Modelling as basis for decision processes in water management in an agricultural catchment (Lunan Water, NE Scotland)

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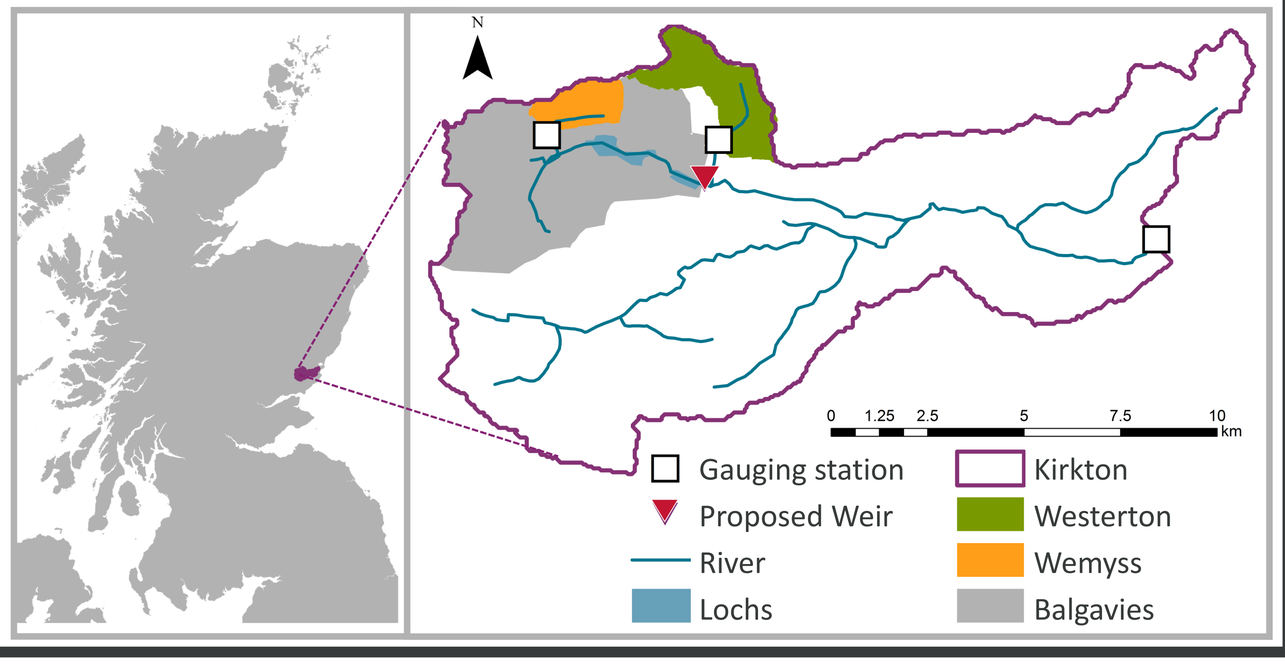
1 Introduction

- Sustainable and robust decision making in water management requires quantification of impacts of potential measures and communication to stakeholders
- The Lunan Water (A = 124 km^2, annual values 1981/2010: P = 755 mm, T = 8.1 °C) is characterized by a high interannual discharge variability – both in terms of flood events (mostly in winter) and drought periods in summer
- Water quality problems: *Carex* wetlands are vulnerable to eutrophication
- The installation of a tilting weir as a lateral structure to release water from a mill lade, would allow for an enhanced storage capacity in Rescobie and Balgavies Lochs, thus mitigating floods as well as providing a means to divert episodic nutrient and sediment rich water away from wetlands



2 Methods

- Coupling of auto matic data download (real time observed weather data and water levels, weather forecast) and models in R to simulate and visualize Loch inflow, Loch storage and Loch outflow for management options (weir open/closed, with/without dredging), 9 day forecast period

Weather (P, T)

Historic (1961-2015)
MetOffice UKCP09, daily, 25 km^2 raster

Realtime (up to current day)
Hourly, station Glensaugh (ca. 20 km from Balgavies Loch)

Forecast (+ 9 days)
Norwegian Weather Service yr.no, 6hourly, Aberdeen, Dundee & Montrose

Loch Inflow
TUWmodel (Parajka et al. 2007), daily time step, 25 parameter sets, calibrated against observed discharge at gauging stations in the catchment

Observed Water Level
Balgavies Loch, 15 min

Loch Storage & Water Level
Loch water balance (daily): $\Delta S = Q_{in} - Q_{out} + P - ETP$

