Case Study TISGraph

Quick Overview of Solution

- Scope: Advanced monitoring and predictive analysis through data
- Implemented: In multiple Austrian critical infrastructures
- Backoffice: TISGraph
- Quantities: Forwarding of data from hundreds of sensors
- Client: Multiple energy & infrastructure companies

Integrated Critical Infrastructure Monitoring and Simulation System (TIS)

Objective

TISGraph is designed to enable advanced monitoring and predictive analysis of critical infrastructure behaviour. By combining real-time structural measurements with statistical modelling and hydraulic simulations, the system enhances safety, operational efficiency, and long-term asset management of large critical infrastructures.

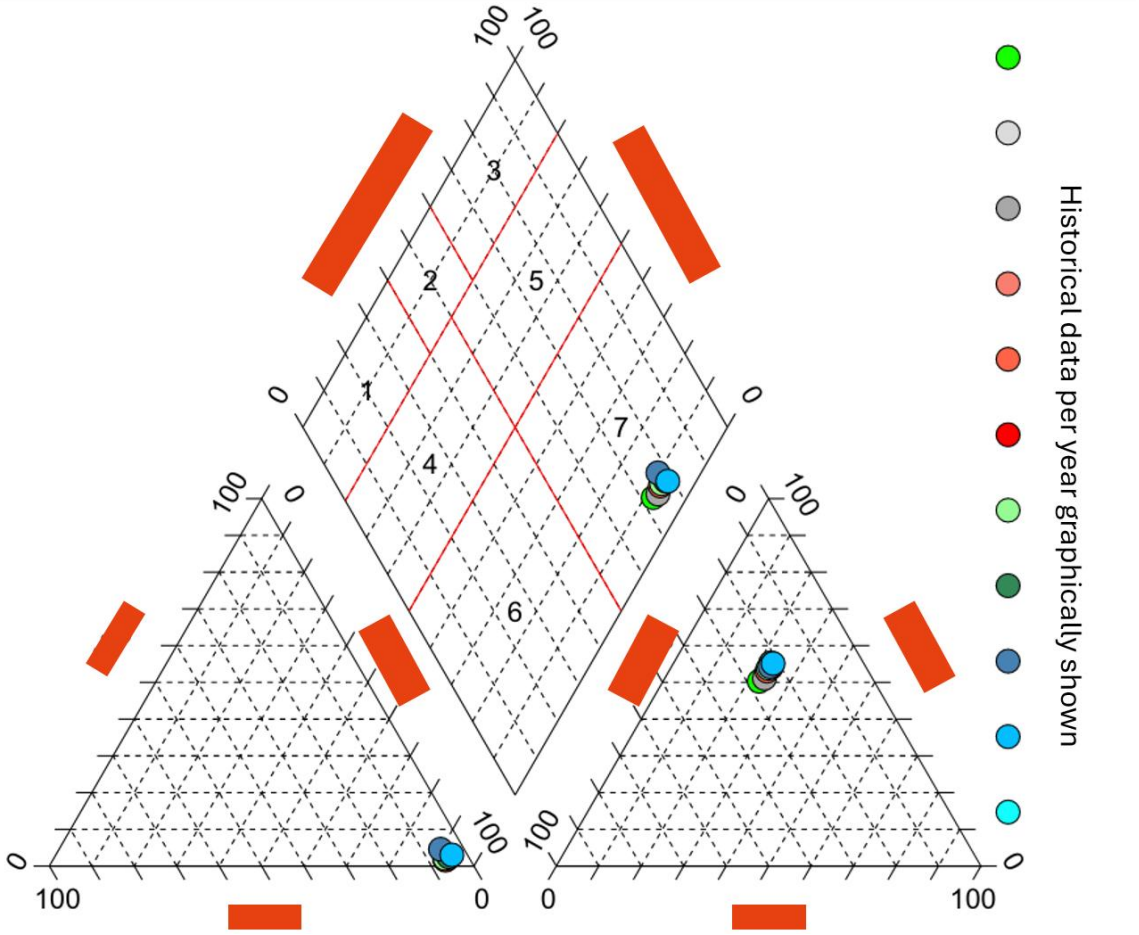

Figure 1: Example piper diagram / © EFKON

Structural Monitoring and Deformation Prediction

TIS utilizes a continuous stream of data from sensors embedded within critical infrastructures. These sensors capture key parameters such as displacement, temperature, and pressure, providing a real-time view of the infrastructure's physical behaviour.

