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Extreme Value Analysis of 96 Daily Series of Precipitation, Denmark 1961 - 2010

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Content:

Abstract

An extreme value analysis for 96 precipitation stations in Denmark with 45-50 years of daily precipitation is published in this report.

Resumé

En ekstremværdianalyse af 96 nedbørstationer i Danmark med 45-50 års daglige nedbørmålinger er publiceret i denne rapport.

1. Introduction

This report presents an extreme value analysis of 45 – 50 years of daily precipitation measurements at 96 Danish precipitation stations, period 1961-2010.

2. Daily precipitation series used in this report

In the selection of the daily precipitation series, two criteria have been considered. First, within the time period 1961 -2010 each time series must amount to at least 45 years of measurements to ensure long series of precipitation, which is beneficial for the extreme value analysis. Secondly, a nationwide extreme value analysis of precipitation is desirable, and a sufficient number of precipitation series with a reasonable geographical coverage of Denmark are needed.

96 precipitation series that fulfil both criteria are selected and their locations are illustrated in figure 1. The data have not been tested for homogeneity.

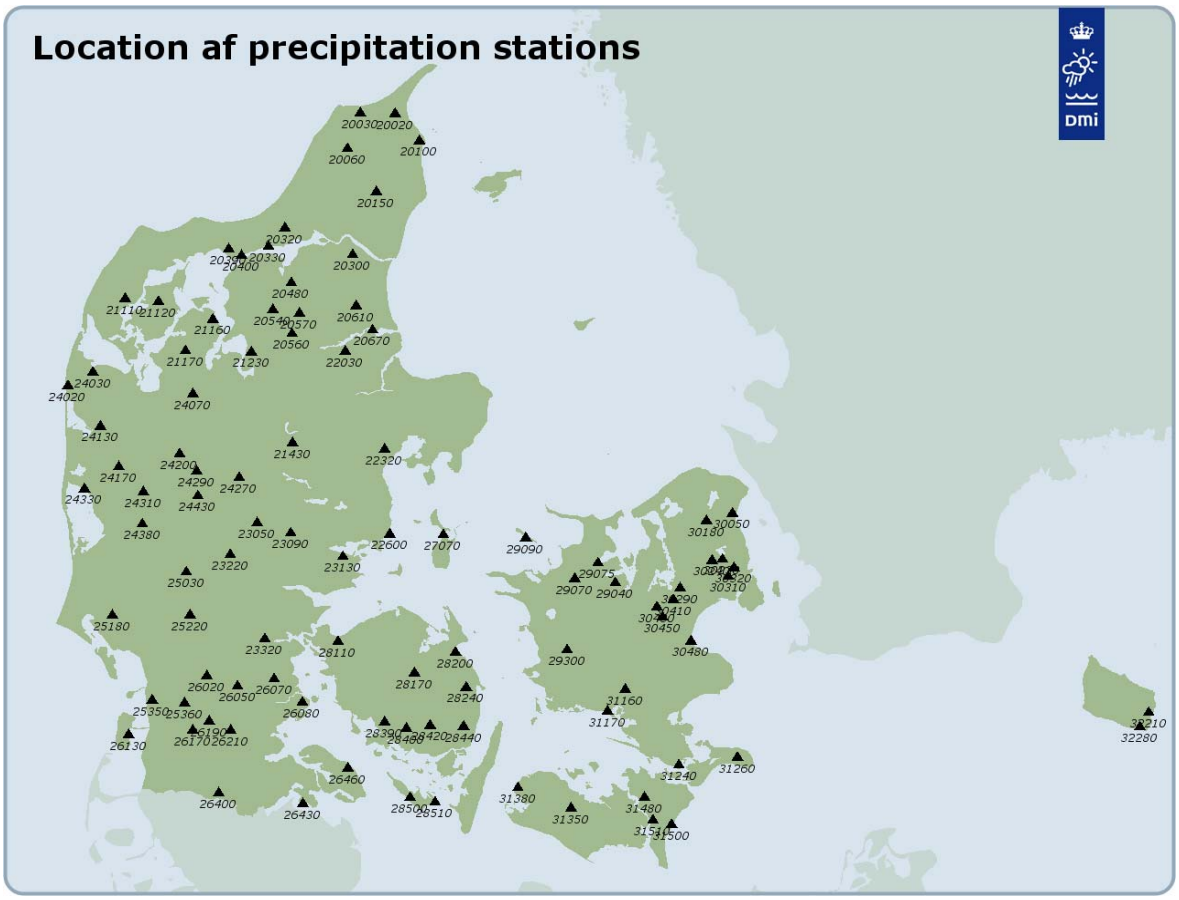

Figure 1. The location of the 96 selected precipitation stations with at least 45 years of measurements and national coverage. Graphics: Michael Scharling.

In table 1, the station data can be seen: station number (Stat) and name (Name), the first and last date of measurements within the time period 2 January 1961 to 1 January 2011 (Start and Stop), latitude (Lat) and longitude (Lon), easting and northing (zone 32) (z32east and z32north) and height above sea level of the station (masl).

