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10 **Impact of hydropower reservoirs on floods: Evidence from large river basins in Austria**

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Abstract

20 Dams and hydropower reservoirs constructed in the headwaters of river basins alter the hydrological characteristics as well as other physical and biological conditions of rivers downstream. In this study the impact of reservoirs on floods is systematically assessed for 8 heavily modified river basins in Austria. Since discharge data prior to the construction is not available the natural unaffected annual peak discharges
25 downstream of the reservoirs were estimated by transposing the peak runoff of an unaffected reference catchment by considering the spatial proximity, the catchment area and the precipitation conditions in both catchments. The potential impact is then calculated by comparing the estimated and the observed discharge peaks. The results show significant flood peak reductions not only at gauges directly affected by the
30 reservoir but also further downstream at receiving rivers. The propagation of the flood peak reduction downstream is also related to the ratios (i) between the reservoir catchment and the total catchment area and (ii) between the storage capacity and the catchment area. This indicates the decrease of possible flood control further downstream. Considering the return periods, results indicated that flood peak
35 reductions are most significantly for events with higher return periods. Extremes events with return periods larger than 30 years show a considerable flood peak reduction of over 33 % on average. These findings show that reservoirs foremost constructed for hydropower generation also contribute significantly to flood control and flood risk mitigation.

40 **1 Introduction**

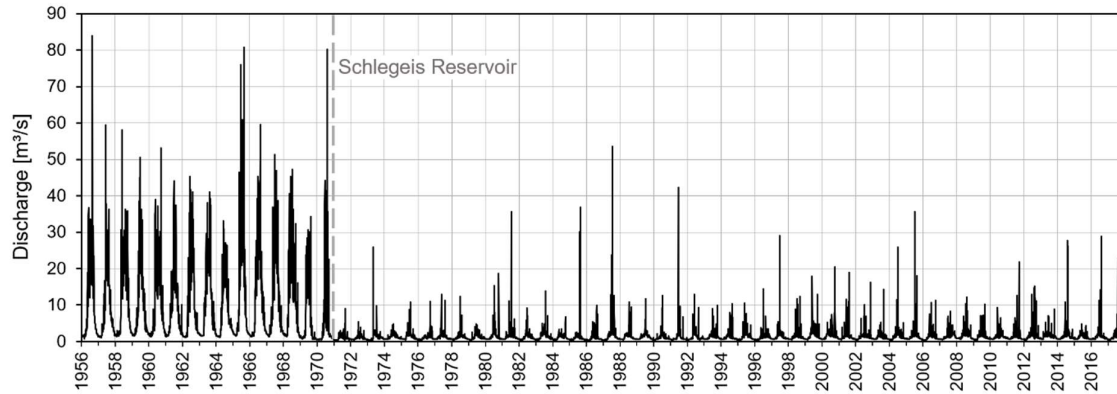
Man-made lakes, created by the impoundment of rivers by dams, can be designed for several purposes, including irrigation, hydropower generation, flood control, navigation, domestic and industrial water supply, sediment control, sport and commercial fishing or recreation (Ackermann et al., 1973b). Today, over 58 000 large
45 dams exist worldwide, of which 47 % are used for irrigation, 21 % for hydropower generation, 12 % for water supply, 9 % for flood control and 11 % for other purposes including navigation, recreation and others (ICOLD, 2021). Independent of single- or multi-purpose use of dams and impoundments they create a complex net of impacts (Ackermann et al., 1973a) and globally, over half of large river systems are impacted
50 by dams (Nilsson et al., 2005). The reservoirs can strongly alter the hydrology and runoff conditions in the downstream reaches along with other river characteristics, including temperature, sediment transport, biological and physical characteristics, but also socio-economic aspects (e.g. Ackermann et al., 1973a; Butcher, 1973; Hoffman & Jonez, 1973; Mei, Van Gelder, Dai, & Tang, 2017; Taylor, 1973). Furthermore, dams
55 are considered the main cause for fragmentation and declining river connectivity (Grill et al., 2019). Dam-induced hydrologic and hydrologic regime changes have been investigated by multiple authors (e.g. Catherine et al., 2011; Ely et al., 2020; Magilligan & Nislow, 2005; Moschen & Lauffer, 1977; Räsänen et al., 2012; Song et al., 2020). The impacts can reach such a level of severity that dams and reservoirs are removed
60 (Habel et al., 2020).

A variety of studies analysed the effect of dams on flood risk and flood control, thereby not necessarily differentiating between single- or multi-purpose dams. Batalla et al. (2004) concluded that almost all rivers within the Ebro basin in Spain showed a flood reduction. The average ratio of pre-dam and post-dam flood peaks for a 2-year flood
65 and a 25-year flood, is 0.69 and 0.58, respectively. Additionally, the ratio between reservoir capacity and mean annual runoff showed a significant association with the flood reduction. Based on the comparison of annual peak discharges in upstream unregulated river reaches and downstream regulated river reaches of 36 of the largest dams in the United States, Graf (2006) determined a reduction of flood peaks of 67 %,
70 on average. The mean daily discharge of the analysed rivers was at the same time also reduced by 12 %. Another study carried out in California investigated the hydrological impacts of dams and its water diversions in the Sacramento and San Joaquin river basins and showed that flood peaks of a 2-year flood was reduced on

average, by 53 % and 81 %, respectively (Mathias Kondolf & Batalla, 2005). Another
75 study from the United States investigated 38 dam affected rivers. Based on pre- and
post-dam annual peak discharge analysis, a flood peak reduction ranging from 7.4 %
to 95.14 % could be found (Mei et al., 2017). At rivers in Quebec, Assani et al. (2006)
determined that the construction of dams change various characteristics of the annual
maximum flow including the magnitude, whereby the magnitude of these changes
80 depends on the hydrological regime the catchment size. Verbunt et al. (2005)
investigated the impact of hydropower storages and land cover changes in the highly
anthropogenic influenced Rhine basin in Switzerland. This study also showed that the
buffering capacity of reservoirs reduces small flood peaks. Hauenstein (2009)
mentioned that in Switzerland the contribution of hydropower storage reservoirs to
85 flood damage reduction should not be underestimated.