This live data is combined with:

- Historical measurement datasets
- Statistical models derived from long-term observations

Based on these inputs, the system predicts structural deformation under varying conditions, primarily influenced by:

- External temperature changes
- Water storage levels and hydrostatic pressure

As part of this project, new deformation models for large critical infrastructures were developed. These models improve the accuracy and reliability of predictions, allowing operators to:

- Detect deviations from expected behaviour early
- Assess structural integrity more effectively
- Support proactive maintenance and safety decisions

Hydraulic Simulation and System Dynamics

In addition to structural monitoring, the system was extended with a 1D Computational Fluid Dynamics (CFD) module. This module is based on an in-house developed FORTRAN program and focuses on simulating hydraulic processes within the critical infrastructure.

Key components modelled include:

- Surge chambers
- Turbines
- Pumps and pump-turbines

A major focus of this simulation is the analysis of water hammer effects, sudden pressure surges caused by rapid changes in water flow (e.g., turbine shutdown or valve closure). These events can generate significant stress on both mechanical components and the critical infrastructure itself.

The integration of CFD capabilities enables:

- Prediction of transient hydraulic loads
- Improved understanding of fluid-structure interactions
- Enhanced design and operational safety

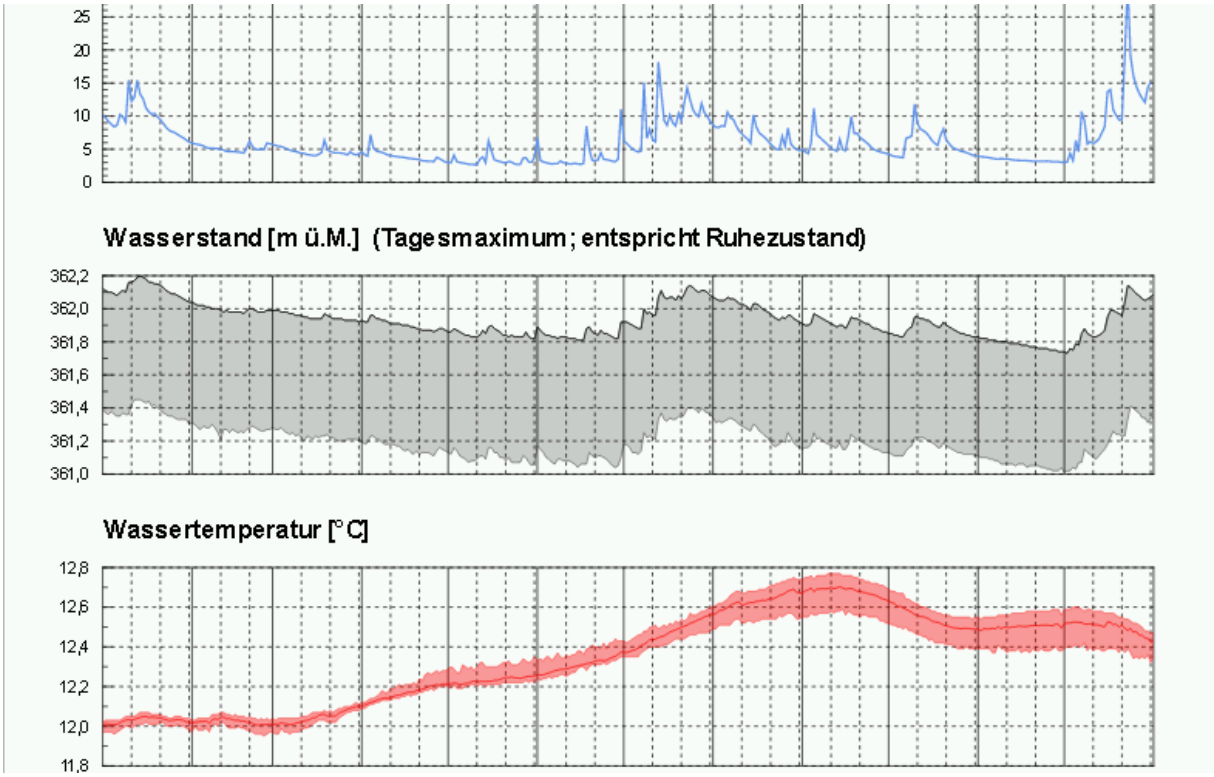

Figure 2: TISGraph application / © EFKON

Integrated System Value

By combining structural monitoring with hydraulic simulation, TIS provides a holistic view of the infrastructure's behaviour, covering both:

- Structural response (deformation, stress)
- Hydraulic dynamics (flow behaviour, pressure transients)

This integrated approach delivers:

- Increased safety through early anomaly detection
- More accurate predictive insights for decision-making
- Optimized operation of hydro infrastructure
- A foundation for digital twin applications in dam engineering

Conclusion

TISGraph represents a significant advancement in critical infrastructure monitoring and analysis by merging real-time data, statistical modelling, and physics-based simulation. The development of new deformation models and the inclusion of CFD-based hydraulic analysis create a comprehensive tool for managing complex dam systems and ensuring their long-term resilience and safety.