Stat	Name	Start	Stop	Lat	Lon	z32east	z32north	masl
20020	NØRRE SØRIG	02-Jan-1961	31-Mar-2009	573400	102100	580595	6381325	12
20030	UGGERBY	02-Jan-1961	01-Jan-2011	573400	100600	566316	6381641	8
20060	HJØRRING	02-Jan-1961	31-Jul-2010	572600	100100	561077	6365980	23
20100	FREDERIKSHAVN	02-Jan-1961	30-Jul-2010	572700	103100	590556	6369461	10
20150	HELLUM	02-Jan-1961	31-Jul-2010	571600	101300	572916	6347114	79
20300	KLARUP	02-Jan-1961	31-Dec-2006	570100	100200	563230	6319547	5
20320	NØRRE ØKSE	02-Jan-1961	31-Mar-2009	570700	93500	535425	6331285	3
20330	ATTRUP	02-Jan-1961	31-Dec-2006	570300	92800	528683	6323138	4
20390	GØTTRUP	02-Jan-1961	31-Dec-2006	570200	91300	512400	6322080	2
20400	AGGERSUND	02-Jan-1961	01-Jan-2011	570100	91700	517625	6319217	8
20480	VEGGERBY	02-May-1961	31-Mar-2009	565400	93800	538065	6307233	48
20540	ÅRS	02-Jan-1961	31-Dec-2006	564800	93000	530496	6295494	38
20560	NØRAGER	02-May-1961	01-Nov-2006	564200	93800	538349	6284972	38
20570	HAVERSLEV	02-Jan-1961	31-Mar-2009	564700	94100	541411	6293958	41
20610	TERNDRUP	02-Jan-1961	31-Jul-2010	564900	100400	564629	6297160	24
20670	HAVNØ	02-Nov-1965	01-Jan-2011	564300	101000	571357	6286556	2
21110	HØRDUM	02-Jan-1961	31-Mar-2009	565100	83000	469925	6300391	28
21120	ERSLEV	02-Jan-1961	01-Jan-2011	565000	84400	483585	6299080	26
21160	JUNGET	02-Jan-1961	01-Jan-2011	564600	90600	505865	6291299	21
21170	OTTING	02-Jan-1961	31-Mar-2009	563800	85500	494645	6277454	33
21230	ULBJERG	02-May-1961	01-Jan-2011	563800	92100	521671	6277007	22
21430	GRØNBÆK	02-Jan-1961	01-Jan-2011	561700	93700	538554	6237217	25
22030	KLOSTERMARKEN	02-Jan-1961	31-Mar-2009	563800	95900	560155	6277295	51
22320	ELSTED	02-Jan-1961	31-Mar-2009	561500	101400	576307	6234394	60
22600	HOV	02-Jan-1961	01-Jan-2010	555500	101500	578432	6197269	2
23050	NØRRE SNEDE	02-Jan-1961	31-Dec-2009	555800	92300	524034	6202165	99
23090	HÅRUP	02-Jan-1961	31-Dec-2006	555500	93600	537815	6197710	71
23130	SEJET	02-Sep-1962	31-Mar-2009	555000	95700	559206	6187415	13
23220	GIVE	02-Jan-1961	31-Dec-2006	555000	91200	513015	6188293	99
23320	HARTE	02-Jan-1961	31-Jul-2010	553000	92600	527171	6151394	52
24020	TRANS	02-Jan-1961	30-Apr-2009	563000	80800	446455	6262239	23
24030	NØRMARK	02-Jan-1961	01-Mar-2007	563300	81800	456656	6268147	23
24070	MOGENSTRUP	02-Jan-1961	31-Dec-2009	562800	85800	497685	6258660	9
24130	VEMB	02-Jan-1961	31-Mar-2009	562100	82100	459759	6244471	8
24170	GRØNBJERG	02-Jan-1961	01-Jan-2011	561100	82800	467314	6226722	36
24200	ØRRE	02-Jan-1961	31-Jul-2010	561400	85300	492252	6232427	30
24270	BODHOLT	02-Jan-1961	31-Dec-2009	560800	91600	516670	6221985	78
24290	GULLESTRUP	02-Jan-1961	31-Dec-2006	561000	85900	499261	6224817	44
24310	VIDEBÆK	02-Jan-1961	31-Mar-2009	560500	83800	477373	6215704	29
24330	RINGKØBING VANDVÆRK	02-Jan-1961	31-Jul-2006	560600	81500	453203	6217103	2
24380	BORRIS	02-Jan-1961	01-Dec-2006	555800	83800	476940	6201655	26
24430	HØGILD	02-Jan-1961	31-Dec-2009	560400	90000	499738	6213987	57
25030	GRINDSTED L/S	01-Apr-1961	31-Dec-2006	554600	85500	494994	6180652	40
25180	TOFTNÆS	02-Jan-1961	31-Mar-2009	553600	82600	464667	6161715	8
25220	HOVBORG	02-Jan-1961	31-Mar-2009	553600	85700	496537	6161921	42
25350	HVIDING	02-Jan-1961	31-Aug-2007	551600	84200	480995	6124624	8
25360	SPANDET	02-Jan-1961	31-Dec-2009	551500	85500	494267	6123284	46
26020	RØDDING	02-Jan-1961	31-Dec-2006	552200	90300	503418	6135225	43
26050	OKSENVAD	02-Jan-1961	31-Mar-2009	551900	91500	515982	6130671	35
26070	CHRISTIANSFELD	02-Jan-1961	31-Dec-2009	552100	92900	530990	6133850	13
26080	HAJSTRUP	02-Jan-1961	01-Jan-2011	551500	94000	542567	6123634	23
26130	KONGSMARK	02-Jan-1961	31-Dec-2009	550800	83300	471344	6109461	5
26170	ARRILD	02-Jan-1961	31-Dec-2006	550900	85800	497630	6111390	32
26190	TOFTLUND	02-Jan-1961	31-Dec-2006	551100	90400	504376	6115389	53
26210	RANGSTRUP	02-Jan-1961	01-Jan-2011	550900	91200	513193	6111380	52
26400	STORE JYNDEVAD	02-Jan-1961	30-Nov-2010	545400	90800	508297	6083963	15
26430	BROAGER BUSHOLM	02-Jan-1961	31-Jan-2009	545100	94000	542822	6079257	5
26460	FREDERIKSGÅRD	02-Jan-1961	31-Dec-2009	550000	95700	561276	6094831	41
27070	KANHAVE	02-Jan-1961	31-Dec-2006	555400	103600	600370	6196975	2
28110	BÅRING	02-Jan-1961	31-Jul-2010	553000	95400	557206	6150252	68

