A SELECTION OF EXTREME FLOOD EVENTS – THE IRISH EXPERIENCE

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1. INTRODUCTION

This paper presents a technical discussion of six significant flood events in Irish Catchments over the past 50 years. These catchments and flood events are the River Dodder Dublin - August 1986, the River Lee Co. Cork – Aug 86 and Nov 00, the River Brosna Mullingar - November 1965, the River Deel at Crossmolina Co. Mayo October 1989, the River Clare Co. Galway November 1968 and the River Griffeen Dublin November 2000. Details as to the severity and rareness of the flood event along with information on rainstorm conditions are presented. Estimated flood runoff rates, flood and storm return periods and percentage storm runoff are presented.

2. RIVER DODDER FLOODING

General Description

The Dodder River which rises in the Dublin Mountains and drains northwards through south Dublin to Ringsend has long been noted for its flashy response to rainstorms. In a paper by F.G. Dixon (1953) to the Old Dublin society he made reference to floods in the Dodder in Sept 1787, Nov 1794, Dec 1802(ranked as the most serious flood), Sept 1807, Jan 1851, Sept 1880, Oct 1891, etc. In a report to the Commissioners of Drainage of Ireland in 1844 by Robert Mallet, he referred to the effect of flooding the river had on the lands along its banks as follows: (source Dublin City Council, 1986)

> "*One of the frequent floods on the river occurred so suddenly at night, of such magnitude, and attended with such appalling circumstances of destruction to property and danger to human life, as to have aroused the public concern for the damage resulting.*"

Over the past century flooding events resulting in overtopping of river banks occurred in 1905 (ranked as second largest flood this century), 1912, 1915, 1931, 1946, 1958, 1965 and the most recent and disastrous 25th/26th August 1986 (known as Hurricane Charlie) following exceptionally heavy rainfall. During construction of the Bohernabreena reservoirs in the 1880's two flood events were noted in September 1883 and October 1886 when 96.5 and 93.5mm of rainfall fell during storms which lasted for approximately 14hours with runoff at a scale of 23.3 l/s per ha (2.23cumec per km^2).

The River Dodder rises near Kippure in the Dublin Mountains at an elevation 751m OD. The principal tributaries are the Owendoher River, the Little Dargle, the Dundrum River and the Tallaght stream. The Dodder has a total catchment area of 113.3 km^2 to its confluence with the River Liffey at Ringsend. Its upper reaches stretch from Kippure to Bohernabreena where it forms a reservoir system which is an integral part of the Dublin City Supply (Bohernabreena Reservoir created in 1883). It flows northwards to Tallaght and then north-eastward through Rathfarnham/Terenure, Donnybrook, and Ballsbridge before discharging into the Liffey Estuary at Ringsend. The total length of the river from source to outfall is 27km. The average channel gradient between the source of the river at Kippure and the spillway at Bohernabreena is 1 in 15. From Bohernabreena Lower reservoir downstream to Ringsend the channel has a gentler gradient of 1 in 115 (this gradient would still be considered significant). The lower 16km of the river contains 13 weirs of varying height. Downstream of the weir at Ballsbridge the river is tidal. The river is gauged by the DCC/EPA at Orwell Weir (95km^2) and at Bohernabreena (28km^2).

Historical Flood Flows

A list of the 15 largest flood flows on the Dodder gauged at Orwell Bridge Station (09010) over at least 100years is presented in Table 1 below. This information was derived from a combination of previous floods in the Dodder (1880 – 1986) compiled by Jack Keyes (1987) and the EPA annual

maximum (AM) flow series (MacCárthaigh EPA, 2005). The Hurricane Charlie Flood represents the historical maximum flood in the Dodder in at least 100years if not significantly longer.

Table 1 List of highest Ranked floods on the Dodder at Orwell Weir

Date	Peak Flow (cumec)
25 August 1986	232
25 August 1905	198
05 November 2000	156
03 September 1931	153
17 November 1965	139
19 December 1958	116
02 December 2003	112
11 June 1993	110
05 November 1982	106
09 April 1998	87
02 November 1968	85
December 1983	82
11 June 1993	81
26 August 1912	80
25 September 1957	74

The number of properties flooded by the Dodder during Hurricane Charlie was estimated to be 340. The main areas of Flooding were from Lower Dodder Road, Orwell Gardens, Dartry Cottages, Clonskeagh Road, Simmonscourt Terrace, Eglinton Road, Anglesea Road, Merrion Road, Wilfield Road, Gilford Road, Shelbourne Road, Ballsbridge Avenue and Beatty's Avenue. Flooding was also observed on the Poddle (85 properties flooded), Camac (30 properties flooded) and Tolka (10 properties flooded) Rivers (Keyes, 1987).

