A sea of potential solutions

STATISTICAL MODEL TO PREDICT THE RISK OF CLOGGING OF WATER INTAKE BY MARINE SPECIES
EDF Energy / University of Oxford

The need

Across the past few decades in North Western Europe, in particular along the Atlantic and the North Sea coast, massive occurrences of jellyfish and seaweed have been observed. These marine species can block power plant cooling systems, reducing their performance, or even stopping them from pumping sea water all together.

Some of these events have led to the halt of electricity production for up to a week, with costly consequences, for example, at Torness Nuclear Power Station, Scotland, where reactors had to be shut down in 2006 and again in 2011.

These clogging incidents appear difficult to predict, mainly due the historical scarcity of such events, which makes it very difficult to pinpoint the driving factors behind them.

What we have achieved

This project was a collaboration between EDF Energy and the University of Oxford. Their challenge was to create an Early Warning System (EWS) for clogging and ingress events at Torness.

Its goal was to build a basis for a model that would be simple to use and that would lay the foundations for an effective tool to be developed.

The project succeeded in gathering and reconstructing the necessary data for the primary analysis. This enabled the team to identify the marine and weather factors that drive the excessive presence of marine debris in seawater, eventually causing ingresses.

The main progress of this project has been achieved comparing potential models and exploring the use of machine learning versus linear regression models.

Both types have beaten the benchmark and the current Torness EWS. These allowed the team to return more accurate predictions of clogging events at the Torness Nuclear Power Plant.

“A better forecasting of potentially clogging events could represent a tremendous support for operators.”

Arnaud Lenes, EDF Energy
How we did it

The project required the construction of a historical archive of all variables that were considered relevant for influencing clogging events. This involved searching literature surveys and discussions with experts. Marine and weather variables, which represented the largest part of the database, were hard to find at the right location and with an adequate sampling period. Furthermore, as the publicly available data is often incomplete, the team reconstructed time series using interpolation and other pre-processing techniques. The second part of the project involved time series analysis and constructing a model in order to improve both our understanding and the performance of the prediction model already in place at Torness. In this aspect the project has been successful as relevant explanatory variables have been identified and the performance level was increased.

One objective was to move beyond traditional modelling techniques, stepping away from the usual linear regression. The team focussed on machine learning in order to compare their efficiency to that of a number of relevant benchmarks.

• The Classification And Regression Trees (CART) modelling has proven to be most effective and produced a decision-support tool that is easy to understand and implement.
• The K-Nearest-Neighbours search tree was also competitive for a large number of values of K using the right distance metric (the mahalanobis distance often proved to be best).
• A two-step threshold model using either a linear regression as a second step or one of the techniques mentioned above also proved more effective than the model currently in place at Torness Nuclear Power Plant.

Meet the team

From left to right
Alexis van Lennep, Dr Patrick McSharry, University of Oxford
Arnaud Lenes, Pietro Bernardara, EDF Energy

“This Patrick and I really enjoyed working on this project. We believe that we have shed some light on the complex structure of the problem the nuclear power plant of Torness is facing.”

Alexis van Lennep, University of Oxford

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Project Details

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