CLIMATOLOGICAL NOTE No. 12

REPORT ON RAINFALL OF NOVEMBER 2009

By

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U.D.C. **MET ÉIREANN, GLASNEVIN HILL, DUBLIN 9**

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Rainfall November 2009

Introduction

November 2009 is notable for the high rainfall recorded and the consequent severe flooding experienced in many parts of the country**.** Atlantic depressions passing close to Ireland brought wet and windy conditions throughout almost all of November, continuing a pattern of very unsettled weather over Ireland which began in the middle of October. Rainfall totals for November were the highest on record at most stations, including the long-term station at Valentia Observatory, where records extend back over 100 years. Valentia's total of 360mm was its highest of any month since observations began in the area in 1866. This report contains an analysis of approximately 440 rainfall stations in the Met Éireann rainfall network.

Rainfall recording:

In this study rainfall depths are analysed from the Met Eireann network of rainfall stations, these are divided into two categories.

Synoptic Weather stations: Reports from synoptic weather stations are made every hour on the hour of basic weather parameters including rainfall, wind speed and direction, temperature, humidity and air pressure. A number of these automatic stations record rainfall at intervals of less than one hour.

Climatological and rainfall stations: The climatological network is a denser network of stations (approx 70) which record a more limited selection of data, rainfall and maximum and minimum temperatures, usually once per day at 0900 UTC. The rainfall station network is of higher density again (approx 400 in total), where rainfall is recorded once per day at 0900 UTC. Daily totals recorded each morning at 0900 are attributed to the previous day e.g. a rainfall reading of 20mm made at 0900 on the 18th is the actual total for a 24hr period beginning at 0900 on the 17th and is attributed to the 17th. These data are communicated to Met Éireann by post at the end of each month. They are then quality controlled and entered into the climate database. For the purpose of this study the quality control and database entry of the November 2009 rainfall was fast-tracked. Rainfall readings from standard rainguages are considered reliable to within 5%.

In total 440 daily observations of rainfall were available at the time of compiling this report.

Locations of rainfall stations used in the report and a quartile analysis of the total monthly rainfall for November 2009 are shown in Fig 1 (page3).

In addition, some data was received from the ESB (Lee catchment) and OPW (Blackwater catchment)

Note:

1.In this paper where comparison is made with 'normal', the normal in question is the average value for the 1961-1990 period which is internationally recognised as the Climatological Standard Normals Period.

2. In line with International Meteorological practice, observations times are in UTC (Universal Coordinated Time), equivalent to GMT.

Overview of the Weather of November 2009

More than twice the average November amounts were measured at almost all stations, and over three times the normal amount fell in some places. Rain or showers were recorded on almost every day, with between 17 and 30 wetdays were observed (days with 1mm or more rainfall), compared with the normal range for November of between 13 and 20 wetdays. Heavy precipitation days (daily rain of 10mm or more) were also well above normal. Heaviest daily falls at most stations were recorded on the 1st, in the period 16th to 19th, and on the 29th in the east; two-day falls of over 100mm were recorded in parts of the west and southwest on the 18th/19th.

Weather Diary: Mid October –November

October 18th to 31st: A period of unsettled weather, as a series of Atlantic depressions and their associated fronts moved over Ireland. Heaviest rain was measured on the 19th/20th, 24th and 30th, with widespread heavy showers also on the 21st and 22nd. Winds were between southeasterly and southwesterly in direction, both daytime and nightime temperatures were around five degrees above normal towards the end of the month. This airstream was also very humid, giving cloudy conditions on most days. Gale to storm force gusts were recorded in all areas on the 24th.

November 1st to 26th: A series of fast-moving deep Atlantic depressions brought active frontal systems across Ireland, bringing very wet and windy conditions. Spells of rain or showers gave falls of 10mm or more on many days across Connacht and Munster, while all areas received heavy falls on the 1st, 9th, in the period 16th to 19th and on the 21st.. The strong south to southwesterly winds for most of the period brought mild conditions, although slacker winds and clear skies allowed frost to form in midland and eastern areas between the 8th and 11th. A depression of central pressure 954hPa off the west coast on the 21st/22nd generated storm conditions, with very high seas.

November 27th to 30th: Low pressure became centred to the east of Ireland, bringing a cold northerly airstream across the country. Showers in western areas died out, but a spell of heavy rain occurred in eastern areas.

Estimation of Return Periods

Met Éireann has completed a study, Estimation of Point Rainfall Frequencies (Fitzgerald, 2007), funded by the OPW as part of the Flood Studies Update (FSU). This enables the production of estimates of rainfall depths for various return periods and duration for any location in Ireland. This depth duration frequency model can be used with confidence for return periods of up to 250 years for durations of less than 24 hours, and return periods of up to 500 years for durations of 24 hours or more. The model can also be used to calculate rarity estimates, i.e. with a given rainfall and duration, calculate the return period. Return Period (rarity) estimates have been made for 1,2,4,8,16 and 25 day durations during November using the output of this study.

The return period is the average number of years between years with one or more rainfalls exceeding a specified value of the rainfall. An event with a 100 year return period has a 1% chance of happening in any given year. The return period and rarity estimates are considered reliable to within 10% .

Analysis:

The rainfall data are generally of good quality, but occasionally some outliers need to be removed. As the rainfall network is largely operated by voluntary observers there are occasions where daily observations are missed, in such cases a cumulative value is entered on the next day an observation is made and the observation is 'flagged' as a cumulative total. These cumulative totals need to be redistributed across the days with missed observations. The procedure for this is as follows: an estimate of the missing daily rainfall is made by interpolation from nearby stations, the cumulative rainfall is distributed according to ratio between the cumulative total and the interpolated total for the days in question.

Monthly Rainfall:

Monthly totals are the sum of the daily values. Figure 1 shows the locations of the stations and a quartile analysis of the monthly totals. The highest rainfall total of 649 mm was recorded at Cloone Lough, Co Kerry, the lowest, 121mm was recorded at Malahide Castle, Co. Dublin. Of the 440 Rainfall stations included in this study , approximately 370 have records longer than 10 years, of these 370 stations, 292 or 79 % recorded their highest ever November rainfall in 2009.

