

Pipeline Integrity Management from Space

Failures of transmission pipelines are high impact events

Huge Natural Gas Explosion Across Highway 77 in Sissonville West Virginia

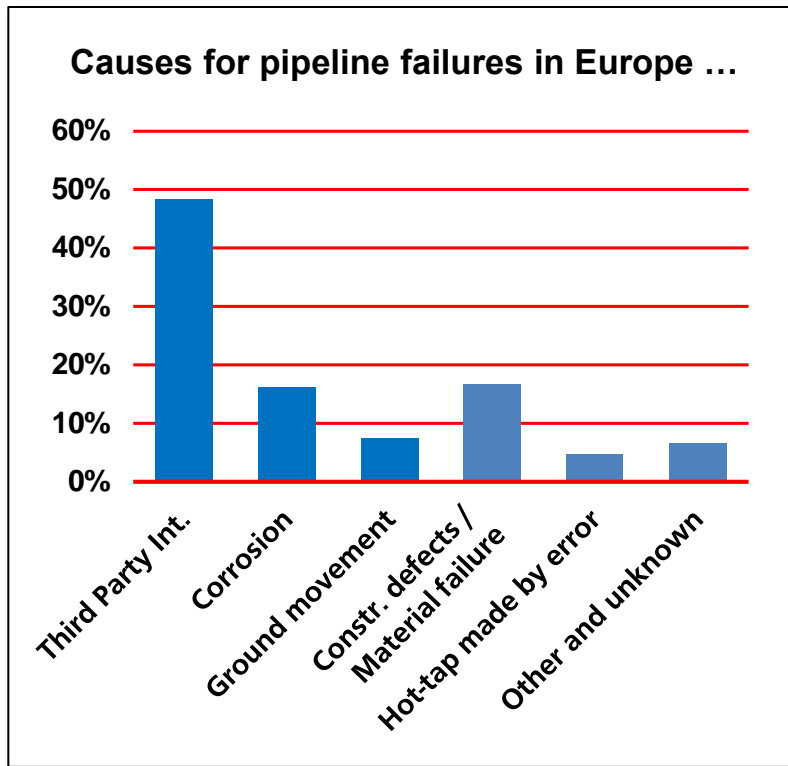


Failures of transmission pipelines are high impact events

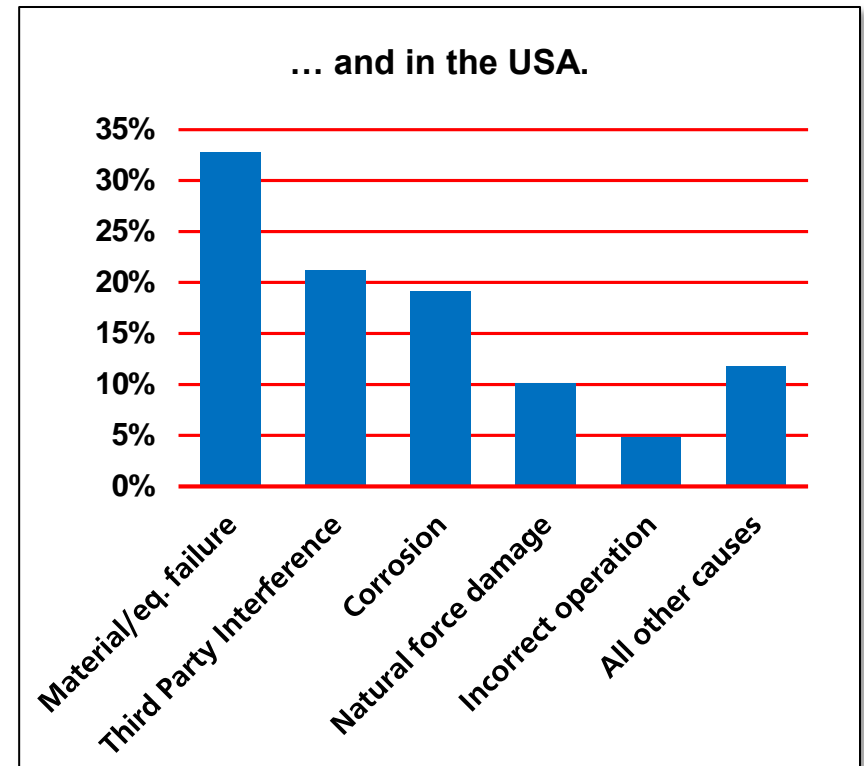
... but prevention of failures is complicated!



Failures in high pressure gas transmission pipelines (1 of 2)



Our PIMSyS services covers over 70% of all failures



Contrary to Europe in the USA most causes are related to the condition of the pipeline system.

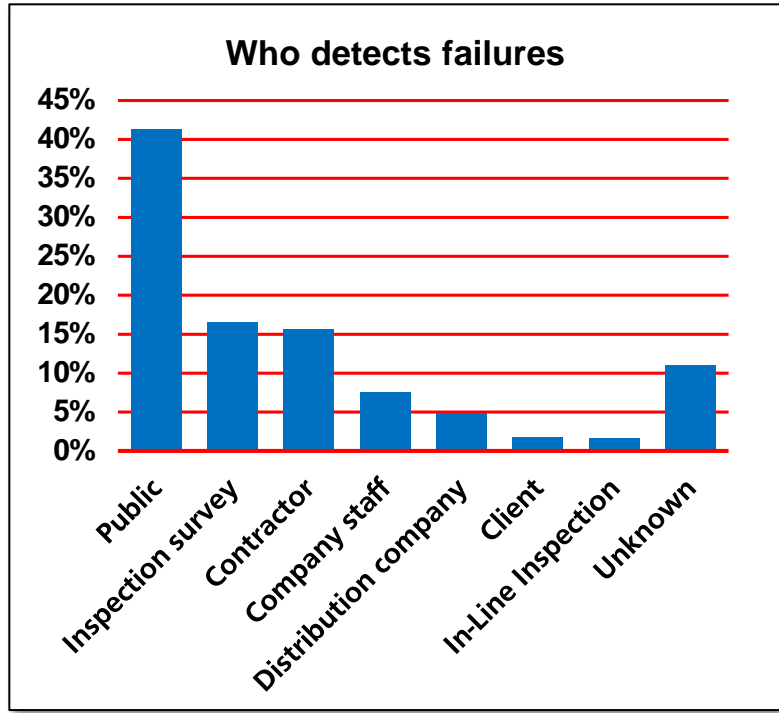
Source: - European Gas pipeline Incident data Group (EGIG)
 - Pipeline and Hazardous Materials Safety Administration (USA DoT)

(www.egig.eu)
 (primis.phmsa.dot.gov)

Failures in high pressure gas transmission pipelines (2 of 2)

- Failure frequency (per 1.000 km x year):
 - Europe : 0,164 (EGIG, 2010)
 - Canada : 0,170 (CEPA, 2011)
 - USA : 0,522 (PHMSA, 2011)

