Gwynedd floods

November 2012

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Document Control Sheet

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Background

This report describes the **flood event which took place on the 22 November 2012 in Gwynedd**. The story however starts in April 2012 when it started to rain and continued, without respite, for the rest of the year. There were prolonged spells of wet weather with intermittent periods of very heavy rainfall which caused flooding.

The first flood event occurred in June and affected south Gwynedd with flooding in Pennal, Abergynolwyn, Corris and Bryncrug with a total of 17 properties flooded. There was also the safety issue regarding the old quarry dam above Pennal and the evacuation procedure that was instigated.

North Gwynedd was affected by heavy rainfall in July which caused some localised flooding on the Llyn Peninsula and almost brought about the cancellation of the Wakestock Festival in Abersoch.

As this persistent and sporadic heavy rainfall continued to fall it was filling all the natural underground voids and raising the water table until the ground was completely saturated. This complete saturation means that rainfall becomes sheet runoff which enters the watercourses very quickly contributing to flash floods.

Flood during Wakestock Festival, Abersoch, July 2012

Flood in Llanberis, November 2012

Met Office data states that **2012 was the third wettest year in Wales** since records began in 1910 and that the week 20 to 26 November 2012 was one of the wettest weeks for 50 years.

This set the scene for the November floods, **the ground was saturated and the river levels were high and the resultant flooding inundated over 250 properties, closed the A55 for 12 hours and caused widespread disruption**. The locations and the density of the flooding are shown on the map in Appendix 1.

All the high profile flood incidents such as Llanberis, Nantlle, Mynydd Llandegai, Talybont, Rhostryfan and the closure of the A55 were all from ordinary watercourses being unable to cope with the volume of water. As an overall estimate, bearing in mind that each individual flood event may have multiple sources, the main sources were 70% from ordinary watercourses, 20% from surface water and 10% from main rivers.

Explanatory note

There is an industry standard term to describe the probability and severity of flood events. This is referred to as the **return period** in years and is used extensively in this report. To assist readers of this report there is an explanation in Appendix 2 of what we mean by probability of flooding and the term return period.

Return period figures can be produced for anything which is repeated and can be measured and is used frequently for meteorological events. For fluvial flood risk there are two variables which can be measured, they are rainfall and river flow. Rainfall is measured using rain gauges and river flow is measured by gauging stations situated in the river. It is important to know what the return period figures refer to because they can differ greatly for the same flood event and if not used correctly they can be very misleading as illustrated in the example below.

