Introduction

The Norfolk and Suffolk Broads experienced widespread flooding in the winter of 2023/24, particularly on the tidal rivers Bure, Ant and Thurne. There was extensive and prolonged flooding of farmland and properties flooded directly from the river. At a public meeting, it was agreed to model the Lower Bure and explore the possible flood risk benefits of dredging the lower reach of the tidal river Bure.

The Broadland Futures Initiative (BFI) seeks to establish a strategic flood risk management approach for the Broads over the next 100 years. As part of the BFI strategy, a hydraulic model has been developed to help appraise the flood risk implications of possible scenarios. This new model has been used to assess the effect of additional dredging. The £13,000 modelling cost has been funded through Flood and Coastal Erosion Risk Management Grant in Aid from the Environment Agency.

Modelled Scenarios

This assessment's focus has been understanding the benefits and implications of additional dredging (beyond that needed for navigation) in the area known as the 'Bure Loop'. In addition to the Broads Authority bathymetric data, the assessment took into account knowledge from local people with experience of this stretch of river, who had highlighted 10 locations where sediment has accumulated.

Three scenarios were input into the model, which included all the locations identified by local stakeholders. The channel cross sections used in the model have been verified against the Broads Authority bathymetric data and found to be satisfactory. Where discrepancies arose, new survey has been commissioned and used within the model.

- Scenario 1: The existing river-bed profile based on the current channel cross sections. This comprises the baseline against which scenarios 2 and 3 are compared.
- Scenario 2: The channel bed level is reduced to **-2.5m Above Ordnance Datum (AOD)** with channel sides of 2:1 gradient.
- Scenario 3: As above but to **-3.0mAOD** bed level. This is roughly one metre below the Authority's current Waterways Specification depth.

A range of both fluvial and tidal events were explored through the model, as was data collected during Storm Babet. Climate change scenarios were used to assess whether additional dredging to deeper bed levels in the future could bring benefits despite the predicted rise in sea level. All scenarios were run for 360 hours (15 days) duration.

Key Findings

- **Tidal Events**
  Dredging to -2.5.AOD and -3.0mAOD resulted in a more extensive tidal range upstream of the Bure Loop, i.e. higher tidal peaks and lower minimum tidal levels.
- Dredging to -2.5m AOD and -3.0mAOD demonstrated an increased water level for the tidal events. The increase in peak levels at Acle in the 5% AEP[1] tidal event is 7 cm & 12 cm in scenarios 2 & 3, respectively. A nominal increase in tidal water level (1 cm for Scenario 2 & 2cm for Scenario 3) occurs at Potter Heigham for both 1% and 5% AEP events.
- **Fluvial Events**
  Scenarios 2 & 3 show a nominal (1cm & 2cm) or no decrease in the peak water levels in the upper reaches of the Bure, Ant and Thurne.

[1] Annual Exceedance Probability (AEP) is a term associated with the magnitude of a flood event and its likelihood of occurrence. For example, for a flood with an AEP of 0.5%, there is a 1 in 200 chance that a flood of this magnitude or greater could occur in any year.

- 15 days after the peak tide or peak river level, for locations in the upper river reaches such as Potter Heigham, additional dredging results in a small (i.e. in the order of 5 cm) reduction in river levels.
- Due to Broadland's relatively flat landscape, the system remains slow to drain whatever the level of dredging.

Storm Babet simulation

The simulation shows no benefit of additional dredging on water levels along the Bure Loop. Scenario 1 shows the lowest peak levels. On the contrary, additional dredging increases peak water levels at Three Mile and Acle (by 9 cm & 3 cm respectively), with no differences in the peak water levels elsewhere in the system.

The flood depth is also largely unaffected throughout the system. Only areas of the Upper Thurne saw a reduction in flood depth of 5 cm & 10 cm and a small section area at the mouth of the Ant with a reduction of 15 cm under Scenario 3.

After 15 days, the Storm Babet model shows a reduced water level overall compared to scenario 1, indicating that the additional dredging scenarios allow a greater transfer of water through the Bure Loop. However, the differences in level between scenarios are less than 6cm for all locations and events, aside from Three Mile House.

Using climate change uplifts for a similar event in 2040, dredging will not reduce the peak water levels for most locations, with increased water levels around Three Mile House (5 cm and 9 cm for Scenario 2 & 3, respectively) and Acle (2 cm and 3 cm for Scenario 2 & 3) respectively.

Cost Estimates

The report produced cost estimates for dredging the two scenarios of -2.5mAOD and -3.0mAOD.

For Scenario 2 (-2.5mAOD), the approximate cost of dredging is £2.7 million, and for Scenario 3 (-3.0mAOD), the estimated cost is £4.6 million.

- These costs presume that the dredged material can be placed on the banks, as with the current dredging regime. This is unlikely, given the huge quantities of material involved, far in excess of those produced currently.
- The estimates would increase substantially if dredgings require disposal from the site.
- Furthermore, these costs do not include the requirement for an MMO licence, Natural England approval or a waste licence (if dredged material cannot be used on the banks), which would add significant cost and time to any dredging project.
- The removed volume required for both scenarios significantly surpasses (3 to 5 times) the Broads Authority's average yearly dredged material from the Broadland network.
- The modelling shows that the effect of dredging on flood-level events is negligible and would most likely increase flood risk lower down the system.

The costs quoted in this document should be treated with caution.

The Environment Agency's total annual maintenance expenditure is £2.1m for the entire Broads system. Any dredging intervention would need to demonstrate a significant decrease in avoided flood damage costs, i.e. economic benefits that outweigh the cost of the dredging activities.

Environmental Considerations

Due to the highly designated environmental status of the Broads, the environmental impact of dredging is a key consideration. If the tidal range of the Bure is increased, then there is an assumption that the salinity regime would also be impacted. Any change to water levels will also impact on the environment.

The impact of dredging in drought conditions has not been assessed. Further environmental assessments would therefore be required.

Conclusion

The modelling report concluded that additional dredging in the Lower Bure results in only small reductions in river levels in the upper part of the catchment following a fluvial event. Similarly, if flooding does occur there is only a small reduction in maximum flood depths. The additional dredging also results in increased flood risk from tidal events, with higher river levels upstream of the Bure loop.

It also found that the work would have considerable costs, which are unlikely to be eligible for central government funding.

There are also considerable licencing requirements and environmental considerations associated with additional dredging.

Furthermore, reallocating the maintenance funds available in this location would significantly limit the Environment Agency's ability to continue its maintenance activities, such as embankment repairs. Therefore, funding would be better targeted at other flood risk interventions, such as maintaining the crest height of raised embankments.

The Broads Authority will continue dredging on the Lower Bure to maintain navigational depths.

Next Steps

While this work is outside the scope of the BFI at this stage, the findings will inform the BFI strategy in the future.

Further independent information regarding dredging for flood risk purposes is available from the Chartered Institution of Water and Environmental Management. Floods-and-Dredging-a-reality-check.pdf (ciwem.org)