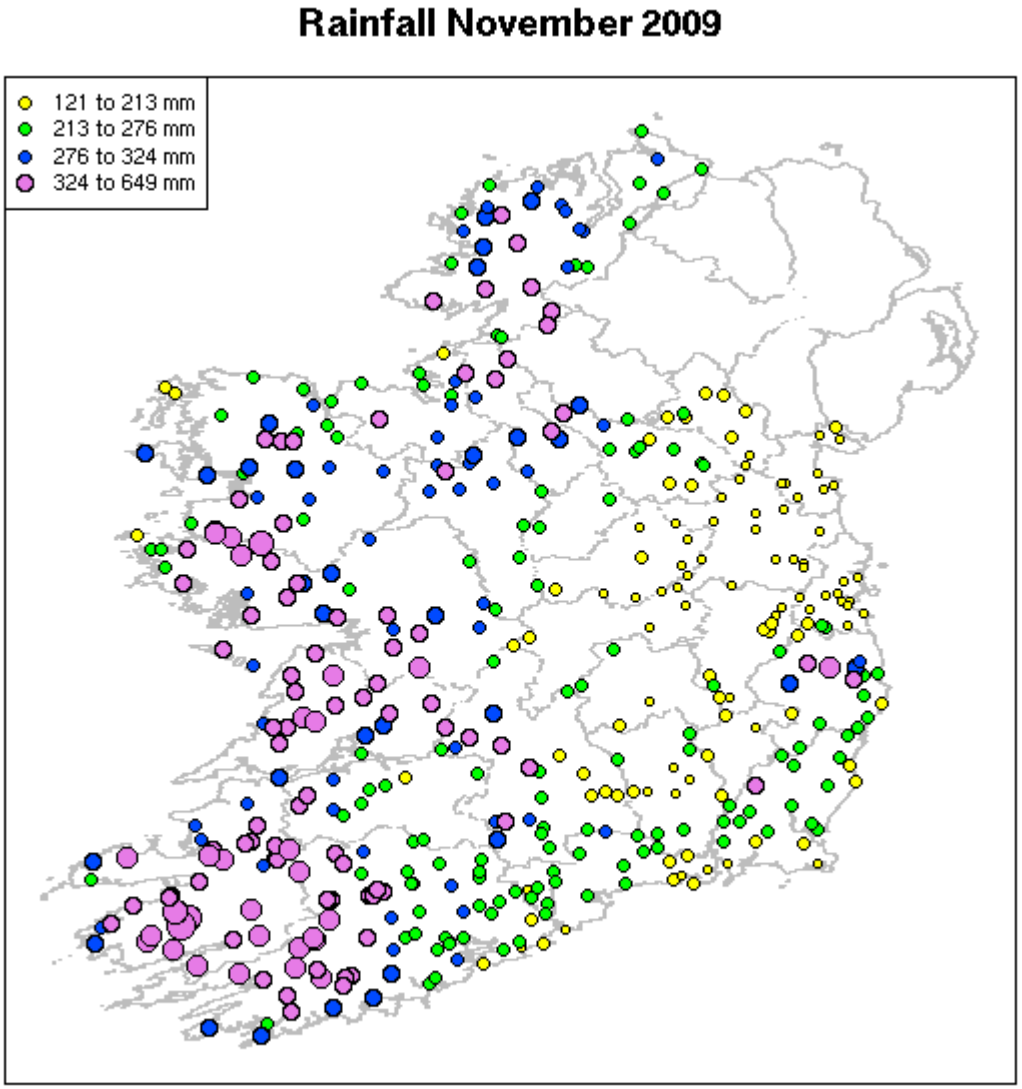

Figure1 Rainfall station Locations and Quartile analysis of November 2009 totals

Wet Days and Heavy Precipitation Days:

A **wet day** is a day on which 1mm or more rainfall is recorded. There were between 1.5 and 2.5 times the number of wet days compared to normal.

A **heavy precipitation day** is a day on which 10mm or more rainfall is recorded. There were between. 3 and 5 times the number of heavy precipitation days compared to normal.

Figures 2 (a) and (b), page 5, show the numbers of wet and heavy precipitation days for November 2009

Monthly Rainfall on 1km Grid

The monthly rainfall values were interpolated onto a 1km grid by the following procedure. First the station monthly values are normalised by dividing by the 1961-1990 November normal rainfall, the normalised rainfall is interpolated by kriging of residuals obtained by linear regression (against elevation, location etc). The values of the regression equation at each grid point were added to the gridded residuals, and finally multiplied by the 1961-1990 normal November rainfall to produce the final result.

The Rainfall totals for November 2009 and the rainfall expressed as a percentage of the 1961-1990 Normal rainfall are shown in figures 3 (a) and (b), page 6. Rainfall was above normal everywhere, with 2.5 to 3.5 times normal in many midland areas.

Error estimation

The Root Mean Square Error (RMSE) was calculated by the cross validation 'leave one out' method. Each value is excluded in turn from the dataset and its value estimated by interpolation from the remaining (439) values, the estimated value is subtracted from the actual value to give the error. This yielded a RMSE for the November 2009 monthly rainfall of 29mm.

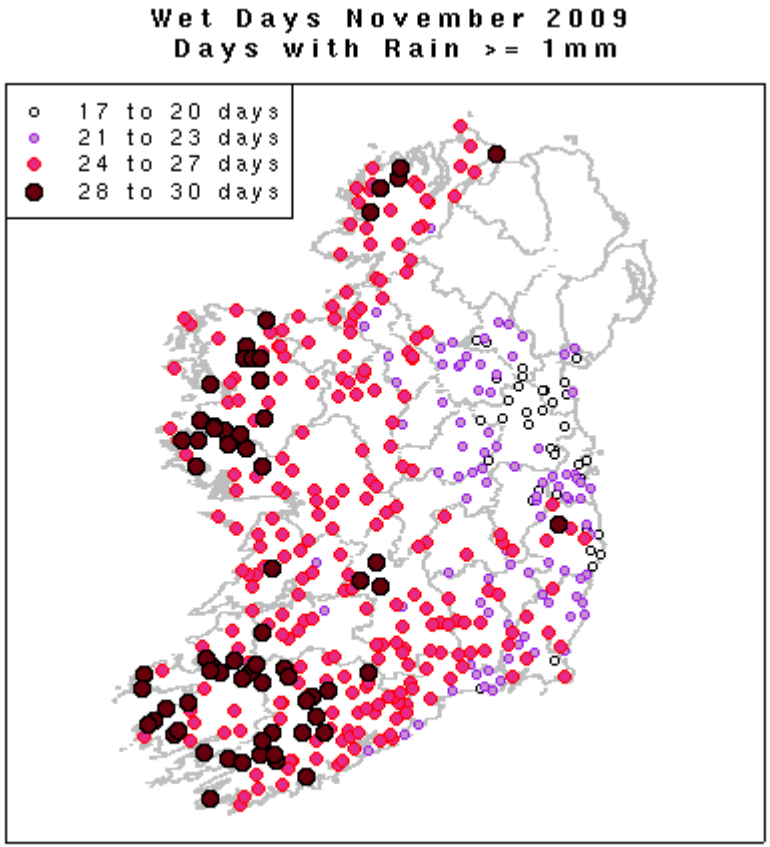

Figure 2(a)

Number of wet days November 2009

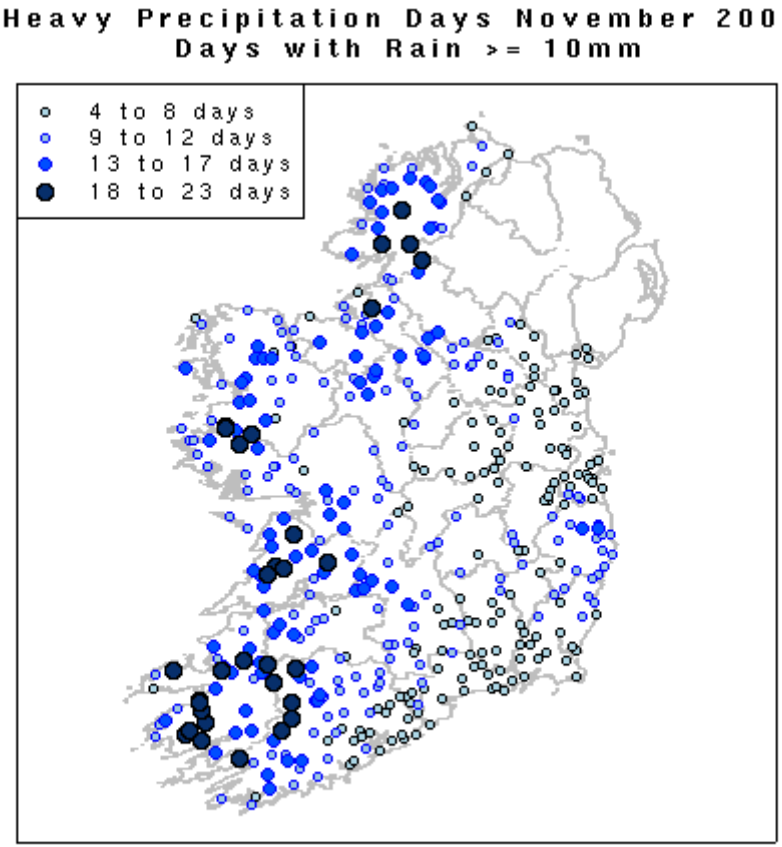

Figure 2(a)

