Title

Water for all: an ecosystem services approach to wetland conservation and flood risk reduction in the Lunan Water, Scotland.

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Summary:

In the Lunan Water catchment, North-East Scotland, an attempt is being made to quantify the impact of proposed changes in water resources management on eutrophication, flood and drought risk, and to assess willingness to adopt such changes. Analysis focuses on installation and management of a tilting weir, as a lateral structure to release water from a confined channel feeding a water mill, and on dredging and maintenance of the channel. Impacts on upstream water levels, wetland eutrophication and downstream flows are considered. Carrying out dredging of the channel reduces the current observed risk of upstream flooding from 3% to 1%. Both under current and dredged channel conditions, the operation of a lateral tilting weir, provides opportunity for diversion of seasonal nutrient/sediment rich water from Balgavies Loch away from Chapel Mires wetland.

Keywords: (max three keywords)

Introduction

The implementation of new technical solutions in water resource management requires long-term planning and involves the participation of multiple stakeholders. To that end, a quantification of the potential impacts on ecosystem services (eg. eutrophication, flood and drought risk) of changes in water resources management, and communication of these impacts to stakeholders is required. In the Lunan Water catchment, North-East Scotland, an attempt is being made to quantify the impact of proposed changes in water resources management and willingness to adopt such changes. The goals of this work are:

a. To determine the impact of introducing a modified water management regime to the outlet of Balgavies Loch on the Lunan Water (eg using a tilting weir as a lateral structure on the common lade, releasing water to the main tailwater channel). This modification may (i) impact upstream water levels in the Loch through additional release of water, compared with that achievable with the existing hydraulic structures at Milldens weir; (ii) modify the distribution of flow and sediment between the Chapel Mires wetland and the Lunan Water downstream of the lade system (see Figure 1 for detail of the site).

b. to assess the impact on upstream water levels in Balgavies Loch, of dredging accumulated sediment from the lade, in conjunction with, or in place of modified water management using hydraulic structures.

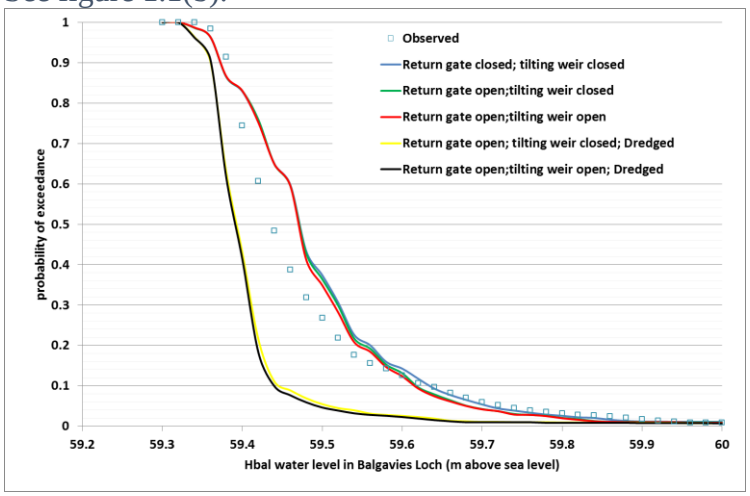
Material and Methods

Our hydraulic modelling objective is to obtain a suite of steady-state stage-discharge relationships to relate the discharge from Balgavies Loch to the water level. These relationships are a function of (a) hydraulic control settings of the existing structures (b) inflow to the channel from the Balgavies Burn tributary (c) a proposed new lateral tilting weir just upstream of the confluence of Balgavies Burn, (d) dredging. We are using the hydraulic modelling package HECRAS 5.0.1 (released 2016) to characterise the impact of lateral hydraulic structures and flows on the stage at Balgavies Loch outlet.

Our hydrological modelling objective is to use this suite of stage-discharge relationships in a dynamic context, via a set of lookup tables, to model the water level in the Loch as a function of conditions of inflow on a daily timestep, using a simple water balance approach.

Results and Conclusions

The existing hydraulic structures in the reach of the Lunan Water downstream of Balgavies Loch, lead to a current risk of upstream roadside flooding of 3%, based on observations from 2014-2017. The analysis suggests that, without dredging, introduction of a lateral tilting weir to release water from the common lade bed will only have a small impact on upstream flooding when levels in the Loch are <59.8m, based on HECRAS model simulations. Carrying out dredging of the channel reduces the current observed risk of upstream flooding from 3% to 1%. However the additional direct benefit of the tilting weir on loch water levels still is quite small. See Figure 1. 1 (a). Both under current and dredged channel conditions, the operation of a lateral tilting weir, provides opportunity for diversion of seasonal nutrient/sediment rich water from Balgavies Loch away from Chapel Mires wetland. When dredging has taken place, the impact of the tilting weir, is greater, especially at water levels >59.6m. See figure 1.1(b).



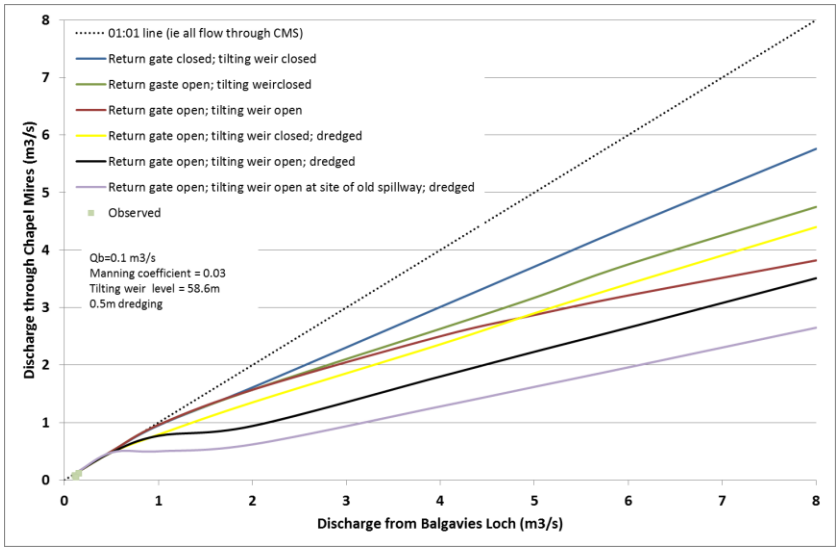


Figure 1.1 (a) Water level exceedance curves for Balgavies Loch – observed compared with modelled values for March 2015-Nov 2017.(b) HECRAS simulations of the split of flow between Chapel Mires spillway and continuation down the common lade with different weir settings and dredging assumptions

References

Hydrological Engineering Center River Analysis Software 5.0.1 (2016) http://www.hec.usace.army.mil/software/hec-ras/ (HECRAS)

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