Hydropower has a long tradition in Europe and provides 41.7 % of the total renewable
electricity generation in the EU (Wagner et al., 2019). As a consequence, the majority
of large dams (39 %) are used for hydropower generation in Europe (ICOLD, 2021). In
Central Europe, Austria is characterized by high precipitation sums and large gradients
90 due to the dominating Alps. This natural setting provides ideal conditions for
hydropower production and the contribution of hydropower to the overall electrical
energy production is significant. The primary goal of storage hydropower schemes in
Austria is power generation. Explicit drawdowns for providing flood control capabilities
are not foreseen, with very few exceptions. Nevertheless, studies have shown that they
95 also reduce flood peaks downstream. Alpine valleys with larger annual or seasonal
storage reservoirs in place have rarely been affected by flood damages since their
construction. (Pircher, 1990).

Figure 1 exemplarily shows discharge data of the Zemmbach before and after the
construction of the Schlegeis storage reservoir in Tyrol in the west of Austria
100 (Hydropower scheme Zemm-Ziller; see Figure 1). The mean annual maximum
discharge (16.8 m³/s, 1971-2017) is reduced by 59% compared to the mean annual
maximum discharge before the completion of the reservoir in 1971 (54.8 m³/s, 1956 -
1970).



105 *Figure 1 Mean daily discharge time series at the gauge Sausteinaste from 1956 to 2017 showing the impact of the 1971 completed Schlegeis reservoir of the power plant group Zemm-Ziller on flood peaks.*

Consequently, also the flood peaks further downstream of reservoirs can be reduced after construction (Pircher, 1990). For instance, extreme flood peaks corresponding to a return period of 1,000 years are estimated to be reduced by about 40 - 50 % downstream due to the construction of the Kaprun hydropower scheme in Salzburg (Lauffer, 1975). Kugi & Weissel (1986) reported that the flood event of 1985 in the Malta Valley was reduced by 42 to 47 % downstream of the Kölnbrein reservoir, the largest reservoir in Austria with a capacity of 200 million m³. At other river basins in Austria influenced by reservoirs comparative reductions for single flood events of different magnitudes were observed (Ganahl, 1988; Hofer et al., 2013; Pircher, 1990)

Reservoirs constructed for hydropower generation generally affect the possible flood risk downstream. The downstream flood risk reduction potential of reservoirs depend on the share of catchment area controlled by the reservoir (Widmann, 1988, Pircher, 1990). Hence, the capacity of flood control decreases with the distance from the dam and with an increase in the catchment area downstream (Pircher, 1990; Schöberl, 2005). Additionally, the storage volume available at the time of the flood event plays a crucial role (Pircher, 1990). Drawdowns for the sake of flood control are not in place, with few exceptions.

Studies analysing the effects of hydropower reservoirs on flood peaks in Austria focused on single events. No systematic assessment exists. Additionally, most studies were done many years or even decades ago. Since that time, longer periods of observations have become available. Already in 1988, Widmann urged to analyse the peak flood reduction based on longer observation records in the future. Considering these limitations in our current knowledge, this study aims to investigate and systematically quantify the impact of the main hydropower reservoirs in Austria on

floods. This allows for a more comprehensive understanding on the reduction of peak discharge, flood hazard and flood risk along the downstream reaches of a river basin influenced by a reservoir in its headwaters. The objectives of this research are:

135 (i) The estimation of the flood peak reduction, including the spatial distribution downstream of the reservoirs

(ii) The analyses of flood hazard mitigation due to the construction of reservoirs considering return periods

(ii) The evaluation of the relationship between the estimated flood peak reduction with catchment and reservoir features.

140 The focus thereby not only lies on selected extreme events (as has been done in the past), but also on annual peak discharges of long-term runoff records and floods of different return periods, thereby covering eight river basins, having areas of 955 – 9 310 km². This allows for a more holistic quantification of the influence of reservoirs on flood peaks and their impact on flood risk in the Alps.

145 **2 Materials and Method**

2.1 Study area

The study covers eight river basins in Austria influenced by storage hydropower plants (Figure 2). With the exception of the Kamp (Basin 8 in Figure 2), which is located in the north-east, the basins are located in the Alps and are, from west to east: Ill (1),
150 Rosanna (2), Fagge (3), Ziller (4), Salzach (5), Drau (6, Drava) and Mur (7, Mura). The main storage power plants of Austria (Table 1) are covered within this study.

The topography in Austria is strongly dominated by the Alps and its adjoining alpine foothills. The Alps account for 65 % of the entire national area. Such elevated areas act as a barrier and govern large-scale weather and wind systems influencing
155 precipitation characteristics and precipitation sums (Fürst et al., 2010). One of the general characteristics of precipitation is the altitudinal gradient with higher sums in elevated areas, which can however vary with local conditions. Mean annual precipitation ranges between 480 mm in eastern lowlands and over 2700 mm in the Alps (Lebiedzinski & Fürst, 2018). Most runoff in Austria is also affected by the alpine
160 characteristics and is therefore strongly influenced by the snow accumulation in winter

and the melting process in spring and summer (Herrnegger et al., 2018; Lebedzinski & Fürst, 2018).