River level and rainfall return periods

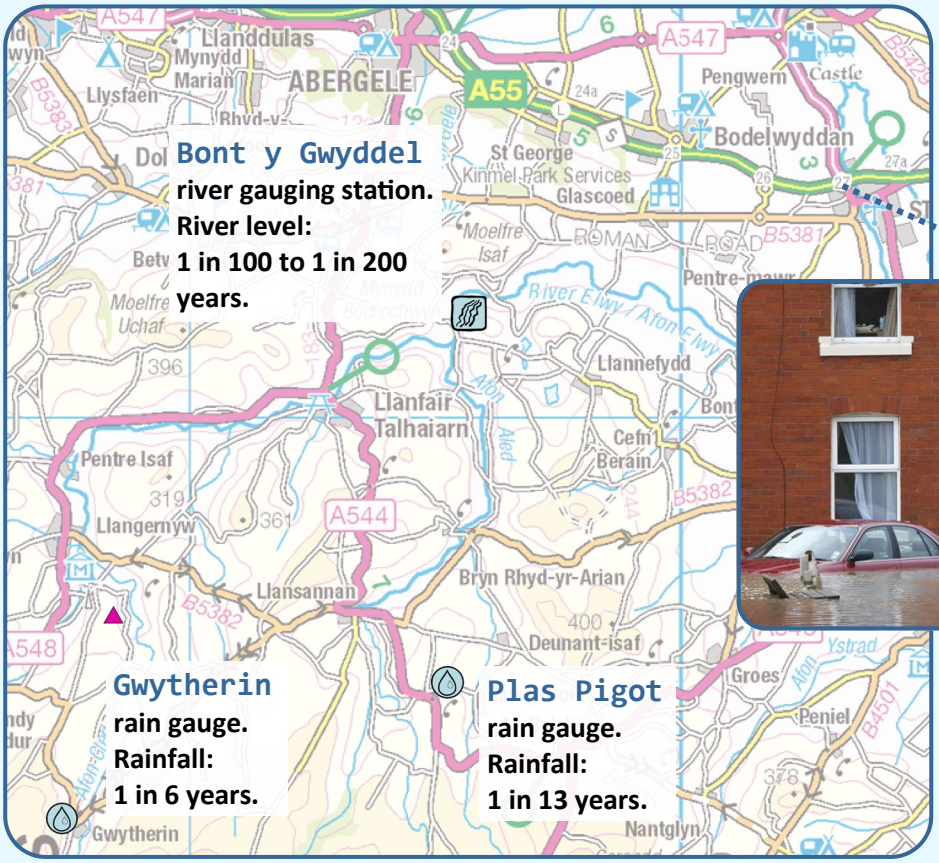
This example is based on the **Afon Elwy in Denbighshire**, using data quoted by Natural Resources Wales, for the flooding event which occurred on the 27 November 2012. The data used is from one river gauging station and two rain gauges.

The river gauging station is at Bont y Gwyddel which is approx 300m downstream of the confluence of the Afon Elwy and Afon Aled and 2.5 miles downstream of Llanfair Talhaiarn. The river gauge at Bont y Gwyddel for 27 November gave a peak flow return period of between 1 in 100 and 1 in 200 years.

At Plas Pigot approx 6.5 miles upstream of Bont y Gwyddel on the Afon Aled the rain gauge recorded a reading of 66mm in 18 hours giving a return period of 1 in 13 years.

At Gwytherin approx 12 miles upstream of Bont y Gwyddel on the Afon Gledwen, a tributary of the Afon Elwy, the rain gauge recorded a reading of 68mm in 18 hours giving a return period of 1 in 6 years.

The return period for the river level is significantly higher than the return periods for the rainfall. This can be explained because the river levels were already high in the Elwy before the rainfall of 27th November and the ground was saturated producing 100% runoff.



St Asaph evacuated after river Elwy breaches flood defences, November 2012

Gwynedd flooding

Tables 1 and 2 below give readings from 7 rain gauges located in the Arfon and Dwyfor areas of Gwynedd, all data is for the 22 November 2012 event.

Rain Gauge	Abersoch	Llithfaen	Criccieth
Most significant intensity	29mm in 1.75 hrs starting at 12:00	21mm in 2.75 hrs starting at 11:15	16mm in 2.25 hrs starting at 12:00
Most significant return period	1 in 21 year	1 in 4 year	1 in 2 year

Table 1. Rainfall summary for Llyn.

