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Water Quality Models and Prioritisation

Using data to inform modelling programmes

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CONTENTS

1. ABSTRACT

Intertek Energy and Water conducted a comprehensive high-level assessment, as requested by Severn Trent Water (STW), on 116 river reaches comprising 321 assets situated in waterbodies across central England and Wales. The objective was to compile large amounts of data to identify the complex river reaches to be taken forward for further investigation and evaluate the corresponding modelling requirements throughout the AMP8 programme. River reaches were categorised into a Boston Matrix plot based on pre-agreed environmental data confidence and reach complexity scores. Scores were compiled based on water company asset data, environmental monitoring data, including river flow data and Environment Agency water quality data, and river reach complexity. An extensive duration of data was assessed within this scoping study including water quality data covering 23 years and river flow data over 100 years. Of the initial 116 river reaches 85 were identified as low complexity with high confidence environmental data and as such likely required the simplest level of modelling (level one or two). On the contrary, a total of 16 reaches were identified as high complexity and represent the priority reaches to be taken forward for further investigation in line with the AMP8 programme. The method used relatively simple, although large, datasets and presents opportunities for the integration of more extensive data sets as well as its coupling with artificial intelligence to amplify its value. However, it is highlighted that the method serves as a testament to the effective management and utilisation of large datasets without the inherent need for complex assessment.

2. INTRODUCTION

Severn Trent Water (STW) requested Intertek Energy and Water to undertake a high-level assessment of 116 river reaches containing 321 assets located within waterbodies across central England and Wales to determine which should be taken forward for further investigation in line with the AMP8 programme.

Due to the large number of reaches and wide geographic spread across several waterbodies, STW required a method to identify complex river reaches and identify the level of modelling these reaches may require. This was to allow the further modelling approaches of these reaches to be optimised.

Available data including water company asset data, environmental monitoring data, river flow data and Environment Agency water quality data, and river reach complexity information was compiled to identify at risk assets within complex river reaches.

The method applied during this study was based on a similar exercise undertaken for STW during PR19 where it was used to evaluate assets and the potential risks they pose to water quality and river status in the aim to determine the correct modelling approaches required for the water quality studies during this pricing review. The exercise was required after it was identified that the programme for the AMP modelling studies and needs of the PR19 pricing reviews did not coincide and as such detailed water quality model outputs were not available in time to inform the required modelling approaches. During AMP8 a similar exercise was applied to provide a strategic and targeted approach to highlight specific reaches requiring more complex modelling to demonstrate that they meet the current water quality requirements.

3. IMPACT SCORING METHODOLOGY

3.1 Environmental data confidence

The environmental scoring in this high-level assessment utilised a range of environmental measures comprising catchment and asset data, including network model availability and performance, river flow data and Environment Agency water quality data. The scoring of these measures provided an overall assessment of the availability of, and confidence in, environmental data within the river reaches of focus. The scores for confidence in the environmental data available for the river reaches assessed within this scoping study could range from a minimum of 3 to a maximum of 40, with higher scores indicating more reliable and robust environmental data. Reaches with higher environmental scores contained river flow and water quality monitoring stations at better locations with the analysis of more parameters over longer time frames. As such environmental data had higher confidence, and more robust conclusions regarding river flow and water quality in these reaches could be made.

3.1.1 River flow data availability

While the hydrometric monitoring network in the UK is extensive it does not cover all waterbodies and several of the smaller watercourses included in this assessment were not covered by flow monitoring sites. As such the location of river flow data availability was scored as follows:

- 10 = River flow monitoring sites were located *within* the river reach of focus
- 5 = River flow monitoring sites were located *up or down stream* of the river reach of focus
- 1 = No river flow monitoring sites were located in the vicinity of the river reach of focus

Within this scoping study over 100 years of river flow data was assessed and additional scores were assigned based on the number of years for which flow data was available. These were ranked as follows:

- 10 = *More than 20 years* of river flow data was available
- 5 = *5 to 20 years* of river flow data was available
- 1 = *Less than 5 years* of river flow data was available

3.1.2 Water quality data availability

The assessment of the availability of water quality data during this scoping study was vital as it had significant roles in defining model inputs and identifying reach boundary restrictions. During this study 23 years of Environment Agency WIMS water quality data was assessed with scores determined based on the number of water quality samples available and the analysis of specific determinands. During this study the determinands of focus were biochemical oxygen demand, dissolved oxygen, ammonia and un-ionised ammonia, with scores of 2.5 awarded for the recording of reach of these determinands.

The scoring breakdown of water quality data availability is as follows:

- 10 = *More than 200 samples* of water quality data was available
- 5 = *50 – 200 samples* of water quality data was available
- 1 = *Less than 50 samples* of water quality data was available

Table 3.1 outlines a summary of the scores.

Table 3-1 Environmental data confidence scoring

Classification item	Confidence scoring		
	High	**Moderate**	**Low**
Location of river flow monitoring station	10	5	1
Duration of river flow data availability	10	5	1
Water quality sample availability	10	5	1
Analysis of key determinands	10	5	0

3.2 River reach complexity

During this scoping study river reaches were analysed for the presence of complexities and constraints which may present significant issues during the modelling of these reaches. These included hydraulic features such as weirs, pools, bifurcations and major interactions with canals.

Scores were assigned based on the presence or absence of hydraulic complexities as well as the availability of environmental data, including water quality and river flow data, in relation to these features. In the case that environmental data was available either upstream or downstream of a pool or on one or both channels of a bifurcation, complex features were able to be scoped out based on the ability for safe assumptions regarding river flow and water quality to be made in regard to these section of the reach.

