Cyfoeth Naturiol Cymru
Natural Resources Wales

Post flood event analysis North & Mid Wales February 2020

1. Summary

February 2020 was one of the wettest on record for parts of North and Mid Wales. A series of successive weather fronts including storms Ciara, Dennis and Jorge, as well as heavy rainfall over the weekend of 22nd February, saw most raingauges recording over 200% of their February Long Term Average (LTA). Several raingauges recorded in excess of 350% of their LTA, with Bala recording 407% of its LTA (*Figure 1*).

Vyrnwy raingauge recorded 515mm of rainfall in February, making it the wettest February, and 2nd wettest 30-day period, since records began in 1908. The daily observer at Llanarmon Dyffryn Ceiriog reported that February 2020 was the wettest February, and the second wettest of any month, since the start of record in 1955.

As a result of the rainfall, several rivers experienced significant peak levels/flows that rank within the top 5 on record. The Elwy and Teme experienced their highest river levels in records that extend back to 1974 and 2002, respectively.

This report provides a summary of peak river levels, flows and rainfall experienced during the month of February 2020. It focuses on storms Ciara (8th - 10th February), Dennis (15th - 16th February), Jorge (29th February to 1st March) and the un-named event of weekend 21st - 24th February. It should be noted that datasets have not yet been fully quality assured and are indicative only at this stage, although rudimentary quality checks have been made where possible.

Care should be taken when comparing recent peak river levels with historic data. For example, the refurbishment of Brynkinalt Weir in 1997 means river levels before and after this date may not be comparable.

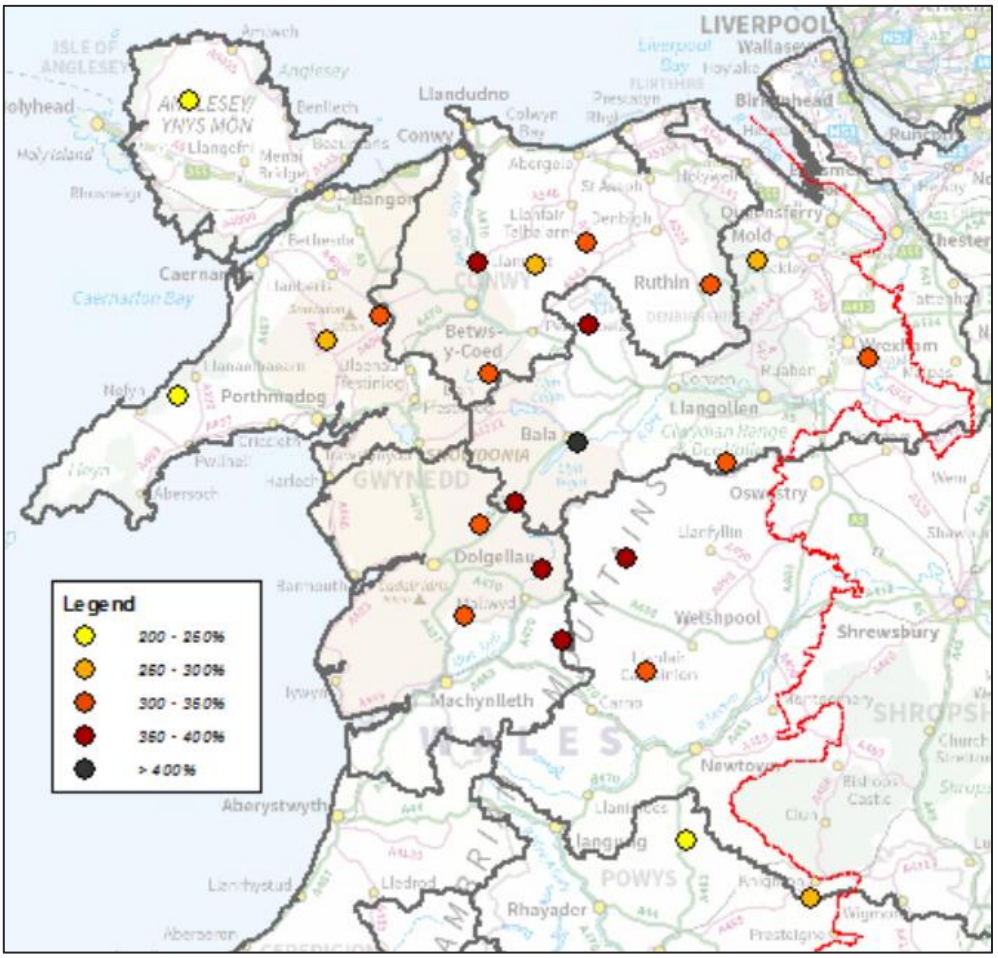

Figure 1. *Rainfall as % of February Long Term Average, at sites across North & Mid Wales*

Natural Resources Wales monitor rainfall and river levels at several locations across North Wales. The locations of the raingauges and river gauging stations used in this analysis are shown in *Figures 2 and 3*, respectively.