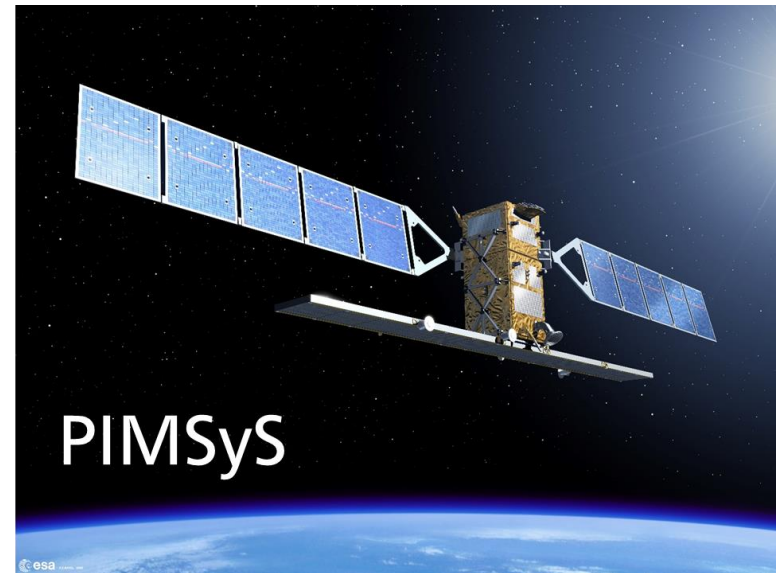
- Pipeline failures (average) per year:
 - Europe : 23 failures (140.117 km)
 - Canada: 12 failures (72.000 km)
 - USA : 287 failures (550.000 km)



Source: European Gas pipeline Incident data Group (EGIG) (www.egig.eu)

Objectives of PIMSyS

- Detection of TPIs, using satellites
- Support workflows to manage “Third Parties”-events



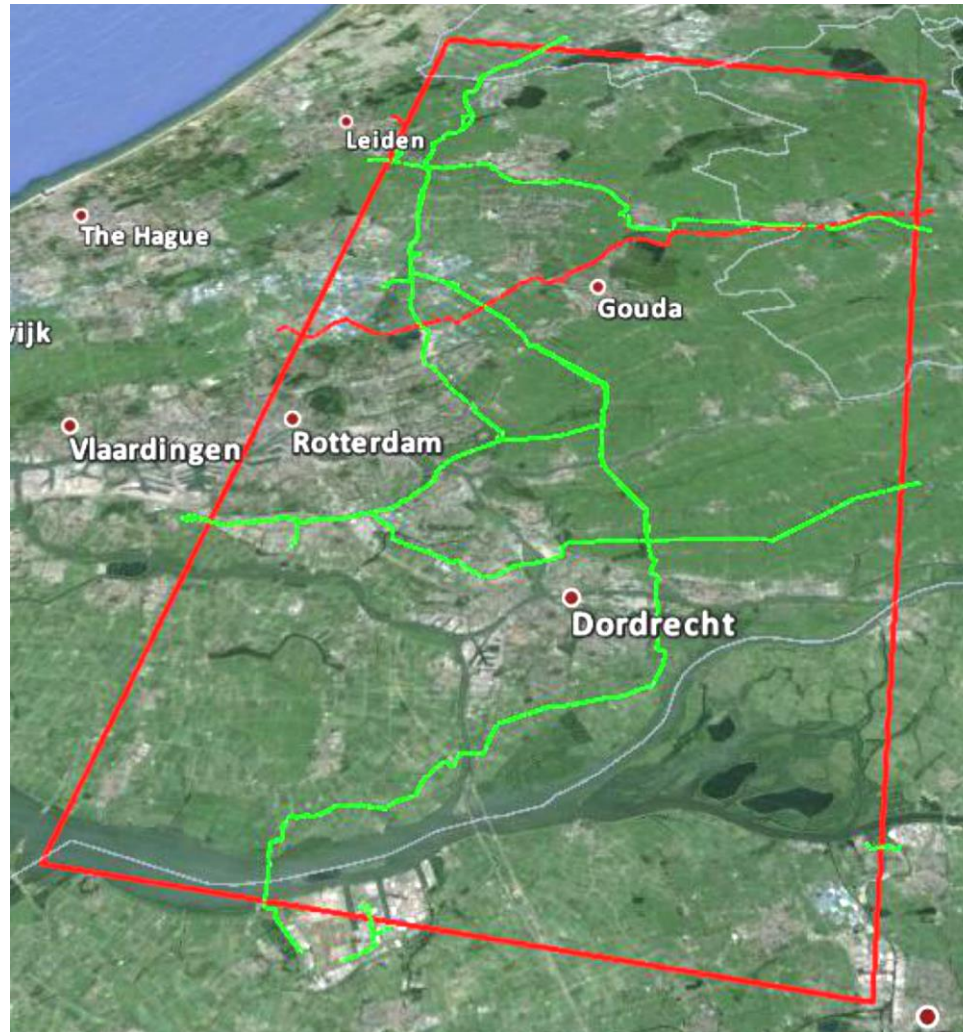
Earth Observation / Synthetic Aperture Radar Satellites (EO/SAR)



