HYDRODYNAMIC MODELLING FOR BUSHFIRE MANAGEMENT AND RECOVERY IN CATCHMENT

Following a fire in the Thomson Reservoir catchment in January 2019, Melbourne Water needed to manage the incident to reduce the likelihood of ash and fire debris contaminating the water supply. The debris had the potential to reduce chlorine efficiency and impact on aesthetic degradation resulting in an inability to supply water.

This is one of two case studies from Melbourne Water about recovery from the Thomson Reservoir catchment bushfires and provides an overview of how Melbourne Water's research program and hydrodynamic modelling assisted in bushfire management and recovery in the Thomson Reservoir catchment. The other case study provides an overview of mitigation works installed by Melbourne Water in the catchment and reservoir to address debris flow risk.

In January 2019 a major fire in the Thomson Reservoir catchment burnt over 6,300 hectares – approximately 13% of Thomson catchment area. The Thomson Reservoir is the largest of Melbourne Water's reservoirs. It has a capacity of 1,068 billion litres, and makes up about 60% of Melbourne's total storage capacity.

Short-term operational decisions

The need to make quick operational decisions was aided by in-reservoir monitoring equipment, and through knowledge of reservoir hydrodynamics including the behaviour of fine sediment.

Vertical Profiling Systems (VPS) installed in Melbourne Water's reservoirs collect data via a water quality probe that periodically moves up and down the water column. Data is relayed to Melbourne Water in near real-time allowing staff to make decisions on reservoir operation. During the fires the VPS showed that higher turbidity water was situated at the surface leading to an immediate decision to lower the offtake level to avoid that water.

3D hydrodynamic reservoir modelling along with data from the VPS was used to assess the potential for high turbidity water transferred from the Thomson Reservoir to short circuit through the reservoir downstream, Upper Yarra Reservoir. Due to Upper Yarra Reservoir being stratified, short-circuiting was expected and shown through modelling to occur so it was decided to increase dilution by artificially mixing the reservoir through the use of an aerator. Data from the VPS was able to show the immediate impact of this decision.

Contingency planning and development of water quality thresholds for water transfer

Hydrodynamic modelling was used as an input to managing transfers from the Thomson Reservoir to the Upper Yarra Reservoir.

The 3D hydrodynamic model (AEM3D) simulates velocity, salinity and temperature subject to external environmental forcing including meteorological conditions and catchment flows.

Previously calibrated hydrodynamic models were used to forecast reservoir conditions under many different inflow scenarios.

Model outputs assisted with operational decisions around transfer rates and timings and were used to establish thresholds for turbidity. Modelling was also able to provide information to help with the placement and assessment of the efficacy of interventions such as silt curtains.

Debris flow modelling coupled with hydrodynamic modelling

The risk of a debris flow, a fast moving mass of water, rock, soil, vegetation, boulders and trees, increases post fire. Sediment loads can be two orders of magnitude higher than erosion by other sources.

Melbourne Water have applied the HydroFire tool, developed by the University of Melbourne, throughout its catchments to determine the probability of debris flows following a fire. Initiation of a debris flow is a function of slope, soil type, burn severity and rainfall intensity.

The magnitude and composition of the total suspended solids mobilised can also be estimated.

Following the Thomson catchment fires the HydroFire tool and burn severity maps were used to identify several high probability debris flow sites. The amount of sediment likely to be mobilised in a worst case scenario was estimated and the entry points to the reservoir identified.

Determining a worst-case scenario was necessary to enable Melbourne Water to undertake water resources planning should the water quality in Thomson Reservoir exceed the turbidity thresholds established. The outputs from the HydroFire tool were coupled with the Thomson Reservoir hydrodynamic model to enable the quantification of a worst-case scenario, in terms of number of days the reservoir would be unavailable due to poor water quality.

Benefits of using hydrodynamic modelling for bushfire events

Melbourne Water's significant investment in understanding debris flow risk in the catchments and in developing hydrodynamic modelling capability has had many benefits. These benefits extend from the operational and day-today decision making necessary during an event to the long-term water resource and water quality questions that drive capital investment. It has been estimated that the savings to Melbourne Water from better management and understanding of risks is in the millions of dollars. The work shows how the practical application of data and knowledge can assisted in mitigation and prediction and also clearly demonstrates the value of long-term research.

More information

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