Rainfall

During Hurricane Charlie it was estimated based on 11 rain-gauging stations using Thiessen's Polygons that the catchment areal rainfall to Orwell Gauging Station was 134mm in 24hours and 137mm in 31hours. Slight adjustment in the rain gauge representation gave a rainfall estimate for the catchment of 142mm in 24hours and 145mm in 31hours. These rain depths averaged over a catchment area of 95km^2 to Orwell Gauge represent substantial rainfalls well in excess of 100years.

Table 2. Comparison of Rainfall amounts at specified gauge locations between 1905 and 1986 events
*(*Extracted from O Reilly Met Report, 1987.)

Location	1986 Storm	1905 Storm
Glenasmole	165.3mm	145.3mm
Bray	86.0mm	113.0mm
Dunlaoghaire (Harbour yard)	77.5mm	80.5mm
Dunlaoghaire (Peoples Park)	67.7mm	79.5mm
Phoenix Park	85.1mm	85.1mm
Stillorgan	89.0mm	81.8mm
Glasnevin	73.5mm	90.9mm

Antecedent conditions prior to the arrival of Hurricane Charlie were reasonably wet resulting in relatively low SMD. In the upper Dodder catchment, approximately 180mm of rainfall fell in a 24hour period from 9:00am Monday to 9.00am Tuesday 26th August. This exceeded the previously largest 24hour rainfall amount recorded in 1905 and practically doubled that recorded during the 1965 flood. The 24 hour rainfalls in the lower catchment are similar to previous recorded highs and would

be of the order of 100year return period storm event. At the Kippure summit 1day fall of 250mm was registered.
The MET Eireann 100-year 24hour duration rainfall amount for Casement rain gauge is 91mm and 128mm for Glenasmole gauge. During Hurricane Charlie 89.2mm fell at Casement and 162.5mm fell at Glenasmole in 24hrs.

Flood Flow Estimate and Return Period

The peak flow rate for Hurricane Charlie was estimated at that time to be between 215 and 254cumec with 232cumec being used (Hennigan et al., 1988). These estimates were based on a rating equation derived from flow measurements having a peak measured flow rate of only 33cumec (not very reliable given the extrapolation length involved). A flow estimate of 228cumec was produced using Horton's (1907) Weir equation for Orwell Weir. Flood profile modelling of the Orwell weir and upstream reach gave a flow estimate of 201cumec (Hennigan et al, 1988).

The EPA's most recent estimate for the Hurricane Charlie flood peak is a flow rate of 269cumec. This is derived from present day rating relationship which includes a maximum gauged flow rate of 106.5cumec (measured on the 3rd Feb 1994). A flow estimate of 264cumec was obtained by fitting a best fit curve to the gauged flows above 20cumec, refer to **Figure 1**. Deriving the Hurricane Charlie flow represents a significant extrapolation from the reliable range of 107cumec with ±30cumec also possible. In the following flood frequency analysis to estimate the flood return period the original flow estimate of 232cumec is retained. A flow rate of 232cumec represents a runoff rate of 2.44cumec per km^2 or 24.4 l/sec per ha over the entire catchment and represents approximately 70% storm runoff. Using the gauged annual maximum flow series for Orwell gauge 1949 to 2004 (8 AM years were missing) and fitting an EV1 and an EV2 (k=-0.15) probability distribution gives a return period for the Hurricane Charlie peak flow of 469years and 142 years respectively, refer to **Figure 2**. The EV1 fit is poor and thus the return period estimate of 469years is not considered accurate bearing in mind the high flow recorded in 1905. The EV2 fit (i.e. the k value) is considerably influenced by the Hurricane Charlie flow estimate. If this estimate represents an outlier or is substantially over-estimated it will skew upwards the return period estimates. A censured flood frequency analysis using the documented 15 highest AM floods in 100years is presented in **Figure 3**. This approach allows inclusion of the highest floods in the past century and gives a return period estimate of 158years which is similar to the EV2 estimate.

