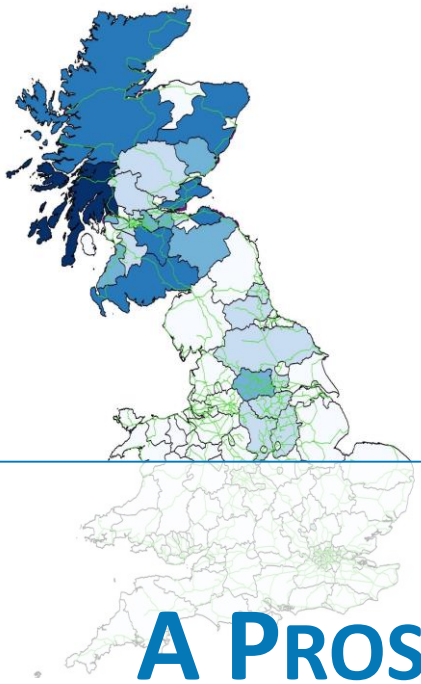
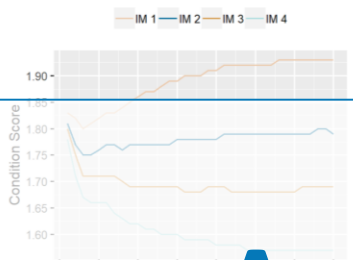
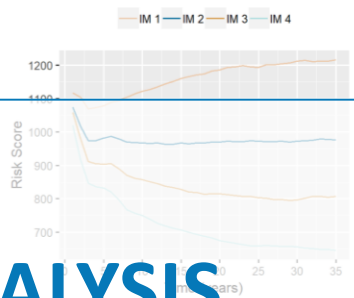
Intelligent Innovative Smart Maintenance of Assets by integRated Technologies

IN2SMART

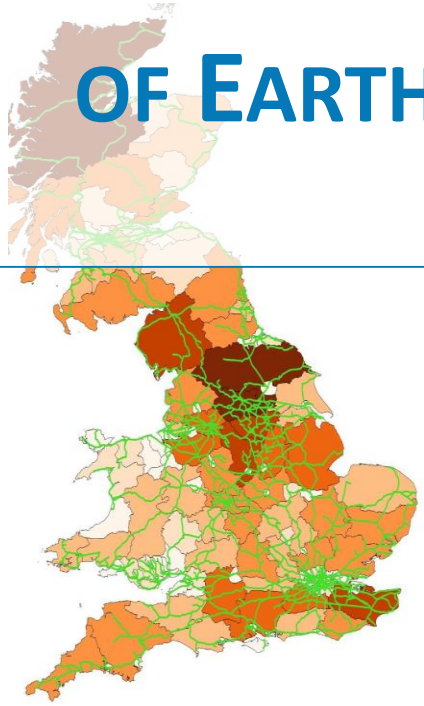
Final Event, Napoli, 10th October 2019







A Prospective Analysis of Earthworks in the UK



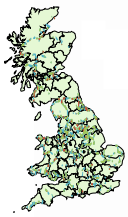
This project has received funding from the Shift2Rail Joint Undertaking under the European Union's Horizon 2020 Research and Innovation Programme (Grant Agreement No. 730569)

Overview

The overall objective of this study is to improve different aspects of the earthworks (EWs) maintenance process in the UK by applying carefully selected data mining techniques and to use the information extracted from them to build an Intelligent Asset Management System (IAMS) at the strategic level. The different areas covered in this work are presented below.

Influence of examination period in EW's surveying process.

How does rainfall affect EW degradation?