28170	DALUM	02-Jan-1961	31-Mar-2009	552200	102400	588540	6136539	23
28200	LUNDSGÅRD	02-Jan-1961	31-Dec-2009	552700	104000	605359	6145534	2
28240	ROSILDE	02-May-1961	01-Jan-2011	551800	104400	609770	6130205	8
28390	HÅSTRUP	02-Jan-1961	31-Mar-2009	551000	101200	576314	6114989	63
28400	KORINTH	02-Jan-1961	31-Mar-2009	550900	102000	585252	6112269	39
28420	HUNDTOFTE MARK	02-Jan-1961	31-Dec-2006	551000	102900	594966	6113560	65
28440	GUDME	02-Jan-1961	31-Dec-2009	550900	104200	608695	6113140	59
28500	VINDEBALLE	02-Jan-1961	31-Dec-2006	545300	102100	586767	6081914	53
28510	MARSTAL	02-Jan-1961	31-Dec-2009	545100	103100	597005	6079890	20
29040	HOLBÆK VANDVÆRK	02-Jan-1961	31-Dec-2006	554200	114300	670902	6175888	19
29070	SVINNINGE	02-Jan-1961	31-Dec-2006	554300	112700	654298	6177803	8
29075	LAMMEFJORDSDÆMNINGEN	02-Jan-1961	31-Mar-2009	554700	113700	663779	6184611	-1
29090	SEJERBY	02-Jan-1961	31-Dec-2009	555300	110900	634197	6195630	8
29300	GUDUM	02-Jan-1961	31-Jul-2010	552600	112300	651137	6146609	26
30050	DAGELØKKE	02-Jan-1961	30-Sep-2006	555700	123000	718951	6206381	17
30180	HILLERØD SØ	02-Apr-1962	31-Mar-2009	555600	122000	708258	6203166	62
30230	STORE HARESKOV	02-Jan-1961	31-Dec-2009	554600	122600	714863	6186215	48
30240	SØNDERSØ VANDVÆRK	02-Jan-1961	01-Dec-2006	554600	122100	710577	6185768	15
30290	MARBJERG VANDVÆRK	02-Jan-1961	31-Dec-2006	554000	120800	697506	6173653	19
30310	ISLEVBRO VANDVÆRK	02-Jan-1961	31-Dec-2006	554200	122700	717216	6178690	10
30320	TINGHØJ VANDVÆRK	02-Jan-1961	31-Dec-2006	554400	123000	719565	6182587	48
30410	ROSKILDE S	02-Jan-1961	31-Mar-2009	553700	120600	694707	6168598	49
30430	LEJRE	02-Jan-1961	31-Dec-2006	553600	115900	687963	6165399	29
30450	VIBY S.	02-Jan-1961	31-Jul-2010	553300	120100	690264	6160995	40
30480	KØGE HAVN	02-Jan-1961	31-Mar-2009	552700	121200	701970	6150456	2
31160	RISLEV	02-Jan-1961	31-Mar-2009	551700	114500	675000	6129330	9
31170	KARREBÆK	02-Jan-1961	31-Dec-2009	551200	113800	667705	6119772	6
31240	PETERSVÆRFT	02-Jan-1961	31-Dec-2006	545800	120500	696953	6096129	5
31260	NY BORRE	02-Jan-1961	30-Nov-2010	550000	122700	720983	6099585	2
31350	TJENNEMARKE	02-Jan-1961	01-Jan-2011	544900	112300	652752	6077323	9
31380	FREDERIKSDAL	02-Jan-1961	31-Dec-2009	545400	110300	630998	6086202	4
31480	ØNSLEV	02-Jan-1961	31-Mar-2009	545100	115100	682856	6082071	3
31500	ULSLEV	02-Jan-1961	31-Jul-2010	544400	120100	693959	6070163	7
31510	BLAGOVESCENSK	02-Jan-1961	31-Mar-2009	544600	115400	686336	6072065	7
32210	SLAMREHUSE	02-Jan-1961	31-Dec-2006	550400	150600	889630	6119181	27
32280	POULSKER	02-Jan-1964	01-Jan-2011	550100	150200	886034	6112877	23