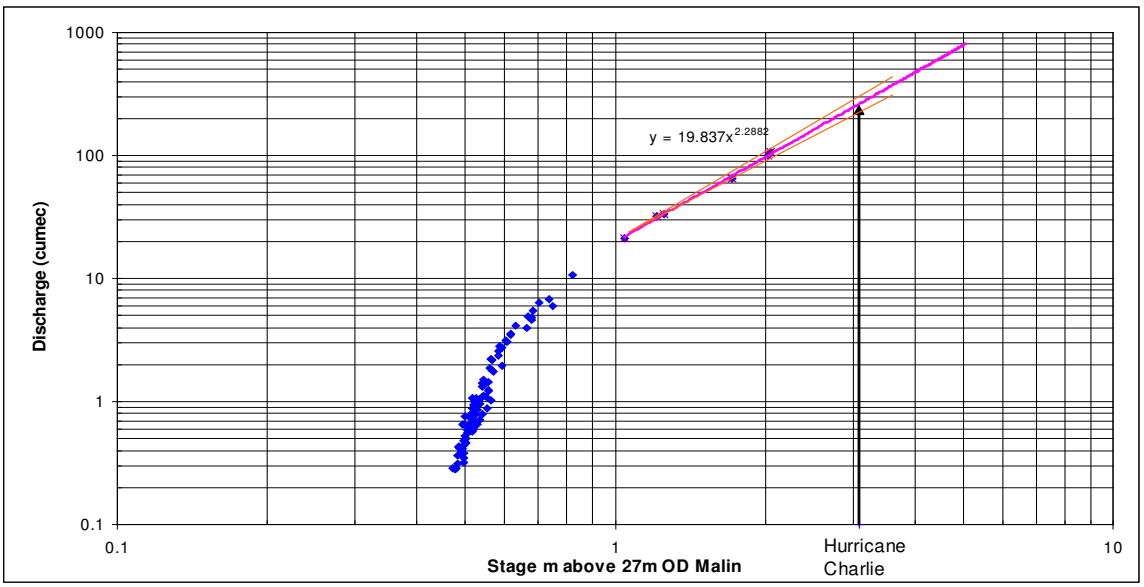

Figure 1 Rating Data and best fit Rating Curve for River Dodder Flood Flows at Orwell Bridge (Station 09010)

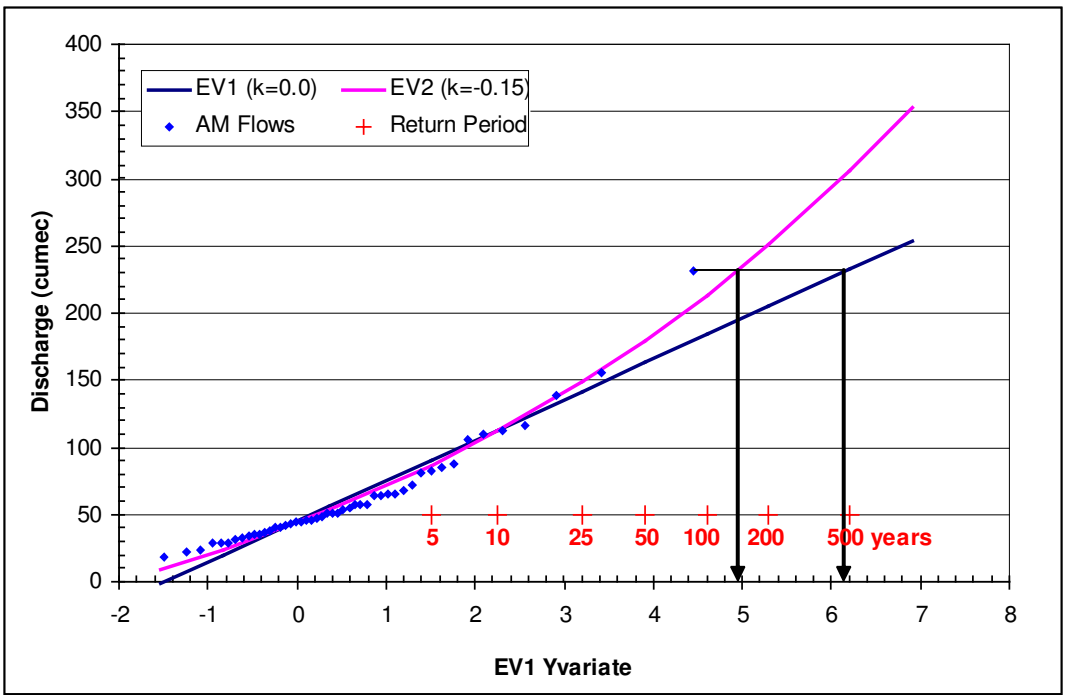

Figure 2 Dodder Flood Frequency analysis and estimate of Return Period for Hurricane Charlie Peak flow

