycle

Credit: Ayo Adediran
Offshore and onshore seep mapping: exploration targeting and basin risk reduction

SAR repeat oil slick sites for Gulf of Mexico from CGG-NPA database

Iron mineral alteration as indicator of micro-seepage; from Lord, 2017

Mineralogical map of part of Neuquén Basin from airborne VSWIR hyperspectral

Source: CGG NPA Offshore Seeps Database product
Onshore seismic planning for Ghazalat, Egypt; from Coulson et al., 2008.

Landsat derived lithological map + DEM data used to predict access and seismic acquisition quality

Land cover mapping for environmental impacts assessment / ESHIA; from Sutton, 2010
Well-pad planning using high resolution aerial imagery + DEM’s to improve efficiency for shale operations.

Below: pad site cut fill visualization with DEM.

Left: ortho’s used to monitor well-pad development progress.

Monitoring dredging activities to ensure effectiveness and compliance.

Source: Spatial Energy

Source: EOMap
InSAR for surface deformation monitoring: used operationally for reservoir management; increasing use for EOR + CCS; caveats around applicability in certain environments


Results: periodic uplift and subsidence associated with steaming + production phases of CSS
Oil spill response: offshore + onshore

Macondo oil slick extent and ocean currents from Radarsat-2 data

Hierarchy of remote sensing surveillance for oil spill response. Source: IPIECA

Left/below: Chevron BVLOS test of long-endurance UAS for real-time coastal imaging
Monitoring land cover/land-use change: monitoring physical footprint over the life of operations; example from BP Sullom Voe terminal 2003-2013 LULC mapping using VHR satellite imagery.
MetOcean applications: monitoring offshore conditions during exploration through decommissioning
Emissions monitoring: e.g. methane; goal of operational leak detection

Methane retrievals for Alison Canyon gas leak (Source: Washington Post)

Methane retrieval from Ball Aerospace DIAL instrument (Source: Ball Aerospace)
Remediation/reclamation applications: use of historical remote sensing imagery to identify sites of concern, monitor earth-works during development, monitor re-vegetation.

Vegetation health as indicator of soil contamination.

Above: historical imagery used to track operations footprint of life of asset.

Left: monitoring revegetation of reclaimed asset.
More routine use of remote sensing supporting production/operations + decommissioning

Increasing surveillance and environmental monitoring: mapping -> monitoring

Onshore applications: managing existing (EOR) and new fields – less focus on ‘mega-projects’
## remote sensing trends: platforms

<table>
<thead>
<tr>
<th>Satellites</th>
<th>Manned aerial</th>
<th>Heavy/long-endurance UAS</th>
<th>Small UAS (sUAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Satellite" /></td>
<td><img src="image" alt="Manned aircraft" /></td>
<td><img src="image" alt="Heavy UAS" /></td>
<td><img src="image" alt="Small UAS" /></td>
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<tr>
<td>- Constellations</td>
<td>- Routine surveillance</td>
<td>- BVLOS restrictions</td>
<td>- Internal operations:</td>
</tr>
<tr>
<td>- &gt; Temporal resolutions</td>
<td>- Opportunities to integrate low-cost</td>
<td>- currently but should open up</td>
<td>increasingly will be used</td>
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<tr>
<td>- RGB + new data types</td>
<td>sensor packages for routine mapping</td>
<td>- Specific missions; e.g.</td>
<td>for mapping</td>
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<tr>
<td>- Seamless workflows +</td>
<td>- With time may be superseded by long-</td>
<td>- emergency response</td>
<td>- Low-cost remote sensing</td>
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<tr>
<td>automated analytics</td>
<td>endurance UAS</td>
<td></td>
<td>platform</td>
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<td></td>
<td></td>
<td></td>
<td>- Business case for</td>
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<td></td>
<td></td>
<td>applications driven by</td>
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<td></td>
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<td>data processing costs</td>
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What platform is right for the task? Not always straightforward to answer!
remote sensing trends: imaging sensors

New sensor types for specific applications

Miniaturization + consumerization

Increasing modalities of commercial sensors + data; e.g. video, multiband SAR

Standard APIs + workflows

Caveat: imaging sensors still require integration on platforms + business case
= more data and products from a variety of platforms

Source: Digital Globe
cloud architecture

Challenges of integrating vendor cloud solutions with the ‘Chevron’ cloud

Tune processing based upon client request

Processing workflow

Orthorectification

Calibration

Analytics Alg

Products served e.g. ESRI Image Server

Clients e.g. ArcMap
Web browser

Scalable storage e.g. Amazon S3

Processing engines running on scalable compute e.g. Amazon EC2

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implications of RS advances for O&G industry

- Increasing opportunities for the use of remote sensing
- Tools for non remote sensing experts
- More routine monitoring applications + integrate into operations
- Better data stewardship across the project lifecycle
- More quantitative remote sensing → sensor networks
- Reduce costs + do things more efficiently
- Supports HES risk reduction
challenges with RS application development

• Significant potential for automation of ‘common’ industry RS applications

• **BUT** ‘long tail’ of ‘bespoke’ applications, e.g.:
  – Local land cover
  – InSAR tuned to local environment

• Challenge: leverage technology advances for the long tail where appropriate

Source: Airbus
external challenges

• Democratization of data: open data archives, growth of UAS
• Increased scrutiny of O&G operations
• No fence-line from the remote sensing perspective
• Reinforces Chevron’s corporate policies around Operational Excellence + reducing our environmental footprint
GRSG oil and gas remote sensing workshop

July 11-12, 2018 – Boulder, Colorado, USA

CALL FOR PAPERS NOW OPEN

Seeking abstracts on applications of remote sensing across the oil and gas project lifecycle including for:

- Exploration + appraisal
- Project development
- Operations including environmental monitoring
  - Met-ocean applications
  - Emergency/oil spill response
  - Decommissioning + rehabilitation

For more information or to submit an abstract email: 
workshop@grsg.org.uk

https://www.grsg.org.uk/events/grsg-oil-gas-remote-sensing-workshop/
Thanks for your attention!
Questions?

references + links

• Samsonov, S., (2017) Short- and long-term ground deformation due to cyclic steam stimulation in Alberta, Canada, measured with interferometric radar, in The Leading Edge, Jan, 2017.
• Earth Observation for Oil and Gas (EO4OG) project case studies: https://earsc-portal.eu/display/EO4/