Storm Ciara

Thirlmere Reservoir February 2020

KFAG 13th Feb 2020
Keswick Flood Action Group

Al Cook for KFAG Feb 2020

For Alan and the late Annalies Brewer, still traumatised residents of St Johns in the Vale and all others affected by recent flood events

Storm Ciara February 2020 Preliminary Report **Keswick Flood Action Group KFAG** 13-02-2020 AlC

This preliminary report provides an analysis of the Thirlmere Reservoir and its associated role in the handling of the UK named storm Ciara on the 8th and 9th of February 2020. Thirlmere Reservoir is an integral part of the river catchments above the town of Keswick, Cumbria. As such the operation and management of the reservoir has a direct impact on the river volumes into the River Greta that flows down through Keswick. Thirlmere and the catchment basin above the reservoir forms approx. 28% of the Greta catchment above Keswick.

Since 2010 the reservoir operators, United Utilities (UU), have operated a trigger level management scheme for the benefit of the Keswick Community. The trigger level scheme instigates releases from the reservoir at key trigger heights which vary from month to month; the trigger height for February is 1m. below the weir level (BTWL). The trigger releases are currently limited to 100Ml/day which is in addition to the constant compensation to St Johns Beck. The trigger releases have a notional impact on the reservoir water levels but, depending on the prevailing weather rainfall, they are often incapable of maintaining the water levels at or near the trigger thresholds.

The object of this discussion paper is to record the reaction of the reservoir to the storm Ciara, observing the filling and spilling of the reservoir due to the associated rainfall, and then to consider the likely variations of that storm if water level in the reservoir had been higher or lower at the start of the storm. I will further try and place the storm in the historical record between 1960 and 2020.

From previous work carried out by KFAG we have developed a mathematical water balance model whereby the volumes of stored water, the rates of spill volumes with any discharge over the spill weir and the relevant rainfall (recorded at Dale Head Hall above Thirlmere) can be applied to the model. Thereby, it is possible to re-run the model and vary the reservoir's starting water level and observe the reaction as the rainfall is applied. Reservoir storage volumes relative to the water height are based on UU's supplied figures and LIDAR measurements. The spill weir discharge rates have been previously verified (by CRM consultants) during examination and appraisal of the reservoir following Storm Desmond, December 2015. The mathematical model closely incorporates these parameters.

Storm Ciara passed over the Keswick/Greta catchment on the 8th and 9th February 2020. At the start of the event the reservoir water level was circa 16.126mm i.e. circa 424mm below the spill weir of 16.55m. The operator, UU, had been running the trigger release of circa 140Ml/day inclusive of the compulsory compensation flow of 13.64Ml/day for all the month of February.

From the January Environment Agency Water Situations Report for NW England https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/864725/North_West_England_Water_Situation_Report_January_2020.pdf we observe that the "soils moisture deficit" was less the 10mm for the whole of the NW including the Thirlmere catchment; i.e. the soil was wet at or near full saturation. The combined Haweswater and Thirlmere water stocks were at 95% full compared to the long term average (LTA) of 89% for January. Rainfall for the month was 99% of the LTA. (n.b. during the passing of Storm Ciara both Haweswater and Thirlmere reservoirs were full and spilling).

Storm Ciara was gradually upgraded in severity as the storm approached the British Isles, however just two days before the storm the forecast was for 40 to 80mm of rain arising from the storm. On the day 146mm was recorded in the 22hrs of the storm passing at the Dale Head Hall 15minute tipping bucket rain *gauge (this is using Environment Agency flood and river level data from the real-time data API (Beta))*. Water levels in the Thirlmere reservoir were also recorded via the *Environment Agency flood and river level data from the real-time data API (Beta)* .