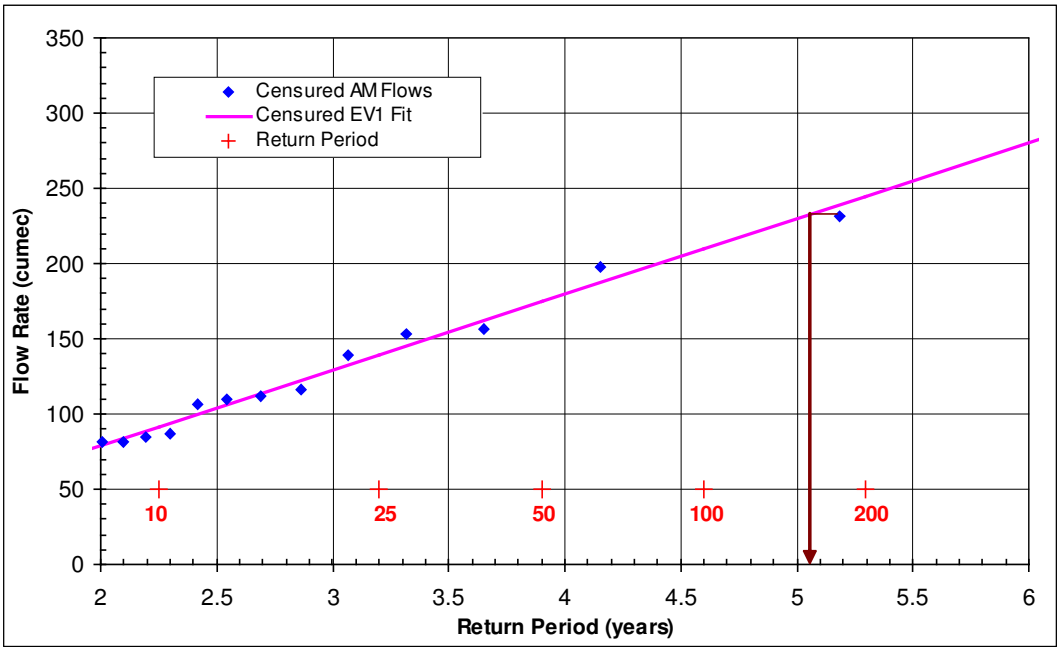

Figure 3 Censured Flood Frequency EV1 analysis using largest 15 AM flows in 100years (period 1905 – 2004).

3 FLOODING ON THE BROSNA MULLINGAR - NOVEMBER 1965

Introduction

It is known that a very large and disruptive flood occurred on the River Brosna in Mullingar in November 1965. This flooding represents the worst flooding in the River Brosna at Mullingar in at least 50years. This rainstorm event also produced significant flooding in neighbouring catchments. This occurred as a result of prolonged heavy rain which fell over a three day period, 16th to 18th November. During these days 24.4mm, 48.6 mm and 45.3mm rain were recorded by Met Eireann at Mullingar Synoptic Weather Station. The maximum hourly rainfall during these days was 11.1mm

which is not remarkable or rare – it could be exceeded once every two years. However when observed over longer durations the observed rainfall amounts correspond to increasingly rare events. For instance the maximum 6 hour total of 41mm occurred between 8pm on 17th November and 2am on 18th November and has a return period of 20 years according to rainfall depth return period data supplied by Met Éireann. The corresponding figures for longer durations are shown below in Table 3 where it is seen that for longer durations of 24 to 72 hours the storm was extremely rare with a return period of 100 years.
Five to six days after this storm Mullingar experienced heavy rainfall again on 24th and 25th November when 4.9mm and 33.9 mm fell respectively. 35.5mm fell in a 12-hour period, an event which has a return period of about 4 years.

Rainfall Statistics

Table 3 Maximum rainfalls of specified duration during the November 1965 storm in Mullingar and their estimated return periods.

Duration, hours	**1**	**6**	**12**	**24**	**48**	**72**
Max Rain, mm	11	41	62	80	98	122
Estimated T, yrs	2	20	50	100	100	≈100

Flow Estimate

Unfortunately there was no river gauging station in operation in the immediate vicinity of Mullingar at that time and while the flooding was described in newspaper articles of the time it is not possible to deduce accurately definite water level information about the flood. The bridge/culvert in Pearse Street was inadequate to convey the flow and part of the excess water found its way onto Pearse St. via Traynor's shop premises. It would appear from one published photograph that depth of flooding in Pearse St. was less than 0.5m but it is quite possible that a higher water level was experienced before the photograph was taken (refer to **Figure 4**).

Figure 4. Photo of 1965 Flooding on Pearse Street Mullingar (Compliments of Traynor Family)

An attempt has been made to "reconstruct" the river flow hydrograph corresponding to the November 1965 rainfall by two methods: unit hydrograph and the SMAR conceptual catchment model.
Hydrometric and rainfall data, from recorded flows in the 1990s were used to calibrate these models but not terribly successfully. The results indicate that the November 1965 flood peak was 10.3 m^3/s when calculated using the unit hydrograph method and 5.7 m^3/s when calculated using the SMAR conceptual model method.

The large disparity is partly due to the different nature of these models, the relatively poor calibration data and the unusual nature of the catchment given that it has no upland headwater portion. Lough Owel divides the 56 km^2 catchment upstream of Mullingar into two independently drained portions only the lower of which, 24km^2, drains through Mullingar. The remainder supplies a feeder channel for the Royal Canal.

Consideration of all the data leads to the conclusion that the November 1965 flood had a peak in excess of 7 cumec with a return period of between 30 and 50 years. This represents a flood runoff rate of 0.29cumec/km^2.

