Grid-to-Grid (G2G) model

- The G2G model is configured on a regular grid to take advantage of gridded driving data (rainfall and potential evaporation) and spatial datasets.
- The reliance on spatial data reduces the need to calibrate the model for each catchment, as spatial heterogeneity is provided by datasets.
- The model can be configured using DTM slope/terrain data alone (Terrain G2G) or with the addition of soil/geology data (Soil G2G) for areas where topography is not the dominant control on runoff-production (e.g. the Thames Basin).
- The model is run at a 15-minute time-step, on a 1km grid over Britain, and consists of:
  - a grid-based runoff-production scheme,
  - kinematic routing applied separately to sub-surface and surface runoff,
  - a return flow term representing surface/sub-surface flow interactions on hillslopes and in channels.

The Terrain G2G estimates gridded runoff by a simple grid-based runoff-production scheme developed from the Grid Model (Bell and Moore, HESS 2(3), 1998).

The Soil G2G estimates gridded runoff using soil properties such as soil depth and hydraulic conductivity to improve runoff estimates in areas where soil/geology is the dominant control on runoff-production.

Classic 1-D kinematic-wave routing along DTM-derived flow-paths is used in both models, but the Soil G2G model introduces channel routing for rivers with varying cross-sectional width.

Model assessment

For assessment G2G is run using historical daily rainfall and monthly potential evaporation (PE) and modelled flows are compared to observed.

Neither model estimates snowmelt, so performance in Scotland is affected.

Artificial influences on river flows (e.g. effluent and abstraction) are not modelled explicitly, so for these catchments performance is affected.

Climate change application using RCM (HadRM3H) data

For a climate change application, estimates of (hourly) rainfall and (daily) PE are provided by climate model (RCM) data on a 25km grid.

Data are available for two time-slices: 1961-1990 and 2071-2100 (under the A2 emissions scenario).

Rainfall estimates are downscaled to 1km using SAAR (Standard Annual Average Rainfall) data for 1961-1990.

Summary / Discussion

- The modelled percentage changes in river flows differ substantially between the Terrain G2G and the Soil G2G in some areas, but are broadly similar elsewhere, particularly in high relief areas, where topography is the dominant control on runoff production.
- This demonstrates that a particularly good understanding of model behaviour is required for such applications, where the ‘correct’ result is unknown.
- Care also needs to be taken for climate change applications when using driving datasets, such as RCM data, which consist of a single run for each time-slice, as ‘outlier’ events in either time-slice can skew the modelled percentage changes between the time-slices. Ideally an initial condition ensemble of RCMs would be used, as this allows some sampling of natural variability.
- The G2G model is still under development and will soon be run with a perturbed-parameter RCM ensemble, which will allow a demonstration of impact uncertainty on river flows due to RCM structure / parameterisation.

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