River reach complexity scores were assigned as follows:

- 10 = The presence of significant hydraulic complexities
- 5 = The presence of hydraulic complexities that were able to be scoped out due to the availability of environmental data
- 0 = The absence of hydraulic complexities

4. ASSESSMENT RESULTS

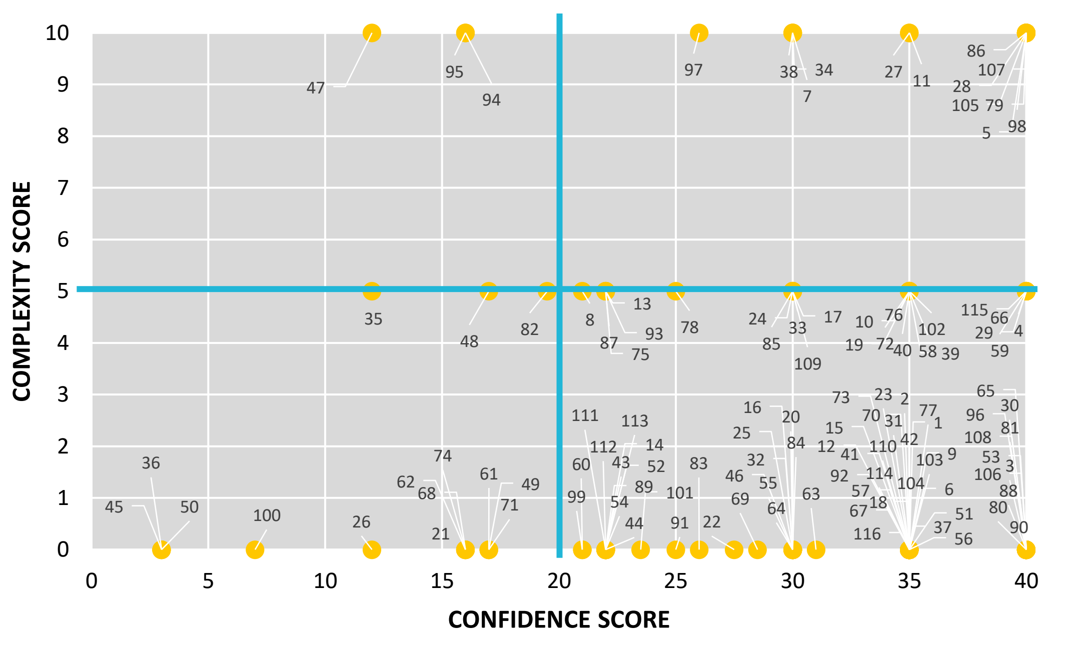
Table 4-1 presents the findings of this scoping study. A majority of the assessed river reaches were identified as low complexity, coupled with a high abundance of robust environmental data. However, notably a total of 16 reaches were discerned as highly complex and as such represented the priority reaches for subsequent investigations in line with the AMP8 programme. Low environmental confidence scores were depicted based on the poor availability of environmental data and limited integrity of this data.

Table 4-1 Scoping study assessment outcomes

Environmental data		Complexity		Risk category	No. reaches	No. assets
Min	Max	Min	Max			
0	20	0	5	Low confidence, Low complexity	15	44
21	40	0	5	High confidence, Low complexity	85	216
0	20	6	10	Low confidence, High complexity	3	16
21	40	6	10	High confidence, High complexity	13	45

The 16 reaches identified as highly complex and thus indicating the priority reaches to be taken forward for further investigation, were categorised into the upper boxes of the Boston Matrix, as presented in Figure 4-1. These sections of the matrix represented high risk assets located within complex rivers.

Figure 4-2 Complexity and data confidence Boston Matrix plot



The utilisation of the Boston Matrix for reach categorisation allowed the identification of the level of modelling for which reaches may require. The upper boxes of the matrix represented reaches likely requiring level 4 modelling attributed to the need for the collection of in-situ environmental data and the inherent complexities within these reaches. Conversely, reaches located in the lower right portion represent those identified as relatively simple and with substantial robust environmental data available. As such these reaches were deemed suitable for inclusion in level 1 or 2 modelling. In the lower left portion of the matrix plot, reaches exhibited simplicity and thus initial expectations were for the suitable inclusion of these reaches in level 1 or 2 modelling. However, owing to the poorly defined data, as identified during the scoping study, modelling of these reaches necessitated level 3 due to the requirement for in-situ surveys to acquire more comprehensive environmental data.

5. SUMMARY AND CONCLUSIONS

This high-level scoping study allowed the crucial categorisation of 116 river reaches into a Boston Matrix plot to identify those as priority to take forward for further investigation in line with the AMP8 programme. This paper presented a high efficiency method designed to extract valuable information in scenarios where model outputs were not available due to misalignments between AMP modelling studies and the needs of pricing reviews.

Furthermore, this method not only presents the opportunities for the integration of more extensive datasets including widespread EDM, ecological and continuous monitoring data but also provides a foundation for future applications. While the initial study exhibits relatively low granularity results, the integration of more extensive dataset and the consideration of additional complexity variables are expected to yield more widespread outputs, enhancing the overall value of the proposed method.

With the increasing availability of data, the management of large complex datasets is only going to become more challenging, and with the enactment of the Environment Act mandating the continuous monitoring of receiving water, there will be a continuous influx of sonde water quality data. Furthermore, with a 10-spills solution at all CSOs being required under this Act, a user-friendly method to handling the ever increasing density of data and an approach to clearly identify priority river reaches of focus for modelling and performance management has never been more vitally important.

While the outlined method does serve as a testament to the simple effective management and utilisation of large datasets, it is recognised that a coupled approach with Artificial Intelligence for predicting spills or network operations could potentially amplify the value of the method outlined within this paper.