4. FLOODING ON THE RIVER LEE CO. CORK

Introduction

The River Lee rises in West Cork close to the Kerry border in the mountains that surround Gougane Barra Lake. It flows almost due east along a narrow valley for about 65km to Cork City, draining a total area of over 1,100 km².

Hydroelectric development was carried out on the Lee by the ESB between 1953 and 1957. Two generating stations were constructed at Carrigadrohid and at Inniscarra, each with a dam and reservoir. Table 4 presents data on the areas drained by the Lee and its tributaries.

Table 4. Areas drained by the Lee and its tributaries

River (draining into)	Subcatchment Area km^2	Catchment Area km^2
Lee (to Carrigadrohid)	616	616
Dripsey (Inniscarra Reservoir)	100	
Lee (Carrigadrohid to Inniscarra)	77 (177)	793
Bride	124	
Shournagh	216	
Lee (Inniscarra to Cork Water Works)	18 (358)	1,151

There is a long history of flooding due to the River Lee and its tributaries in Cork. The construction of the hydroelectric scheme and the subsequent control of the Lee have had a major influence on the nature of flooding on the Lee. Therefore, this review of past flooding considers separately events pre and post the development.

Pre Hydroelectric Scheme

Severe flooding was recorded in Cork City in January 1789 due to a combination of heavy rainfall and snowmelt. It was noted that low-lying areas of the city were inundated to a depth of between 5 and 7 feet.
On 2nd November 1853, Cork City was subjected to major flooding. Reports indicate that 12 people died as a result of the flooding and St Patrick's Bridge was washed away.
In November 1916, Cork City was again struck by flooding of a magnitude comparable to 1853. The peak flow at the Waterworks Weir in Cork during this flood was estimated at 523m³/s.

Post Hydroelectric Scheme

Inflow from the Upper Lee catchment is managed at Carrigadrohid through storage in the reservoir and controlled discharge. Inniscarra reservoir provides additional flood storage potential and controlled discharge via Inniscarra Generating Station and three overflow spillway gates and thus regulates discharge downstream towards Cork City.

The Lee dams have reduced significantly the extent and frequency of flooding along the Lee valley into Cork City but because of the relatively small size of the Lee reservoirs, the amount of flood alleviation reduces for the more extreme flood events.

The most severe flood event of the River Lee since 1957 occurred on the 5/6th August 1986. Significant rainfall occurred on the Upper Lee catchment. The mean area rainfall was estimated at 92mm.
Arising from this rainfall, the peak inflow at Carrigadrohid was 574m³/s and at Inniscarra was 504m³/s. However, due to the attenuation affects of the dams and reservoirs, the discharge from Inniscarra was 331m³/s. This inflow has a return period of approximately 100 years.

Downstream of Inniscarra, additional input to the Lee comes from the Bride, Shournagh and Curraheen catchments which comprise over 30% of the overall Lee catchment area.

The peak discharge from the Shournagh tends to be relatively large in relation to the peak discharge from Inniscarra. During August 1986, the maximum estimated discharge from the Shournagh was 158m³/s which is almost 50% of the maximum discharge from Inniscarra.

It is beneficial to avoid compounding the peak discharge from the Shournagh and Inniscarra dam at Leemount Bridge. In this case, the peak discharge on the Shournagh occurred 8 hours before the Lee. The Shournagh catchment is a relatively steep catchment and has a relatively quick response to flood events.

The water level recorder on the Bride ceased to function during this flood. The Bride catchment is relatively flat and the contribution of the Bride to the Lee during this flood was considered to be small relative to the dam discharge.

Table 5 Summary of Notable Lee Floods

	Carrigadrohid Area 616 km²	Inniscarra Area 793km³		Leemount d/s Area 1133km²	Waterworks Weir Area 1151 km²	
Flood	**Peak Inflow m³/s**	**Peak Inflow m³/s**	**Peak Discharge m³/s**	**Peak Discharge m³/s**	**Peak Discharge m³/s**	**Areal Rainfall mm**
Jan 1789		-	-	-	-	
Nov 1853		-	-	-	-	
Nov 1916		-	-	-	523 (4.5 l/s per ha)	
Aug 1986	574 (9.3 l/s per ha)	504 (6.4l/s per ha)	331 (4.2l/s per ha)	445 (3.93 l/s per ha)	-	92
Nov 2000	460 (7.5l/s per ha)	380 (4.8l/s per ha)	274 (3.4l/s per ha)	-	-	51

The most recent major flood on the Lee occurred in November 2000 which an estimated return period of 20 years. Summary information on this flood and the other floods discussed is presented in **Table 5**.