As a consequence of the storm passing there were excessive flows in the rivers, St Johns Beck (immediately below Thirlmere), Glenderamakin, Glenderaterra and the Greta (flowing through Keswick). In Keswick flood gates on the Fitz Park flood plain were closed (partial flooding of the park occurred), Keswick camp site was evacuated at circa 02:3mhrs on Sunday 9th Feb, high flows were recorded at Greta Bridge in Keswick with the level approaching the bottom of the "Glass Wall" flood protection measure. There was significant scour at Low Briery where the Greta flows below steep wooded and unstable slopes which are liable to landslides. Initial preliminary estimates by KFAG members placed the maximum flow in the river at circa 220cumecs. As previously stated, Thirlmere reservoir comprises approximately 28% of the Greta catchment above Keswick. The flows in St Johns Beck were in excess of the 34cumecs arising from the reservoir. From the March 2019 spill event it has been demonstrated that St. Johns Beck is at bank-full with circa 20cumecs from Thirlmere and the antecedent flows from the other valley streams. Threlkeld New Bridge at the confluence of the Glenderamakin and St Johns beck reached close to the top of the arches at the peak of the event (picture at 9am prior to the peak flow around noon – courtesy Rachel and Larry Cowper).

Members of the KFAG and the Keswick Flood Response team were in action monitoring properties and reacting as the situation developed.