It should be noted that rainfall return periods often don't reflect the scale of flooding that has occurred. Pre-cursor conditions such as soil saturation, starting river level and floodplain inundation play a big part in determining how rivers respond to rainfall. These factors are not specifically accounted for in rainfall return period analysis. Furthermore, the raingauge network is only able to provide data where raingauges are situated and isn't necessarily representative of catchment rainfall.

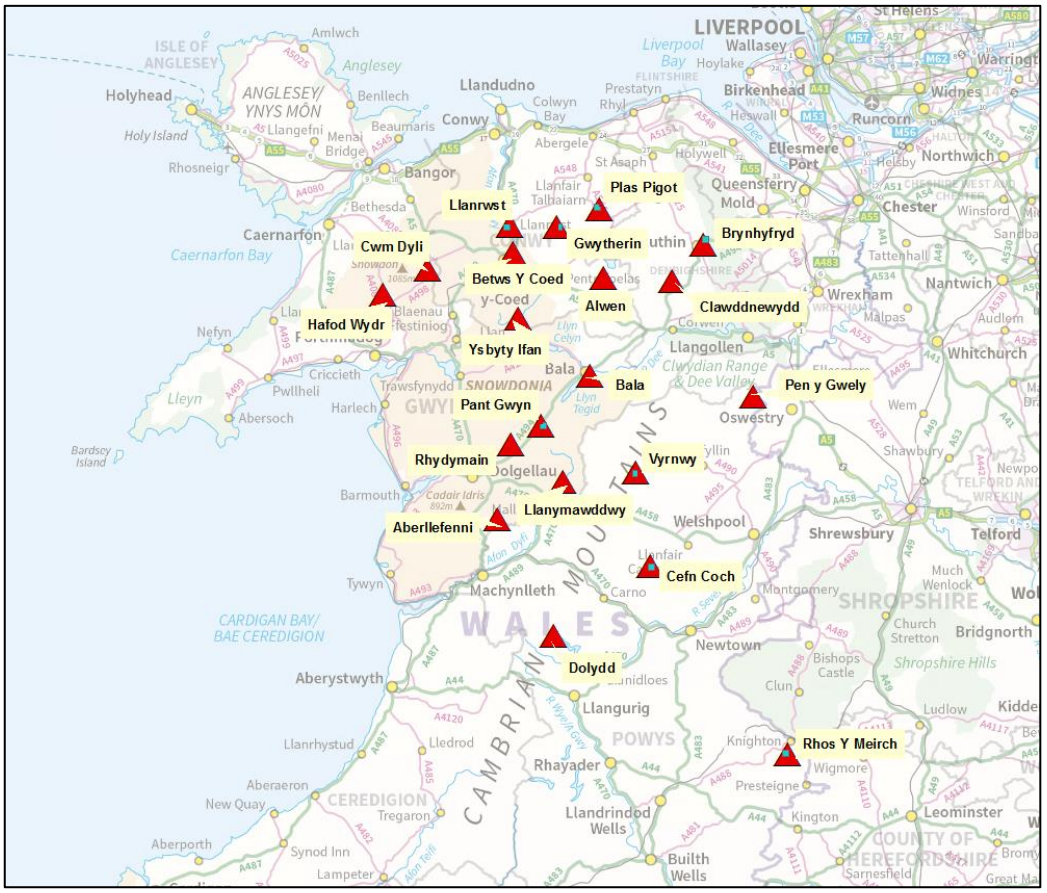

Figure 2. *Locations of raingauges used to inform this report.*

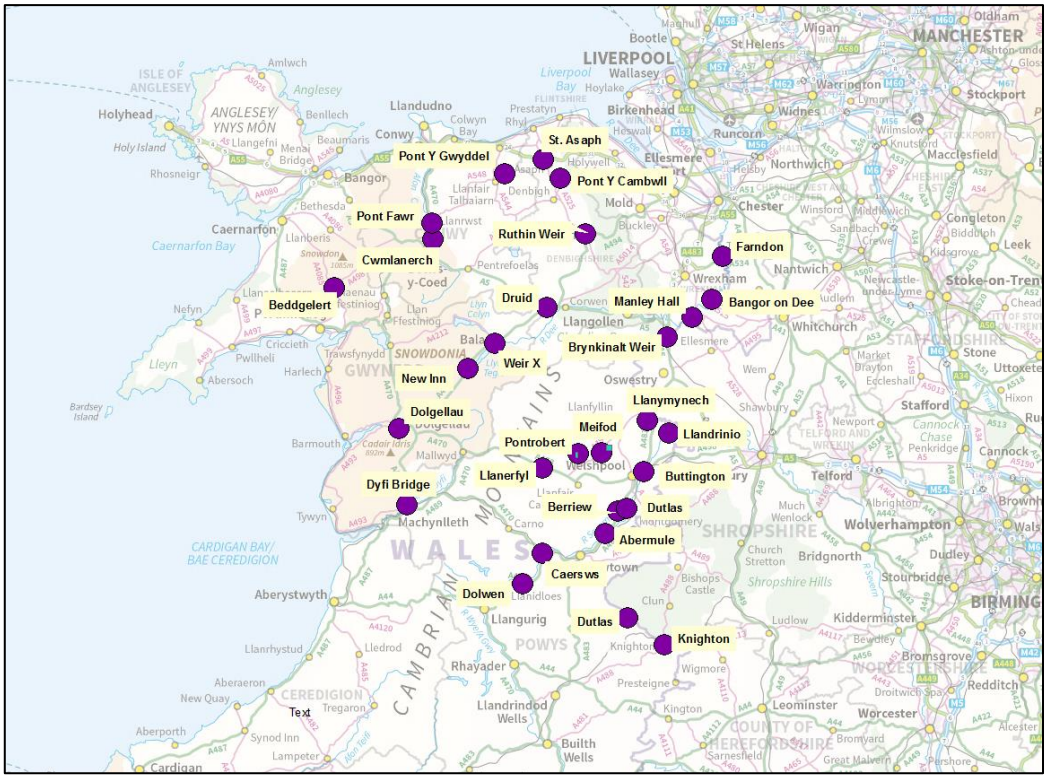

Figure 3. *Locations of river gauging stations used to inform this report.*

2. A note on long duration rainfall analysis

February 2020 brought extreme rainfall to many parts of North and Mid Wales through a series of consecutive storm events. At some locations such as Bala and Vyrnwy, the rainfall was unprecedented for that time of year and in context of their long-term records.

The Flood Estimation Handbook (FEH) depth-duration-frequency tool on the FEH Web Service allows for return period analysis for durations of up to 10 days using the FEH2013 rainfall model. Analysis of rainfall over this duration is included in this report for each of the February storms. The FEH Web Service also allows for return period analysis for durations of up to 16 days using the FEH99 rainfall model, but this has not been carried out because that rainfall model has been superseded. There are also concerns regarding inconsistency in results if two separate rainfall models are used for analysis.

Monthly rainfall totals for several sites were compared against Tabony Tables, where available. Tabony Tables compare cumulative monthly rainfall excess/deficit against the long-term average, providing return periods for durations ranging from 1 month to 120 months. For February 2020 the Tabony Tables yielded highly unrealistic return periods and so this approach was not considered appropriate.

The Vyrnwy rainfall record extends back to 1908. Analysis of daily data shows that February 2020 was the second wettest 30-day period on record, with the 30 days leading up to 26th December 2015 being the wettest. At Bala, February 2020 was the second wettest month since the start of record in 1961, with December 2015 being the wettest. The daily observer at Llanarmon Dyffryn Ceiriog reported that February 2020 was the wettest February, and the second wettest of any month, since the start of record in 1955.