PIMSyS

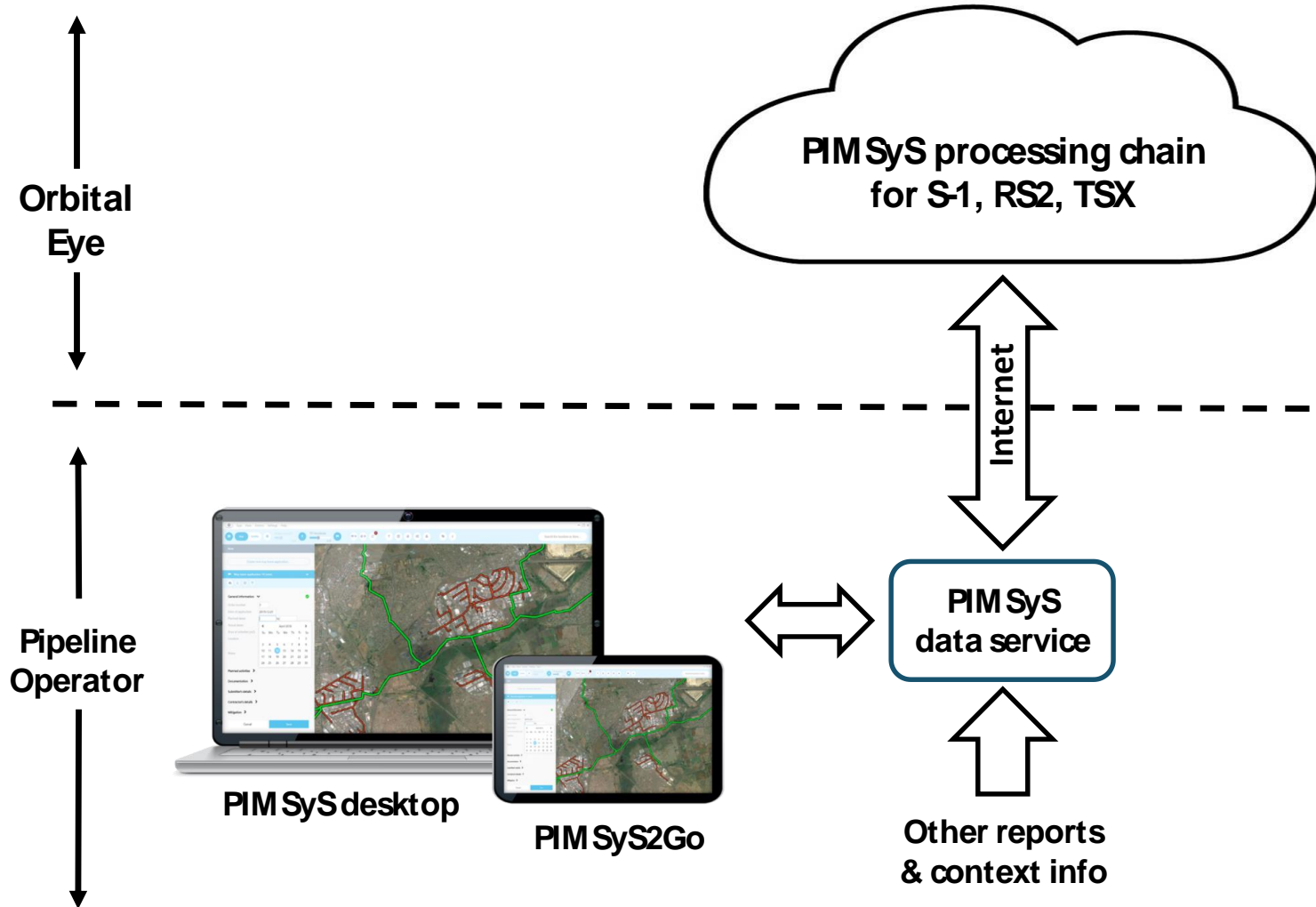
Principle of Operation

How PIMSyS detects TPIs



Deployment of PIMSyS service

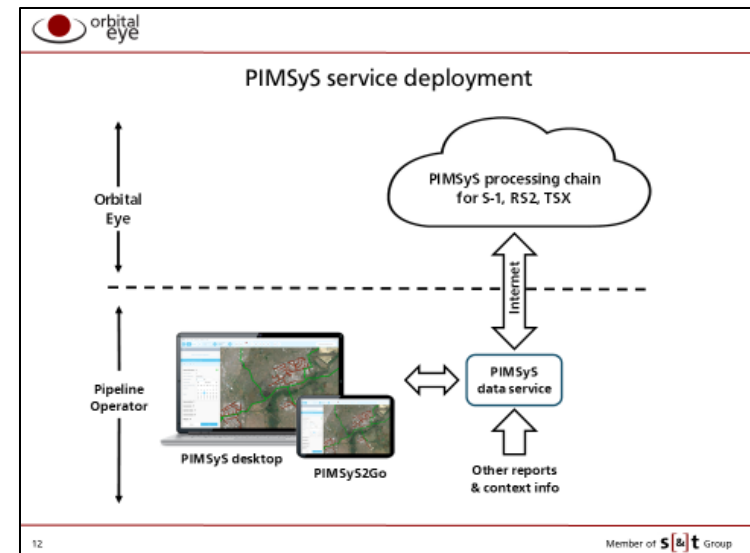
PIMSyS service deployment



PIMSyS – Processing chain

- Fully automatic processing chain for complex data (level 1 SLC):
 - Downloading images from the data repository of satellite operator
 - Processing, analyses and generation of TPI notifications
 - Uploading of TPI notifications to PIMSyS data service

- Our processing chain can process:
 - Sentinel-1 => IWS
 - TerraSAR-X => StripMap
 - RadarSAT-2 => XF



PIMSyS data service & PIMSyS apps

■ Context information:

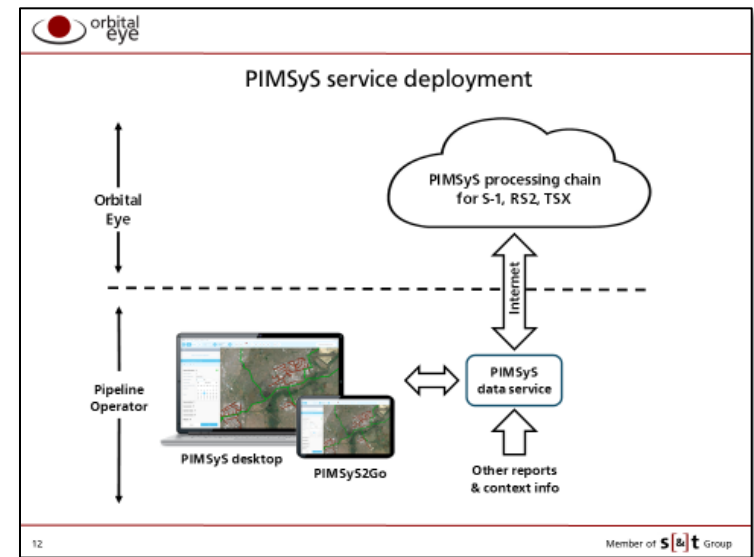
- Geographic map
- Pipelines, valves & stations
- CP-objects
- Landowners (n v)
- Town localities (n v)
- Helicopter-reports

■ Business processes:

- Tasks allocation to field engineers (n v)
- Sign-off procedure of reports (n v)
- Planned 3rd party activities

■ Information for business processes:

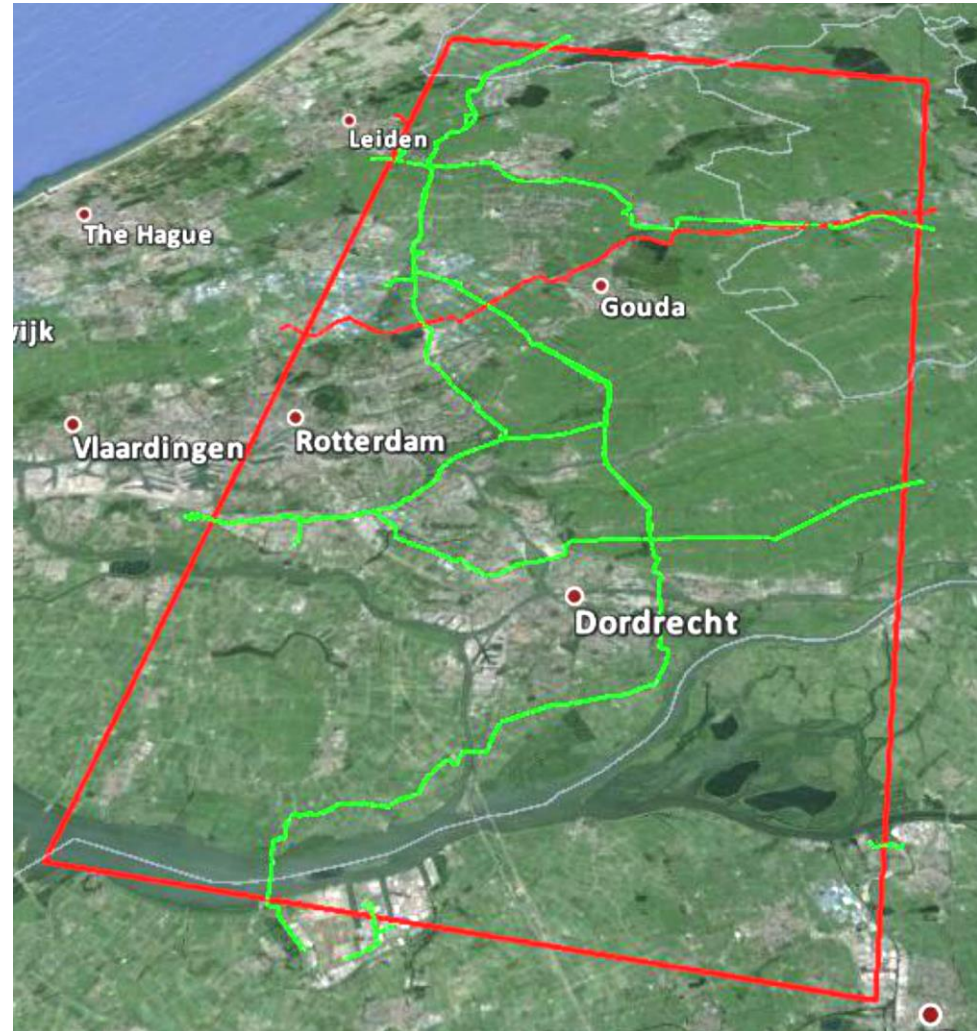
- TPI-reports
- Vehicle Investigation-reports (n v)
- Planned 3rd party activities-reports