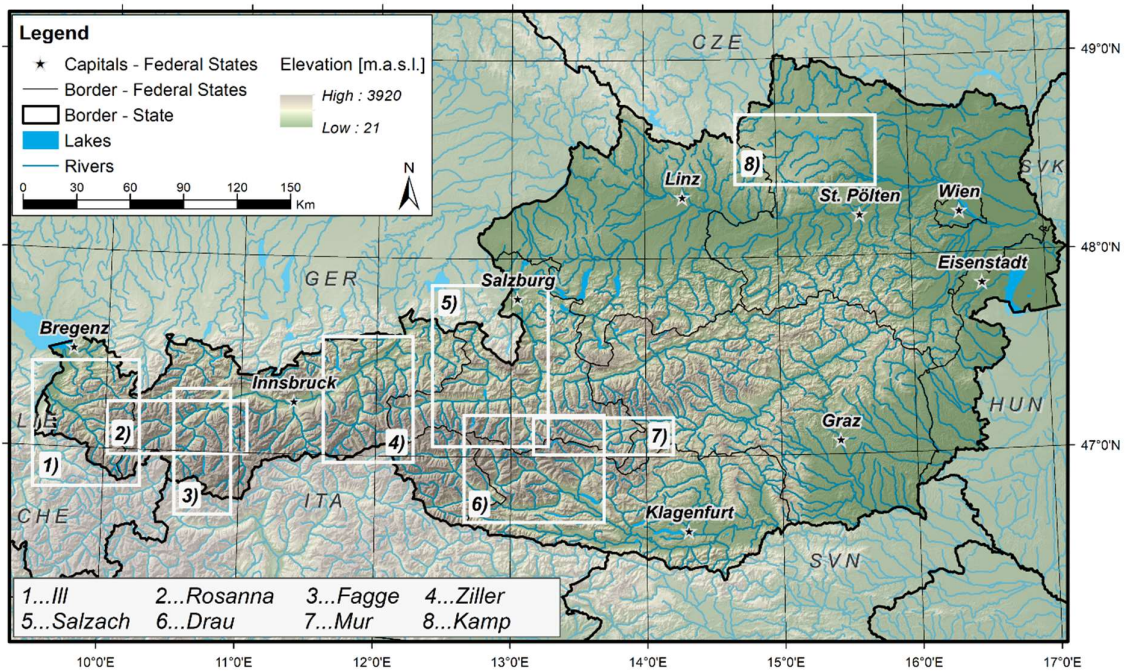


Figure 2 Overview of the studied river basins

165 Glacier melt processes can contribute significantly to runoff, however depending on
the catchment size. Koboltschnig & Schöner (2011) showed that the glacier melt
contribution to runoff has a logarithmic relationship with the relative glacierized
catchment area. Hence, mean runoff regimes also show a clear spatial pattern
influenced by the altitude. In alpine areas, runoff regimes are determined by (glacio-)
170 nival characteristics. In the alpine foothills and lowlands in the north and east, pluvial
runoff regimes dominate (Lebedzinski & Fürst, 2018).

During the last two decades, major flood events took place in 2002, 2005, 2013 and
2018 (Leis & Kienberger, 2020). For example, during the flood event in the upper
Danube catchment in June 2013, several tributaries (Saalach, Tiroler Ache,
175 downstream reaches of the river Inn and Salzach) experienced runoff in the order of a
100-year return period. Peak discharge exceeded the largest observed floods in many
parts of the Upper Danube catchment. The August 2002 flood event was most severe
in the catchment of the river Kamp, which showed unusual high runoff coefficients due
to antecedent saturated soils (Komma et al., 2007). This extraordinary event showed
180 estimated return period in the order of 2000 to 10,000 years (Gutknecht et al., 2002).

The June 2005 flood event was most severe in the western provinces of Vorarlberg and Tyrol. Here, the event runoff exceeded the maximum discharge records at several rivers. This led to substantial flooding and damages along major rivers in Tyrol including the river Inn. At the gauge in Innsbruck, the largest runoff (1511 m³/s) since
185 observations began was recorded. This runoff corresponded to an estimated 200-year event (BMLFUW, 2006). In October 2018, another flood event took place in the southern province of Carinthia, where gauges along tributaries showed discharge peaks exceeding return periods of 100 years (Moser et al., 2019).

The alpine topography does not only characterise spatio-temporal discharge and
190 precipitation trends, but also provides the topographic gradients for hydropower generation. Over 90 % of large single purpose dams are hydropower dams (ICOLD, 2021). In Austria hydropower is a significant part of the energy system, providing about 65.7% of the national gross energy generation, whereas 28 % are produced by storage and pump-storage power plants (Wagner et al., 2015). The operation of these power
195 plants also affects the downstream hydrology. About 80 % of large rivers (n = 52, > 500km²) are moderately to heavily affected by humans. 49 % of these rivers show hydrological alterations including impoundments (16 %), water diversions (19 %) and hydropeaking (14 %) (Muhar et al., 2000). Within the river basins covered in this study, power plant groups consisting of multiple water reservoirs are installed (Table 1). In
200 total, these hydropower plants produce about 7400 GWh/a, which represents over 60% of all storage – and pump-storage plants in Austria (11,812 GWh/a) (ICOLD, 2021, Wagner et al., 2015). The main purpose of most water reservoirs is hydropower production and not flood control.

Table 1 Storage water reservoirs and power plants within the study areas (ICOLD, 2021)

Nr.	River Basin	Power plant (group)	Reservoir Name	Reservoir Capacity [10 ⁶ m ³]	Catchment area [km ²]	Purposes*	River	International Code	Year of Const.
1)	ILL	OBERE ILL - LÜNERSEE	Kops	44600	170	H	III	I01000072	1965
			Luenersee	94000	10	H	III	I01000089	1958
			Silvretta	39100	35	H	III	I01000131	1948
			Vermunt	5700	75	H	III	I01000151	1931
2)	ROSANNA	KARTELL	Kartell	8000	15	H	Moosbach	I01000066	2005
3)	FAGGE	KAUNERTAL	Gepatsch	139000	108	H/C	Faggenbach	I01000041	1964
4)	ZILLER	GERLOS ZEMM-ZILLER	Durlassboden	53500	75	H	Gerlosbach	I01000018	1966
			Gmuend	850	108	H	Gerlosbach	I01000043	1945
			Schlegeis	129000	122	H	Zemmbach	I01000128	1971
			Zillergruendl	89500	67	H	Ziller	I01000169	1986
5)	SALZACH	KAPRUN STUBACHTAL	Stillup	7900	61	H	Stilluppe	I01000019	1968
			Margaritze	3800	64	H	Moell	I01000091	1952
			Mooserboden	87000	99	H	Kapruner Ache	I01000097	1955
			Wasserfallboden	86000	43	H	Kapruner Ache	I01000086	1951
6)	DRAU	FRAGANT REISSECK	Tauernmoos	55300	23	H	Stubache	I01000143	1973
			Weissee	16000	10	H	Stubache	I01000160	1952
			Feldsee	2450	3	H	Fragant	I01000027	2008
			Grossee	14400	3	H	Moell	I01000053	1980
			Haselstein	43	9	H	Kl. Fragantbach	I01000057	1968
			Hochwurten	12700	6	H	Fragant	I01000061	1980
			Innerfragant	210	-	H	Wurtenbach	I01000063	1967
			Oscheniksee	33000	3	H	Fragant	I01000105	1979
			Woella	10	13	H	Woellabach	I01000166	1984
			Wurtenalm	2800	10	H	Wurtenbach	I01000167	1971
7)	MUR	HINTERMUHR	Zirmsee	8650	4	H	Moell	I01000170	1983
			Galgenbichl	4800	51	H	Malta	I01000038	1974
			Goesskar	2000	11	H	Malta	I01000046	1975
			Gr. Muehldorfersee ¹	7850	2	H	Malta	I01000050	1957
8)	KAMP	KAMPTAL	Koelnbrein	205000	52	H	Malta	I01000071	1977
			Rotgueldensee	15600	10	H/C	Mur	I01000121	1991
			Dobra	21000	940	H/R	Kamp	I01000016	1953
			Ottenstein	73000	889	H/R/N/C	Kamp	I01000107	1956
			Thurnberg	2570	1012	H/R/N	Kamp	I01000145	1952