5. FLOODING ON THE RIVER DEEL AT CROSSMOLINA

Introduction

The River Deel through Crossmolina underwent Arterial drainage works in the reach immediately downstream of the town to its outfall with Lough Mask. These arterial drainage works involved channel deepening and widening with underpinning of bridge structures. These works alleviated flooding in the Town and adjacent lands. However on the 27th / 28th October 1989 a major flood occurred on the Deel which resulted in substantial flooding of the town with the main road in passable for approximately 18hours.

Anecdotal flood levels from a number of residents gave a consistent maximum flood level in the village centre adjacent to Crossmolina Bridge of 18.69m O.D. A maximum flood level of 18.69m O.D. at Crossmolina Bridge represents a flow depth in the river of 3m which completely submerges the Bridge opening. The Storm event of the 27th / 28th October 1989 produced the highest rainfall and runoff rates encountered since records commenced in (1944 for rainfall and 1952 for hydrometric gauging). The recorded water level hydrograph at Ballycarroon Gauge 2.5km upstream of Crossmolina shows a time to peak of about 12 hours from commencement of rainfall at 06:00 on the morning of the 27th October 1989 and the peak prevailed unabated for well over 12hours before slowly receding, refer to **Figure 5**.

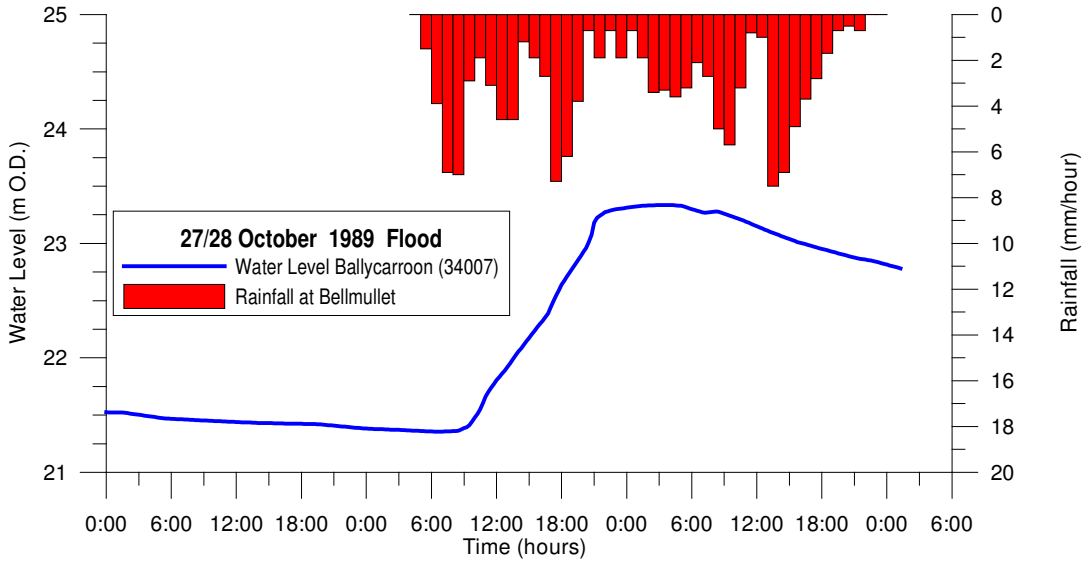

Figure 5 Rainfall and runoff characteristics of the 1989 Flood event

Flow Estimate

An automatic water level recorder is located at Gortnaraby (34082) on Lough Conn, grid location G151168, with lake level records available since 1953. The winter flood level in the lake dropped following the completion of the Moy/Mask Drainage Scheme in 1965/1966. The highest lake level recorded up to 1992, post arterial drainage, was 10.94m OD occurring in October 1989.

The main Gauging Station for the River Deel is located at Ballycarroon approximately 2.5km upstream of Crossmolina having a catchment area of 155km^2. Flow measurements for rating purposes have been carried out, be it on an infrequent basis, over the past 60years at Ballycarroon. The rating data has generally concentrated on the low to medium flows with very few reliable flood flows being captured. Mr. Tim Joyce of the Design Section of the OPW indicated that the Ballycarroon gauging station has remained remarkably stable since 1940, which should allow a good quality relationship between water level and discharge to be developed. The largest discharge that has been measured is 41.34cumec and while small in relation to the overall range the contained nature of the river at the gauging station and the stability of the rating relationship over time to allow estimates of flood peak magnitudes to be made well beyond this value.

This has enabled the OPW to convert the annual maximum flood level series to flow series for Ballycarroon producing a mean annual maximum discharge estimate QBAR = 87.5cumec. Using a flood growth curve derived for the west region by Cawley and Cunnane (2003) the 100year flood flow is estimated to be 156cumec, whereas, using the FSR(1975) National Growth curve a Q100 of 172cumec is obtained. The October 1989 flood peak at Ballycarroon based on the OPW rating is estimated to be 171 cumec which has a return period of the order of 100years.