Number of Heavy Precipitation days November 2009

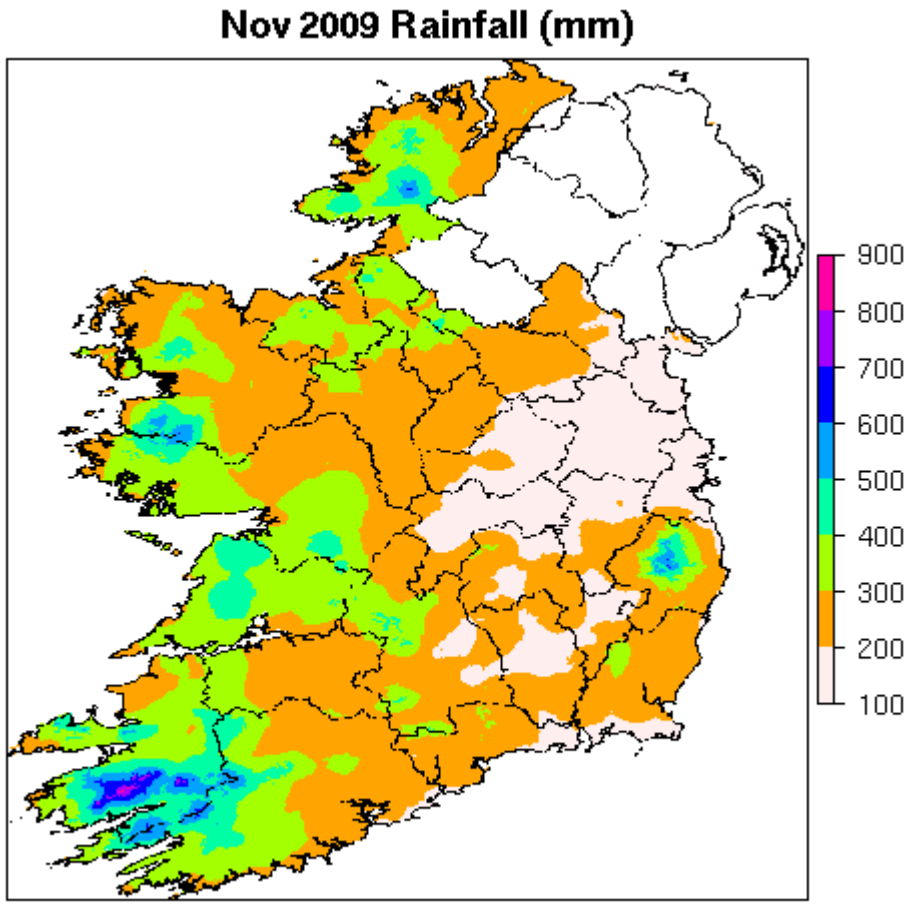

Figure 3(a)

1km Gridded Rainfall November 2009

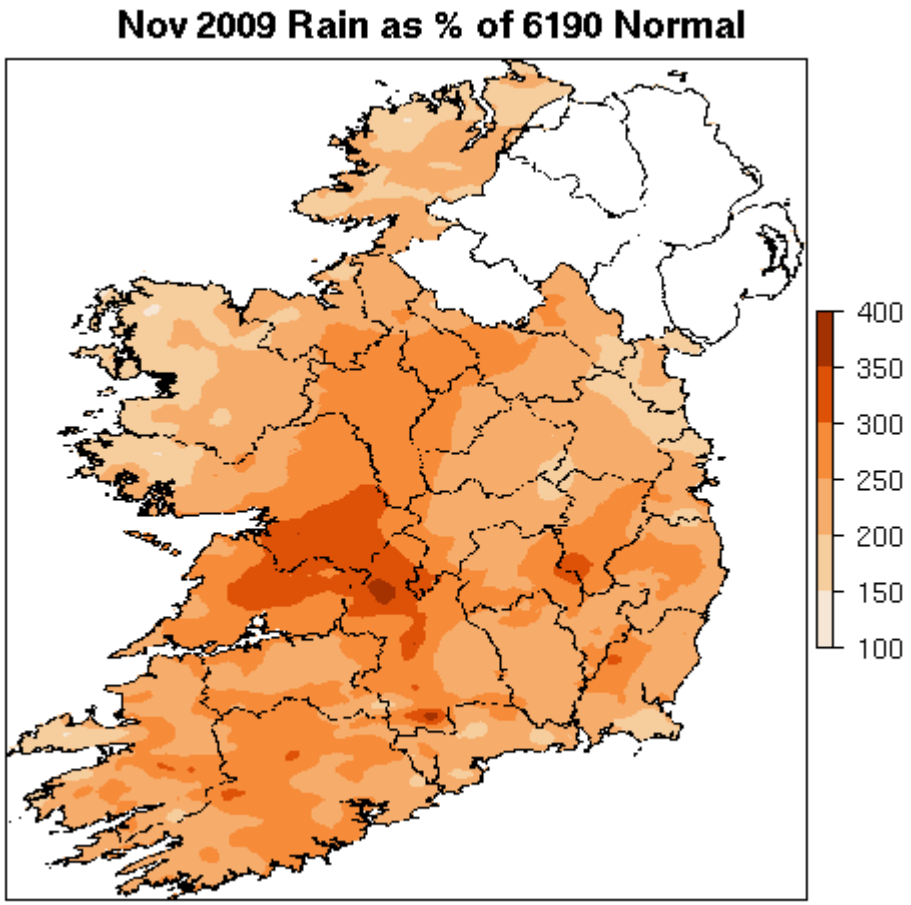

Figure 3(b)

November 2009 Rainfall as % of Normal

Daily Rainfall

Daily values varied considerably in space and time, the maximum daily rainfall recorded was 119mm at Cloone Lake, Co Kerry on 18th November.

Cumulative daily totals for rainfall stations:

Maximum cumulative daily totals were calculated for 1,2,4,8,16 and 25-day durations for all stations. These were used to derive estimated return periods for the rainfall depths and durations. Appendix 1 contains the 1,2,4,8,16 and 25-day rainfall depths and estimated return period for a selection of stations.

In general, the maximum rainfall for 1 and 2-day durations, which occurred on 18th/19th November have estimated return periods of less than 50 years, however some 2-day totals in the Galway region have return periods in excess of 100 years. From 4 to 25-day durations, the estimated return periods increase in the areas of highest rainfall, in many cases exceeding the 500 year recommended limit on the accuracy of the return period model. (Note: At shorter durations the time of the rainfall reading becomes important, since the rainfall is only read once a day at 0900 at most locations, a rainfall event spanning this time will be recorded in two different daily totals.)

Gridded Daily Values:

Daily rainfall totals were interpolated onto a 1km grid as follows. Daily station values are normalised by dividing by the 1961-1990 November normal rainfall, the normalised rainfall is interpolated onto a 1km grid by inverse distance weighted interpolation, the gridded normalised rainfall is multiplied by the 61-90 Normal November rainfall to produce the final grid.

Maximum cumulative daily totals were analysed for 1,2,4,8,16 and 25-day durations, and used to derive gridded estimated return periods. In the case of the 1,2,4,8,16 and 25-day gridded totals, the end day chosen is the day on which the maximum number of stations (mode) recorded the maximum n-day duration total; e.g. most stations had their maximum 2-day total ending on 19th November, this is the end day on which the 2 day gridded rainfall was produced.

The gridded return period estimates for the 1 to 25-day durations are shown in Figures 4(a,b,c,d,e,f), pages 8-10. In general for the shorter durations (< 4 days) the estimated return periods are relatively small, but for longer durations the return periods increase, to 500 years or greater in the some places.

Error estimation

The Root Mean Square Error (RMSE) was calculated by the cross validation 'leave one out' method. Each value is excluded in turn from the dataset and its value estimated by interpolation from the remaining (439) values, the estimated value is subtracted from the actual value to give the error. The RMSE was calculated for each day, daily RMSE values ranged between 2 and 10mm, the highest values occurring on the days with greatest rainfall.