¹ including Kleiner Muehldorfersee, Hochalmsee, Radlsee

*H...Hydroelectricity; R...Recreation; N...Navigation; C...Flood Control

205 A few reservoirs have secondary purposes covering flood control, recreation and navigation. Apart from hydropower generation, the reservoirs Gepatsch, Rotgueldensee and Ottenstein are additionally used for flood control and to mitigate flood risk. At the Gepatsch reservoir for instance, seasonal flood storage volumes were defined following the flood event of 2005. In August, 4 m retention space (10.2 mio m³) is exempted from regular operation and in September 2 m (5.4 mio m³) (Hofer et al., 2013).

2.2 Data and Methodology

Other studies investigate the impact of reservoirs on flood events by using (i) long-term discharge data up – and downstream of reservoirs (Graf, 2006), (ii) pre- and post-dam runoff data (Mei et al., 2017, Mathias Kondolf & Batalla, 2005) or (iii) other data including, discharge of diversions, reservoir inflow and outflow for detailed event-based analyses (Ganahl, 1988, Hofer et al., 2013). For the current study, (i) to (iii) are not an option, since the data is not available.

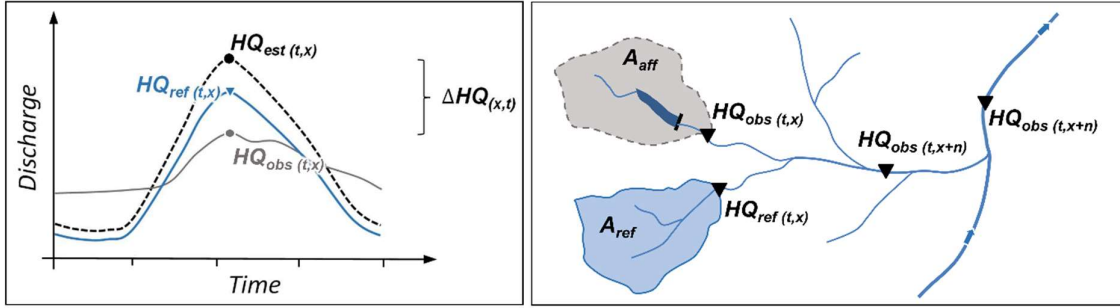
The basis for the analysis is the calculation of the ratio between observed runoff peaks
220 after construction of a reservoir with an estimated peak representing the natural state.
The estimation of the numerator in the ratio is a problem of runoff prediction in an
ungauged setting, where several methods exist (Ancil et al., 1998; Assani et al., 2006;
Blöschl et al., 2013; Hrachowitz et al., 2013; Ralf Merz, 2006; Wundt, 1949).

Here, flood estimates are derived through transposition or regionalisation of gauge
225 records of catchments with undisturbed runoff conditions (reference catchments). As
a measure of suitability and similarity, spatial proximity of the two catchments is used.
Catchments close to each other act similar with respect to their flood responses, since
it is expected that hydroclimatic and hydrogeological conditions only change smoothly
in space (R. Merz & Blöschl, 2005). Additionally, the land cover of the catchments were
230 analysed (see Table A5 and A6 in the Appendix) based on the CORINE land cover
data set (European Union, 2021). The differences in catchment area is considered by
multiplying the annual peak discharge from the reference catchment (HQ_{ref}) with the
ratio of the catchment area of the affected gauge (A_{aff}) and the area of the unaffected
catchment (A_{ref}). Thus, the estimated natural peak discharge downstream of the
235 reservoirs (HQ_{est}) increases or decreases linearly with the catchment ratio.

Additionally, precipitation was included as a scaling factor for the estimation of the
 HQ_{est} . The SPARTACUS dataset (Hiebl & Frei, 2018), which is a gridded (1x1 km)
daily precipitation dataset for Austria, was used to calculate the precipitation ratio
between (i) the catchment of the reservoir (affected) and (ii) the reference (unaffected)
240 catchment. Based on this dataset, the 3-day precipitation sum ($\sum_{t=1}^3 P$) starting three
days before the day of HQ_{est} , of the affected catchment (P_{aff}) is compared to the
precipitation sums in the reference catchment (P_{ref}). Thus, the prevailing antecedent
hydrological conditions (e.g. saturation) in the catchments prior to the annual peak
discharge are considered in the estimation of the annual peak discharge. To avoid
245 discharge estimations of HQ_{est} with large differences in precipitation, e.g. due to very
small-scale events, thresholds of the ratio were defined. If the precipitation ratio
exceeds 1.3 or is below 0.7, the estimated HQ_{est} was not used for further analysis.
Similar to the catchment area ratio used in the estimation, the precipitation ratio
increases or decreases the estimated annual peak flood linearly.

250 Figure 3 shows a schematic illustration for the estimation of the discharge peak at the
affected catchment. On the left side, a hydrograph of the observed, reference and

estimated flood schematically illustrated. The right side shows a schematic river basin and the water reservoir influenced gauges, also including the reference catchment.



255 Figure 3 Schematic illustration of hydrographs including the observed and estimated HQ based on records of a reference catchment (left); and a schematic map of a river basin influenced by a water reservoir (right).