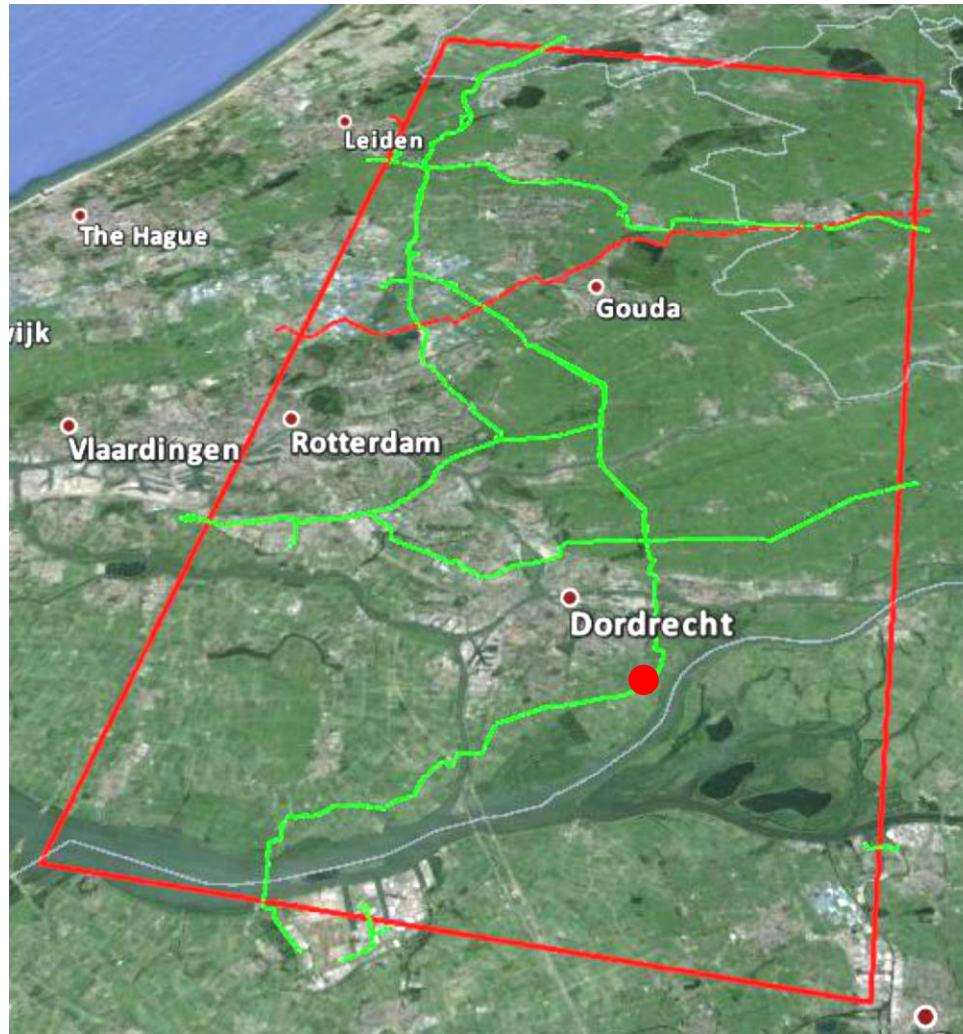


PIMSyS validation project

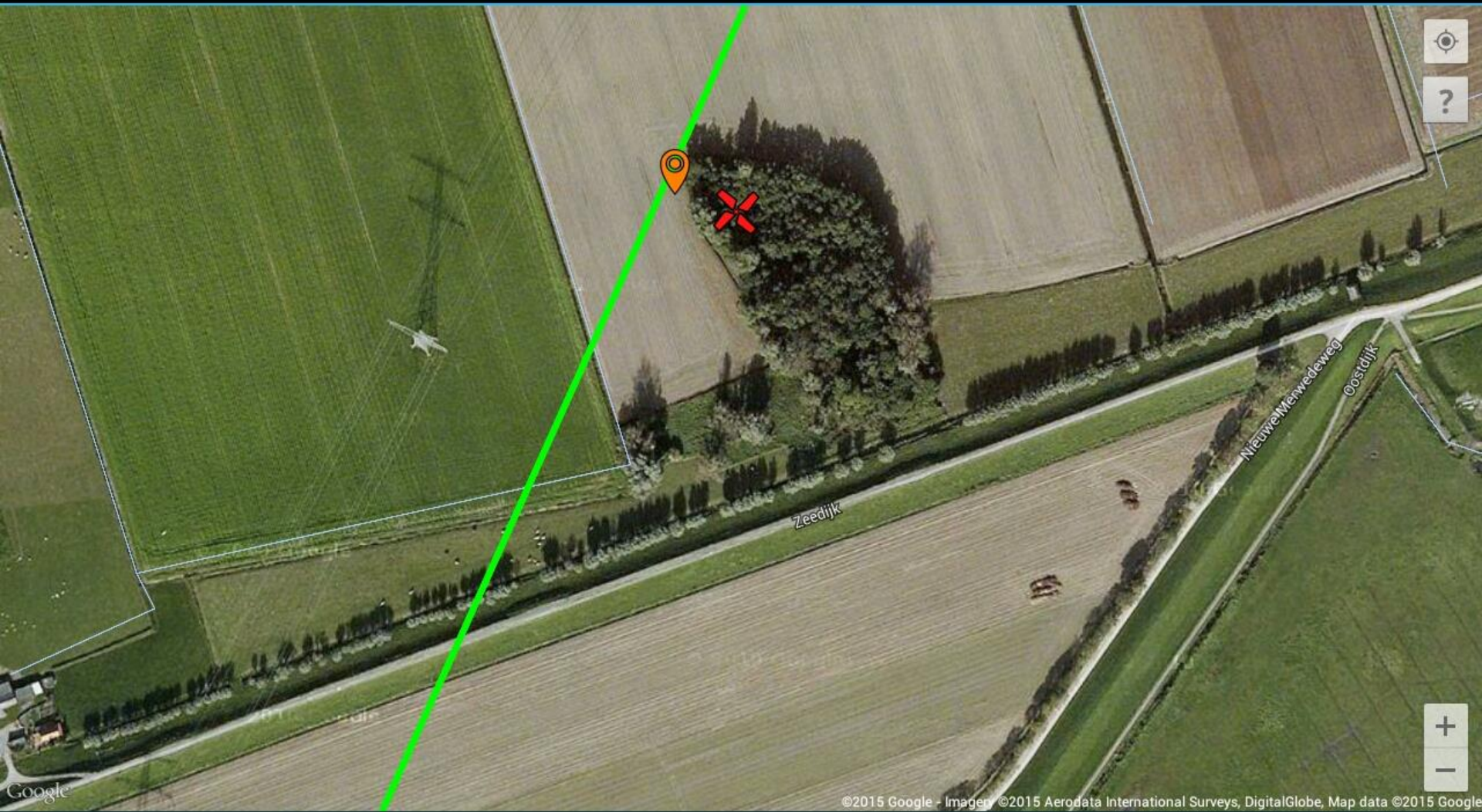
Validation project

- Test area: 30 x 50 km
- Pipeline route : ca. 238 km
Pipeline length : ca. 365 km
- Period: 8 month (17-05-14 – 14-01-15)
- 6 time steps with intervals 22, 33, 55, 66 days
- Context info:
 - Pipelines routes
 - Helicopter reports
 - KLIC messages