Extrapolation using catchment area gives a flow rate at Crossmolina of 177cumec for the Oct '89 flood. Hydraulic modelling of the river reach at Crossmolina to produce the observed flood level of 18.69m O.D. requires a flow rate of 150cumec for a Manning's n of 0.04 and a flow rate of 180cumec for a Manning's n of 0.032. The order of magnitude of the peak runoff rate for the Oct 89 flood is approximately 1 cumec/km^2 or 10l/s per ha and the percentage storm runoff is 60 to 65%.

Rainfall

Over 100mm of rain fell in a 24 hour period on the 27th and 28th October 1989 over a large area of Mayo (particularly Northwest Mayo). Such daily rainfall amounts are rare for Ireland and particularly west of Ireland. Rainfall charts for Belmullet Met Station show the rainstorm commencing after 5:00 hrs on the 27th and continuing until 20:00hrs on the 28th ,producing a total of 130.5mm in 36hrs and a 24hour maximum of 87.3mm. In terms of the Daily maximum rainfall this was not the worst affected station with the majority of other inland stations in the North and northeast of Co. Mayo recording daily rainfall totals on the 27th in excess of 100mm.

During this storm 118mm of rain was reported at Crossmolina (Castlehill) and 113mm at Ballina. These 1 day rainfalls are far in excess of any other 1 day rainfalls in this area since records began there in 1944. One of the highest 1 day falls in the Mayo area are in the range 75-80mm and they occurred in 1959 and 1970. At Belmullet the 24hour fall of 87.3mm surpasses the previous highest fall of 64.8mm (since records began in 1957). The 36hour total recorded at Belmullet is 130.5mm which is a record rainfall also.

The following daily totals were reported at the specified locations in the 3day period from 26th to 28th and are as a result of the slow approach and passage of a single depression (Met Eireann, 1989).

Table 6 Recorded Daily Rainfall amounts (mm)

	Ballina	**Crossmolina**	**Attymas**	**Belderrig**
26th	8.7	7.0	18.6	15.5
27th	102.7	118.4	108.6	106.3
28th	18.5	31.4	15.6	59.3

6. FLOODING ON RIVER CLARE (CORRIB CATCHMENT) OCT – NOV 1968

The River Clare is a major tributary of the River Corrib, rising on the north eastern end of the catchment just north of Ballyhaunis. It flows south and south westwards through Tuam and Corofin and enters Lough Corrib 10km north of Galway city. A substantial amount of rain, approximately 100mm, fell on the Clare catchment during the 3 day period 30th October – 1st November 1968 as follows:

Table 7 Recorded Daily Rainfall amounts (mm)

Date	30th Oct	31st Oct	1st Nov
Catchment areal rainfall, mm	9.5	60.9	29.3

At the OPW gauging station at Corofin (30004), where the contributing catchment area is 695 km^2, the resulting flood hydrograph peaked at 185 m^3/s on 2nd November this represents a flood runoff rate of

0.27cumec/km2 . It is estimated that there was a baseflow of 24 m^3/s leaving a peak quick response hydrograph of 161 m^3/s. It is estimated that the percentage storm runoff was 63.5%. The flood hydrograph at Corofin is presented in **figure 6**.

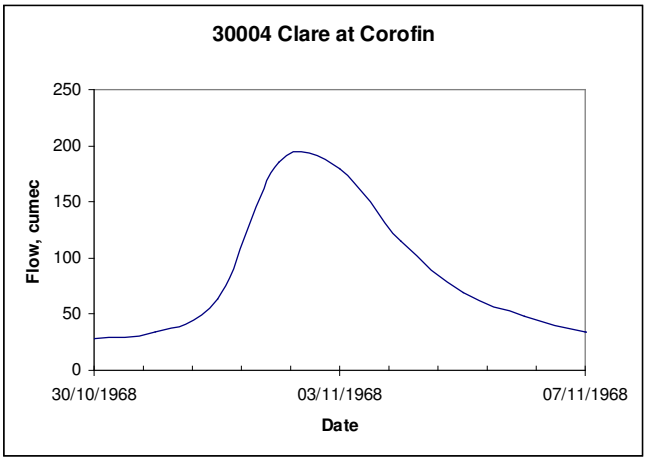

Figure 6. 1968 Flood Flow Hydrograph at Corofin

Flood frequency analysis of annual maximum flows at Corofin Gauge give a 100year flood estimate of 165cumec and a mean annual maximum flow of 95cumec.