In a first step, the annual peak discharge (HQ_{est}) at the affected gauge (x), including the catchment area and precipitation conditions for the day per year (t) respectively, can be calculated based on equation (1).

$$HQ_{est}(t, x) = HQ_{ref}(t) * \frac{A_{aff}}{A_{ref}} * \frac{\sum_{t=1}^3 P_{aff}}{\sum_{t=1}^3 P_{ref}} \quad (1)$$

260 The next step is to actually calculate the potential impact of the reservoirs by comparing the estimated peak discharge (HQ_{est}) with the observed discharge (HQ_{obs}) at the affected gauges. Based on equation (2), the potential flood peak reduction (FPR) can be calculated for every location x and day per year t .

$$FPR(t, x) = \left(1 - \frac{HQ_{obs}(t, x)}{HQ_{est}(t, x)} \right) * 100 \quad (2)$$

For analysing the potential impact of reservoirs, not only at the gauges directly
 265 downstream (Eq. 1 & 2), but also their impact further downstream, it was necessary to propagate the estimated peak discharge HQ_{est} of the directly affected gauge onto these downstream gauges ($x + n$). Since the day (t) of the annual peak discharge can vary considerably between a downstream gauge of interest ($x + n$) and the gauge (x) of the influenced catchment, the transposition formulated in equation (1) was applied at the
 270 day corresponding to the recorded HQ_{obs} at the gauge ($x + n$). The estimated $HQ_{est}(x)$ and the observed $HQ_{obs}(x)$ were then used to compute the $HQ_{est}(x+n)$ at the respective day based on equation (3).

$$HQ_{est}(t, x + n) = HQ_{obs}(t, x + n) - HQ_{obs}(t, x) + HQ_{est}(t, x) \quad (3)$$

Following Eq. (2) the potential flood peak reduction at this gauge can then be calculated. For downstream gauges with more than one affected catchment in their headwaters the transformation (Eq. 1) was applied to all reservoir influenced catchments.

In Table 2 the affected and the used reference catchments and their gauging stations with other attributes including the location, altitude, area and the distance between the gauges are listed. Discharge data for the selected gauges was obtained from the hydrographic central office of Austria, which publishes mean daily discharge data at <https://ehyd.gv.at/> (HZB, 2021). Depending on the gauge, the time series cover a period starting earliest from 1976 to 2017. The gauges selected for this study for each river basin can be found in the appendix.

Table 2 Affected and reference gauges (marked with an asterix*) used for the estimation of annual peak discharges

Nr	river basin	ID	Name	Latitude	Longitude	Altitude [m]	Area [km ²]	Distance between gauges [km]
1	Ill	231688	Beschling	47° 12'10,08''N	09° 40'48,54''E	489.2	1118.6	15.01
		200105*	Garsella	47° 13'36,54''N	09° 52'34,23''E	736.5	95.5	
2	Rosanna	201251	St.Anton am Arlberg-Moos	47° 07'23,16''N	10° 15'36,36''E	1386.9	130.6	31.29
		200105*	Garsella	47° 13'36,54''N	09° 52'34,23''E	736.5	95.5	
3	Fagge	202119	Platz-Loch	47° 03'24,12''N	10° 45'03,24''E	1227.1	191.5	17.58
		230300*	Gepatschalm	46° 53'55,54''N	10° 44'18,90''E	1891.9	55	
4	Ziller	201749	Mayrhofen	47° 10'09,48''N	11° 51'41,75''E	629.3	610.9	30.06
		203034*	Sulzau	47° 13'54,39''N	12° 14'51,79''E	885.8	80.7	
		201970	EW-Gmünd	47° 12'41,03''N	12° 00'10,07''E	1193.0	141	18.68
5	Salzach	203554	Uttendorf (Summenpegel)	47° 16'02,63''N	12° 34'12,35''E	844.2	127.9	24.71
		203034*	Sulzau	47° 13'54,39''N	12° 14'51,79''E	885.8	80.7	
		203109	Kaprun	47° 16'22,79''N	12° 45'34,91''E	767.5	88.6	39.01
203034*	Sulzau	47° 13'54,39''N	12° 14'51,79''E	885.8	80.7			
6	Drau	213124	Flattach	46° 55'59,88''N	13° 08'00,60''E	692.9	705.3	6.39
		212381*	Mallnitz	46° 58'59,94''N	13° 10'29,04''E	1176.5	85.3	
		212472	Pflüghof	46° 59'31,91''N	13° 27'29,52''E	851.5	131.3	21.58
		212381*	Mallnitz	46° 58'59,94''N	13° 10'29,04''E	1176.5	85.3	
7	Mur	203745	Muhr	47° 06'11,87''N	13° 29'18,95''E	1121.2	75.7	18.35
		203778*	Weißpriach	47° 10'37,02''N	13° 42'18,77''E	1099.7	77.1	
8	Kamp	207985	Rosenburg	48° 37'53,40''N	15° 37'02,28''E	281.8	1150.2	32.71
		207944*	Zwettl-Bahnbrücke	48° 36'34,61''N	15° 10'28,67''E	519.1	621.8	

285 Some of the reference catchments used for the transposition define a sub-catchment
of the affected catchment or are located within the same river basin. Other reference
gauges are used for multiple reservoir influenced gauges (e.g. Garsella). The distance
between the affected and the reference gauging station used ranges from about 6.4 km
to 39.1 km.

290 3 Results

3.1 Impact of hydropower reservoirs on peak discharges, including their spatial characteristics

The possible role of water reservoirs in flood control and hence reducing flood risk
downstream is investigated for eight river basins. In Table 3Table 1 the estimated
295 median flood peak reduction (FPR_{median}) of all investigated gauges is summarized. The
basis for the calculation of the FPR_{median} are thereby the annual maximum floods of the
period 1976-2017 (42 years). The data availability differs between the basins (see
header in Figure 5 on data availability of the single gauges). Additionally, the observed
and the estimated long-term mean annual peak discharge is shown.

300 Table 3 Median flood peak reduction (FPR_{median}) and long-term mean annual peak discharge observed (HQ_{obs}) and estimated (HQ_{est})

River basin	ID	Gauge	River	Area [km ²]	FPR_{median} [%]	HQ_{obs} [m ³ /s]	HQ_{est} [m ³ /s]
Ill	231688	Beschling	Ill	1118.6	53.6	155	289
	200147	Gisingen	Ill	1281	36.1	233	341
	2437 (CH)	Diepoldsau	Rhein	6119	8.4	910	1010
Rosanna	201251	St. Anton am Arlberg-Moos	Rosanna	130.6	59.7	17	42
	202036	Landeck - Bruggen	Rosanna	727	9.2	84	85
	201319	Imst (Bahnhof)	Inn	3842	0.1	372	370
Fagge	202119	Platz-Loch	Fagge	191.5	96.7	2	58
	201194	Prutz	Inn	2461.5	9.6	292	329
	201319	Imst (Bahnhof)	Inn	3842	6	423	453
Ziller	201749	Mayrhofen	Ziller	610.9	56.25	88	224
	201780	Hart im Zillertal	Ziller	1094.7	42.15	165	296
	201806	Brixlegg	Inn	8503.6	9.3	984	1083
	201889	Kirchbichl	Inn	9310	8.05	1061	1151
	201970	EW-Gmünd	Gerlosbach	141	73.45	14	50
	201772	Rohr	Gerlosbach	196.8	67	17	54
Salzach	203554	Uttendorf	Stubache	127.9	66.3	13	41
	203109	Kaprun	Kapruner Ache	88.6	77.85	9	31
	203125	Bruck (Salzach)	Salzach	1168.7	14.4	183	213
	204297	Salzburg	Salzach	4425.7	2.6	711	726
Drau	213124	Flattach	Möll	705.3	47.9	66	127
	212399	Kolbnitz a.d. Tauernbahn AHP	Möll	1043.8	32.95	114	171
	213199	Drauhofen	Möll	3674.4	11.2	450	510
	212472	Pflügelhof	Malta	131.3	76.75	10	27