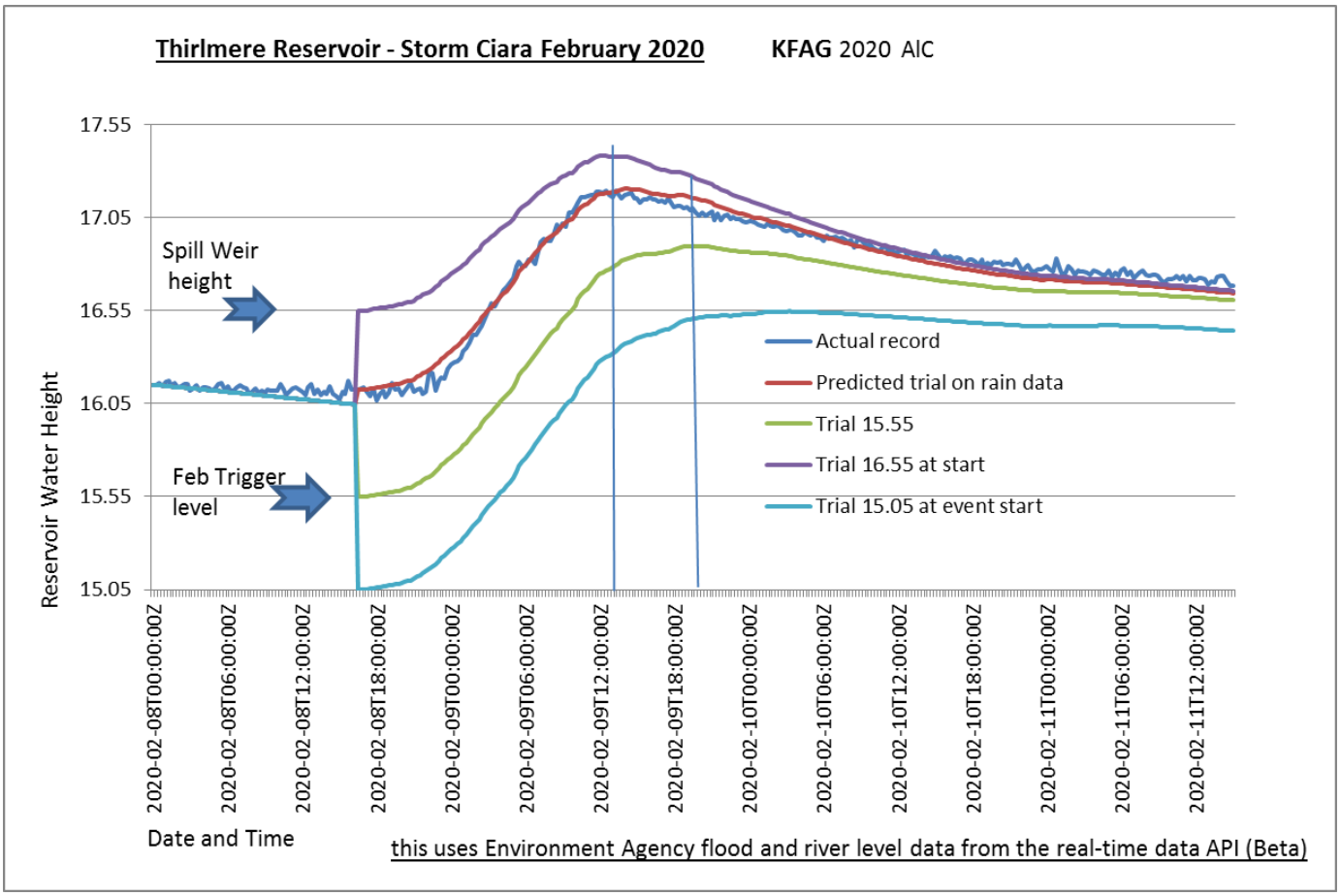
Thirlmere Reservoir Model Runs

Running the Thirlmere reservoir model it was possible, in the first place, to calibrate the rainfall inputs to get a near match to the actual recorded water levels in the reservoir. From there it was then possible to apply other reservoir water starting levels and observe the impact on the flows over the spillway and into the river system.

From observation of the actual event, the readings of the reservoir water level, we see that the storm filled (16.55m) the reservoir and then raised the water level to 17.19m or 0.64m above the spill weir. From the CRM calibration work we can then apply the discharge rate to the spilling and calculate the actual spill rates.

Figure 1. below shows the actual recorded reservoir level through the event (deep blue wavy line) and the rainfall calibration run (red line); the near correlation of these two runs can be observed (circa ± say 3%).