Table 1. Station data: station number (Stat), station name (Name), date of first and last measurement within the period 2 January 1961 – 1 January 2011 (Start and Stop), latitude (Lat), longitude (Lon), easting (z32east) and northing (z32north) (zone 32) and meters above sea level (masl). Some station relocations have taken place during the period. In the table the latest locations are shown.

3. Extreme value analysis

3.1 Method

An estimation of the amount of both daily precipitation expected once within the next 10, 20, 50, and 100 years – the so-called 10, 20, 50 and 100 years return levels is calculated using extreme value theory [3]. What we want is an estimation of the return levels (amount of precipitation) for daily precipitation for each of the return periods 10, 20, 50, and 100 years. The challenge here is especially to estimate the amount of daily rain that will occur once in the next 100 years given at most 50 years of measurements. Extreme value theory provides a framework that enables extrapolations of this type.

One type of extreme values analysis is to define an event as extreme if it exceeds a certain high level or threshold and exclusively to look at values above this threshold. This method of extreme value analysis is called POT (Peaks Over Threshold) and is typically applicable of time series – hourly or daily values of a given parameter – e. g. daily precipitation. As the threshold increases, the distribution of excesses – values above the threshold – approaches a known distribution called generalized Pareto distribution (GPD). The GPD is said to be a limiting distribution of the excesses. This type of extreme value analysis was chosen for the estimation of the return levels for the daily measurements of precipitation for each of the return periods 10, 20,

50 and 100 years.

The choice of this threshold is a balance between bias and variance. Too low a threshold might violate the limiting basis of the model, and too high a threshold will generate few excesses with which the model can be estimated, leading to broad confidence intervals in the estimated return levels. By a quite laborious method, an appropriate threshold can be estimated. This was found to be too time-consuming for the 96 stations of this project and inspired by example 4.4.1 in [4], a number of about 150 excesses for each station were chosen. It is believed that this number of excesses is sufficient to i) describe a probability distribution (in this case a GPD) and to ii) ensure that the probability of an excess (approximated by the number of excesses divided by the number of measurements) is much less than one – since excesses are characterized by being rare. For all of the 96 time series of precipitation, the threshold lay between 16 and 23 mm.

The applied POT extreme value analysis assumes a fixed number of observations per year (for daily precipitation 365.25 observations per year), and if observations in some years are missing, the frequency or return period of an extreme event is changed. Since the POT (Peaks Over Threshold) extreme value analysis is an analysis confined to values of precipitation above the threshold – the distribution of precipitation below the threshold doesn't affect the extreme value analysis. To avoid missing values in the precipitation data – in accordance with the above consideration – any erroneous values identified in the visual evaluation are for the extreme value analysis set equal to zero (0 mm) – well below the threshold.

The extreme value analysis in this work is performed using the statistical programming language "R" [1] and an additional package to R called "extRemes" [2].