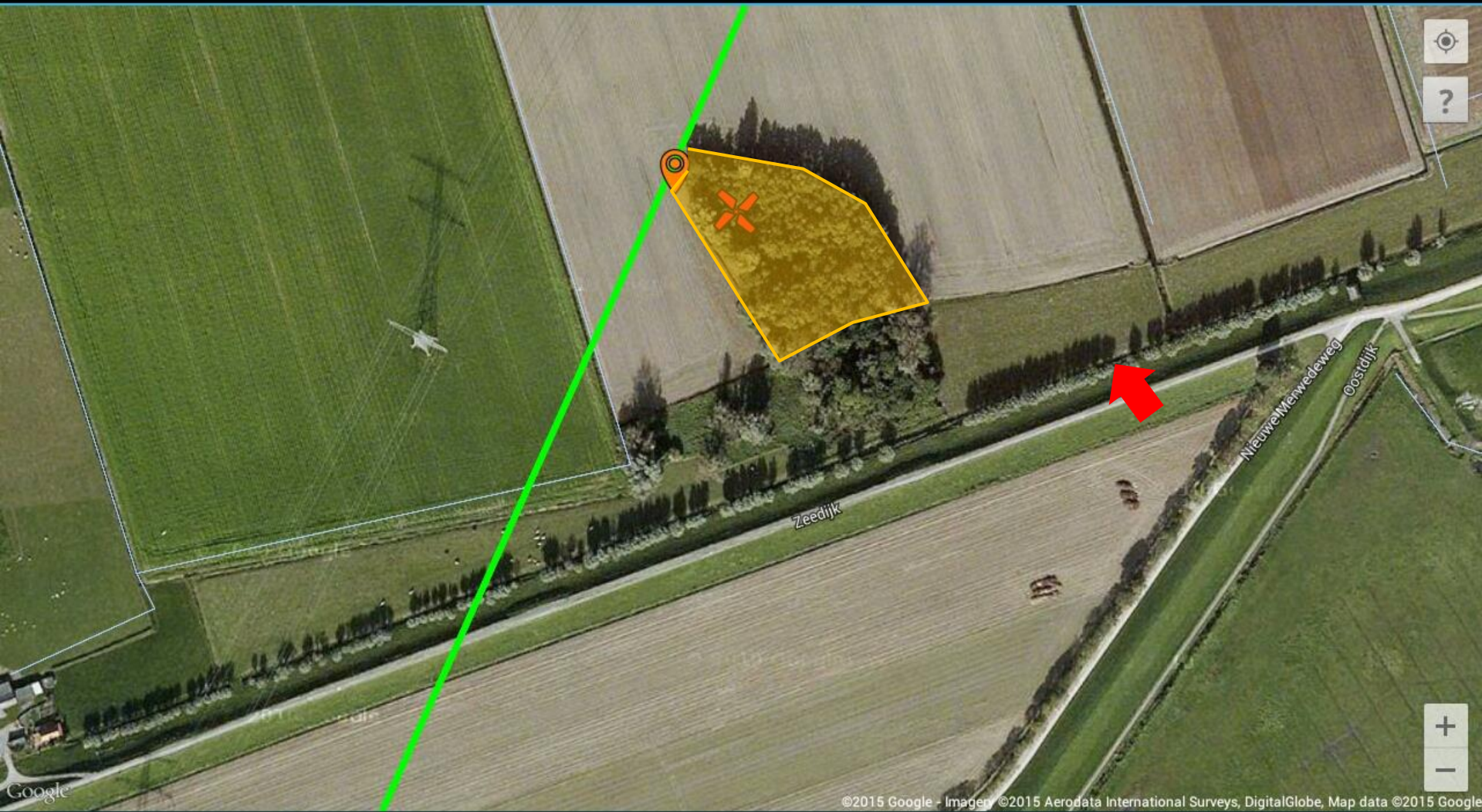
Example 1: Cutting the trees





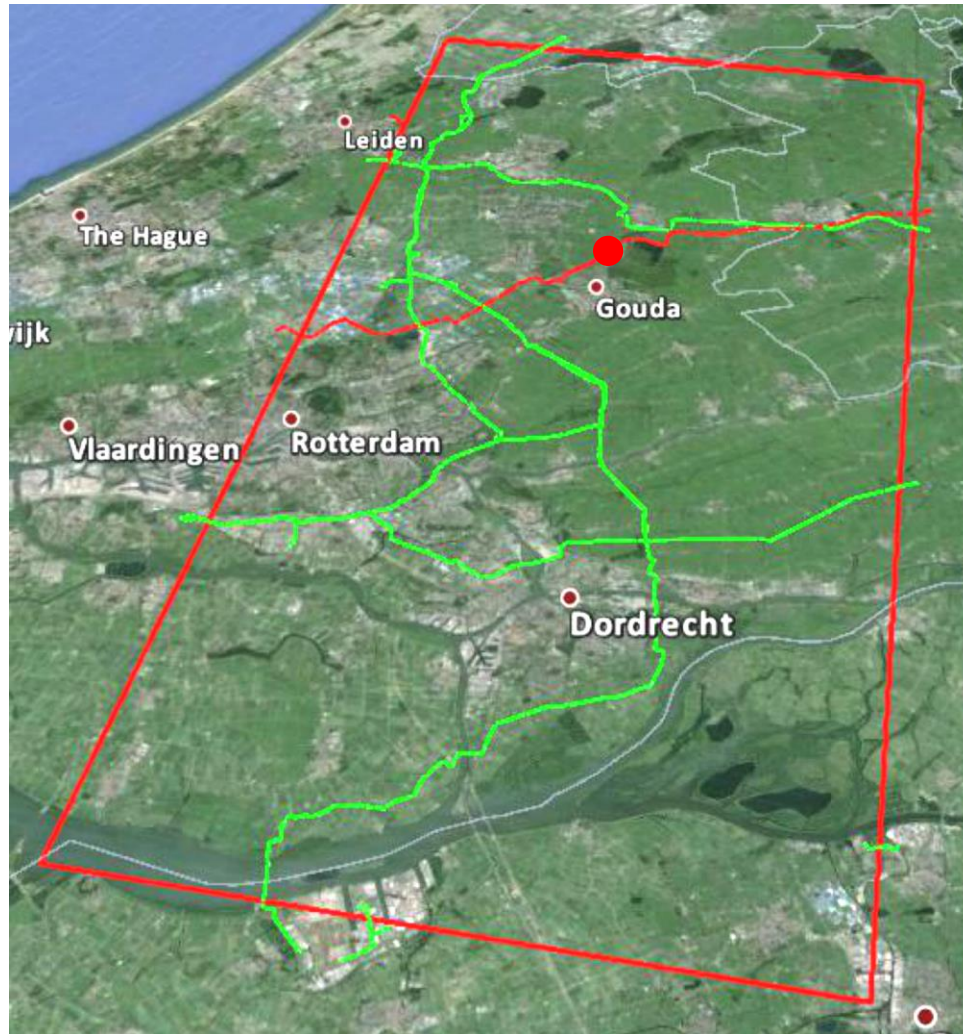