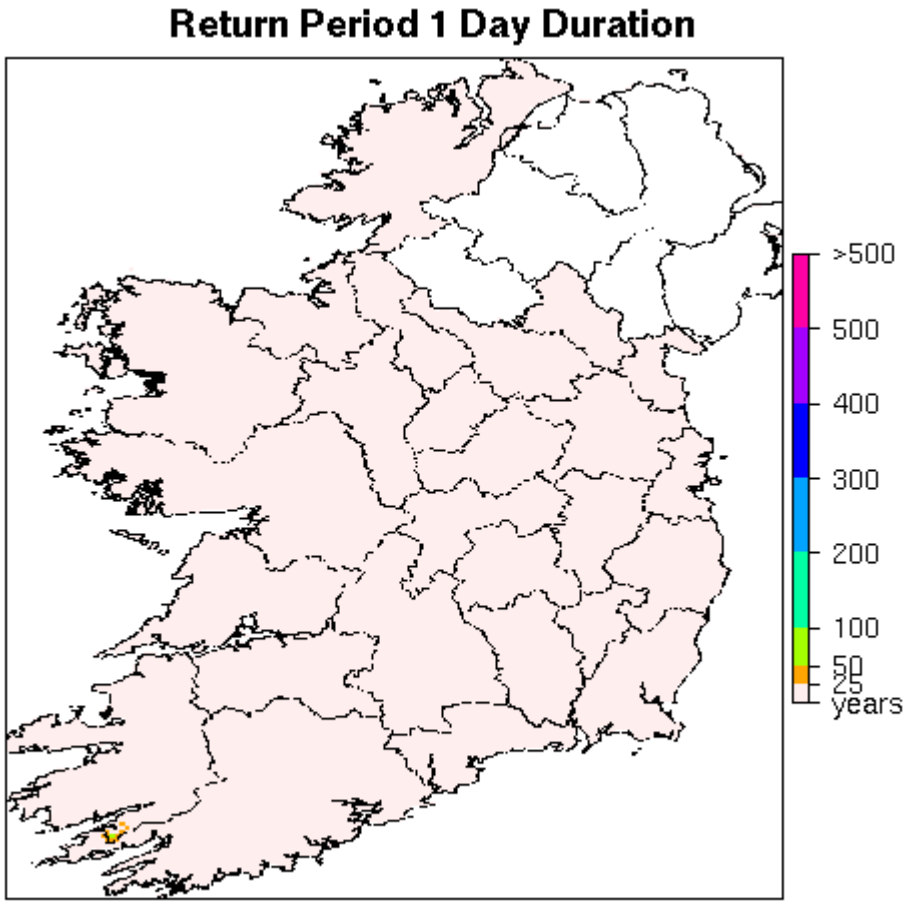

Figure 4(a)

Return Period estimates for 1 Day rainfall ending at 0900 on 18th November 2009

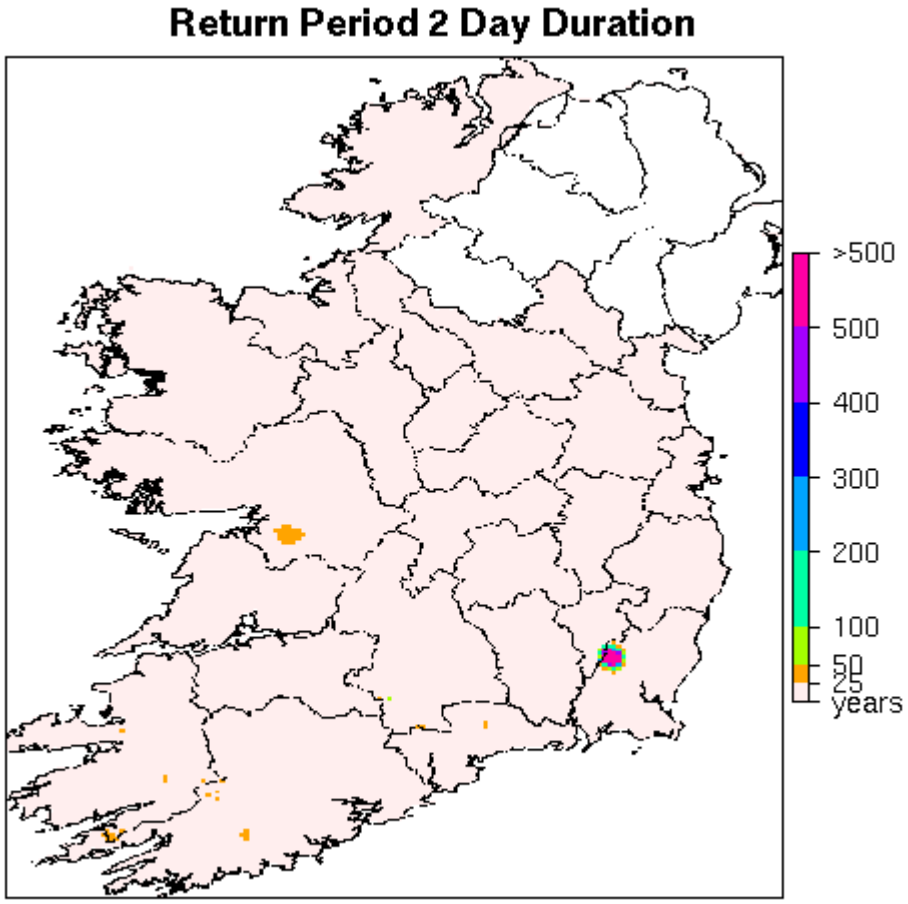

Figure 4(b)

Return Period estimates for 2 Day rainfall ending at 0900 on 19th November 2009

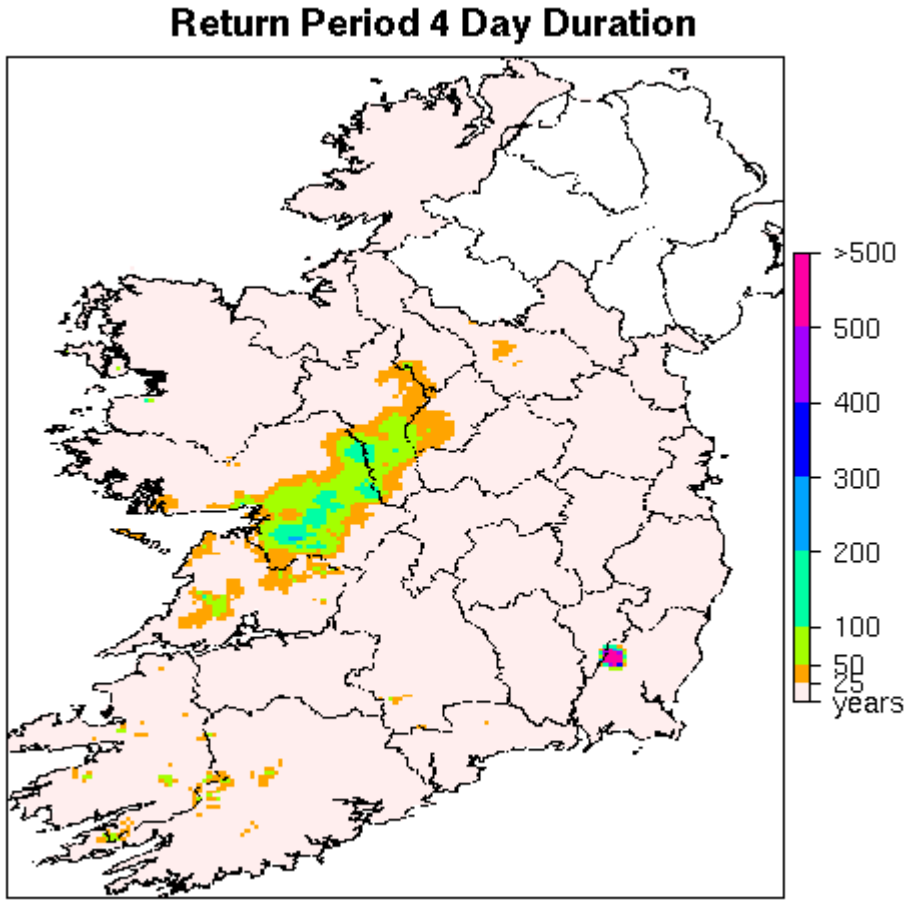

Figure 4(c)