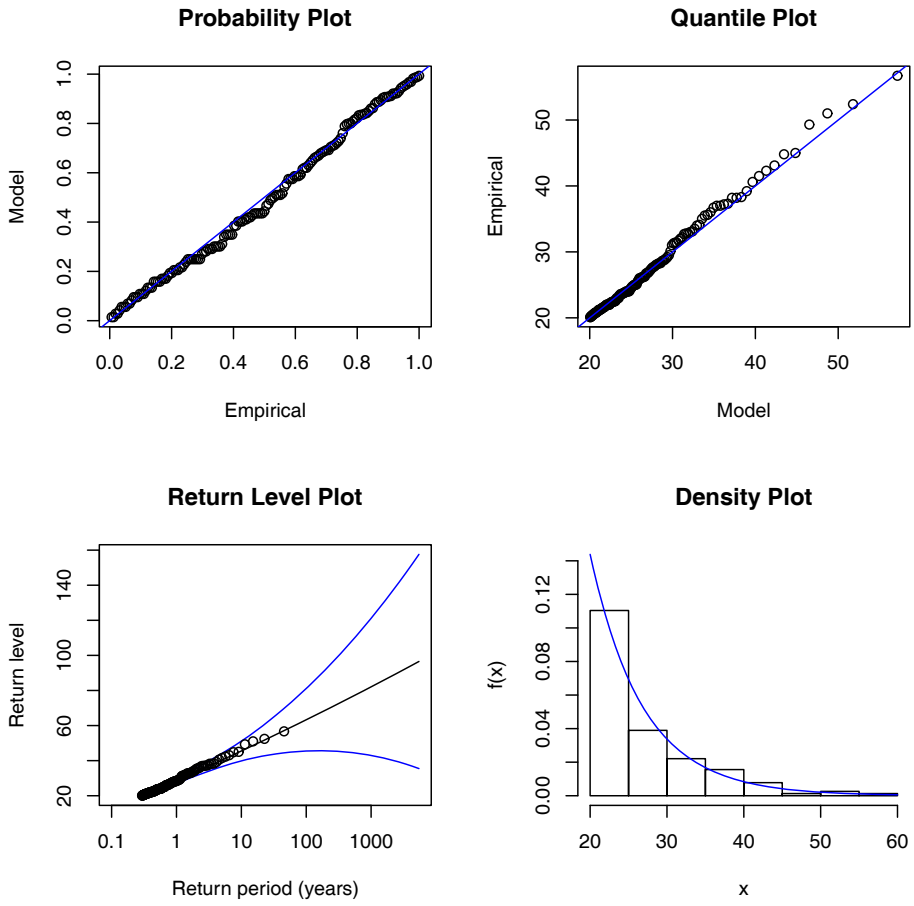

Figure 2. Diagnostic plots of the "extRemes" package for station 20390 (Gøttrup).

A result of using the "extRemes" package is among other things four diagnostic plots show in Figure 3. The Probability Plot and the Quantile Plot (upper figures) gives an idea of how well the model (the approximating distribution) describes the data (the excesses). If data follow the straight blue line, it lends support to the current GP distribution[1], which is the case here. The Density Plot (lower right figure) shows the distribution of the excesses along with the approximating GP distribution (blue curve) and the Return Level Plot (lower left plot) shows the estimated return levels (amounts of precipitation) as a function of return periods (in years). The black line in the Return Level Plot is the estimated return levels and blue lines indicate the 95 % confidence interval of the estimated return levels. The true return levels that by means of the data set are estimated, lies with 95 % certainty within the 95 % confidence interval. The open circles are the measurements. In extrapolating in time the return levels, the width of the confidence interval grows rapidly as displayed in the Return Level Plot.

3.2 Results

Figure 3 shows the distribution of the 96 estimated return levels for return periods of 10, 20, 50, and 100 years. The estimated values are approximately normal distributed – both skew and kurtosis (measures of normality of a data set) are below one for all four return periods thereby indicating normality of the return levels. This is considered as an indication that all 96 estimated return levels are reasonable.

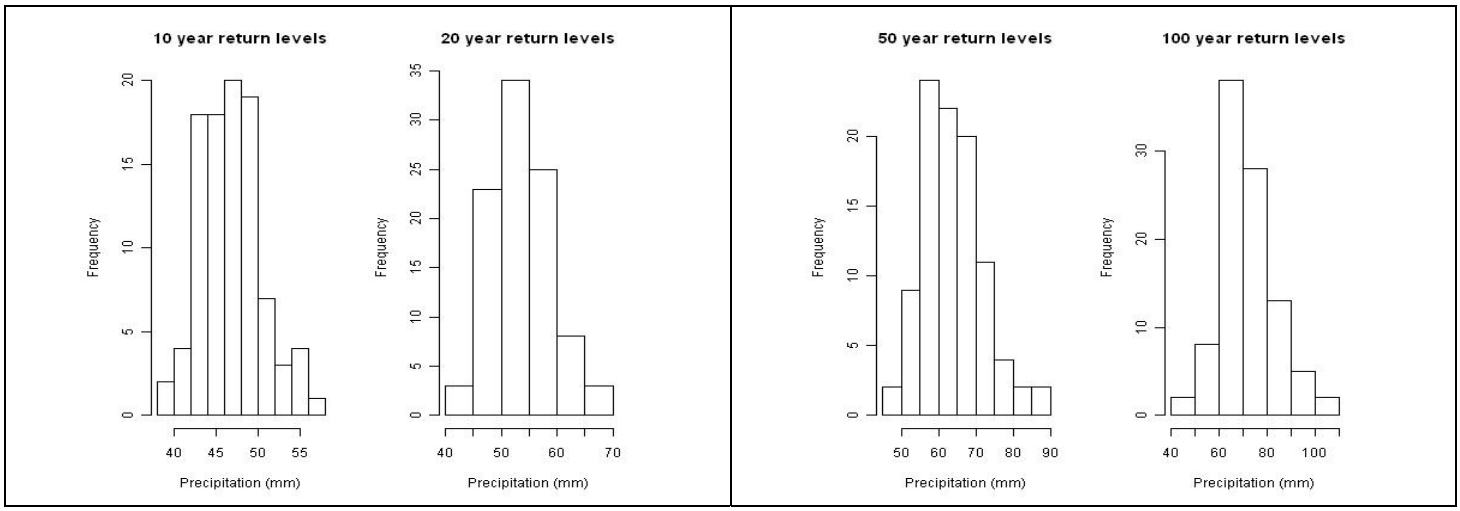

Figure 3. Distribution of the 96 return levels for the 10, 20, 50, and 100 years return periods.