	212498	Sandriesen	Malta	266	22.6	30	38
	212530	Spittal (Fasan)	Lieser	1035.5	10.1	96	105
	213215	Amlach	Drau	4789.6	14.65	525	614
	203745	Muhr	Mur	75.7	50.7	10	18
Mur	203752	St.Michael i. Lg. (Mur)	Mur	289.2	14.35	34	41
	203794	Mörtelsdorf	Mur	366.9	14.75	39	46
	203976	Kendlbruck	Mur	955	5.9	108	114
Kamp	207985	Rosenburg (EVN)	Kamp	1150.2	70.2	39	80
	207993	Stiefern	Kamp	1493.3	22.2	69	79

Generally, the median of the calculated FPR_{median} indicates a clear positive impact on annual floods at all stations. The FPR_{median} values range from 96.7% at the Platz-Loch gauge along the Fagge to 0.1% in Imst (Inn river). The overall mean FPR_{median} value is 27.4%, with a standard deviation of +/- 31.9 %. The FPR_{median} shows high values of over 45 - 70% or more for gauges located in the proximity of reservoirs. Further downstream, the FPR_{median} is reduced, but can still show values of 5 – 20%, e.g. at the Inn, Drau or Kamp.

Based on the median values calculated for each gauging station, Figure 4 shows the spatial trends of the FPR_{median} values along the river reaches, including the reservoirs/hydropower groups and the affected catchment. The reduction of the FPR_{median} along the stream between the gauges is derived by linearly interpolating the median values along the river stretch. The results show the clear decreasing trend of the FPR_{median} with increasing distance from the reservoir. This is particular pronounced right after the confluence of tributaries.

At the most westerly located river basin, FPR_{median} values range from 53.6 % at the closest gauge (231688, 1118.6 km²) to the reservoirs to 8.4 % at the gauge located at the river Rhein. The construction of the water reservoir Kartell in the Rosanna river basin, was only finished in 2005. Due to the short time series after the construction and the applied precipitation thresholds in the estimation only very few results are available. Therefore, results for this river basin are highly uncertain and should be seen with caution.

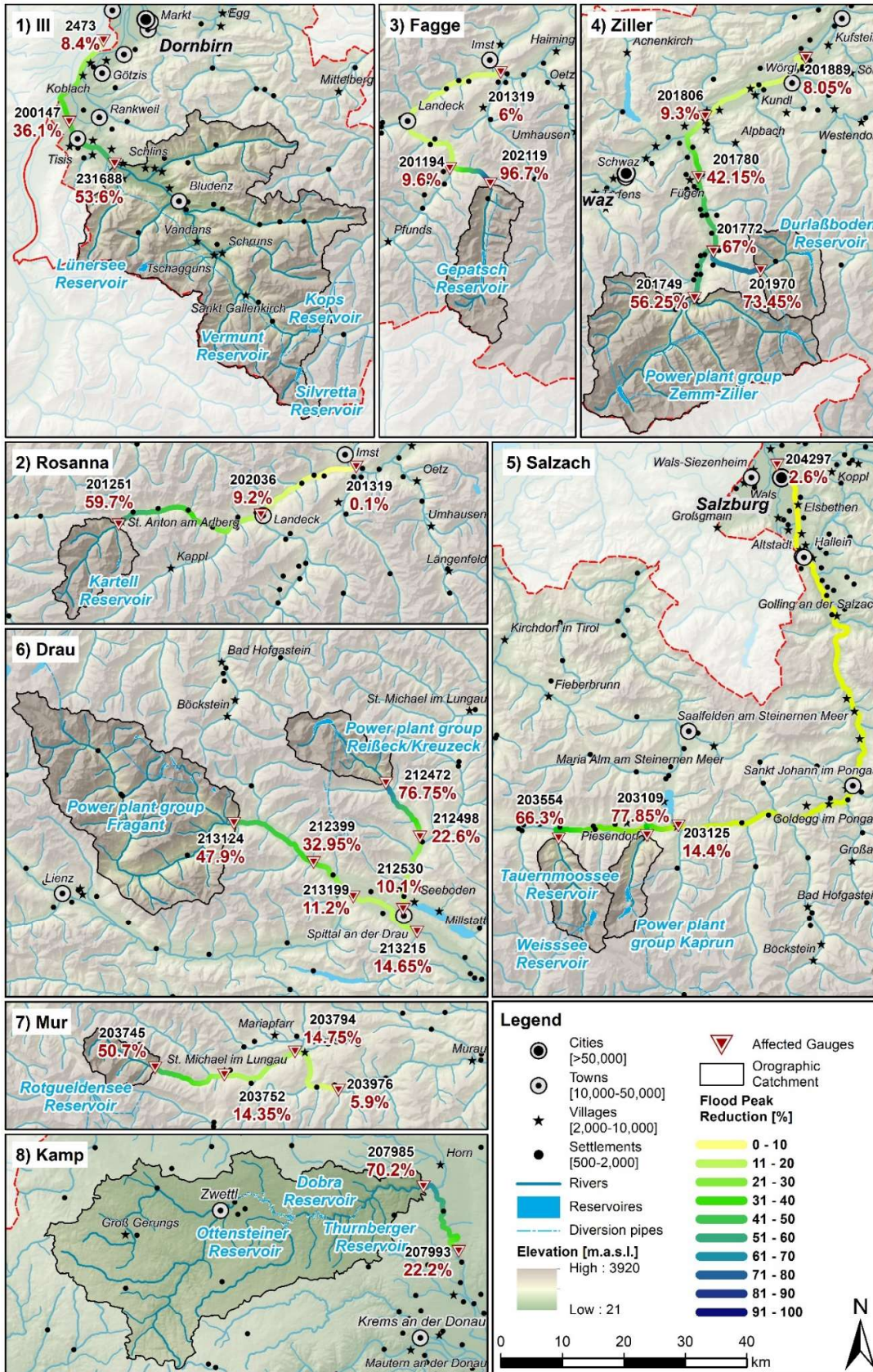
The largest FPR_{median} value of 96.7 % can be found at the gauge 202119 Platz-Loch (191.5 km²), which is situated downstream of the Gepatsch reservoir. It is the second largest reservoir in Austria with a total capacity of 139 million m³. The high FPR translates further downstream to the next gauges. The Prutz gauge (201194), of which the catchment is over 12 times larger, still shows a median FPR of nearly 10 %. This

gauge however is not located along the impacted river reaches, but right upstream of the confluence of the affected river (Fagge) and the receiving river (Inn).