Return Period estimates for 4 Day rainfall ending at 0900 on 20th November 2009

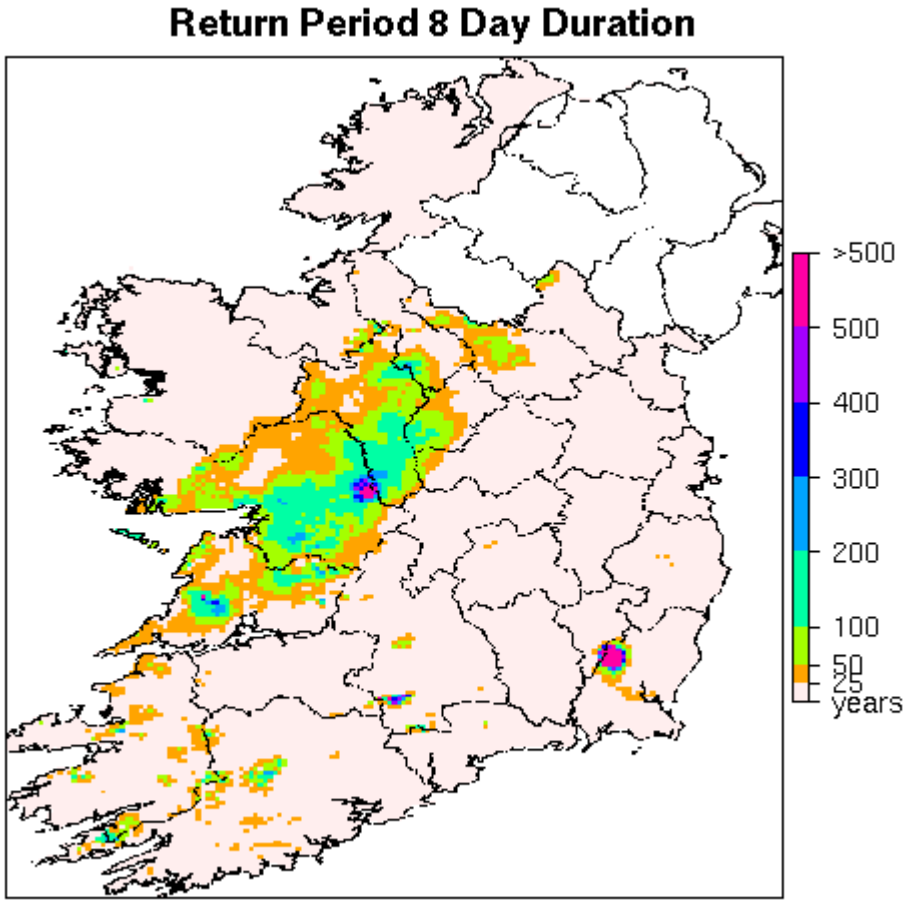

Figure 4(d)

Return Period estimates for 8 Day rainfall ending at 0900 on 20th November 2009

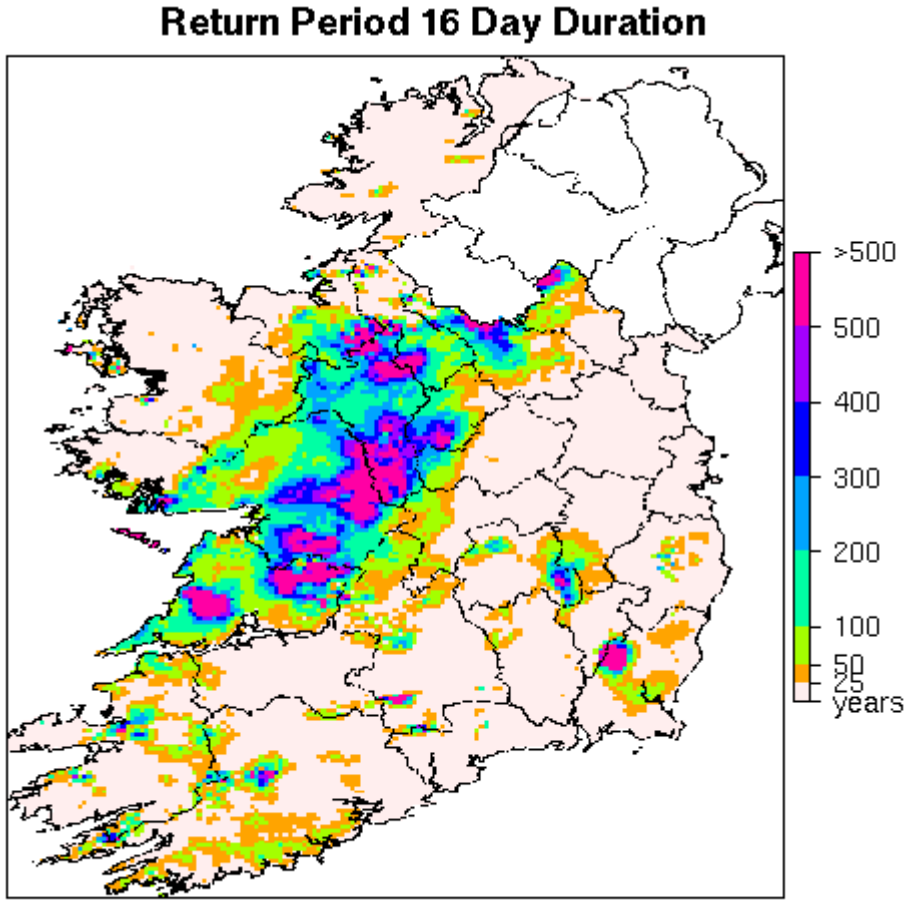

Figure 4(e)

Return Period estimates for 16 Day rainfall ending at 0900 on 24th November 2009

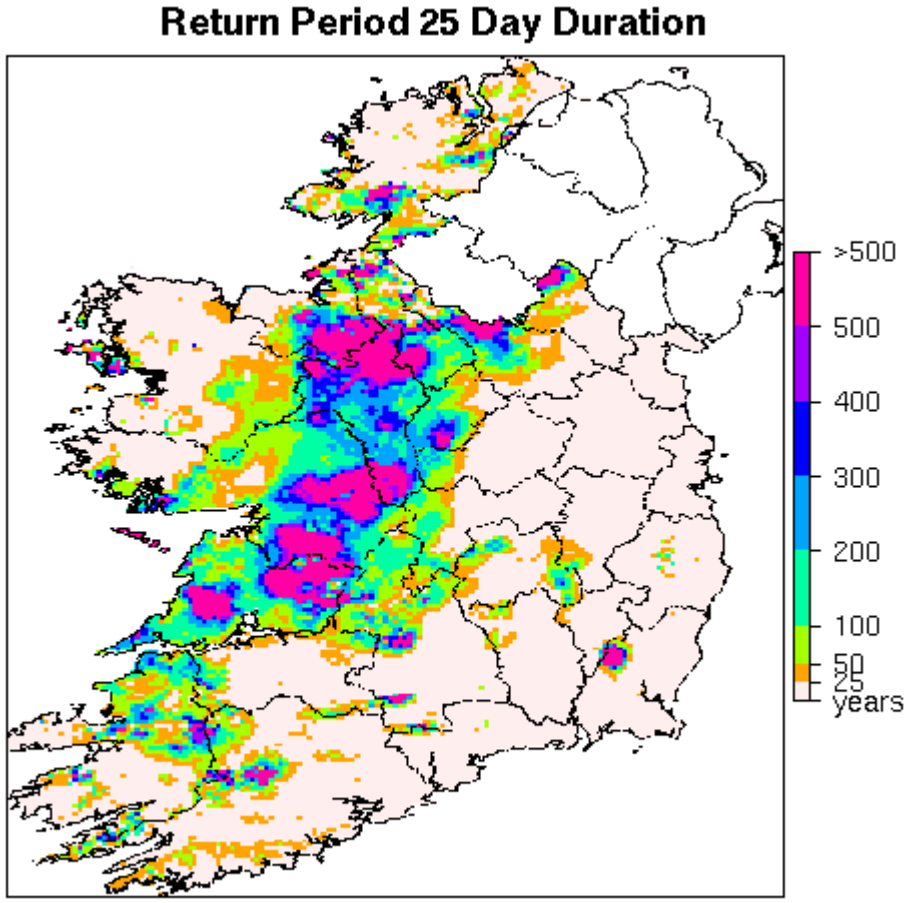

Figure 4(f)

Return Period estimates for 25 Day rainfall ending at 0900 on 26th November 2009

Rainfall of 18th and 19th November

The most extreme rainfall occurred on the 18/19th November. This led to flooding in many areas, but especially the Lee catchment. As previously mentioned, most rainfall stations record rainfall once per day at 0900 UTC, so a particular rainfall episode may be split over two (or more) days. The rainfall of the 18/19th has been studied to obtain a more accurate maximum 24 hr rainfall in the Munster region during the two day period. Hourly rainfall data from the Met Éireann synoptic network, and some other locations with rainfall recorders were examined, the average ratio of the maximum 24hr rainfall to the 2-Day total was calculated (88%). This ratio was applied to the 2-day total in the Munster region and return periods estimates were made.