The estimated return levels and the corresponding 95 % confidence intervals can be seen in table 2 and in the attached file tr11_08.txt.

"station" is the station number and X.yr.l is the return level (in mm) for at return period of X years. X.ci1 and X.ci2 is the lower and upper confidence interval, respectively, of the estimated X years return level. To illustrate, for station 20020, the 10 year return level is 52.6 and the 95 % confidence interval is [46.5, 64.7]. This means that we are 95 % sure that the true 10 year return level, that we by means of our data set is estimating, lies between 46.5 and 64.7 mm.

[1] Just as a normal distribution is described by two parameters (mean and variance), the GPD is described by three parameters (location, variance, and shape). The current GPD is here synonymous to a GP distribution with the current estimate of these three parameters.

Table 2. Estimates of return levels and the corresponding 95 % confidence intervals for each of the 96 precipitation series

Station	10.yr.l	ci1.10	ci2.10	20.yr.l	ci1.20	ci2.20	50.yr.l	ci1.50	ci2.50	100.yr.l	ci1.100	ci2.100
20020	52.6	46.5	64.7	60.8	52.1	80.9	72.9	59.3	109.2	83.0	64.6	137.5
20030	50.0	44.3	61.2	58.0	49.7	77.1	70.2	57.0	105.6	80.6	62.5	134.8
20060	46.7	42.1	55.8	52.6	46.3	67.5	60.8	51.3	86.7	67.2	54.8	104.8
20100	57.3	49.6	73.1	67.8	56.4	94.9	83.8	65.4	135.0	97.7	72.3	176.8
20150	51.8	45.8	63.3	60.2	51.5	79.7	73.0	59.2	109.1	84.1	65.2	139.1
20300	50.9	44.3	63.6	60.3	50.6	81.5	74.8	59.4	114.3	87.6	66.4	148.1
20320	50.6	42.8	67.5	61.7	49.3	92.8	80.4	58.6	144.3	98.1	66.2	203.8
20330	52.2	45.2	66.4	62.0	51.4	86.3	77.3	60.1	123.2	90.9	66.9	162.1
20390	45.5	41.2	54.1	50.8	44.9	64.4	57.8	49.2	81.1	63.3	52.1	96.4
20400	48.7	44.3	56.8	54.4	48.6	66.9	62.1	53.6	82.9	68.0	57.0	97.2
20480	50.0	44.1	61.7	58.1	49.6	77.9	70.1	56.8	106.6	80.3	62.2	135.7
20540	47.3	41.4	60.0	55.3	46.4	77.7	67.8	53.0	111.2	78.7	58.0	147.2
20560	49.4	42.8	62.7	58.7	48.8	81.5	73.2	57.1	116.3	86.3	63.6	153.2
20570	44.9	40.4	53.6	50.7	44.6	64.3	58.8	49.9	81.8	65.1	53.6	97.9
20610	45.4	40.9	53.9	51.2	45.0	64.6	59.1	50.0	81.8	65.4	53.5	97.7
20670	55.1	46.4	74.6	67.2	53.4	102.6	86.9	63.2	158.6	105.3	70.9	222.3
21110	43.7	39.4	52.5	49.5	43.3	64.2	57.9	48.3	84.5	64.9	51.9	104.8
21120	44.3	40.4	51.2	49.6	44.3	60.4	56.9	49.4	75.2	62.8	53.1	88.7
21160	42.9	39.1	50.1	47.7	42.6	59.2	54.2	46.7	73.8	59.1	49.5	87.1
21170	47.8	43.4	55.9	53.4	47.4	66.1	61.0	52.3	82.4	67.0	55.5	97.1
21230	44.2	39.9	52.9	49.7	43.7	64.0	57.4	48.4	82.4	63.5	51.5	99.8
21430	44.3	40.1	52.0	49.8	44.1	62.3	57.5	49.1	79.0	63.6	52.6	94.6
22030	48.8	41.7	64.3	59.2	48.1	87.2	76.2	57.2	132.9	92.0	64.6	184.8