EWs Condition Database (065)

Process Mining

Predictive Modelling

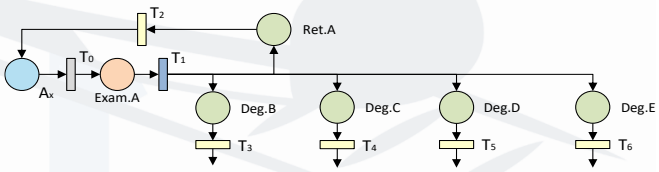
Anomaly Detection

IAMS

EWs Condition Database (065)

TG evolution Database (Wales)

EWs Failures Database



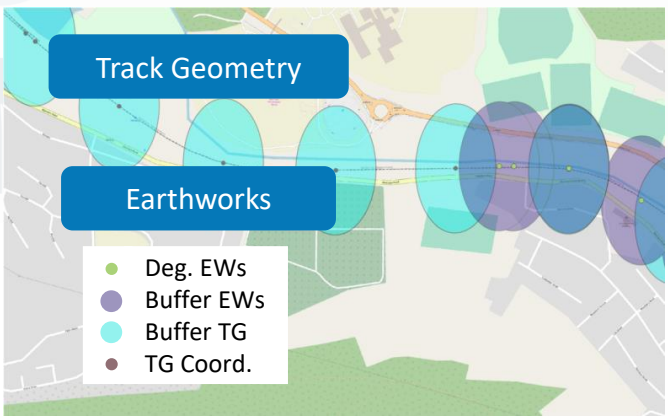
TG condition acting as a precursor of EW failures or rapid degradation.

Optimisation of EW intervention volumes. Budget allocation.

Anomaly Detection

Development of a methodology to find the track geometry conditions which act as precursors of EW failures or degradation.

- Promising results relating the degradations of EW and TG. Definition of recommendations for further work.
- Extension of this study in In2Smart2 with an improved synchronized TG-EW monitoring methodology implemented by NR.



Spatial Match → Temporal Match

Process Mining

Objective:

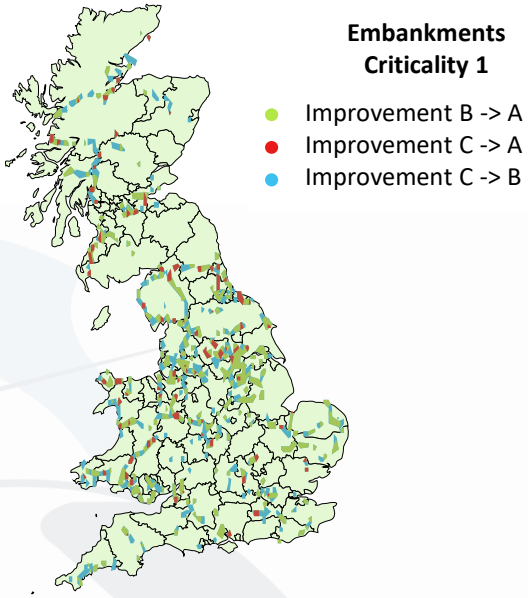
The aim of this study is to determine whether the process of EW surveying is biased by the time of the year in which it takes place.

Markov chains used to analyse survey data:

- Examination period: 80% of surveys.
- No examination period: 20% of surveys.

Conclusions:

- ✓ The influence of inspection time has been confirmed.
- ✓ Consecutive measurements should be taken in the same examination period.
- ✓ The study suggests having two different EW condition weightings depending on the season in which surveys are taken.



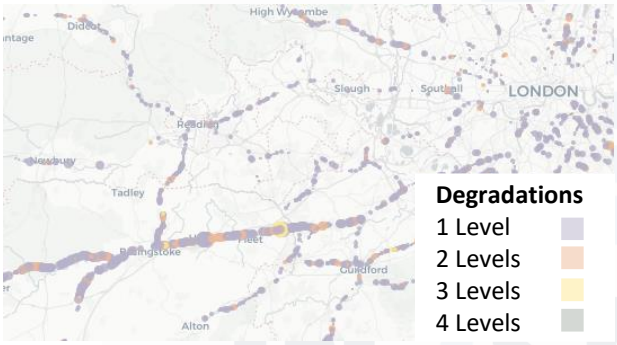
Predictive Modelling

Objective:

Testing the hypothesis that increased rainfall levels during winter and extreme desiccation during summer - due to climate change - will translate in the future in a faster degradation of EWs in wetter and drier areas of the UK.