3. Storm Ciara (8th - 10th February)

2.1 Background

On the evening of the 8th of February, Storm Ciara brought high winds and heavy widespread rainfall across Britain. North Wales experienced large waves around the coast and most areas were affected by the rainfall. River levels rose accordingly, most notably in the Elwy, Conwy and Dee catchments, resulting in several flood warnings being issued and two severe flood warnings issued on the Elwy at St. Asaph.

This section of the report concentrates on those catchments that experienced the most notable rainfall and river levels; the Elwy, Conwy, Glaslyn and Dee.

3.2 River level & flow data

The peak river levels and flows experienced over the 9th and 10th of February 2020 are summarised in *Table 1* (below), along with their rankings against the long-term historic record.

On the Afon Elwy, Pont Y Gwyddel gauging station reached its highest flow since start of record in 1974. The peak at Pont Y Gwyddel (3.652m) exceeded the November 2012 peak by 17cm. Unfortunately, the level gauge at St Asaph failed and missed the peak, but the data does suggest it was the highest peak on record here also (corroborated by the Pont y Gwyddel peak upstream). Furthermore, on-site observations both during and after the event suggest the peak at St Asaph was in excess of 4.8m.

In the Dee catchment, the Afon Alwen and the Afon Ceiriog experienced large events with Brynkinalt weir recording the highest stage since the November 2000 floods.

It should be noted that there is some uncertainty in the accuracy of flow data at Cwmlanerch after the floods of March 2019, but the stage data appears to be OK.

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Peak Flow (m3/s)	Rank	Record Start
Pont Y Gwyddel	Elwy	09/02/2020 11:30	3.652	1	220	1	1974
St. Asaph	Elwy	09/02/2020 15:30	Gauge failed and data suspect. But likely the highest peak on record, exceeding the previous maximum of 4.352m in Nov 2012.				
Ruthin Weir	Clwyd	09/02/2020 16:30	1.129	3	22.7	7	1971
Pont Y Cambwll	Clwyd	10/02/2020 00:15	2.792	6	59.3	18	1973
Cwmlanerch	Conwy	09/02/2020 10:15	4.729	4	544	4	1964
Pont Fawr	Conwy	09/02/2020 11:30	8.406	7	LEVEL ONLY SITE	n/a	1999
Beddgelert	Glaslyn	09/02/2020 08:30	2.150	5	117	5	1967
Druid	Alwen	09/02/2020 10:30	2.176	5	131	4	1970
Brynkinalt Weir	Ceiriog	09/02/2020 12:30	1.449	3	52.6	7	1971
Manley Hall	Dee	09/02/2020 20:15	2.816	8	363	8	1969

