Overview of Modelling

Hydraulic and hydrological models are a collection of mathematical equations that give a simple representation of reality. We use models as a tool to help us predict future flood risk. There are a number of different types of models that are used for different reasons. We tend to use 'design' flood events to guide our thinking when planning a flood scheme or producing our Flood Maps. This is because not everywhere will have experienced a significant flood event in recent times and it allows us, Local Authorities, Emergency Services and others to plan for future flooding.

Design events typically cover a spread of flooding events from small to extremely large and we can assess where actual witnessed flood events sit within this design. It is unlikely that we will re-run a model after each actual flood event however we will use the information to make improvements to model performance, update any gaps in our Flood Mapping information and use the information to calibrate the performance of future modelling updates (See main response document).

There are several hydrological and hydraulic models used to represent the Severn/Vyrnwy catchments. The application of each depends on the geographic location of interest and the specific purpose the model has been designed for. In terms of your query there are probably three broad types of model that are of most interest –

* **River level and flow forecast models** –

    - These are typically what are known as 1D routing models that quickly and effectively undertake a series of conveyance calculations considering both actual rainfall recorded across a catchment and live forecast rainfall totals as provided by the Met Office. It is these models that provide forecast level information to support the Environment Agency's flood warning service and that can be, in part, seen on the Environment Agency's "Check for flooding" service.

* **Detailed 1D and 1D-2D hydraulic models** –

    - Whilst forecast models provide rapid information on forecast river levels, there are a series of more detailed hydraulic models that provide a substantial amount of information regarding future risk. Whilst varying in age, these explicitly cover the majority of Main River catchments across the Severn/Vyrnwy basin whilst also accounting for flow from minor watercourses, overland runoff and underground baseflow.

      It is these models that support production of the Environment Agency's Flood Maps providing information on future risk, as well as detail regarding predicted flows, velocities, flood depths and hazard across all areas of the represented floodplain. It is these models that are typically then used to support development of flood risk management schemes, dependant on the scale and type of assessment being undertaken.

    - Of particular interest across the Severn catchment are three key detailed hydraulic models (it should be noted that the first two outlined are models produced and provided by Natural Resources Wales) –

        - 1D-2D Flood Modeller Pro/TUFLOW hydraulic model covering the Upper Severn in Powys (constructed in 2007).

- 1D-2D Flood Modeller Pro/TUFLOW hydraulic model recently constructed for the Newtown area (constructed in 2021).
- 1D-2D Flood Modeller Pro/TUFLOW hydraulic model for the Severn/Vyrnwy confluence and upper Severn in England (completed in 2020).

* **Catchment Scale Generalised Modelling** –

  - There are two primary forms of catchment scale modelling that have been adopted across the upper Severn catchment, again to support differing requirements.

    - **2D Overland Routing Modelling** – Used to ensure complete coverage of floodplain mapping across the catchment, even for more minor watercourses that do not fall under the permissive powers of either the EA or NRW. This form of modelling is not as detailed or complex as the detailed hydraulic modelling outlined above but provides an indicative picture of flood risk and is a good tool to inform where more detailed investigations may be required.
    - **Aggregated Storage Model** – To support development of the Severn Valley Water Management Scheme (SVWMS) a hydrological routing model has been constructed that considers how changes across the catchment could impact on flood hydrographs as they are routed through the system. At a catchment scale, a model of this nature enables multiple combinations of potential flood risk management interventions to be tested to determine their likely combined impact. Given that the SVWMS will likely be a hybrid programme of measures, the tool needs to consider the combined impact of thousands of individual interventions across a 2,500km^2 catchment. The tool is a quick and efficient means to iterate varying proposals without the need for explicit representation within detailed hydraulic models which require hours to run for each tested scenario.

Next Stages of Modelling for Severn Valley Water Management Scheme

As you are aware, the Severn Valley Water Management Scheme is currently focussed on demonstrating the “art of the possible” – I.e. that there is a viable catchment-based approach that can be taken forward that will have a meaningful impact in terms of flood risk reduction for communities across the catchment, and that could reasonably be delivered. Some of the models and tools listed above have been used to support that process, which is critical in enabling the case for further investment to be made. As the project progresses to the next stage, a series of upgrades and updates are proposed as the requirement for more specific details in certain geographic locations increases. This will be undertaken in conjunction with a more robust engagement programme to ensure that, as the programme of interventions develops, it aligns with the aspirations and requirements of those living, working, and visiting the upper Severn catchment. Unfortunately, that engagement programme has had to be delayed for reasons outside of the project teams’ control but is expected to commence shortly.

It is important to note that the modelling tools used to inform the varying stages of project development will vary in terms of their ultimate use and the level of detail built into them. It should be recognised that a proportionate and well tested approach to model development to inform project conception, appraisal and (ultimately) detailed design will be applied to ensure that any future scheme implementation is underpinned by a robust and detailed evidence base.