Table 8 The distribution of daily rainfalls at various stations over the 3 days

Date	Corofin	Kilconly	Tuam	B'haunis	Barnadearg	Dunmore	Galway
30 Oct	9.0	12.5	10.7	16.7	6.5	7.5	8.7
31 Oct	43.3	65.3	42.0	83.6	42.3	62.5	50.0
1 Nov	30.5	23.4	25.8	44.6	26.2	26.6	n/a

7. FLOODING ON RIVER GRIFFEEN (LIFFEY CATCHMENT) NOV 2000

Introduction

Serious flooding occurred on the 5th and 6th November 2000 in the lower reach of the Griffeen River. A considerable number of properties in the Griffeen Valley Park and Lucan Village were flooded during this event. Previous flooding in Lucan Village had occurred on the 11th and 12th June 1993 and to a lesser extent during Hurricane Charlie on the 25th/26th August 1986.

The Griffeen rises in Saggart Hill (elevation 395m OD) 3 km to the south of Rathcoole. It is fed by nearby streams which rise near Athgoe just southwest of Newcastle, It flows from there northwards passing beneath the Grand Canal and through the Griffeen Valley Park before heading northwest to Lucan where it outfalls to the River Liffey at the grounds of Italian Embassy . The catchment area to Lucan Village is approximately $38km^2$. The current urban fraction of the catchment is estimated to be approximately 24% ($9km^2$).

Flood Estimates

A hydrometric gauging station (09002) is located in Lucan Village approximately 500m upstream of its confluence with the River Liffey and is operated by the EPA on behalf of Dublin City Council since 1977. The highest gauged flow for this station is 12cumec and flow rates in excess of this are based on extrapolation of the rating curve

Since records began in 1977, there have been three relatively significant flood events, viz.-

25th August 1986	16.6cumec
11th June 1993	22.5cumec
6th November 2000	23.6cumec

Flood frequency analysis of the Annual Maximum flow series (N= 24) gives a Q_{50} of 22.6cumec, a Q_{100} of 25.8cumec and a QBAR of 7cumec (without including the statistical standard error). This analysis suggests that the flood peak of 23.6cumec has return period magnitude of 60years (Hydro E, 2002). The flood runoff rate of this flow is 0.62cumec/km^2 (6.2 l/s per ha). The percentage storm runoff for this event based on rainfall-routing is estimated to be of the order of 55 to 60%.

Rainfall

Wet antecedent conditions preceded the flood event with 20mm of rainfall being recorded on the 2nd November, three days prior to the flood. Such antecedent wetness conditions may have contributed to increased soil moisture levels and hence increased storm runoff (J.B. Barry & partners, 2001). The autographic rainfall recorder at Casement Aerodrome (Baldonnel Aerodrome) located in the Griffeen catchment, indicated a total rainfall depth of 84mm (70year return period) over a 24hour period and 58mm (25year) in a 12hour period. At Dublin Airport 66mm of rain fell (30yr return period) and at Glenasmole (Castlekelly) 137.2mm was recorded (approx 100year event, 186mm was recorded at the same gauge during Hurricane Charlie).

The June 1993 event produced 108.6mm of rainfall in just over 24hours at Casement setting new records:

12hour rainfall – a return period of over 100years

24hour rainfall – a return period of 250years

The fact that the November 2000 storm produced greater flooding than in 1993 is probably due to the antecedent wetness conditions in the catchment leading up to the storm event.

8 CONCLUSIONS

Six notable flood events were presented in this paper with estimated runoff rates varying from 3l/s per ha up to 24l/s per ha. Common to all these flood events was the difficulty in estimating the peak flow rate as it was generally well outside the measured rating range and thus involved considerable extrapolation of the rating relationship. The estimated percentage storm runoff based rainfall-runoff analysis was generally found to be between 60 and 70% with the Dodder Catchment somewhat higher at approximately 75% during Hurricane Charlie. The River Dodder is a relatively unique catchment producing exceptionally high runoff rates of the order of 24 l/s per ha for an estimated flood event of 158years return period and producing a flood growth factor (Qpeak/QBAR) for this event of 3.7.

In respect to the Dublin region rare rain storm events of 12 to 24hour duration have occurred quite frequently over the past two decades (Aug 1986, June 1993, November 2000 and November 2002) with estimated Met Eireann 50year and 100year 24hour duration rainfalls being equaled or exceeded in a number of these events. This begs the question as to how accurate is the current estimate of the 50 and 100year rainfall intensity for the Dublin Region. Many other catchments in Ireland have not suffered over the duration of their available AM series the 50year and 100year rain storm event. In assessing annual maximum (AM) flood flow series for purpose of estimating return period events or the rareness of a particular flood flow it would be prudent to consider the rainstorm history of the catchment so as to identify whether notable rainstorm activity had occurred during the period of the AM flow series. An extreme storm event similar to the Oct '89 Crossmolina / River Deel event which produced 24hour rainfalls exceeding 100mm over the entire catchment area (155km^2 area) could occur on any small to moderate size catchment with devastating affect.

9 REFERENCES

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