Table 1. *River levels and flows recorded over 9th & 10th Feb 2020 and their rankings in the long-term record*

3.3 Rainfall data

3.3.1 Event specific rainfall

It should be noted that rainfall data has undergone only basic quality assurance and that most rain gauges were in broad agreement with the adjacent storage check gauges. Data from Llanarmon DC and Capel Curig Tipping Bucket Raingauges (TBRs) was rejected due to poor quality. The Capel Curig storage gauge data appears to be OK and recorded 190.6mm of rainfall over the first 15 days in February. This equates to 108% of the Long-Term Average (LTA) for February (175.3mm).

Data from most raingauges show that the most intense rainfall lasted around 16 hours, with event rarity diminishing after this time period. *Tables 2, 3, 4 and 5* show the highest rainfall totals experienced at each gauge for a range of durations. In addition, rainfall totals from 1st February to 10th February are expressed as a percentage of the February LTA. Rainfall totals at Brynhyfryd, Alwen and Betws Y Coed were particularly significant, with all 3 sites recording 100% of their LTA in the 1st ten days of February. Rainfall return periods were calculated using the Flood Estimation Handbook (FEH) Depth Duration Frequency tool on the FEH Webservice.

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 10th of Feb (mm)	%LTA February
Gwytherin	18.6	5	74.2	14	16	101.0	87%
Plas Pigot	16.4	4	57.6	16	11	71.6	94%
Brynhyfryd	6.6	0	38.4	15	3	53.6	100%
Clawddnewydd	9.8	1	50.6	16	7	72.6	87%

***Table 2**. Elwy and Clwyd Catchment Summary rainfall totals over a range of durations, Storm Ciara*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 10th of Feb (mm)	%LTA February
Alwen	10.6	1	67.0	15	20	104.8	107%
Pant Gwyn	9.2	0	63.6	17	1	96.8	38%

***Table 3**. Upper Dee Catchment Summary rainfall totals over a range of durations, Storm Ciara*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 10th of Feb (mm)	%LTA February
Llanrwst	22.0	6	100.2	16	25	130.6	99%
Betws Y Coed	13.6	2	79.2	15	14	107.8	100%
Ysbyty Ifan	10.0	0	58.6	16	0	95.4	61%

***Table 4**. Conwy Catchment Summary rainfall totals over a range of durations, Storm Ciara*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 10th of Feb (mm)	%LTA February
Cwm Dyli	15.4	2	117.6	12	4	170.0	77%
Hafod Wydr	15.2	2	90.7	16	5	104.4	61%

***Table 5**. Glaslyn Catchment Summary rainfall totals over a range of durations, Storm Ciara*

Maximum return periods ranged between being commonplace at Ysbyty Ifan and Pant Gwyn, to 1 in 25 years at Llanrwst (*Figure 4*). Both Ysbyty Ifan and Llanrwst are situated within the Conwy catchment. Notable 1-hour rainfall totals were experienced at both Llanrwst (22.0mm) and Gwytherin (18.6mm) raingauges. Rainfall return periods reduce after the 16

hours duration, as the rainfall dissipated. Rivers also started recessing within 24 hours of the start of the event.

Figure 4. *Distribution of maximum rainfall return periods across the area, Storm Ciara.*

3.3.2 Longer duration rainfall

The FEH Web Service allows for return period analysis for durations up to 10 days using the FEH2013 rainfall model. Analysis of longer duration rainfall totals for the 10 days preceding and including Storm Ciara yielded no events more significant than already presented in Tables 2 to 5 in the previous section.

4. Storm Dennis (15th - 16th February)

3.1 Background

On the morning of the 15th of February, Storm Dennis brought high winds and heavy widespread rainfall across the western area of the United Kingdom. Most North and Mid Wales catchments experienced high volumes of precipitation. River levels across the area were still recessing after Storm Ciara had brought flooding to parts of the region only 5 or 6 days earlier. This section of the report concentrates on those catchments most notably affected by Storm Dennis; the Dee, Teme, Upper Severn and Clwyd.

4.2 River level & flow data

The peak river levels and flows experienced over the 16th and 17th of February 2020 are summarised in *Table 6* (Dee, Clwyd & Elwy) and *Table 7* (Severn, Vyrnwy & Teme), along with their rankings against the long-term historic record.

On the River Teme, within the Upper Severn area, both level-only gauging stations recorded their highest levels since records began. There were some notable peaks in the middle and lower Dee catchment, with Bangor on Dee reaching its second highest stage value (16.249mAOD) since the record began in 1987. Farndon experienced it's 3rd highest peak of 9.288m, with only the October and November 2000 peaks having been higher. The River Severn at Buttington peaked at 5.403m, which is the 3rd highest peak since start of record in 1985. The Afon Clwyd and Afon Elwy also experienced notable peaks.

