SUMMARY – QUESTIONNAIRE TOPIC 2: Hydraulic models for urban pluvial flooding and forecasting

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GENERAL REQUIREMENTS OF URBAN PLUVIAL FLOOD MODELS:

- Models are being used for both, off-line as well as real-time applications. However, real-time applications are less common (most operational models are used for planning purposes).
- Software commonly used in the UK:
    - For hydrological and hydraulic modelling: InfoWorks CS, ICM, RS/2D, FloodWorks, XPStorm, WinDes FloodFlow – all of these models are being used operationally
    - For mapping: MapInfo and ESRI (ArcGIS).
- Desirable additional tools:
    - Ability to alter the DTM within the software for option appraisal/design purposes
- Main requirements for models used for off-line (e.g. planning) purposes
    - Accuracy
    - Speed of simulation ("viable" run times)
    - Ease of use (including ease of setting up and maintaining models)
    - Visualisation of results
    - Tools for testing and analysing different flood alleviation schemes
    - Seamless modelling: pipes/channels/rivers/overground
    - Professional support
    - Stable mathematics
- Main requirements for models used for Real Time (e.g. flood forecast, RT control) purposes:
    - Same requirements as models for off-line applications, but with more emphasis on runtimes (short runtimes are essential in this case)
    - Desirable use: suitability for providing early warning information at locations likely to be at risk of flooding during the storm event. This would then allow some proactive flood prevention works to be undertaken.

DUAL DRAINAGE:

- For surface flood modelling, risk estimation and mapping, do you think it is **enough to model only the surface** (without considering interactions with the sewer system)? Do you have a proof or it is your "gut feel"?
    - **For urban areas it is not enough.** There are real cases in which inflows to the sewer network at one location cause flooding at another which does not flood from just surface runoff. It has been proven that failure to include interactions with the sewer system are likely to result in the surface water modelling over estimating the level of flooding together with the possibility of predicting flooding being identified in the wrong locations within the catchment.
- Do you think it is enough to model only the sewer system (without considering interactions with the surface)?
    - This is **enough** if the model is being used for designing or testing the capacity of the sewer system or for analysing simple things such as overflows and input to treatment plant
    - It is **not enough** if the model is used to identify flood risk / to understand the impact of flooding
- Modelling of interface between the sewer system and the surface:

  - Manholes and watercourses are usually modeled as weirs, some as orifice and road gullies by means of head-discharge relationships
- Main obstacles for implementation of dual drainage models:
  - Lack of data (e.g. data on highway drainage systems, lack of good quality LiDAR data
  - Difficulty/complexity of setup and maintenance (time to collate all the data and difficulty in undertaking verification of the surface/subsurface interactions).
  - Increased runtimes, together with handling of a large amount of output data. This may result in a requirement to purchase larger/faster computers to run these complex hydraulic models.
  - Willingness to adopt new technological approaches.
  - Lack of awareness for need

SEWER MODELS:

- Required level of detail in sewer models:
  - This depends on the purpose of the model (i.e. the required output) and also on whether the area is prone to flooding or not (skeletal models may be enough in areas which do not flood, but more detailed is required in flood prone areas)
  - In areas where the major and minor flows are constrained by pipe walls or highway kerbs, the modelling can be done in 1D, even if there is major/minor interaction.

SURFACE MODELS:

- Views on 1D vs. 2D models of the surface:
  - Controversial views on this issue: some participants consider that 2D models should be used whenever possible; some consider that there is room for 1D models
  - Those who support 1D models indicate that where the surface flows are adequately constrained/channeled (e.g. between highway kerbs), it is better to model in 1D as the simulation times are significantly shorter and the results are satisfactory. Besides, modeling of water quality is also easier in 1D.
  - One of the main problems of 1D models is the poor visualization of results.
- Views on the runtime and computational requirements of 2D models of the surface:
  - 2D models are not yet fast enough, although software houses are working on making them faster and significant improvements have been achieved in this direction
  - It is possible to manage runtimes by appropriately choosing mesh size parameters.
  - 2D models are in their infancy in development, but at some point they may completely replace 1D models (but we are not at this stage yet).
- Desirable resolution of surface models:
  - A balance must be found between detailed needed, runtime available and ease of use
  - The resolution is also determined by the resolution and quality of the available LiDAR data
  - Best approach: variable resolution, depending on the characteristics of the area. The minimum resolution is the one which adequately represents all potential flow routes; narrow passages between houses may be particularly important.

RAINFALL FOR PLUVIAL FLOOD MODELS

- Rainfall inputs currently used:

  - Mainly raingauges (these are used for model verification)
  - Weather radar is seldom used
  - Met Office forecast is not being used operationally
- Barriers for broader use of the forecasted rainfall:
  - Accuracy
  - Availability
  - Price
- Application of rainfall to the hydraulic model
  - The best balance is a combination of subcatchments and rainfall applied directly to the 2D surface: subcatchments drain to the sewers and surface runoff everywhere else (attention must be paid so that areas of the catchment are not missed or double counted).

CALIBRATION:

- Calibration of urban pluvial flood models is done by using flow monitoring, historic flooding records and historic rainfall figures.
- Flooding records for calibration are limited, but not nonexisting. Flooding records may include photographs, videos, CCTV data. It is important to understand their accuracy and confidence (depending on the source) and make the best use of the limited data that is available.
- Seasonal variations in the system are not being taken into account (at least not by the participants in this session)
- There are some relatively well documented cases of surface flooding in the UK which can be used for model calibration; however, many of these are not exclusively pluvial flooding, but a combination of fluvial and pluvial. Some of the well documented cases are the following: Gloucestershire (2007 flood), Torbay, Hull, East Riding, Cheltenham, North London.
- In addition, cases from other countries around the world could also be used as benchmarks (larger databases, not limited only to the UK, should be implemented).
- What should be done to improve surface flood monitoring so that we can have at least a couple of reliable "benchmark" cases in the UK?
  - Better and more consistent investigations should be done during and after major flood events, including photographic records, surveys of wrack lines, questionnaires and interviews
  - Better monitoring of events is promoted by the Flood and Water Management Act 2010, which places new responsibilities on Lead Local Flood Authorities. This will ensure better records of future floods.
  - Investments should also be done on permanent monitoring.

UNCERTAINTY:

- There are many different sources of uncertainty in urban pluvial flood models, so it is difficult to carry out a comprehensive analysis of them.
- In general, the "best judgement" of the modeller is used
- Communication of results and uncertainty:
  - Simulation replays showing direction arrows have proven to be useful for discussing flooding with community members
  - The media try to simplify results and flood probabilities and this may make things misleading.
  - A consistent type of message/way of communicating flood risk is necessary