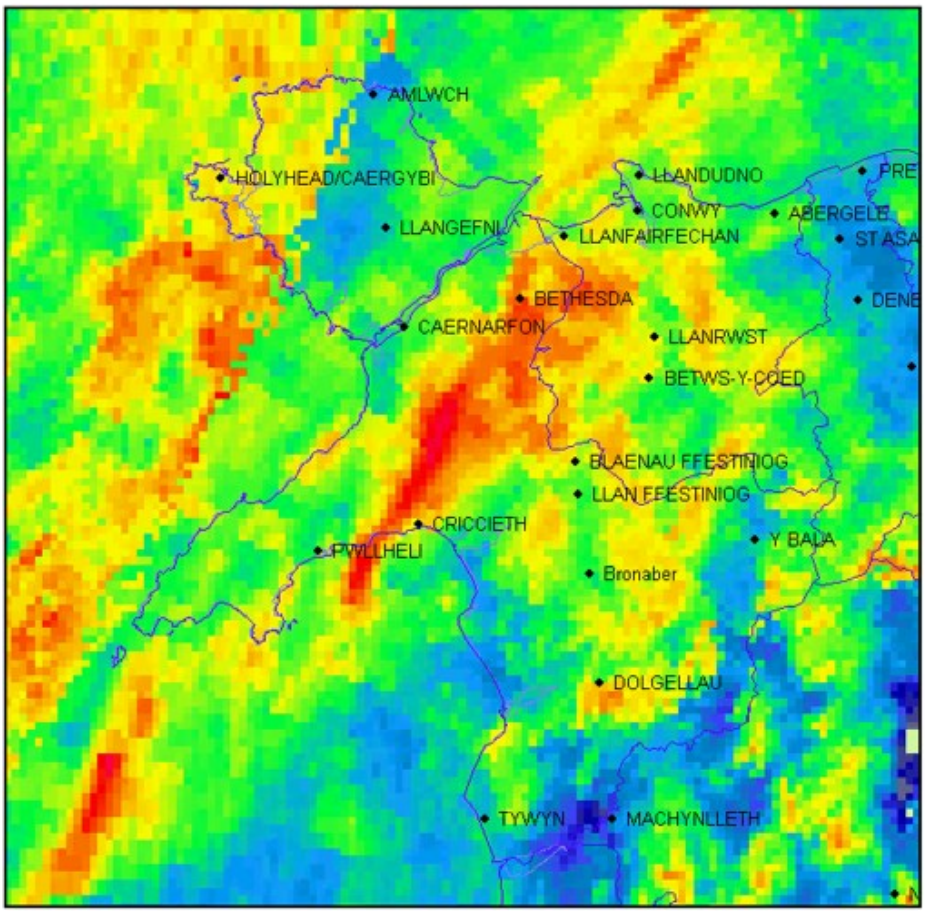
Rain Gauge	Cwm Dulyn	Betws Garmon	Cwm Dyli	Bethesda
Most significant intensity	42mm in 2 hrs starting at 12:15	45mm in 2.25 hrs starting at 12:15	20mm in 2.25 hrs starting at 12:15	34mm in 2 hrs starting at 12:30
Most significant return period	1 in 23 year	1 in 21 year	1 in 1 year	1 in 11 year

Table 2. Rainfall summary for Eryri.

The locations of the rain gauges are shown on the map in Appendix 1.

It can be seen on the map in Appendix 1 that the spine of the heavy rainfall was along a line stretching from Abersoch to Llanllechid with nearly all the flood locations being on north west side of the line.

The red colour on the radar image represents the most intense areas of rainfall at 13:00 on 22nd November 2012.



MetOffice Rainfall Radar Image for North West Wales

When undertaking flood risk analysis it is important to know what the data refers to. Is it rainfall or river levels? The Afon Elwy example given above illustrates the potential pitfalls of using the return period figures out of context.

On one hand the rainfall gauge data giving a 1 in 23 year return period event ties in with the last known event of this magnitude 25 years ago in 1987 which affected Llanberis, Rhostryfan, Talybont and the A55. Using the rain gauge data only suggests that both flood events had a return period of approximately 1 in 25 years.

If this is correct then the probability is that locations which flooded recently will experience flooding of a similar magnitude again within 25 years. Climate change forecasts indicate that such events will occur more frequently in the future. Therefore, people should be prepared to deal with the effects of such events more often.