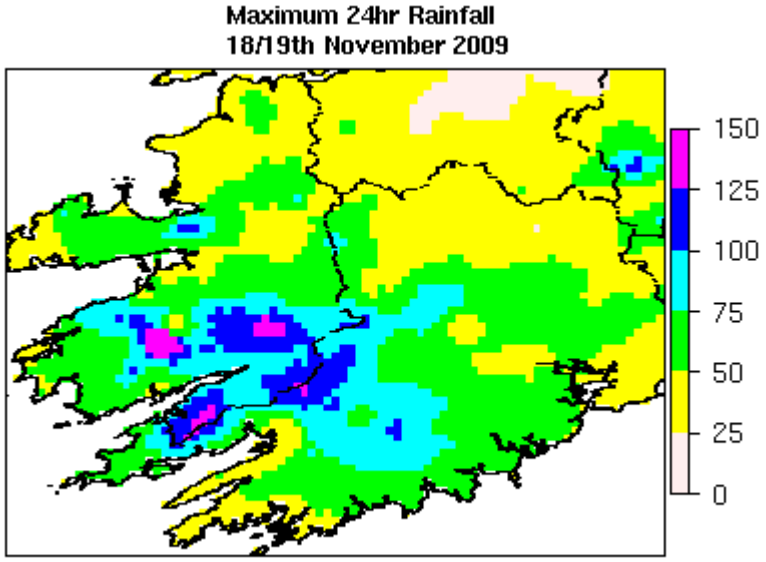

Figure 5 (a)

Maximum 24hr rainfall in the 2-Day period 18/19th November

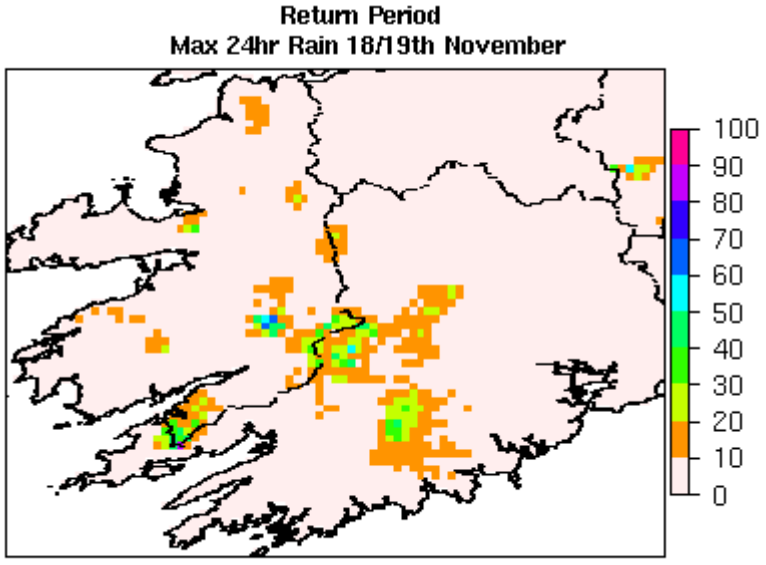

Figure 5 (b)

Return Period estimates of Maximum 24hr rainfall in the 2-Day period 18/19th November

In the study area the maximum 24hr rainfall totals have a return period of less than 100 years and over most of the area significantly less, from Figures 4 (c,d,e,f) higher return periods occurred for longer duration rainfall totals (> 4 days).

Conclusions:

The rainfall of November 2009 was notable for the number of stations which recorded their highest ever November monthly rainfall; for the number of wet days and the number of heavy precipitation days. The return period analysis indicates that the rainfall totals over the longer durations (8 days or more) in the midlands, and parts of the southwest and northwest, were extremely rare events.

Is this related to climate change?

The extreme rainfall of November 2009, follows flooding in many areas in the summer of 2008. These events have occurred against a backdrop of very poor (i.e. wet) summers in three consecutive years (2007-2009).

In Met Éireann, basic trend analysis has been performed on a number of high quality rainfall stations over a fifty year period. Some stations show an increase in the frequency of heavy precipitation (>10mm) / very heavy precipitation (>20mm) days over the past decades, however other stations show a decrease, there is large regional variation and occasionally conflicting trends from stations that are geographically relatively close. The fact that rainfall displays such a high degree of variability, both temporally and spatially makes it difficult to be definitive about trends.

If the current rainfall climate is changing, attribution of the change is a separate issue that will not be easily resolved. Any change could be due to a natural variation in the climate system, or to global warming.

References:

Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Éireann, Dublin.

(Return periods in years)		1 Day Totals			2 Day Totals			4 Day Totals			8 Day Totals			16 Day Totals			25 Day Totals		
Name	**County**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**
HACKETSTOWN	**CW**	24	15	1	31	19	1	49	15	1	88	15	2	158	24	4	192	29	4
OAK PARK	**CW**	18	19	1	36	19	1	53	21	2	90	24	7	151	24	46	181	29	30
DRUMCONNICK	**CN**	39	19	3.3	57	19	9	92	19	49	129	22	120	187	24	299	231	25	347
BAILIEBORO	**CN**	32	17	1.4	55	18	4	81	19	10	122	24	25	198	24	103	241	25	66
COLLEGE	**CN**	44	19	5.5	61	19	13	95	19	67	131	22	137	186	24	287	227	25	290
BALLYHAISE	**CN**	33	19	1.7	49	19	4	80	19	17	115	22	38	167	24	75	210	25	79
CARRON	**CE**	49	17	2.4	83	18	9	118	18	15	209	24	83	310	26	96	418	26	122
ENNISTYMON	**CE**	33	15	1.3	60	18	4	103	18	19	168	22	68	254	26	110	346	25	177
SHANNON APT	**CE**	20	22	1	37	18	2	57	20	3	101	22	12	167	26	42	231	26	81
KILMALEY.	**CE**	48	18	1.8	87	18	13	139	19	63	226	22	374	363	26	>500	460	26	>500
DOO-LOUGH	**CE**	34	18	1.2	63	19	4	113	19	63	173	22	240	272	26	>500	352	25	>500
QUILTY	**CE**	30	18	1.2	48	19	2	76	21	5	134	22	37	211	24	79	279	25	85
KILLALOE	**CE**	38	17	1.6	58	18	3	85	20	6	152	24	51	250	26	163	371	26	>500
TULLA	**CE**	40	18	2.6	63	18	14	101	19	80	157	22	293	250	24	>500	342	26	>500
MILLSTREET	**CK**	35	15	1.1	64	19	2	108	21	4	174	22	13	255	26	15	334	26	15
LITTLE ISLAND	**CK**	34	18	1.1	58	19	2	81	21	2	115	22	3	190	24	9	224	26	5
BALLINCURRIG	**CK**	32	18	1	62	19	2	81	21	2	126	20	5	202	24	12	235	26	6
SHERKIN IS	**CK**	37	15	1.2	56	19	2	81	18	4	137	18	24	218	24	77	280	27	72
BANTEER LYRE	**CK**	46	18	1.5	90	19	9	123	21	16	180	22	34	268	24	62	351	26	88
CLOYNE	**CK**	27	18	1.1	53	19	2	68	20	2	112	19	3	186	24	13	214	28	6
CORK AIRPORT	**CK**	30	18	1	58	19	2	79	20	2	119	20	3	189	24	5	224	27	3
ROCHES POINT	**CK**	26	11	1.1	43	19	1	57	20	1	96	18	2	161	24	6	184	27	2
FERMOY	**CK**	27	18	1.2	53	19	2	73	21	3	115	20	5	196	20	17	242	26	13
CLOVER HILL	**CK**	29	11	1	53	19	2	74	21	2	119	20	3	193	24	8	229	30	5
MALLOW	**CK**	22	18	1	37	19	1	64	21	2	102	20	4	170	26	12	235	26	23
WATERGRASSHILL	**CK**	40	18	1.3	71	19	3	92	21	4	152	20	13	230	24	27	279	26	21
BALLYVOURNEY	**CK**	55	18	1.7	93	19	5	139	20	13	204	22	23	311	26	36	410	25	41
FREEMOUNT	**CK**	25	18	1.2	46	19	2	71	21	2	123	22	3	200	26	5	274	26	6

