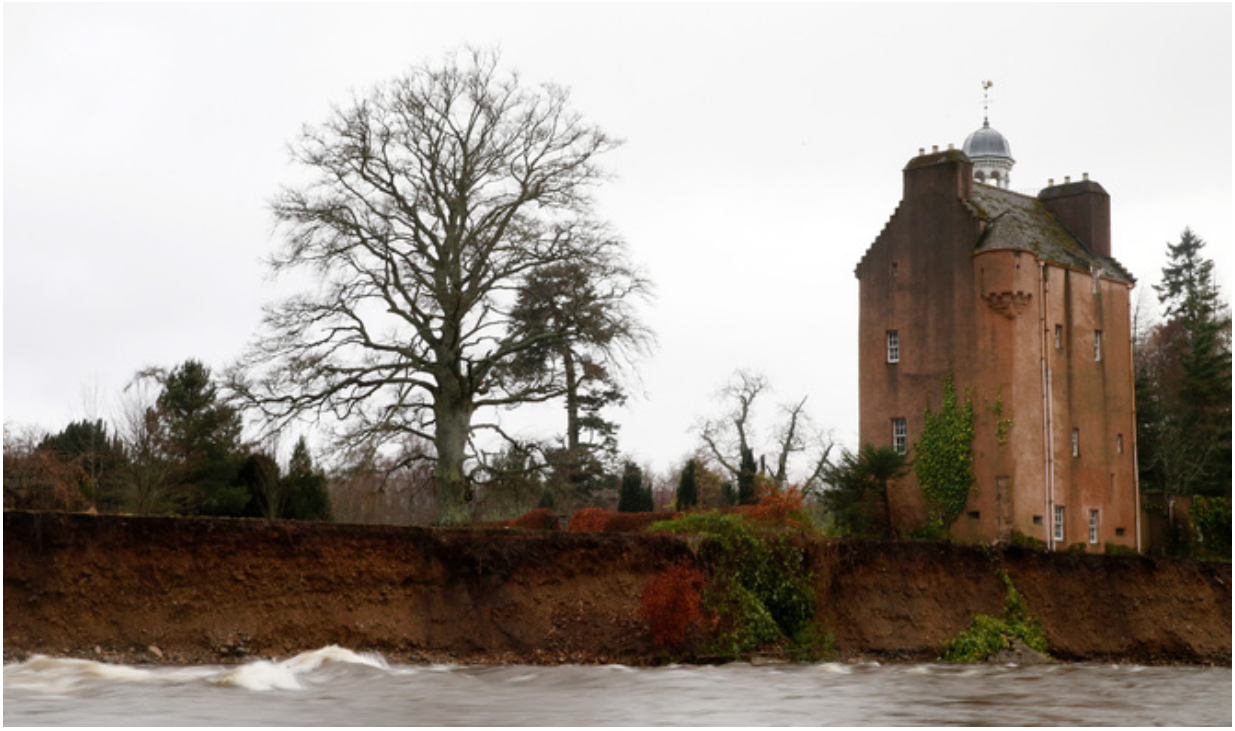
How to stop a castle falling into a river

January 6 2016, by Donald Cook, Edinburgh Napier University



Teetering: Abergeldie Castle. Credit: Russell Cheyne

Fierce storms and floods have made this a very difficult winter for many parts of the UK, not least the owners of a historic castle in Aberdeenshire, close to the Queen's residence at Balmoral. Some 20 metres of land behind the 450-year-old Abergeldie castle has collapsed into the River Dee, leaving its rear wall just feet from the bank.

With the building on the brink of disaster, Baron Abergeldie, John

Gordon, and his wife have vacated to stay with a neighbour. They have begun talking to specialists in order to try to save the castle. This is how I would approach the problem, based on what I can see from the reports in the media.

In my employment with consulting engineers over 35 years I have been involved with a number of landslides and erosion problems. Abergeldie's issue has been partly caused by the fact that the natural granular soils present in this area are more likely to be eroded by flowing water than are clay soils. The risk is that the bank erodes just a little more and undermines the building's foundations, which are probably about a metre below the ground. This could topple part of the castle into the river.

Direct support to the building could be provided by piled foundations sunk deep into the ground and connected into the building walls and foundations. But even if this could be implemented in time, this is still unlikely to be a suitable or adequate solution, since the ground around the piles could still be washed away.