Figure 1:



Three further runs were put through the Thirlmere Model with event start points at:

1. Start point of 15.55m – the base trigger level for February. (Green line)
2. Start point of 16.55m – considering if the reservoir had been full. (Purple line)
3. Lastly a start point of 15.05m – 1.5m below the weir level i.e. not an agreed trigger level. (Light Blue line)

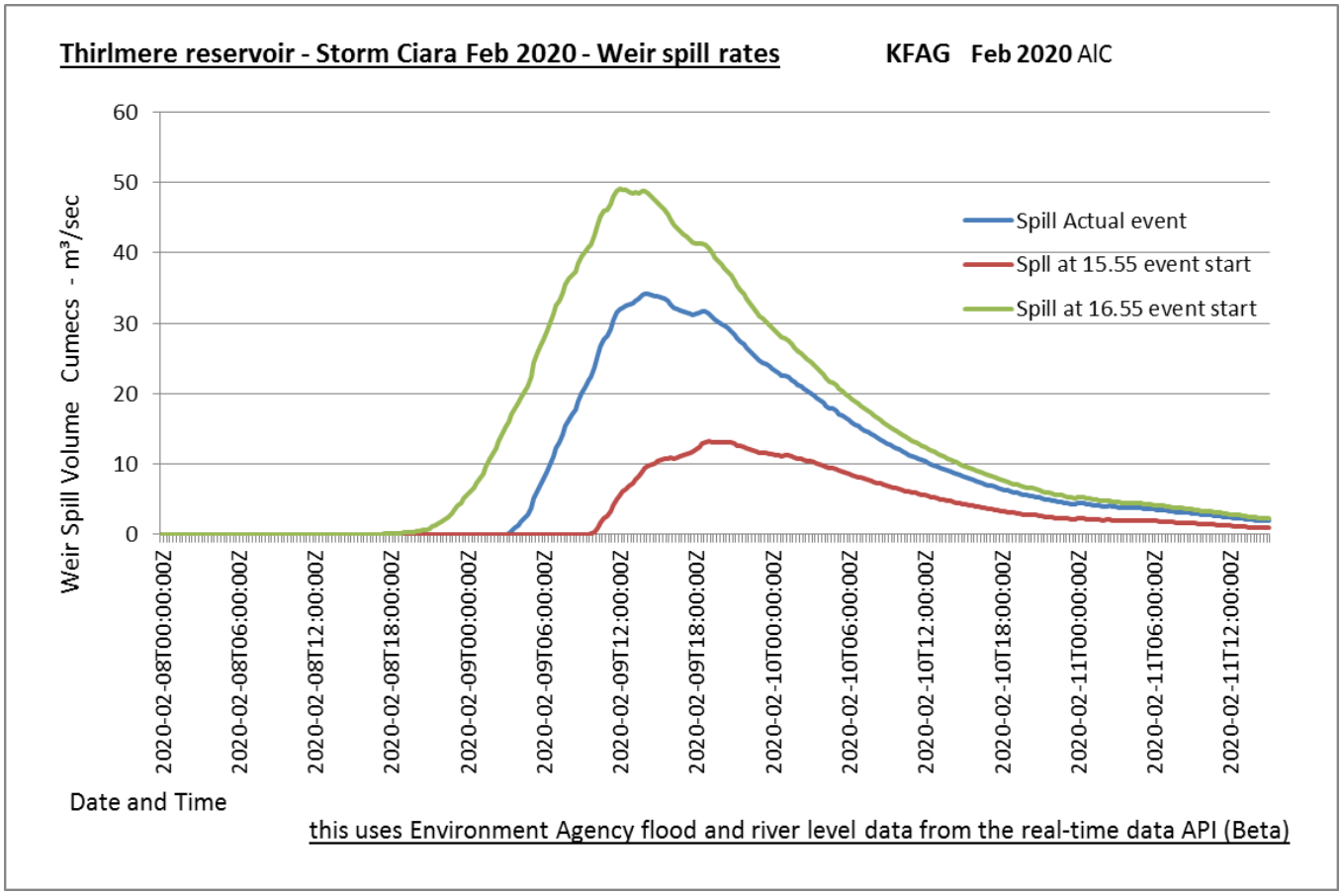
When the water level rises in the reservoir there is an increase in the spilt volumes over the weir (these are shown in figure 2 below). With the different model runs it is possible to observe both the increase and decrease in flow rates as well as the alteration in the peak flow timing. One of the very significant benefits in flood risk management during a storm event is to see delays in the individual river peaks, thereby avoiding the peaks coming together – in the Greta in this case – and giving an increased gross peak flow.