Appendix 1

Maximum 1,2,4,8,16 and 25 Day durations, and estimated Return Periods for a selection of Rainfall stations
(Rainfall in mm, Return Periods in Years)

(Return periods in years)		1 Day Totals			2 Day Totals			4 Day Totals			8 Day Totals			16 Day Totals			25 Day Totals		
Name	**County**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**
BALLYSHANNON	**DL**	30	22	1.2	44	22	2	61	24	2	102	22	3	154	24	4	230	25	16
GLENTIES	**DL**	27	4	1	46	16	1	73	18	1	111	19	1	196	27	2	285	26	5
CROLLY	**DL**	27	16	1.1	44	19	1	83	19	3	130	22	5	207	24	9	291	25	18
MALIN HEAD	**DL**	32	16	1.3	39	16	1	52	19	1	83	22	2	139	16	3	205	25	6
GREENCASTLE	**DL**	35	1	2	41	2	2	70	4	8	88	8	5	146	16	24	210	25	122
FINTOWN	**DL**	35	16	1.2	56	16	1	91	18	2	161	22	3	265	26	4	373	26	5
TERMON	**DL**	22	22	1.1	37	23	1	62	4	2	101	19	3	185	24	9	279	25	42
BALLYSHANNON	**DL**	28	22	1.1	43	16	2	60	18	2	107	22	5	178	18	17	257	25	69
ARDNAWARK	**DL**	34	25	1	56	26	1	91	26	1	138	25	1	246	26	2	379	26	11
LETTERKENNY	**DL**	21	23	1.1	41	23	1	67	24	2	107	24	4	193	26	23	265	25	46
BALLYEDMONDUF	**DB**	20	13	1	29	13	1	50	15	1	85	18	2	139	24	3	165	29	2
CASEMENT	**DB**	23	28	1.1	36	29	1	40	19	1	68	19	2	111	28	3	152	29	4
PHOENIX PARK	**DB**	21	28	1.1	34	29	1	37	20	1	62	18	1	101	24	2	144	29	3
MERRION SQ	**DB**	17	13	1	27	29	1	36	15	1	57	18	1	92	24	2	126	29	3
LEIXLIP	**DB**	27	28	1.2	40	29	2	42	29	1	71	18	2	111	28	3	160	29	7
GLENASMOLE	**DB**	31	28	1.1	43	29	1	58	20	1	108	19	1	174	28	2	226	29	2
DUBLIN AIRPORT	**DB**	28	28	1.3	38	29	1	38	29	1	64	18	1	100	28	2	137	29	3
MALAHIDE	**DB**	16	11	1	25	29	1	31	20	1	56	18	1	87	24	1	115	29	2
CLOOSH	**GY**	45	17	1.4	87	18	9	139	18	45	184	18	50	269	26	75	344	26	70
BALLINASLOE	**GY**	38	17	2.4	63	18	20	99	20	159	153	19	>500	225	26	>500	271	26	>500
ROUNDSTONE	**GY**	39	9	1.6	66	18	4	101	20	11	147	23	19	251	23	110	348	25	280
GALWAY (Univ Coll)	**GY**	61	17	29	90	18	134	127	18	293	175	19	306	255	24	272	316	27	131
MAAM VALLEY	**GY**	34	23	0.9	61	18	1	99	19	1	194	24	1	301	26	1	432	25	1
BALLYGAR	**GY**	43	17	5.5	77	18	73	110	20	201	157	24	405	228	24	>500	267	26	251
GORT	**GY**	48	17	3.4	93	18	45	125	20	69	205	24	443	301	24	>500	413	26	>500

Appendix 1

Maximum 1,2,4,8,16 and 25 Day durations, and estimated Return Periods for a selection of Rainfall stations
(Rainfall in mm, Return Periods in Years)

(Return periods in years)		1 Day Totals			2 Day Totals			4 Day Totals			8 Day Totals			16 Day Totals			25 Day Totals		
Name	**County**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**
N KERRY LANDFILL	KY	40	18	1.7	65	19	5	99	20	14	159	22	53	255	26	130	365	26	341
LISTOWEL	KY	32	18	1.1	57	19	2	85	21	4	141	22	11	227	26	25	310	26	35
KILLARNEY	KY	65	18	1.5	104	19	3	162	20	9	241	22	13	355	26	12	467	25	11
CLOONE LAKE	KY	119	18	4.6	168	19	10	212	21	9	307	22	14	494	26	35	606	26	23
ARDFERT	KY	29	18	1.3	46	19	2	74	20	5	118	20	14	190	27	41	264	27	95
GLENCAR	KY	66	18	1	106	18	2	179	20	10	268	24	22	400	26	29	506	26	18
KENMARE	KY	112	18	18.6	128	18	14	180	18	31	243	22	36	342	26	36	425	25	22
VALENTI A	KY	47	18	1.6	71	19	3	98	20	4	150	22	9	250	26	41	304	26	19
CASTLEISLAND	KY	24	18	1	33	19	1	59	18	1	107	22	3	176	26	7	261	26	20
KILLORGLIN	KY	32	18	1.2	52	19	2	83	21	3	133	22	6	219	26	13	317	25	30
ATHY	KE	24	22	1.2	37	22	2	54	22	3	97	22	22	166	24	200	209	29	278
NAAS	KE	32	28	1.4	45	29	2	45	29	1	65	24	2	122	29	6	174	29	13
MULLINAVAT	KK	31	18	1.1	61	19	2	75	21	2	113	19	2	169	24	3	201	29	2
COON	KK	24	11	1.1	44	19	1	58	20	1	104	18	3	172	24	6	212	29	4
THOMASTOWN	KK	23	19	1	36	19	1	51	21	1	80	19	1	139	24	3	167	25	2
CLONASLEE	LS	32	19	1.1	50	19	1	70	19	1	116	19	3	175	26	4	216	25	3
SLIEVE BLOOM	LS	23	22	1.1	36	23	1	54	25	2	99	24	5	162	24	14	227	25	30
DRUMSHANBO	LM	27	17	1	52	18	3	92	18	15	145	19	57	229	24	200	318	25	>500
AUGHNASHEELAN	LM	52	19	3.9	55	20	2	101	19	11	168	19	45	264	24	143	369	25	471
MANORHAMILTON	LM	25	15	1	42	16	1	73	6	2	132	22	6	205	16	10	324	25	83
PATRICKSWELL	LK	20	13	1.2	32	13	1	44	15	1	73	19	2	133	26	4	197	26	9
CASTLEMAHON	LK	25	19	1.1	35	19	1	58	22	1	93	24	2	154	24	2	223	25	3
MOUNT RUSSELL	LK	26	15	1.1	46	19	1	71	21	2	122	20	5	197	24	11	255	26	13
CASTLECONNELL	LK	21	17	0.9	36	18	1	57	20	2	105	24	5	178	26	15	258	26	34
SHANAGOLDEN	LK	25	6	1	43	18	1	67	20	2	118	22	4	193	26	7	278	26	11
GRANARD	LD	34	17	1.7	59	18	6	83	19	10	123	22	23	171	24	24	216	25	22
ARDEE	LH	24	17	1	33	18	1	47	20	1	73	18	1	117	24	2	130	25	1
MELLIFONT	LH	20	17	1.1	33	18	1	46	18	1	77	18	2	127	24	3	147	27	2
DUNDALK	LH	24	17	1	35	18	1	48	18	1	75	18	1	121	19	1	160	25	1
CASTLEBELLING	LH	28	17	1.3	35	18	1	50	18	1	79	18	2	121	24	4	146	25	3
RIVERSTOWN	LH	25	11	1	32	18	1	46	18	1	78	18	1	127	19	2	175	25	2