330 The headwaters of the Ziller are influenced by two power plant groups. The power plant group Zemm-Ziller and its reservoirs (total capacity = 226 million m³) are located at several streams and rivers upstream of the gauge Mayerhofen (201749, 610.9 km²), where a FPR_{median} of over 56 % is found. Between the gauges Mayerhofen and Hart im Zillertal, the Gerlosbach, which has another large reservoir in its headwaters, drains
335 into the Ziller. The Durlaßboden reservoir has a capacity of 53.5 million m³ and strongly reduces annual flood peaks along the Gerlosbach. The influence on the Inn is in the range of 8% – 9%.

Multiple reservoirs in the headwaters of the Salzach river affect flood peaks, reducing them by about 15 % at the gauge Bruck (203125, 1168.7km²). The Stubache is
340 influenced by two large reservoirs (71.3 million m³; Wesemann et al. 2018), which leads to a FPR_{median} of 66.3 %. Likewise, in the valley running parallel to the east, the power plant group Kaprun decreases the annual floods by about 78 % due to the reservoirs Tauernmoos and Wasserfallboden (176.8 million m³). For the Salzach, the influence of the reservoirs in the headwaters is still visible in Salzburg, where a FPR_{median} of around
345 3 % is still evident. Additionally, diversion from the Möll catchment in the south transfer water to the north towards Kaprun, also influencing discharge of the Möll.

The discharge at the Möll river is predominantly affected by a number of reservoirs of the power plant group Fragant (total capacity = 74.3 million m³). The FPR_{median} at the Flattach gauge (213124, 664.5 km²) located downstream lies around 47 %. With a
350 FPR_{median} of over 11 % the influence is still evident at the Drauhofen gauge (213199, 3674.4 km²). At the Amlach gauge (213215, 4789.6 km²) further downstream at the river Drau, an increase of the FPR_{median} can be seen. Here the Drau river is also influenced by the power plant group Kreuzeck in the headwaters of the Malta river, which is another tributary. In the headwaters of the Malta river the Kölnbrein reservoir
355 is situated. With its overall reservoir capacity of 200 million m³ it is the largest reservoir in Austria. Annual flood peaks downstream are significantly reduced. At the gauge Pflügelhof (212472, 131.3 km²) and Sandriesen (212498, 266 km²) the median flood peak reduction is 76.65 % and 22.6 %, respectively.



360

Figure 4 Median Flood peak reduction (FPR) for the eight study basins.

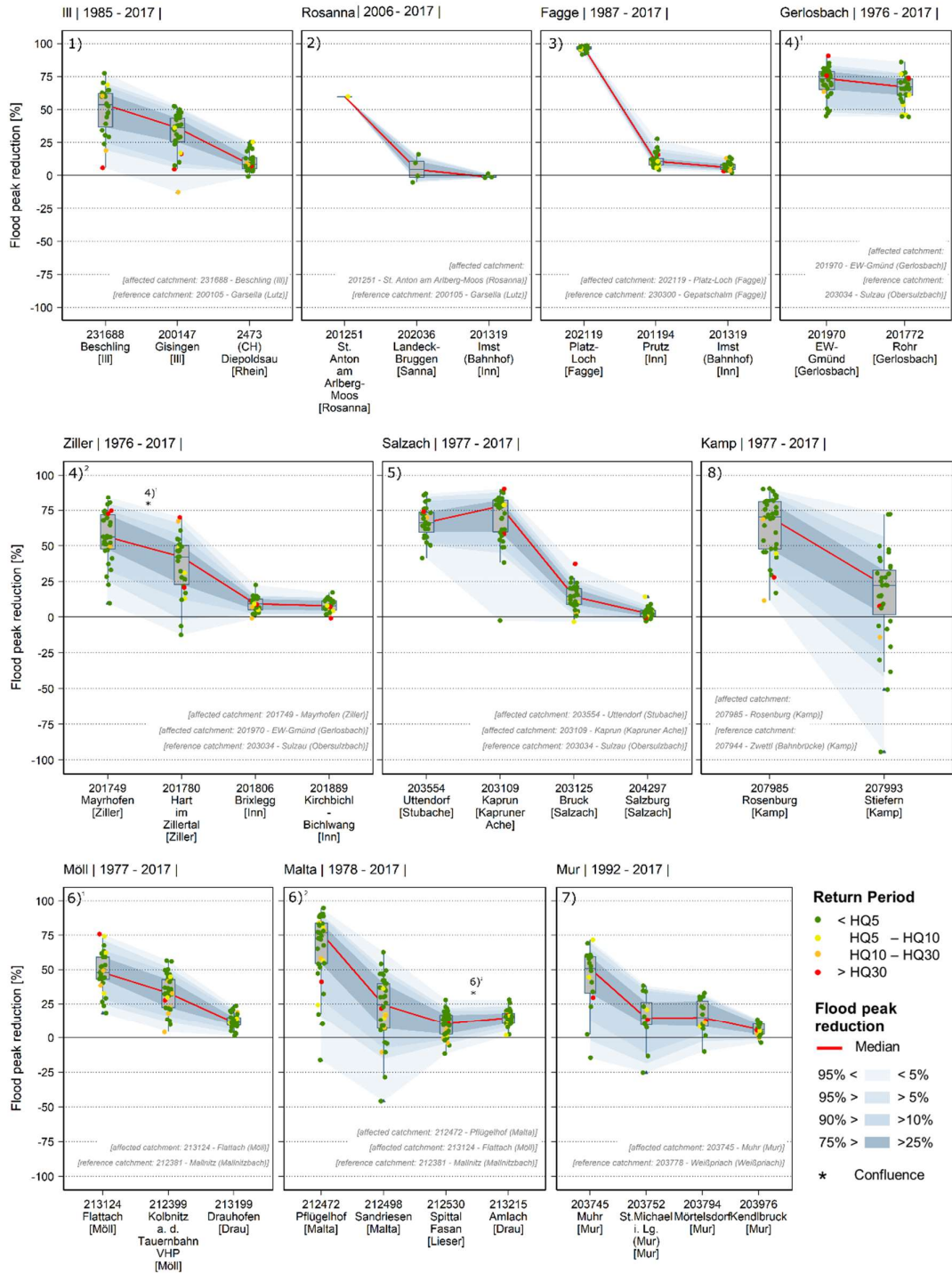
At the Mur river basin, FPR_{median} values ranging from over 50 % (203745, 75.7 km²) to 5.9 % (203976, 955 km²) further downstream at the last gauge analysed, are found. FPR_{median} values in at gauges in the mid-stretches of the Mur are over 14 %.