Ground truth photo taken at location indicated by the red arrow

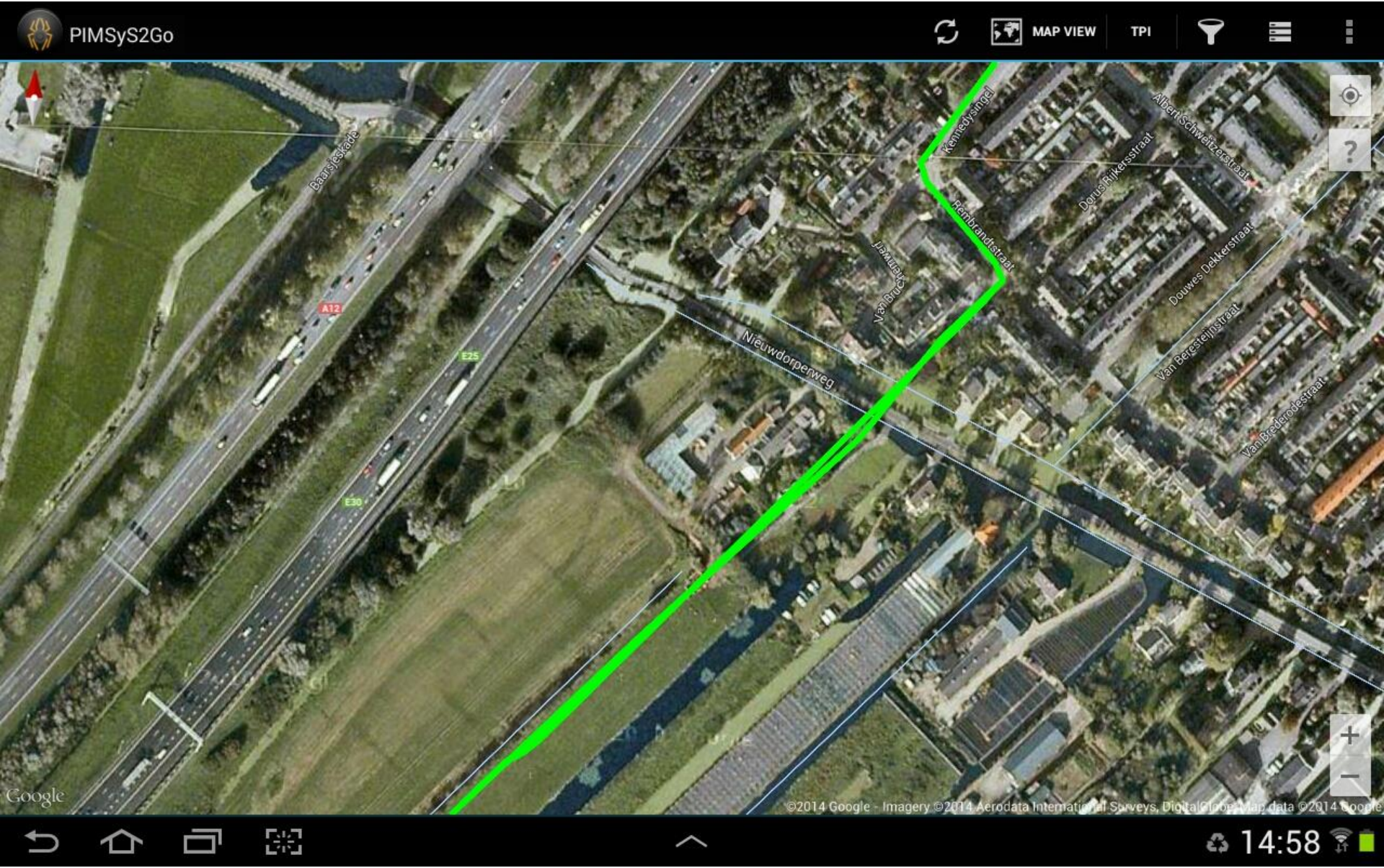


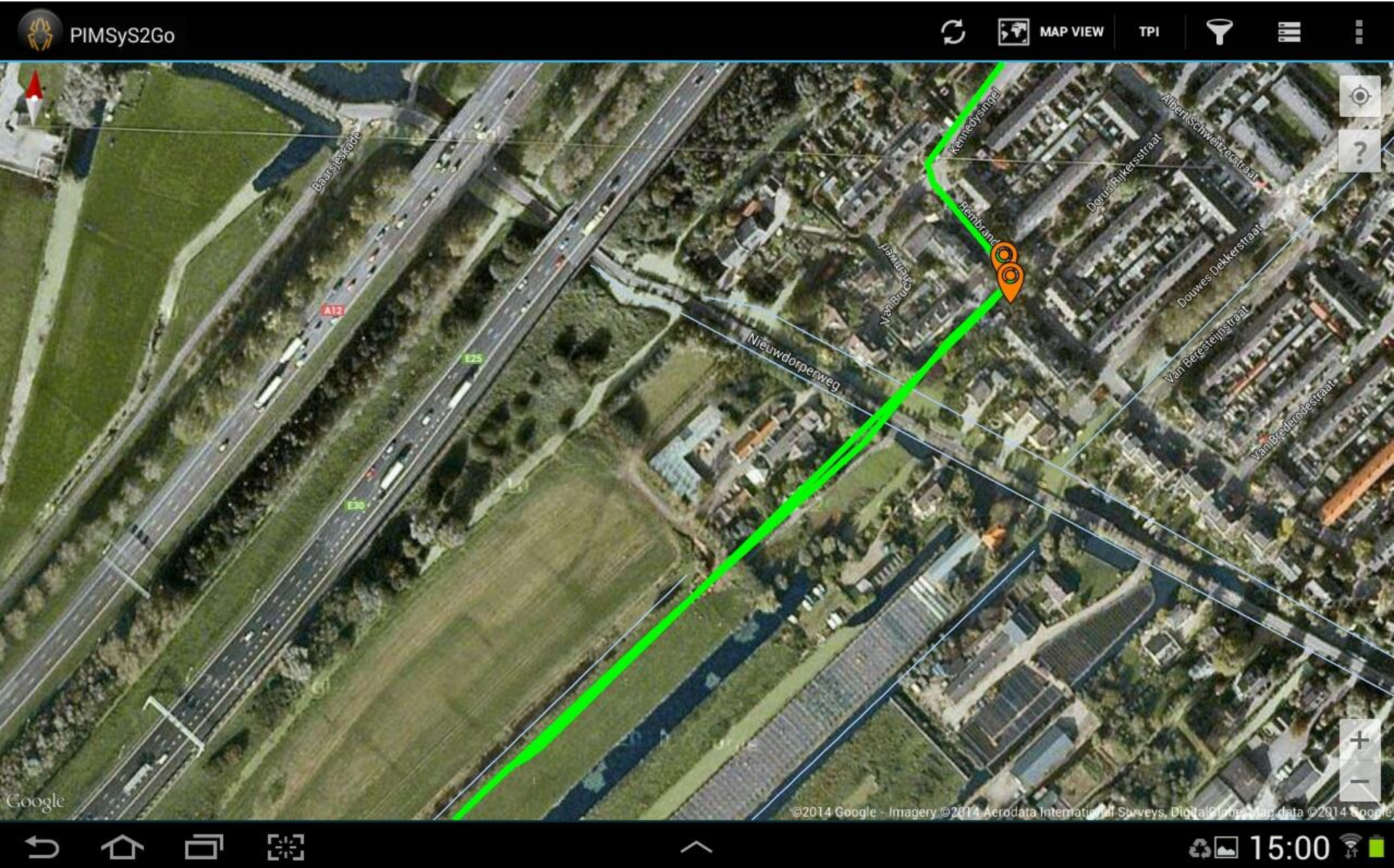