Looking at the model run for a start reservoir water level of 15.55 (1m. below the weir) and comparing it with the actual event, there is both a reduction in the peak flow from the reservoir 34cumecs actual to 13.1cumecs for 15.55m start. The time delay of this run is from an actual peak at 14:00hrs on the 9th to 20:30hrs peak for the 15.55m start; the peak is cut to 38% of the actual peak and the delay is significant at 6.5 hours.

By comparison, run 2 with the reservoir full at the event start we see an increase of the peak flow to 49.1cumecs (from 34cumecs actual) a 44% increase, and the peak move earlier at 12:00 hrs, 2.5 hrs sooner and therefore much nearer the peaks from the other contributory rivers.

The last run at 15.05m start point gives an example of the reservoir just absorbing the storm event without spilling, whilst this is not a level applicable to February it does demonstrate that the reservoir would be still in a controlled position after the storm and further it would be possible, with adequate releases, to attempt to provide storm storage space before the next storm – in this instance Storm Dennis due on 15th February.

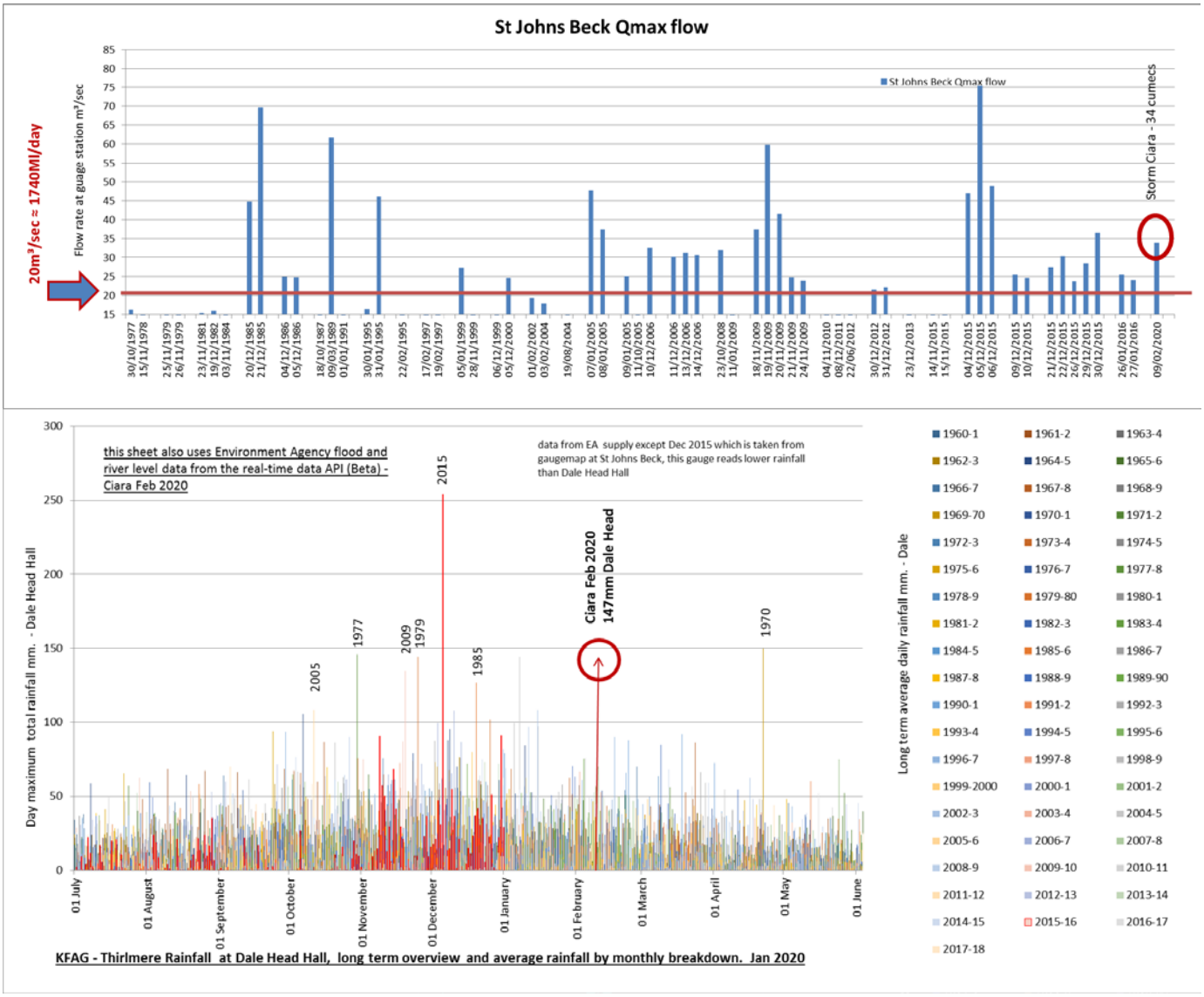
Figure 2 Reservoir spilling rates.



Storm Ciara significance in the Historic Record 1960 to 2020

With the considerations that we now give to the possible effects of Climate Change it is useful to look at the position of Storm Ciara in the Historic Record. KFAG has access through EA previously supplied data to day maximum events for the reservoir and flows in St Johns Beck, these comments are based on that historic record.

Given the size of Storm Ciara it sits as an unusual event for February which is generally late in the winter rainfall season. The record places the storm about eighth in the size record (there are major storms that cover two and three days and these I have categorised as single events). There are no other events of this size in the February to March record, further there is another storm expected on the 15th February - of unknown size. It is too early to comment further on the grading of the storm but it appears to have a very significant size for the time of year.



In conclusion

Storm Ciara was a significant storm with significant impact on St Johns Beck, the Greta and Keswick. There was some storm storage available at Thirlmere and that storage had the effect of reducing the peak flow to the river system, as the storage was used up, together with a small delay in the river peaks. If water levels at the reservoir had been closer to the trigger level of 15.55m for February there would have been a further significant reduction in the ultimate flows into Keswick, which together with the greater delay in peak flow at Keswick, may have reduced or prevented the flood incursion onto Fitz Park in Keswick. It is noted with the model run at 1m below the weir, 15.55m, the reservoir would still have been full after the storm had passed.

When the reservoir is full and overflowing the present protocol prevents any drawdown releases from the reservoir until the water level is below the weir. It is then the case that further intervention is not possible to provide storm storage space in advance of any further storm events. The model run at 1.5m below the weir does demonstate that is is possible to absorb a storm of this size and still be below the weir, thereby allowing further intervention to provide storm storage space. There is a discussion to be held to work through this storm example, it may yet be further educated by the approaching storm Dennis.

Storm Ciara may, in future, be viewed as another potential pointer to the impacts of climate change. In situations where the overall water company stock is abundant, it is apparent that there is an increasing likelihood that there will be circumstances where more imaginative solutions need to be worked out between all relevant parties to protect life, property and the environment.