22320	48.4	42.0	62.0	57.3	47.6	81.2	71.4	55.2	118.0	84.1	61.2	158.0
22600	43.3	38.9	52.5	48.9	42.7	64.0	56.7	47.2	83.2	62.9	50.3	101.4
23050	43.7	39.6	52.1	49.0	43.1	62.9	56.4	47.4	81.2	62.4	50.3	98.9
23090	47.0	41.9	58.0	53.9	46.3	72.6	64.0	52.0	98.9	72.4	56.1	125.7
23130	41.8	37.8	49.6	47.1	41.6	59.5	54.4	46.5	75.7	60.2	49.9	90.8
23220	45.0	40.7	53.4	50.7	44.7	64.1	58.7	49.7	82.1	65.2	53.3	99.2
23320	42.3	38.9	48.4	46.8	42.3	56.2	52.8	46.3	68.3	57.4	49.1	79.1
24020	42.6	39.5	48.4	46.3	42.2	55.1	50.9	45.3	65.1	54.2	47.2	73.5
24030	48.5	43.2	59.4	55.8	48.0	74.1	66.6	54.3	100.6	75.8	59.1	127.7
24070	43.7	39.7	51.3	49.3	43.7	61.3	57.1	48.8	77.8	63.4	52.6	93.2
24130	48.4	43.2	58.6	55.4	47.9	72.3	65.9	54.1	96.5	74.9	58.8	120.9
24170	49.1	44.1	58.9	56.2	48.9	72.6	66.8	55.4	96.8	75.8	60.2	121.1
24200	43.6	40.3	49.9	47.8	43.3	57.2	53.1	46.9	68.2	57.0	49.2	77.6
24270	51.2	45.3	63.1	59.5	50.8	79.5	72.0	58.1	109.0	82.8	63.6	139.2
24290	47.1	41.7	57.7	54.5	46.7	72.2	65.8	53.4	98.2	75.6	58.6	124.8
24310	43.0	40.0	48.4	46.8	43.0	54.9	51.6	46.4	64.8	55.1	48.8	73.2
24330	46.0	41.0	56.0	52.7	45.4	69.5	62.8	51.2	93.6	71.3	55.5	118.0
24380	46.2	41.0	57.3	53.1	45.4	72.1	63.4	50.9	99.1	72.2	55.0	127.3
24430	47.1	42.8	55.3	52.9	47.0	66.0	61.1	52.3	83.6	67.8	56.1	100.2
25030	54.3	47.5	68.4	63.8	53.5	88.0	78.4	61.7	124.4	91.2	68.0	163.0
25180	45.8	42.3	52.3	50.4	45.7	60.2	56.3	49.7	72.1	60.7	52.4	82.5
25220	49.5	45.2	57.7	55.3	49.3	68.3	63.3	54.5	85.5	69.7	58.1	101.5
25350	49.1	43.5	60.0	57.1	48.9	75.3	69.1	56.3	102.6	79.5	61.9	130.5
25360	49.0	44.1	58.6	55.3	48.4	70.9	64.4	53.9	91.7	71.7	57.8	111.7
26020	48.7	44.1	57.9	54.6	48.2	69.6	63.0	53.3	89.2	69.8	56.9	107.9
26050	41.6	39.6	45.6	43.7	41.4	49.3	45.9	43.2	54.2	47.3	44.2	57.8
26070	45.7	41.5	53.3	51.5	45.7	63.7	59.8	51.2	81.0	66.7	55.4	97.4
26080	42.8	38.3	51.5	49.3	42.7	64.0	59.2	48.7	86.5	67.7	53.3	109.6
26130	44.2	40.2	52.0	49.7	44.0	62.1	57.1	48.7	78.5	63.0	52.0	93.7
26170	45.7	41.6	53.3	51.1	45.5	63.0	58.6	50.4	78.8	64.5	53.9	93.5
26190	49.1	44.2	58.8	55.6	48.6	71.9	65.1	54.3	94.4	73.0	58.5	116.6
26210	50.5	45.6	59.7	57.0	50.3	71.9	66.3	56.1	92.3	73.8	60.4	111.6
26400	42.1	39.0	47.8	46.0	41.9	54.9	51.1	45.3	65.9	54.9	47.6	75.5
26430	43.1	39.2	50.4	48.4	43.0	59.8	55.6	47.7	75.1	61.4	51.0	89.3
26460	39.1	36.5	43.5	42.3	29.1	48.6	46.2	42.2	55.8	48.9	44.1	61.5
27070	43.2	39.1	51.2	48.5	42.9	61.0	55.5	47.5	76.6	61.0	50.6	90.8
28110	46.0	40.3	56.8	54.2	45.9	72.9	67.2	53.6	102.8	78.7	59.8	134.3
28170	48.0	42.4	59.0	55.8	47.7	74.0	67.4	54.7	100.4	77.4	60.1	127.0
28200	47.0	41.3	58.3	54.5	46.4	73.0	65.3	52.8	98.1	74.1	57.4	122.6