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Peak Flow (m3/s)	Rank	Record Start
Pont Y Gwyddel	Elwy	16/02/2020 06:00	2.817	4	138	4	1974
St. Asaph	Elwy	16/02/2020 08:30	3.922	3	LEVEL ONLY SITE	n/a	1997
Ruthin Weir	Clwyd	16/02/2020 08:30	1.143	2	23.3	4	1971
Pont Y Cambwll	Clwyd	16/02/2020 15:45	2.820	5	60.4	14	1973
Weir X	Tryweryn	16/02/2020 04:15	1.357	8	81.0	12	1992
Druid	Alwen	16/02/2020 06:00	2.176	9	123	8	1961
Brynkinalt Weir	Ceiriog	16/02/2020 07:45	1.458	2	53.4	5	1971
Bangor on Dee	Dee	16/02/2020 16:15	16.249	2	LEVEL ONLY SITE	n/a	1987
Farndon	Dee	17/02/2020 05:30	9.288	3	LEVEL ONLY SITE	n/a	1988
Manley Hall	Dee	16/02/2020 12:30	3.084	4	428	4	1969

Table 6. *Dee, Clwyd & Elwy catchments. Peak river levels & flows, 16th & 17th Feb 2020 and their rankings in the long-term record.*

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Peak Flow (m3/s)	Rank	Record Start
Dutlas	Teme	16/02/2020 03:15	2.535	1	LEVEL ONLY SITE	n/a	2006
Knighton	Teme	16/02/2020 06:15	2.852	1	LEVEL ONLY SITE	n/a	2002
Caersws	Severn	16/02/2020 06:00	3.371	12	LEVEL ONLY SITE	n/a	1986
Dolwen	Severn	16/02/2020 03:00	2.077	20	101	20	2000
Abermule	Severn	16/02/2020 09:30	4.174	7	351	3	1960
Munlyn	Severn	16/02/2020 13:15	3.909	4	LEVEL ONLY SITE	n/a	1998
Buttington	Severn	16/02/2020 19:30	5.403	3	LEVEL ONLY SITE	n/a	1985
Llandrinio	Severn	16/02/2020 22:15	7.061	4	LEVEL ONLY SITE	n/a	1994
Berriew	Rhiw	16/02/2020 02:15	2.184	9	LEVEL ONLY SITE	n/a	2004
Llanerfyl	Banwy	16/02/2020 06:30	2.835	27	LEVEL ONLY SITE	n/a	1998
Pontrobert	Vyrnwy	16/02/2020 07:00	3.155	3	LEVEL ONLY SITE	n/a	1998
Meifod	Vyrnwy	16/02/2020 08:30	3.552	6	LEVEL ONLY SITE	n/a	1985
Llanymynech	Vyrnwy	16/02/2020 12:30	5.046	3	510	3	1970

Table 7. *Vyrnwy, Severn and Teme catchments. Peak river levels & flows, 16th & 17th Feb 2020 and their rankings in the long-term record.*

4.3 Rainfall data

4.3.1 Event specific rainfall

It should be noted that rainfall data has undergone only basic quality assurance and that most rain gauges were in broad agreement with the adjacent storage check gauges.

Data from Llanarmon Dyffryn Ceiriog TBR raingauge, near the top of the Afon Ceiriog was rejected due to poor quality data. Pen y Gwely raingauge at the upper reaches of the River Vyrnwy, near Llanarmon Dyffryn Ceiriog has been included for comparison. Rainfall return periods were calculated using the Flood Estimation Handbook (FEH) Depth Duration Frequency tool on the FEH Webservice. *Tables 8, 9 and 10* show the highest rainfall totals experienced at each gauge for a range of durations. They also include the rainfall totals for February up to 17/02/2020, and how they compare to their respective February Long Term Averages.

At most sites, the highest return periods were associated with a storm duration of approximately 24 hours. The highest return periods of 1 in 8 years were at Bala and Rhos y Meirch raingauges *(Figure 5)*. Most sites didn't record extraordinary rainfall over short time periods. However over 24 hours, most areas recorded significant rainfall totals that contributed to flooding - particularly in catchments with rivers still elevated following the previous weekend's rainfall. Notably Pant Gwyn raingauge at the top of the River Dee recorded 91mm over 24 hours.