Appendix 1

Maximum 1,2,4,8,16 and 25 Day durations, and estimated Return Periods for a selection of Rainfall stations
(Rainfall in mm, Return Periods in Years)

(Return periods in years)		1 Day Totals			2 Day Totals			4 Day Totals			8 Day Totals			16 Day Totals			25 Day Totals		
Name	**County**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**
NEWPORT	**MO**	27	17	1.1	42	18	1	73	5	1	121	24	2	191	27	2	301	26	4
BELMULLET	**MO**	21	16	1.1	32	17	1	51	18	2	89	18	3	143	24	5	198	26	7
STRAIDE	**MO**	35	15	1.6	57	18	3	97	18	13	149	22	30	220	26	45	283	26	44
LAHERDANE	**MO**	51	18	1.5	78	18	3	111	20	4	180	24	9	251	24	8	328	26	7
BANGOR ERRIS	**MO**	17	19	1.1	31	19	1	56	20	1	97	24	3	150	26	4	220	26	8
BELDERRIG	**MO**	22	23	1.1	39	23	1	66	23	2	124	24	5	174	24	3	242	26	4
KNOCK AIRPORT	**MO**	30	17	1.3	52	18	2	87	18	7	137	22	20	205	24	35	275	26	61
MULRANY	**MO**	29	17	1.2	55	18	3	85	20	7	128	24	16	203	25	41	310	26	297
DHULOUGH	**MO**	53	18	1.1	88	18	1	132	20	1	232	24	2	343	26	2	460	26	2
DELPHI LODGE	**MO**	57	18	1.1	85	18	1	128	21	1	208	24	2	311	26	2	435	26	2
WARRENSTOWN	**MH**	22	17	1.1	35	18	1	52	20	2	74	18	2	125	24	4	157	28	3
KINGSCOURT	**MH**	25	17	1.1	39	18	1	51	18	1	84	18	2	129	24	3	161	25	2
NAVAN	**MH**	21	17	1	36	18	1	53	20	2	85	19	3	141	24	9	167	25	5
MOYNALTY	**MH**	25	17	1.2	40	18	2	52	18	2	87	18	5	138	24	14	170	25	10
CASTLESHANE	**MN**	26	19	1.4	47	19	3	79	19	8	108	22	10	168	24	24	206	25	21
NEWBLISS	**MN**	31	19	1.4	46	19	3	65	19	4	103	22	11	168	24	41	207	25	35
CARRICKMACROS	**MN**	28	17	1.3	41	18	2	53	18	2	88	18	3	135	24	3	159	25	2
EDENDERRY	**OY**	17	17	1	28	18	1	40	19	1	62	18	1	109	24	3	141	25	3
DERRYGREENAGH	**OY**	25	17	1.2	40	18	2	52	20	2	81	18	4	136	24	12	171	25	11
LANESBORO	**RN**	36	17	2.1	61	18	9	99	20	53	149	19	193	207	24	328	247	25	272
DRUMSNA	**RN**	35	19	1.5	64	19	15	99	19	94	156	19	>500	223	19	>500	278	26	>500
LECARROW	**RN**	35	17	1.8	61	18	11	99	20	84	144	19	224	211	24	439	244	26	179
BOYLE	**RN**	27	18	1.1	54	18	3	85	18	9	133	19	30	213	24	160	287	26	>500
ELPHIN	**RN**	37	18	2	62	18	9	94	19	31	143	22	117	219	24	456	279	26	>500
FRENCHPARK	**RN**	31	18	1.4	59	18	4	95	18	13	151	22	45	232	24	145	320	25	>500
ARDTARMON	**SO**	29	9	1.4	35	22	1	56	18	2	100	22	14	174	24	193	250	25	>500
CLOONACOOL	**SO**	47	18	2	66	18	3	103	18	6	156	22	12	242	24	22	331	26	38
COOLAVIN	**SO**	35	15	1.9	59	18	4	98	18	15	141	22	27	210	24	52	291	26	152

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Name	**County**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**	**Total mm**	**End Day**	**Ret Per**
MULLINAHONE	**TP**	25	11	1.2	27	12	1	44	14	1	83	18	2	142	20	6	187	25	7
CAHIR PARK	**TP**	30	18	1.2	38	19	1	58	18	1	113	18	6	171	24	10	215	26	9
CARRICK-ON-SUIR	**TP**	40	18	1.1	74	19	3	92	21	2	132	20	3	204	24	5	233	27	3
FETHARD	**TP**	21	13	1	35	19	1	45	20	1	85	20	3	138	24	6	180	25	7
SILVERMINES	**TP**	36	22	1.1	58	18	2	95	20	4	178	24	55	276	26	120	385	26	289
BANSHA	**TP**	55	18	1.3	98	19	3	129	21	4	205	20	12	282	24	11	333	26	6
NENAGH	**TP**	37	17	2.7	48	18	4	71	20	6	127	24	29	190	26	39	292	25	144
DUNGARVAN	**WD**	42	18	1.3	71	19	3	84	21	3	126	19	4	190	24	6	227	25	4
TALLOW	**WD**	38	19	1.2	69	19	2	90	21	3	129	22	3	205	21	5	240	25	3
CAPPOQUIN	**WD**	30	15	1.1	51	19	1	68	21	1	117	20	3	197	20	8	254	26	8
FENOR	**WD**	27	18	1.1	53	19	2	63	21	2	109	19	3	166	24	5	189	28	3
TYCOR	**WD**	29	18	1.1	56	19	2	69	20	2	128	19	11	175	24	11	192	27	4
STRADBALLY	**WD**	42	18	1.5	76	19	5	85	21	3	125	19	5	194	24	8	223	26	4
TRAMORE	**WD**	30	18	1.1	50	19	2	59	21	1	106	18	3	163	24	4	185	28	2
MULLINGAR	**WH**	27	17	1.4	48	18	3	70	20	6	103	24	9	156	24	14	188	25	8
ATHLONE	**WH**	38	17	2.4	55	18	7	77	20	16	123	19	104	179	24	273	216	26	229
RATHWIRE	**WH**	25	17	1.2	44	18	2	62	20	4	86	24	4	141	24	10	173	26	7
COOLE	**WH**	26	17	1.3	41	18	2	62	19	3	87	24	4	131	24	4	168	25	4
FOULKESMILLS	**WX**	28	13	1.1	47	19	2	70	14	3	120	19	8	165	20	7	193	29	4
JOHNSTOWN	**WX**	34	13	1.4	48	13	2	65	15	2	112	19	6	158	24	6	199	29	5
CAHORE	**WX**	37	13	1.8	46	19	2	66	15	2	120	19	6	171	24	7	203	29	5
BUNCLODY	**WX**	27	19	0.9	53	19	1	69	21	1	118	19	2	185	24	5	215	29	2
JFK PARK	**WX**	35	18	1.3	59	19	3	72	20	2	125	19	6	184	24	9	222	29	6
WILDFOWL RES	**WX**	32	13	1.3	54	19	3	77	21	4	130	19	17	186	24	25	234	29	26
GOREY	**WX**	32	29	1.3	45	20	2	72	21	4	111	20	7	185	24	27	235	29	33
CLONROCHE	**WX**	45	18	2.2	82	19	12	97	21	8	155	19	28	226	24	45	262	29	23
GLENMACNASS	**WW**	61	19	1.5	98	19	3	141	20	4	216	24	9	327	24	18	418	29	23
ARKLOW	**WW**	32	19	1.2	54	19	2	72	21	2	125	19	6	189	24	10	226	30	7
ASHFORD	**WW**	23	13	1.1	36	19	1	58	15	1	103	19	2	178	24	5	211	29	4
GLEN OF IMAAL	**WW**	43	28	1.2	65	29	1	65	30	1	120	24	1	212	28	2	293	29	3

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