INTRODUCTION

- Hydropower generation is a key component for Scotland’s aim of meeting all electricity demands from renewable sources by 2020.
- Conflict between energy demands (hydropower schemes) and ecological flow requirements in many regulated Scottish rivers (Water Framework Directive).
- Atlantic Salmon’s (Salmo salar) flow requirements are different for different life stages - these requirements strongly link to dynamics in spatio-temporal hydrological connectivity.
- To inform sustainable management, there is a need for appropriate assessment of reference conditions and effects of current schemes, which are limited by data and decision support tools.

Aims and Objectives

- The main aim is to provide a cross-scaling modelling framework to under-stand the cumulative impacts of existing and new hydropower schemes on flows and ecological status of Scottish rivers, as a basis for informing sustainable river management.
- The objectives are to:
  1. Use a generic rainfall-runoff model to assess hydrological reference conditions at the catchment scale and effects of hydropower schemes on flows.
  2. Use 2D-hydraulic models to assess the impacts of hydrological change derived from (1) on habitat quality at the reach scale.
  3. Use output from (1) and (2) to investigate the role of hydrological connectivity in determining the system’s resilience to hydrological changes.
  4. Use scenario analyses to project trade-offs between different river regulation scales in a way that can be communicated to stakeholders.

Study Catchments

- Tay Catchment
  - Heavily regulated, large catchment, diverse hydrology.
- Main rivers of interest in Tay Catchment:
  - River Tay: 4970km²; precipitation west to east ~3000-750; evapotranspiration in lowland areas ~450 [mm a⁻¹]; average discharge at Ballatie 169m³/s.
  - River Lyon: 390km²; responsive soils; low permeable geology; heath and moor-land vegetation; precipitation ~2300; evapotranspiration ~400 [mm a⁻¹]; average discharge 12.5m³ s⁻¹; major tributary to River Tay.
- Girnock Burn Catchment
  - Unregulated catchment, single river drains catchment.
- River of interest in Girnock Burn:
  - Girnock Burn: 30km²; precipitation ~1000mm, evapotranspiration ~400 [mm a⁻¹]; discharge ~0.52m³ s⁻¹; granitic with glacial history.

Methodology/Approach

- Integrate modelling and analyses for natural and regulated catchments.
  1. Collect empirical hydrometric data to determine reference condition for construction of a catchment-scale hydrological model (see Geris et al., 2014).
  2. Engage with stakeholders for input into model and to collect hydroscheme regulation data. Focus on hydropower schemes in heavily regulated rivers.
  3. Study effects of hydroschemes on reference condition flows.
  4. Incorporate the outputs from the generic large-scale hydrological model into 2-D reach-specific hydraulic models.
  5. Impacts on habitat quality of selected life-stages of Atlantic salmon will be assessed by comparing output of reference conditions to regulated conditions and available or collected field data.
  6. Study how hydroschemes affect the connectivity in the hydrological systems compared to a non-regulated reference state. Determine impacts on resilience and vulnerability to change.

- Spatial connectivity
- Temporal connectivity

References