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 17th of Feb (mm)	%LTA February
Alwen	5.4	0	62.8	24	7	205.2	205%
Bala	6.2	0	70.6	24	8	220.6	228%
Pant Gwyn	10.6	1	91.0	24	3	258.4	102%

***Table 8**. Upper Dee Catchment Summary rainfall totals over a range of durations, Storm Dennis*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 17th of Feb (mm)	%LTA February
Clawdd-newydd	4.2	0	48.8	24	4	151.0	180%
Brynhyfryd	5.2	0	44.0	24	4	118.0	220%
Gwytherin	6.2	0	56.8	18	3	193.8	167%
Plas Pigot	3.8	0	37.8	18	2	139.4	185%

***Table 9**. Clwyd and Elwy Catchment Summary rainfall totals over a range of durations, Storm Dennis*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 17th of Feb (mm)	%LTA February
Dolydd	7.8	0	78.0	24	3	218.4	122%
Vyrnwy	5.4	0	73.8	24	4	255.4	175%
Cefn Coch	4.8	0	58.0	42	2	144.8	148%
Pen y gwely	3.6	0	41.6	24	2	129.2	151%
Rhos Y Meirch	7.0	0	62.6	30	8	131.8	179%

***Table 10**. Upper Severn Catchment Summary rainfall totals over a range of durations, Storm Dennis*

Figure 5. *Distribution of maximum rainfall return periods across the area, Storm Dennis*

4.3.2 Longer duration rainfall

The FEH Web Service allows for return period analysis of durations up to 10 days using the FEH2013 rainfall model. Analysis of longer duration rainfall totals for Storm Dennis and the preceding 10 days (including the rainfall of Storm Ciara) yields some significant return periods that exceed the event-specific results presented in the previous section. These are summarised in *Table 11*, below.

Raingauge	Rainfall (mm)	Duration (Days)	Return Period (Years)
Alwen	166.8	8	17
Bala	174.2	8	12
Clawdd Newydd	128.0	8	10
Brynhyfryd	103.2	8	8
Gwytherin	170.2	8	8
Plas Pigot	124.8	8	8
Vyrnwy	194.2	8	8
Pen y Gwely	125.4	8	5

***Table 11**. Longer duration rainfall analysis for Storm Dennis and the preceding 10 days*

5. Event of 21st to 24th February (un-named storm)

4.1 Background

Following Storm Ciara on 9th of February and Storm Dennis on the 15th of February, the prolonged wet weather over North and Mid Wales continued into the weekend of the 21st to 24th of February. The weather system produced frontal rainfall, which fell on saturated ground and caused river levels to rise again.

This section of the report concentrates on those catchments most notably affected by rainfall over the weekend of 21st to 24th February; the Dee, Clwyd, Conwy, Teme, Upper Severn, Mawddach, and the Dyfi.

5.2 River level & flow data

The peak river levels and flows recorded at locations over the 22nd to the 25th of February 2020 are summarised in *Tables 12 and 13* (below), along with their rankings against the long-term record.

It should be noted that there is some uncertainty in the accuracy of flow data at Cwmlanerch after the floods of March 2019, but the stage data appears to be OK.

On the Afon Tryweryn in the Dee Catchment area, Weir X recorded its 5th highest peak since the record began in 1992. Dolgellau level only site reached its second highest peak in record of 3.952m, with the previous highest level being recorded in February 2005. The River Teme has recorded its highest level three times during the various storms in February 2020.

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Peak Flow (m3/s)	Rank	Record Start
Ruthin Weir	Clwyd	24/02/2020 12:00	1.120	4	22.3	8	1971
Pont Y Cambwll	Clwyd	24/02/2020 19:15	2.690	11	55.7	20	1973
Cwmlanerch	Conwy	22/02/2020 02:00	4.677	6	528	5	1964
New Inn	Dee	22/02/2020 01:15	2.595	3	96.6	3	1982
Weir X	Tryweryn	22/02/2020 01:30	1.513	1	114	5	1992
Manley Hall	Dee	23/02/2020 14:15	2.526	12	299	12	1969
Bangor on Dee	Dee	23/02/2020 18:00	16.055	8	LEVEL ONLY SITE	n/a	1996
Farndon	Dee	25/02/2020 06:15	9.113	7	LEVEL ONLY SITE	n/a	1988
Dolgellau	Mawddach	22/02/2020 02:00	3.952	2	LEVEL ONLY SITE	n/a	1990
Dyfi Bridge	Dyfi	24/02/2020 11:30	3.915	7	353	13	1979

***Table 12**. Dee, Clwyd, Mawddach and Dyfi catchments. Peak levels and flows over 22nd to 25th Feb 2020 and their rankings in the long-term record*

Gauging Station	River	Date/Time of peak	Peak stage (m)	Rank	Peak Flow (m3/s)	Rank	Record Start
Dutlas	Teme	23/02/2020 07:45	2.227	3	LEVEL ONLY SITE	n/a	2006
Knighton	Teme	23/02/2020 09:45	2.157	3	LEVEL ONLY SITE	n/a	2002
Caersws	Severn	24/02/2020 13:15	3.395	10	LEVEL ONLY SITE	n/a	1986
Dolwen	Severn	24/02/2020 11:45	2.552	5	152	5	2000
Abermule	Severn	23/02/2020 12:30	4.027	11	292	7	1960
Munlyn	Severn	23/02/2020 15:30	3.660	8	LEVEL ONLY SITE	n/a	1998
Buttington	Severn	23/02/2020 20:15	5.280	8	LEVEL ONLY SITE	n/a	1985
Llandrinio	Severn	24/02/2020 02:00	6.996	9	LEVEL ONLY SITE	n/a	1994
Berriew	Rhiw	23/02/2020 08:30	2.297	5	LEVEL ONLY SITE	n/a	2004
Llanerfyl	Banwy	23/02/2020 07:00	2.835	9	LEVEL ONLY SITE	n/a	1998
Pontrobert	Vyrnwy	23/02/2020 07:00	2.913	7	LEVEL ONLY SITE	n/a	1998
Meifod	Vyrnwy	23/02/2020 09:30	3.586	5	LEVEL ONLY SITE	n/a	1985
Llanymynech	Vyrnwy	23/02/2020 15:30	4.874	6	435	6	1970