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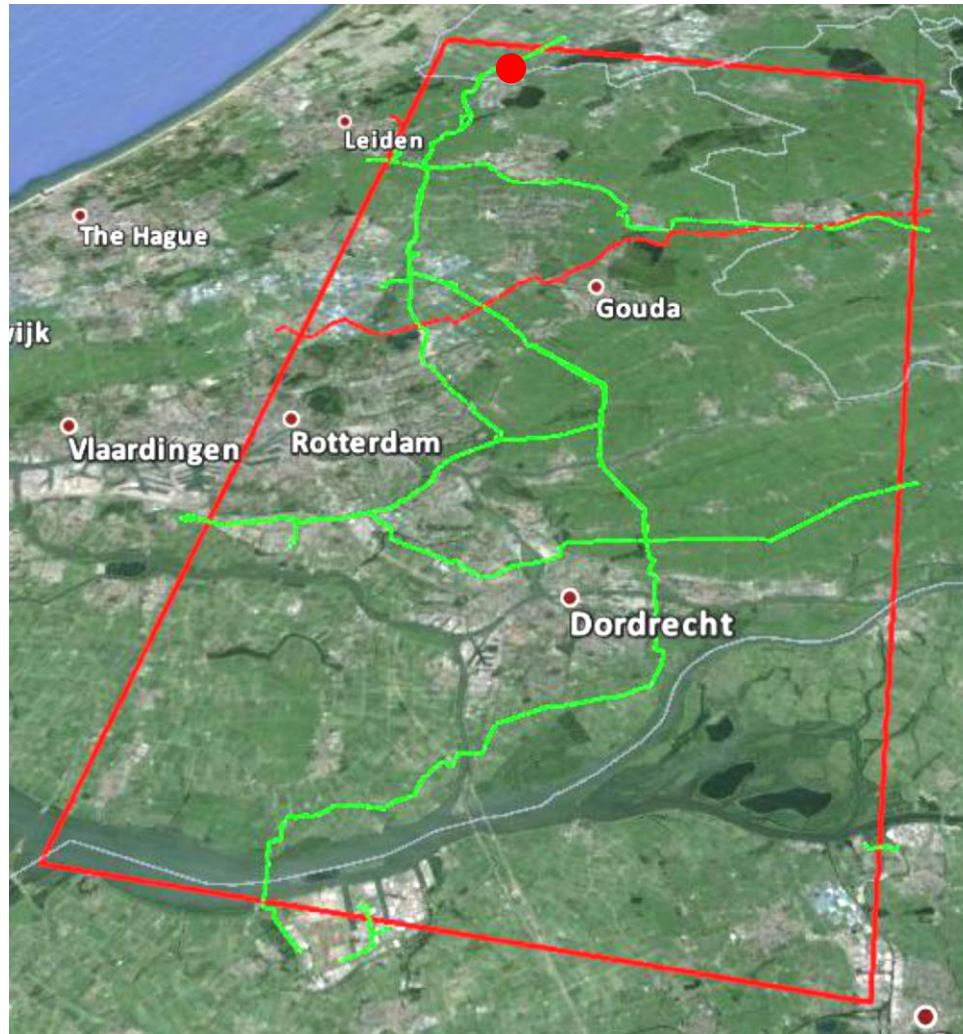
Example 2: Drilling a pipe



