An assessment of the footprint and carrying capacity of oil and gas well sites: the implications for limiting hydrocarbon resources.

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Objectives

1. Define the physical footprint of conventional well pads
2. Use these estimates to understand the carrying capacity of the environment
3. How does this limit recoverable resource assessments?
4. Compare footprint to other industries

Preese Hall, Lancashire (UK)

Kirby Misperton, North Yorkshire (UK)
Objectives

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Kirby Misperton, North Yorkshire (UK)
Methodology

1. Footprint of conventional hydrocarbon operations

- Number of wells studied:
  - UK 2193
  - The Netherlands 426
  - Poland 802
Methodology / Results

1. Footprint of conventional hydrocarbon operations

- Well pad and access road footprints were measured
- These were categorised by reliability
- Results were then bootstrapped

Northwood 1 near Stoke-on-Trent (UK)

Anjum- 03 well, Friesland (The Netherlands)

Barnowko 7 near Barnowko (Poland)
Results / Conclusion

1. Footprint of conventional hydrocarbon operations

- Average conventional well site footprint and area per well:
  - UK - 10800 m² and 541 m²/well
  - The Netherlands - 44600 m² and 6370 m²/well
  - Poland - 3000 m² and 2870 m²/well

- Average access road lengths:
  - UK - 230 m
  - The Netherlands - 310 m
  - Poland - 250 m
Objectives

- 1. Define the physical footprint of conventional well pads
- 2. Use these estimates to understand the carrying capacity of the environment
- 3. How does this limit recoverable resource assessments?
- 4. Compare footprint to other industries
Methodology
2. Impact of well sites and setbacks

- Setback – the distance well pads have to be away from existing infrastructure

- Protect water resources, personal and public property, and the health and safety of the public

Pasop-3 wells (Groningen, The Netherlands)
Methodology

2. Impact of well sites and setbacks

- Setbacks taken from the Maryland Report
- A variant of the Buffon’s needle approach was used
- Well pads with varying setbacks were placed into the currently licensed blocks
- If a feature of interest was crossed it was recorded
2. Impact of well sites and setbacks

Methodology / Results

- Impact of well sites and setbacks

![Map showing well pad infrastructure and distances]

- 609 m setback from the nearest road
- 152 m setback from the nearest road
Results

2. Impact of well sites and setbacks

100 well pads were assessed

- **well pad (10800 m²)**
  - Mild infrastructure
  - Moderate infrastructure
  - Considerable infrastructure
  - Immoveable infrastructure

- **152 m setback**
  - Mild infrastructure
  - Moderate infrastructure
  - Considerable infrastructure
  - Immoveable infrastructure

- **609 m setback**
  - Mild infrastructure
  - Moderate infrastructure
  - Considerable infrastructure
  - Immoveable infrastructure
Methodology

2. Wells per licence block

- How many well pads with their setbacks could be placed into a licenced block?
Results

2. Wells per licence block

- Mean carrying capacity was 26%
Objectives

1. Define the physical footprint of conventional well pads
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Conclusion

3. Wells per licence block

- Mean carrying capacity was 26%
- $8.5 \times 10^{11} \text{ m}^3$ gas resources estimate for the Bowland Basin
- $2.21 \times 10^{11} \text{ m}^3$ actual amount of gas accessible

Preese Hall, Lancashire (UK)
Methodology

3. Conventional well setbacks

Are the setbacks used in our analysis realistic?

Average setbacks:

- 329 m from a building (min 21 m)
- 447 m from a house (min 46 m)
- 238 m from a train line (min 38 m)
Results

3. Conventional well setbacks

The distribution of the measured setbacks for the 121 sites
Objectives

1. Define the physical footprint of conventional well pads
2. Use these estimates to understand the carrying capacity of the environment
3. How does this limit recoverable resource assessments?
4. Compare footprint to other industries

Mogden WwTW near Isleworth in London

A random petrol Station located within the UK
Comparator industries - petrol stations and wastewater treatment works:

- Often located in a similar rural setting
- Manage hazardous chemicals and hydrocarbons
- And petrol stations are approximately a similar size

Minworth WwTW, Birmingham (UK)
Petrol stations

- 50 of the 8494 UK petrol stations were analysed
- Average area was 1360 m² (range 558 - 2600 m²)
- Total footprint was calculated at 11.6 km²
4. Comparator industries in the UK

- **Wastewater treatment works**
  - 21 of the 9000 wastewater treatment works in the UK were analysed
  - Footprint ranged from 2417 m² to 1.48 km²
  - Total footprint was calculated at between 54 km² and 89 km²

![Shap WwTW, Cumbrain Fells (UK)](image1)
![Chapel-en-le-Firth WwTW, Derbyshire Peak District (UK)](image2)
Conclusions

4. Comparator industries in the UK

- If 127 licenced blocks developed 26 well pads, 3302 wells would be developed.

- Generating a direct footprint of 35.7 km² and a total surface footprint of 305 km².

- The total footprint for petrol stations was 11.6 km² and the total footprint for wastewater treatment works was between 53 km² and 89 km².

- The footprint required for shale gas development is not unique.
Overall Conclusions

- Average conventional well site footprint and area per well:
  - UK - 10800 m² and 541 m²/well
  - The Netherlands - 44600 m² and 6370 m²/well
  - Poland - 3000 m² and 2870 m²/well

- Average setbacks:
  - 329 m from a building (min 21 m)
  - 447 m from a house (min 46 m)

- Mean carrying capacity was 26%

- $2.21 \times 10^{11}$ m³ actual amount of gas accessible

Wytch Farm, Dorset (UK)
Overall Conclusions

- Sites should be multi-well and located as far apart as technically feasible
- Making maximum use of horizontal drilling technology
- Methodologies applied here are transferrable

Numerous fracking sites in Colorado (US)
Current work
Spills and leaks

- Pollution incidents via spills and leaks at the well site and during transportation

- Assessing data from:
  - Texas Railroad Commission
  - Colorado Oil and Gas Commission
  - UK pollution incident database
  - News reports

Colorado truck crash leads to significant oil spill
Overturned milk tanker floods road
Future Work
Legacy and mitigation

Castletown 1 near Wrexham (UK)

Cropwell Bulter 2/3 near Nottingham (UK)
Future Work
Legacy and mitigation

Willoughbridge 1 near Stoke on Trent (UK)

Rufford 1 near Chesterfield (UK)
Future Work

Legacy and mitigation

Formby, Merseyside (UK)
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