Table 13. *Upper Severn Area River levels and flows recorded over 22nd to 24th of Feb 2020 and their rankings in the long-term record*

5.3 Rainfall data

5.3.1 Event specific rainfall

It should be noted that rainfall data has undergone only basic quality assurance and that most rain gauges were in broad agreement with the adjacent storage check gauges. The exception being Rhydymain raingauge in the Mawddach catchment which recorded 14% less data than its adjacent check gauge. Data recorded after Storm Ciara at Dolydd raingauge has been deemed as good quality, however caution is advised when looking at totals for the whole month at that site.

Rainfall return periods were calculated using the Flood Estimation Handbook (FEH) Depth Duration Frequency tool on the FEH webservice. *Tables 14, 15, 16, 17* and *18* show the highest rainfall totals experienced at each gauge for a range of durations. They also include the rainfall totals for February (up to 25/02/2020) and how they compare to their February Long Term Averages. Pant Gwyn raingauge recorded over 249mm of rainfall over a duration

of 120 hours, which equates to a return period of 1 in 51 years. Llanymawddwy also recorded a significant amount of rainfall, with a 1 in 14-year event over a 120 hours duration. Maximum return periods for each raingauge for this event are shown in *Figure 6*, below.

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 25th of Feb (mm)	%LTA February
Alwen	5.4	0	85.2	120	2	303.6	303%
Bala	6.6	0	96.8	60	5	357.6	370%
Pant Gwyn	15.6	2	249.2	120	51	537.4	324%

***Table 14**. Upper Dee Catchment Summary rainfall totals over a range of durations, 21st to 24th Feb*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 25th of Feb (mm)	%LTA February
Clawdd-newydd	4.6	0	52.8	60	2	227.0	271%
Brynhyfryd	5.2	0	44.0	60	2	177.6	331%
Gwytherin	5.0	0	97.2	120	2	301.6	259%

***Table 15**. Clwyd and Elwy Catchment Summary rainfall totals over a range of durations, 21st to 24th Feb*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 25th of Feb (mm)	%LTA February
Dolydd	9.6	1	176.6	120	6	415.4	231%
Vyrnwy	9.8	2	156.8	120	8	436.0	298%
Cefn Coch	6.8	0	78.4	66	4	255.6	261%

***Table 16**. Upper Severn Catchment Summary rainfall totals over a range of durations, 21st to 24th Feb*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 25th of Feb (mm)	%LTA February
Betws Y Coed	6.2	0	144	120	6	366.2	277%
Ysbyty Ifan	9.8	0	211.0	120	6	423.4	218%

***Table 17**. Conwy Catchment Summary rainfall totals over a range of durations, 21st to 24th Feb*

Raingauge	Rainfall over 1 hr (mm)	Return Period (years)	Critical Rainfall (mm)	Duration (hours)	Return Period (years)	Rainfall from 1st to 25th of Feb (mm)	%LTA February
Aberllefeni	10.6	0	206.2	120	5	443.6	219%
Rhydymain	9.8	0	154.8	120	3	311.4	202%
Llanymawddwy	11.6	1	218.8	120	14	487.6	240%