28240	49.4	44.2	59.3	56.7	49.3	72.7	67.1	56.0	95.4	75.7	60.9	117.3
28390	43.5	39.1	51.5	49.5	43.4	62.3	58.0	49.0	80.4	64.9	53.2	97.5
28400	46.7	42.2	55.1	52.5	46.4	65.6	60.6	51.7	82.6	67.0	55.4	98.2
28420	47.7	41.2	61.7	56.6	46.6	81.4	71.0	54.1	119.7	84.1	60.0	162.0
28440	46.5	41.5	56.4	53.6	46.3	70.0	64.2	52.9	94.0	73.1	57.8	118.1
28500	41.9	36.3	54.2	49.6	40.9	70.8	61.6	47.2	102.5	72.5	52.2	136.8
28510	43.1	37.7	53.9	50.7	42.8	69.3	62.3	49.7	97.9	72.6	55.0	127.8
29040	46.2	40.4	58.2	53.9	45.4	74.1	65.5	51.9	102.7	75.4	56.9	131.9
29070	44.6	39.6	54.4	51.2	44.1	66.9	60.5	49.8	87.9	68.1	53.9	108.1
29075	44.8	40.3	53.8	50.7	44.4	65.1	58.6	49.4	83.6	64.8	52.8	100.7
29090	40.0	36.5	46.1	44.7	40.2	53.6	50.8	44.7	64.8	55.4	47.9	74.4
29300	47.0	42.4	56.4	52.9	46.4	67.8	60.6	51.0	85.8	66.4	54.1	102.2
30050	47.8	42.0	59.7	55.9	47.3	75.9	68.2	54.5	105.4	78.8	60.1	135.8
30180	54.1	48.8	64.3	60.9	53.8	76.7	69.9	59.8	96.1	76.7	63.9	113.3
30230	50.4	45.4	60.8	56.6	49.7	73.2	64.9	54.6	93.3	71.1	57.8	111.8
30240	45.9	41.4	54.8	51.3	45.3	65.2	58.4	49.8	81.6	63.7	52.7	96.4
30290	44.7	40.2	53.2	50.3	44.3	63.5	57.9	49.2	79.8	63.7	52.5	94.4
30310	47.9	43.2	56.5	53.8	47.6	67.1	61.9	53.0	83.9	68.1	56.8	98.9
30320	48.6	43.7	58.4	54.8	48.1	70.4	63.2	53.3	89.8	69.7	57.0	107.6
30410	50.3	43.6	64.3	59.4	49.4	83.5	73.2	56.9	118.7	85.1	62.6	155.6
30430	43.4	38.1	54.0	50.6	42.9	68.2	61.2	49.1	93.1	70.2	53.7	118.1
30450	53.3	46.8	66.1	62.4	52.9	84.1	75.9	61.0	116.1	87.3	67.0	148.6
30480	47.6	43.1	56.4	53.3	47.3	67.2	60.9	52.2	84.1	66.5	55.4	99.3
31160	42.8	38.5	51.5	48.2	42.3	62.2	55.7	46.8	79.7	61.6	50.0	96.1
31170	41.3	37.7	48.0	45.9	41.1	56.2	51.9	45.1	68.9	56.4	47.8	80.0
31240	46.3	41.2	56.2	53.0	45.9	68.8	62.4	51.9	89.6	70.0	56.2	109.2
31260	47.6	41.8	59.3	55.5	47.0	75.4	67.2	53.9	104.2	77.2	58.9	133.4
31350	55.2	46.8	73.1	67.7	54.4	100.1	88.1	65.2	153.9	107.1	73.8	214.6
31380	42.8	38.2	51.5	49.2	42.7	63.1	58.2	48.6	82.6	65.6	52.9	101.3
31480	45.8	39.6	58.2	55.0	45.6	76.8	70.0	54.1	112.5	83.9	61.2	151.8
31500	46.5	40.5	58.9	54.7	45.8	76.4	67.4	52.8	109.1	78.6	58.2	143.7
31510	48.5	41.9	63.2	57.6	47.4	83.8	72.1	54.9	124.2	85.2	60.6	168.9
32210	49.0	43.7	59.1	55.8	48.6	71.9	65.3	54.6	93.0	73.0	58.9	112.9
32280	48.5	42.7	59.6	56.2	48.1	74.6	67.5	55.1	100.4	76.9	60.4	125.7
Mean	**46.8**	**41.8**	**56.8**	**53.6**	**46.3**	**70.2**	**63.5**	**52.3**	**93.6**	**71.8**	**56.7**	**117.0**
Min/Max		**36.3**	**74.6**		**29.1**	**102.6**		**42.2**	**158.6**		**44.1**	**222.3**

Country-wise values for Denmark are calculated as simple averages for the 96 estimated return levels of daily precipitation for return periods of 10, 20, 50, and 100 years:

Return level	Country-wise value (mm)	Minimum (mm)	Maximum (mm)
10 year return level	46,8	41,8 (36,3)	56,8 (74,6)
20 year return level	53,6	46,3 (29,1)	70,2 (102,6)
50 year return level	63,5	52,3 (42,2)	93,6 (158,6)
100 year return level	71,8	56,7 (44,1)	117,0 (222,3)

Table 3. Country-wise values for Denmark calculated as simple averages for the 96 estimated return levels of daily precipitation (24 hours accumulated precipitation) as well as lower (minimum) and upper level (maximum) for the 95% confidence intervals and for return periods of 10, 20, 50, and 100 years. The numbers in brackets are the lowest and highest value for the 96 stations. See also Table 2.

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