Variables

- ✓ Rainfall
- ✓ Soil composition
- ✓ Soil Moisture Index
- ✓ Slope Angle Height Category
- ✓ Earthwork type
- ✓ Route



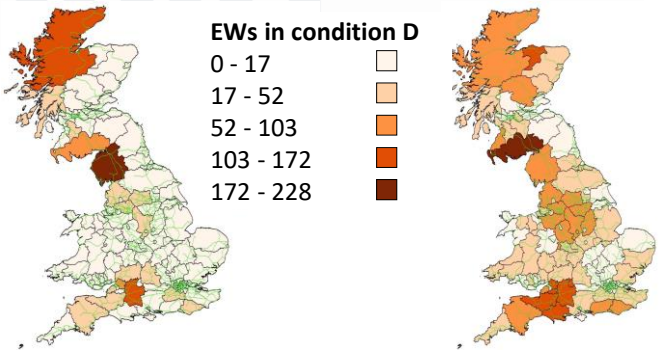
ANOVA

- ✓ The effect of rainfall in earthworks degradation was confirmed.
- ✓ Results support previous studies performed by NR in this regard.

Markov Chains

- ✓ Development of a predictive model to compute the probabilities of earthworks maintaining their condition state, suffering condition degradation and undergoing condition improvement.
- ✓ A heatmap of the UK by counties, routes, lines, areas, etc. can be constructed using this model, as shown in the figure.

1 Year Prediction

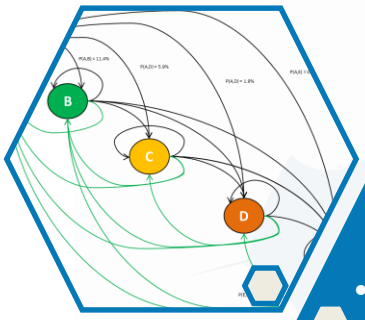


Earthwork Asset Management using Petri Net Models

Objective:

Development of a strategic IAMS model based on Petri Nets to investigate optimal intervention schemes so as to offset the effect of earthworks degradation under budget and resource constraints.

The aim is to improve the capabilities of SCAnNeR, NR's strategic model for EWs.

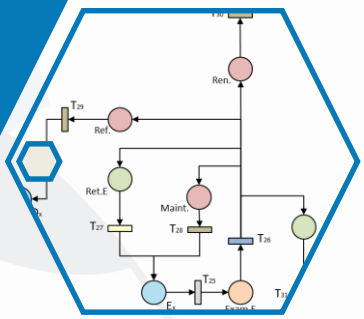


SCAnNeR

- NR's strategic DST for earthworks.
- Life cycle cost optimisation.

PN Model

- ✓Granularity.
- ✓Asset tracking.
- ✓Further complexity layers.

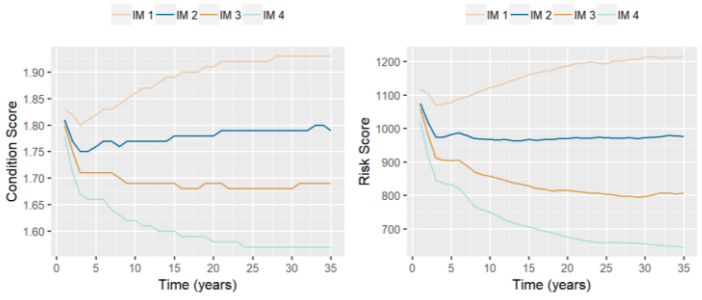


Achievements:

- ✓ Model based on strategic KPIs (right hand side image):
  - Intervention volumes.
  - Costs.
  - Health of the infrastructure.
- ✓ Full validation of the model.
- ✓ Successful analysis of a full cohort of earthworks in the UK.
- ✓ Improved capabilities:
  - Asset tracking.
  - Improved granularity.
  - Higher versatility related to factors such as examinations, restrictions or degradation paths.

Specify the amount of assets to be intervened:

Health of the infrastructure (Risk & Condition Scores).



This demonstration has been prepared by:

cemosa

NetworkRail