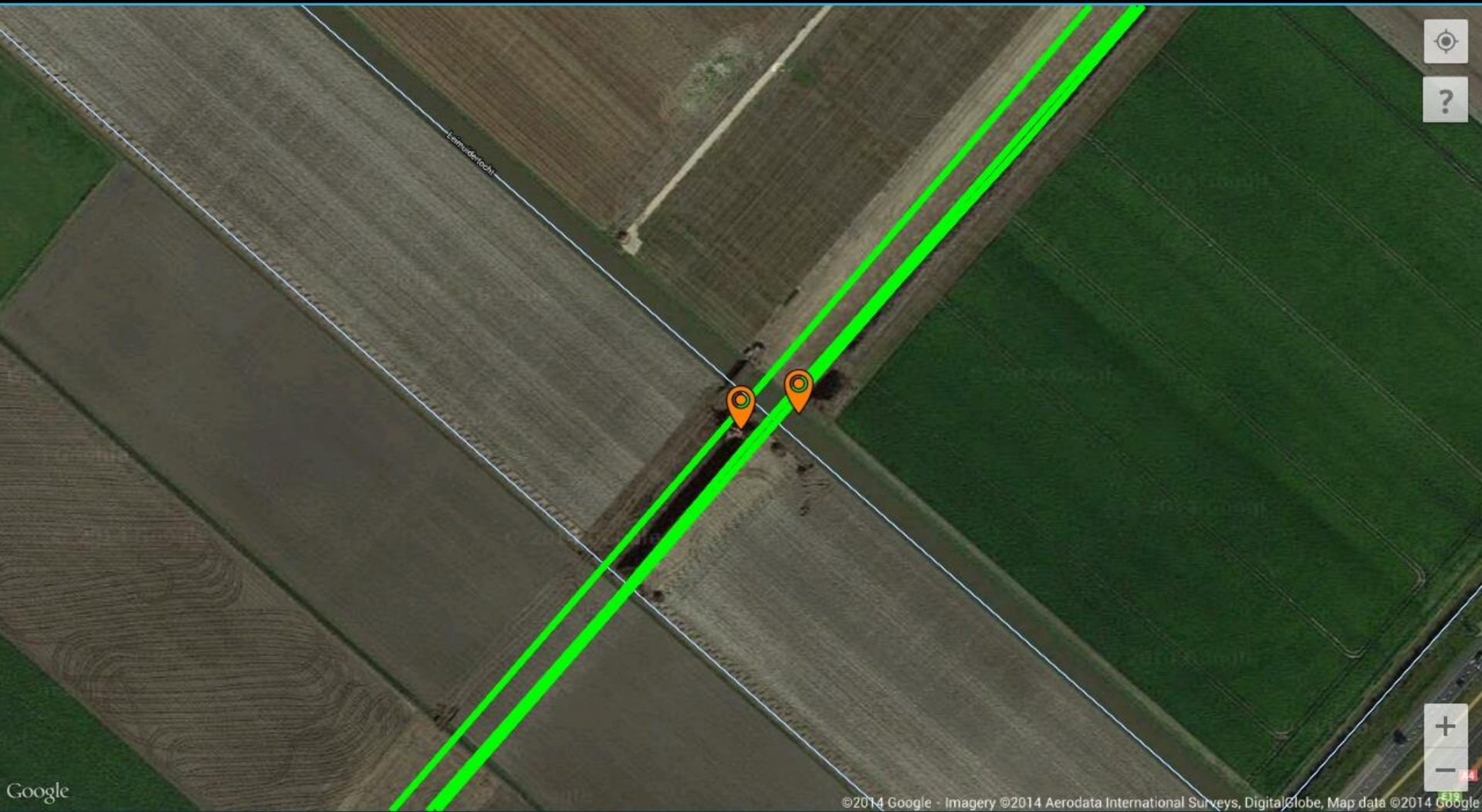




Ground truth photo taken on 15-09-14 at location of TPI



Example 3: Temporary dams for pipe laying



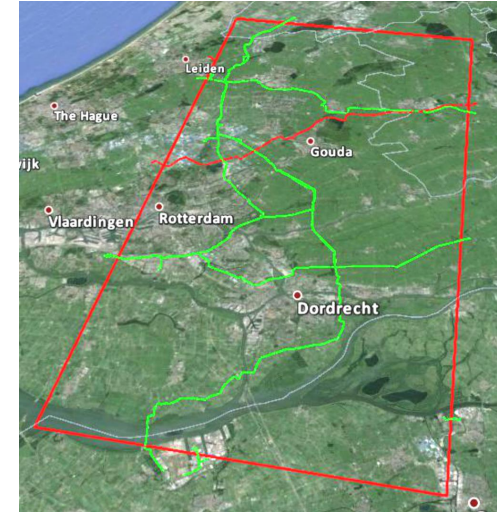


Validation project - Results

- Period: 8 months
- Events have been reported for 152 unique locations:
 - Helicopter reports : 80 locations (52.6%)
 - PIMSyS : 134 locations (88.2%)

PIMSyS results are biased due to pipe laying activities during demonstration project
- Correlation with planned third party activities (KLIC):
 - Helicopter reports : 11 locations (7.2%)
 - PIMSyS : 36 locations (23.7%)

So PIMSyS has a 3x better correlation with known third party activities than surveys by helicopter



New developments and product summary

PIMSyS – New developments

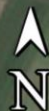
- **Market:**
 - Commercial contract for monitoring 3,000 km pipeline with S-1
 - Expect growth to monitoring 15,000 km pipeline in very near future
- **R&D:**
 - Automatic classification for agriculture and loading & parking areas
 - Validation of more radar satellites
- **Software platform:**
 - Add more context information
 - Extend business processes to support field engineers and the back-office



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Google earth

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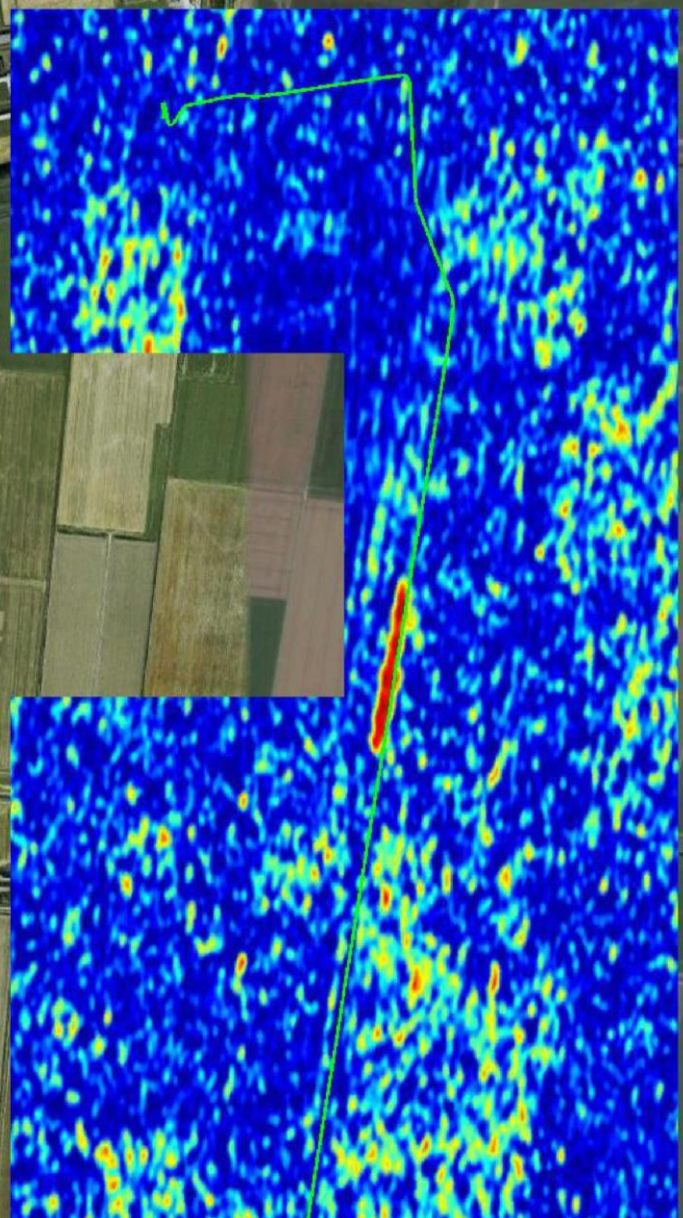


1 km



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PIMSyS, with false alarms resulting from agricultural activities



Google earth

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1 km

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PIMSyS, with new algorithm to reduce false alarms resulting from agricultural activities



Google earth

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1 km