Pile style. Credit: Zhangyang13576997233

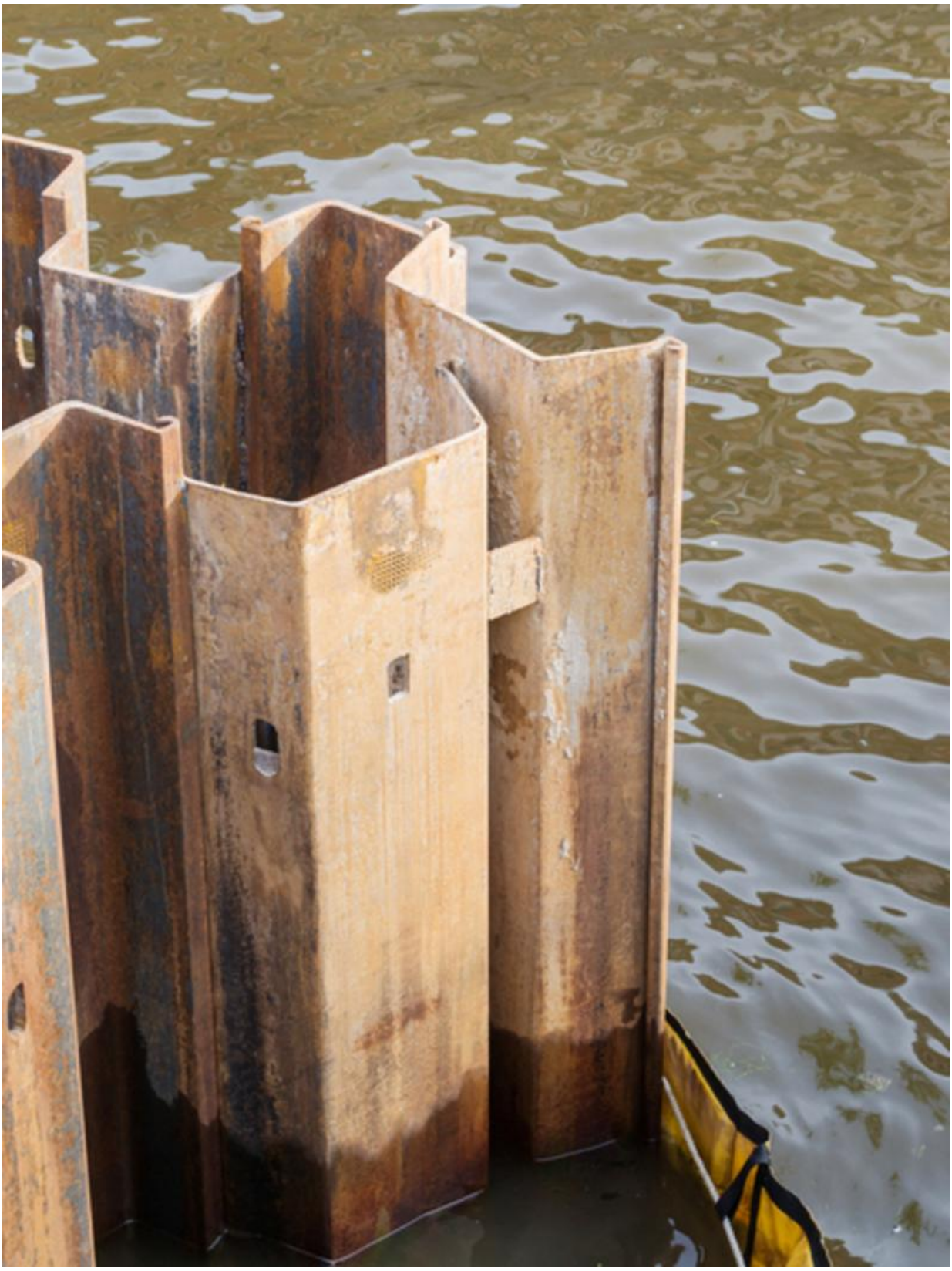
The best, fastest and most pragmatic way of avoiding catastrophe would be to build a containment wall some distance into the river and infilling the space between it and the current bank – essentially reinstating the river bank. To ensure that the load from the castle is adequately supported, you would have to build the wall some distance from the current eroded river bank – I would estimate about five or six metres from looking at the photographs.

For the length of the wall, you would want to provide a robust solution by extending some ten metres upstream and downstream of the castle. By the time you take in the outbuilding and road next to the castle, you might be talking about a length of 50m.

Material difficulties

When it comes to materials for building the wall, you have a couple of options. One solution might be to drive a set of interlocking steel-sheet piles into the river bed, but this brings difficulties. These need to penetrate relatively deeply into the ground, approximately twice the height above ground – in this case possibly ten metres below the river bed. The river bed may comprise shallow rock or dense gravel and boulders which prove difficult or impossible to penetrate. The inevitable vibrations might destabilise the ground and threaten the castle. You would also need specialist equipment and contractors of the kind that would take many weeks or even months to procure and mobilise, all of which would drive up the cost.

The better option is to form a wall using large rocks, known in the profession as rip-rap. You would then infill the area between the wall and the bank with smaller rocks.



Sheet piling. Credit: Sergeii Tverdokhlibov

But we are talking about a massive job. Depending upon the extent of the new wall, the job could require thousands of tonnes of stone. Each wagon for transporting these materials can take 20 tonnes. If money was no object and you could obtain all the materials from a local quarry, you could maybe have the work done in a week – plus whatever time it takes to get permission from the council, water authorities and so forth. Under the circumstances, you would hope that could be done in another week.

In addition, you would need to develop and implement a safe method of construction due to the nature of the problem and the risk of a collapse, including the system for making sure it was being followed. The total cost is very difficult to estimate, but we are potentially talking about many hundreds of thousands of pounds.

It's unclear whether there is enough time to complete this job. It's an extremely precarious situation and you have to feel very sorry for the owner. One hopes he's got a dungeon, since that could mean the foundations extended down to river-bed level and therefore be better protected. But that's probably not the case, so the pressure is on.

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