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Review of Monitoring Methods for Dam Reservoir Safety

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The average age of UK reservoir impounding dam has now exceeded 100 years. At the same time the number of safety incidents occurring at dam and dike sites each year is on the rise, with more incidents to be going unreported. The current dam crisis is fuelled not only by the ageing water infrastructure but also by the added pressure being exerted on flood safety assets due to an increase in the (ir)regularity of flooding conditions and extreme weather events due to the changing climate.

As a result, there is a demand for more thorough and advanced safety monitoring of dams and other flood risk management assets. However, the vast majority of dam inspections in the UK is based on visual and empirical methods. This form of assessment is reactive and may not identify an issue that is driven by internal processes until they are in progression. More detailed studies are then employed in the form of geotechnical investigation, which require intrusive and costly operations.

One answer to this often posited is the use of latest technologies for non-invasive monitoring of sub-surface conditions. However, the fact that many geophysical survey methods are advanced and long established as a cost-effective alternative to traditional investigation techniques begs the question - Why have these practices not yet been adopted on a significant scale?

This study reviewed principle geophysical methods in existence that have potential for use in reservoir and flood safety assessment. Assets types were initially characterised as permanently impounded structures (i.e. steady state seepage conditions) and flood defence dikes/levees/ storage (i.e. transient seepage conditions) with sub-categories for location (urban/rural/coastal). A review of non-invasive monitoring methods was carried out, identifying their respective strengths and weaknesses with a focus on resolution, cost, ease of use/deployment and interpretation. Each method was examined in terms of its application and suitability across a range of needs by first categorising potential sites by dimension, composition and environment, as well as the failure modes and requirements of the stakeholder. The summarised collation of this examination is in the form of a set of two matrices of analysis, which can be utilized as a quick-reference comparison of the non-invasive methods, for selecting the most appropriate method for an investigation in a digestible and concise manner.

Discussion is also provided with an outline of a possible methodology for the most widely applicable investigation and examples about the field employment of non-invasive methods. This is followed by recommendations and best practises to better integrate these strongly scientific practices with large-scale engineering implementation.