***Table 18**. Mawddach and Dyfi Catchments Summary rainfall totals over a range of durations, 21st to 24th Feb*

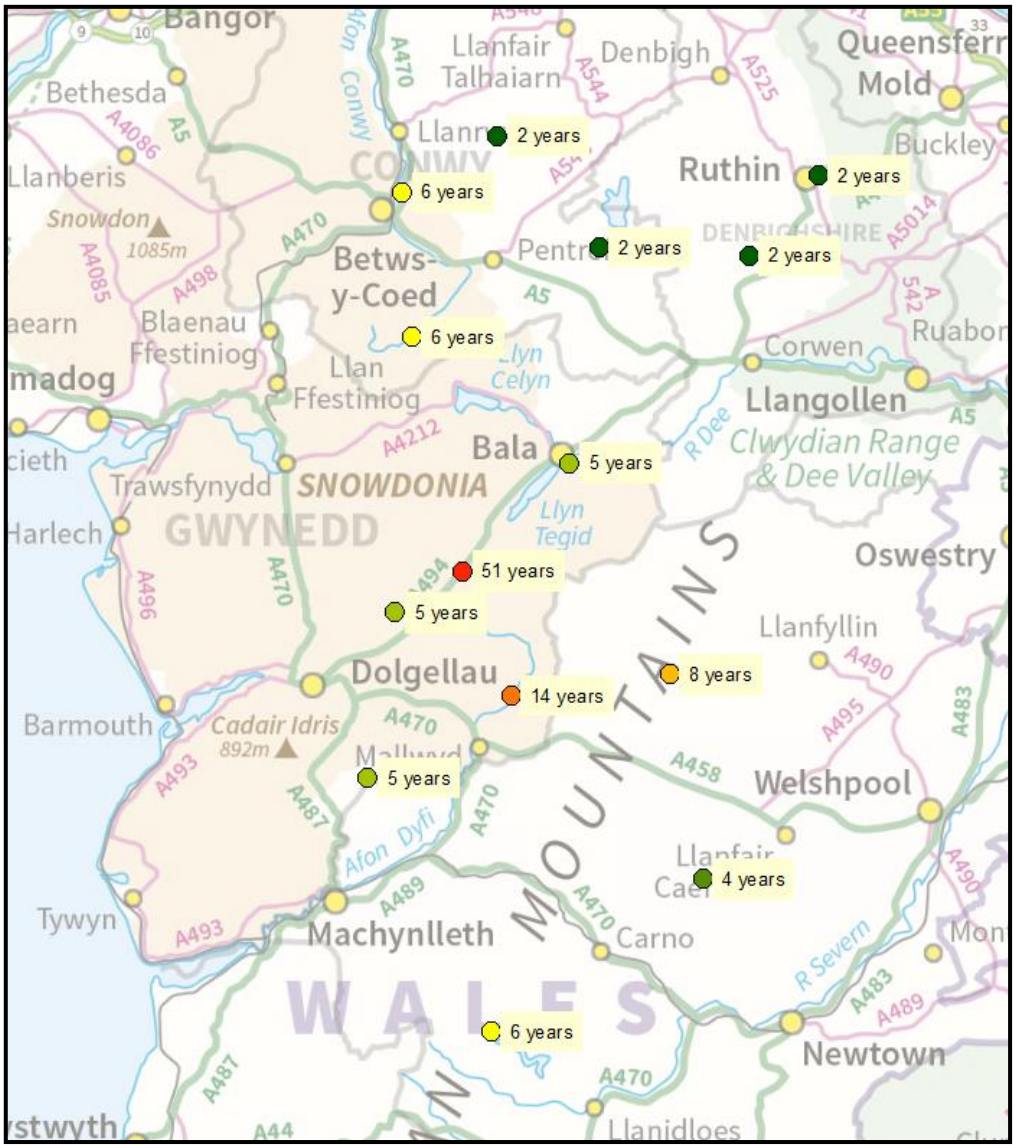

***Figure 6.** Distribution of maximum rainfall return periods across the area, 21st to 24th February 2020*

5.3.2 Longer duration rainfall

The FEH Web Service allows for return period analysis of durations up to 10 days using the FEH2013 rainfall model. Analysis of longer duration rainfall totals for storm of 21st-24th February and its preceding 10 days (including the rainfall of Storm Dennis) yields some significant return periods that exceed the event-specific results presented in the previous section. These are summarised in Table 19, below.

Raingauge	Rainfall (mm)	Duration (Days)	Return Period (Years)
Alwen	170.4	8	19
Bala	190.0	8	24
Clawdd Newydd	130.2	8	12
Brynhyfryd	106.0	8	10
Gwytherin	172.0	8	9
Dolydd	276.2	8	15
Vyrnwy	226.6	8	26
Cefn Coch	145.4	8	8
Betws Y Coed	185.8	8	8
Aberllefenni	297.4	8	10

***Table 19**. Longer duration rainfall analysis for the storm 21-24th Feb 2020 and its preceding 10 days.*

6. Storm Jorge (29th February – 1st March)

The prolonged wet weather continued over the UK into the weekend of the 29th of February with Storm Jorge, which brought yet more heavy rainfall to saturated ground and caused river levels to rise again. For North and Mid Wales, the resulting peak river levels were not nearly as significant as had been experienced over the previous 3 weeks, and as such have not been considered further in this report.

Analysis of long duration rainfall for the 10 days preceding (and including) Storm Jorge reveals some significant rainfall totals at several locations. These are summarised in *Table 20*, below. At Pant Gwyn, 354.4mm of rain fell in just 9 days. This equates to 140% of the February LTA and has a return period in excess of 100 years. At Vyrnwy, 255.4mm of rain fell in 9 days, which gives a return period of 40 years.

Raingauge	Rainfall (mm)	Duration (Days)	Return Period (Years)
Pant Gwyn	354.4	9	>100
Bala	209.6	9	31
Cwm Dyli	275.6	5	10
Hafod Wydr	198.3	5	9
Llanymawddwy	314.2	9	25
Vyrnwy	255.4	9	40
Cefn Coch	165.0	9	12
Dolydd	276.2	9	15

***Table 20**. Longer duration rainfall analysis, up to 10 days preceding Strom Jorge.*