Conclusions

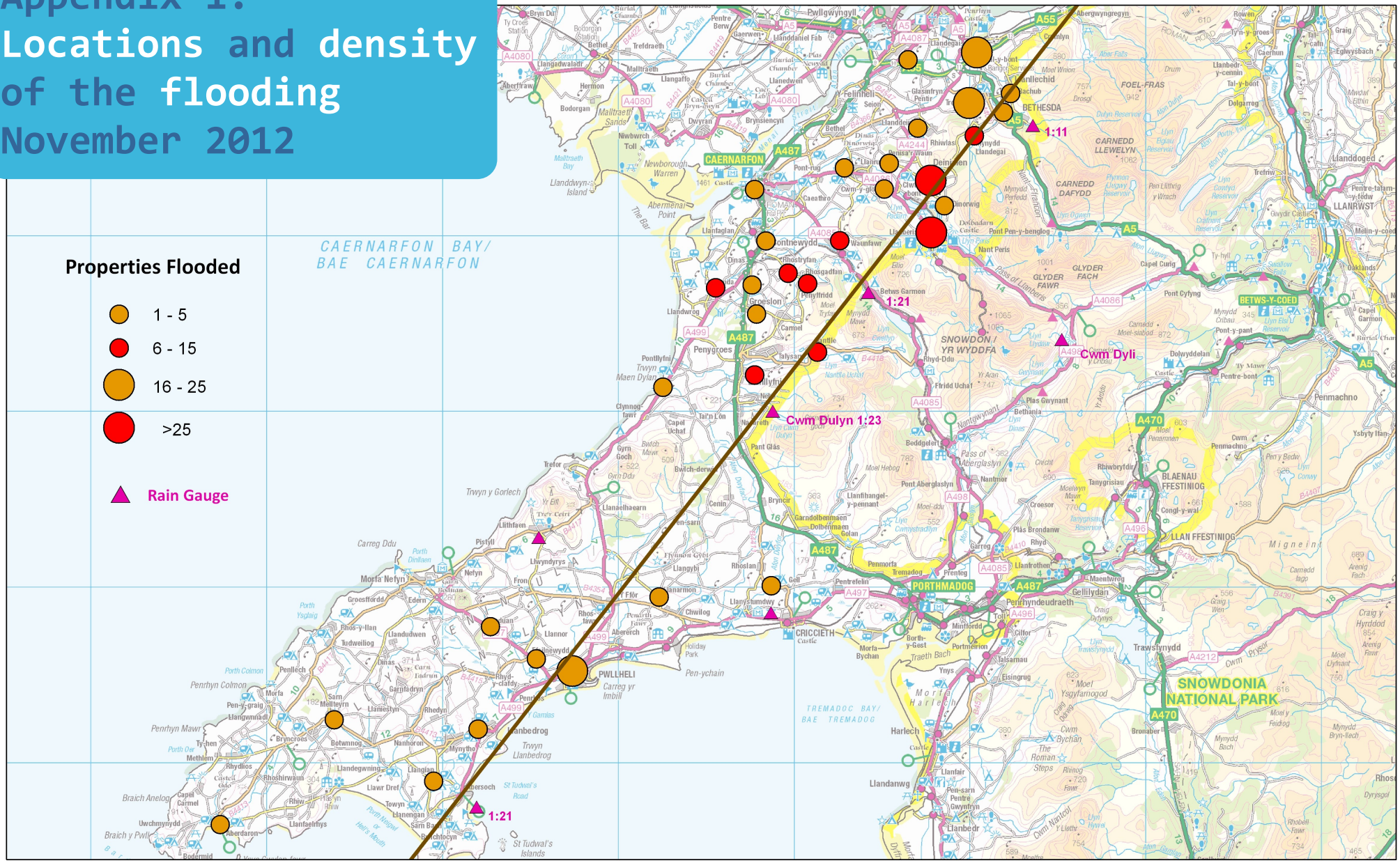
Rainfall gauge readings do not take into consideration the degree of saturation of the ground nor the level of the rivers leading up to the flood event. This is illustrated by the example of the Afon Elwy where there was a significant difference between the return period of the rainfall and the river level.

For the flooding which occurred from the Afon Goch in Llanberis and the Afon Wyled in Rhostryfan we only have rainfall data, the river levels prior to and during the event are unknown therefore we do not know what the return period of the river levels were.