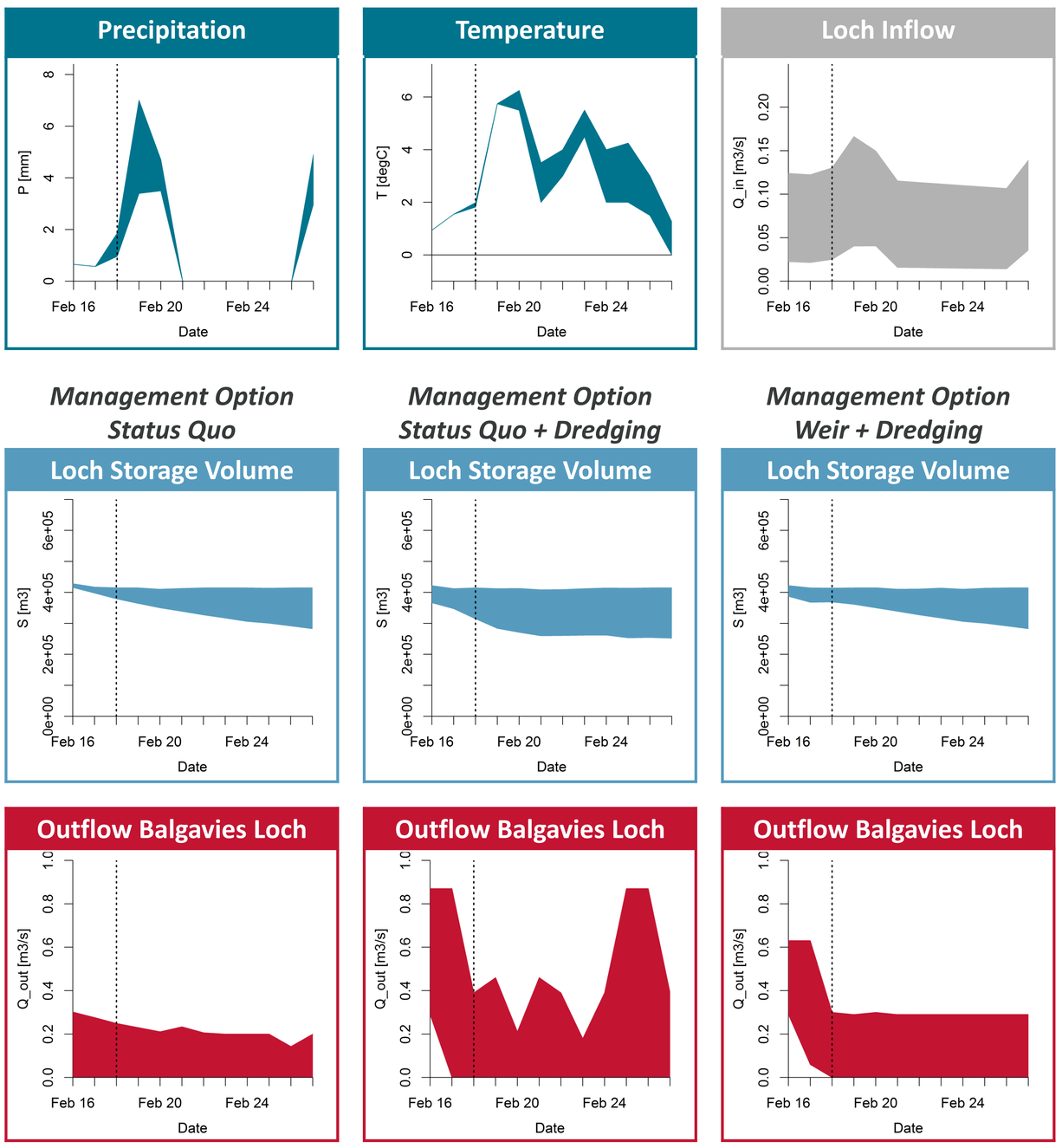
Water level – volume - relationship

Outflow Balgavies Loch
Water level – discharge relationship (family of curves depending on discharge at Westerton and weir management option, derived by HECRAS modelling)

Flow at Westerton station
TUWmodel (Parajka et al. 2007), daily time step, 25 parameter sets, calibrated against observed discharge at gauging stations in the catchment

3 Selected results

- Example simulation on 18th February 2018 20:04 (real time weather data untikl 18th February 2018 20:00, thereafter forecast data) for three management options: status quo, status quo + dredging, weir open + dredging
- Uncertainty bands based on weather forecast & 25 parameter sets of TUWmodel



4 Summary & Outlook

- Coupling automatic download of realtime and forecast data with modelling of loch inflow, storage and outflow allows quantifying and visualizing impacts of potential management options „in real time“
- The tool can be provided online (r shiny application) to stakeholders and can also be used for operational purposes
- Together with simulation results of different management options for longer time period this can be used to support decision processes in the catchment

Referenes:
Parajka, J., R. Merz, G. Blöschl (2007): Uncertainty and multiple objective calibration in regional water balance modelling: case study in 320 Austrian catchments, Hydrol. Processes, 21, 435-446.
R Core Team (2018): R: A Language and Environment for Statistical Computing. https://www.R-project.org

Data Sources:
Historic weather data: UK MetOffice UKCP09
Realtime weather data: Station Glensaugh of the Environmental Change Network
Weather forecast: Yr, provided by the Norwegian meteorological institute and NRK
Observed water level and discharge: James Hutton Institute and National River Flow Archive

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