It could be that the flooding we experienced in 1987 and 2012 were from river levels with a return period of say 1 in 100 years and that we have just been unlucky to experience two such events in 25 years. It can happen.

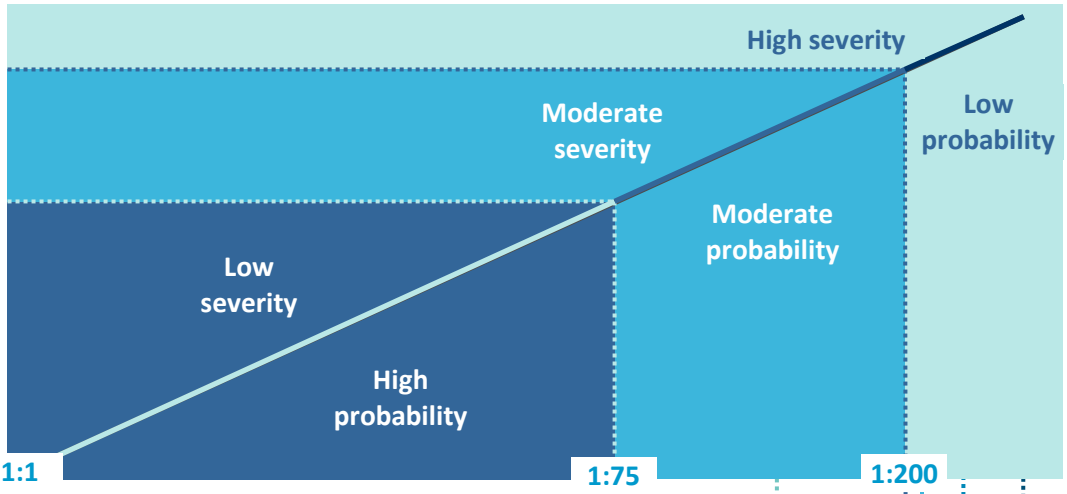
Appendices

Appendix 1. Locations and density of the flooding November 2012



22/11/2012

Appendix 2. Probability or likelihood of flooding explained

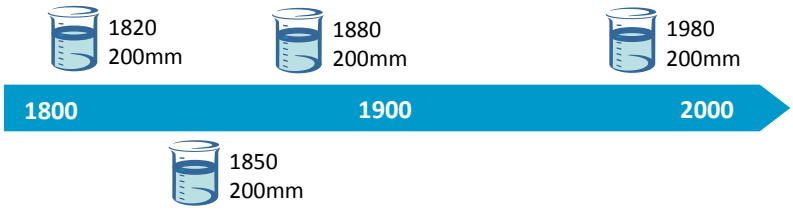


The probability or **likelihood of flooding** is described as the chance that a location will flood in any one year. This may be expressed as:

1:20 A 1 in 20 chance of flooding in any one year; or,

5% A 5% annual probability of flooding.

For Flood Risk Analysis the **return period** is an estimate of the likelihood or expected frequency of an event of a certain magnitude. In the example below, a 200mm rainfall has occurred 4 times in 200 years, so the return period for such event is 1 in 50 years (200/4).



Therefore, the return period is:

a statistical value based on historical data,

the average recurrence interval between floods of the same magnitude.

But keep in mind:

Floods do not occur at regular time intervals. A **1 in 50 year return period** does not mean...

that a flood will occur every 50 years,

that if it has occurred it will not 'return' for another 50 years. The fact that a flood has happened does not change the chance of it happening again.

that a flood of this magnitude will always have a 1 in 50 year return period. Climate change will increase the frequency of flooding, i.e. 1 in 50 now might be 1 in 30 in the future.

When we describe **the chance of flooding**, we put it into one of three categories:

	Chance of flooding in any year
High probability	1:1 to 1:75 (100% to 1.3%)
Moderate probability	1:75 to 1:200 (1.3% to 0.5%)
Low probability	1:200 (0.5%) or less

1:100?

1:200

1:250

1:400

1:1000