365 The impact of the Powerplant Kamptal significantly reduces flood peaks downstream at the Rosenberg gauge ($FPR_{\text{median}} = 70.2\%$). This impact reduces to 22.2 % at the next gauge (207993, 1493.3 km²), which is located after the tributary Taffa confluences with the Kamp river.

Figure 5 shows the distribution of the estimated flood peak reductions based on the single annual flood peaks of the individual gauges in the eight river basins. The return periods of the single events are thereby plotted in different colours. In the headwaters of the Ziller and Drau river basin, reservoirs exist at different tributaries. Hence, the impact of the reservoirs along these tributaries is plotted individually and the location of the confluence is marked by an asterisk within the respective plots of the river basins.

375 The impact of the reservoirs is generally positive, leading to a reduction of the estimated annual peak discharge peak throughout all river basins. The FPR_{median} , plotted in red, shows the decreasing trend with increasing distance from the reservoir in all river basins with the exception of the Amlach gauge at the river Drau. The majority of all analysed flood peaks (n=838) show positive values (n=792), indicating reductions of the estimated flood peaks. Compared to the total analysed events at all gauging stations, around 5.5 % (n=46) show an increase of the respective maximum annual discharge.

380 On average, the flood peak reduction is strongest at the first gauges downstream of a reservoir. Here, the mean flood peak reduction is 63.5 %. At the second gauges after the reservoirs, mean flood peak reduction decreases to 26.5 %. Further downstream, at the third and fourth gauge included in the analyses, the mean FPR values further decrease to approximately 10 %.



390

Figure 5 Event based flood peak reduction and return periods at gauges affected by hydropower reservoirs

3.2 Relating return periods and flood peak reduction

395 Figure 6 shows the relationship between return periods based on the Gumbel extreme value distribution and the FPR. Generally, floods with lower return periods (\sim <HQ10) show a larger flood peak reduction. On average, the FPR for these events lies around 31-35 %. For return periods between 10 and 30 years, the mean FPR is further reduced to about 23 %. For events with a lower probability ($>$ HQ₃₀) a mean FPR of over 33 % can be found. 400 over 33 % can be found. It is clear that the sample size for this category is smaller, compared to the other categories.

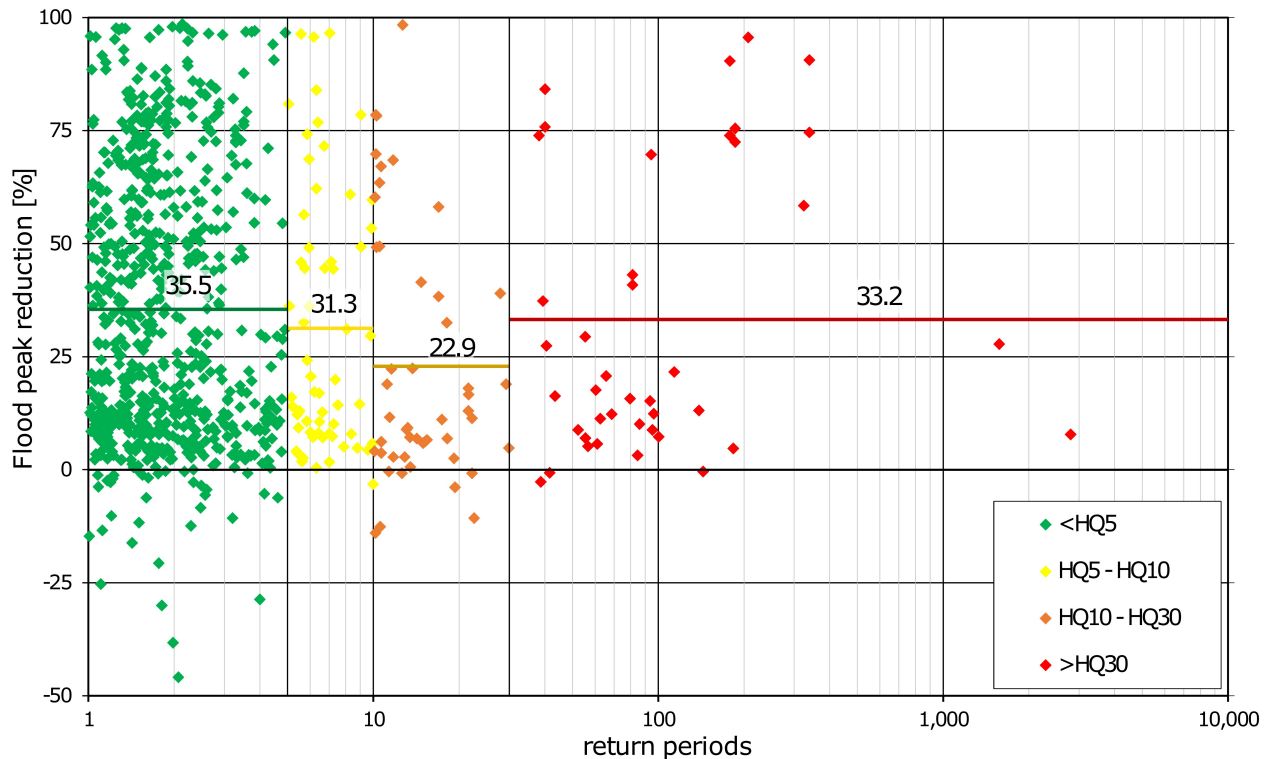


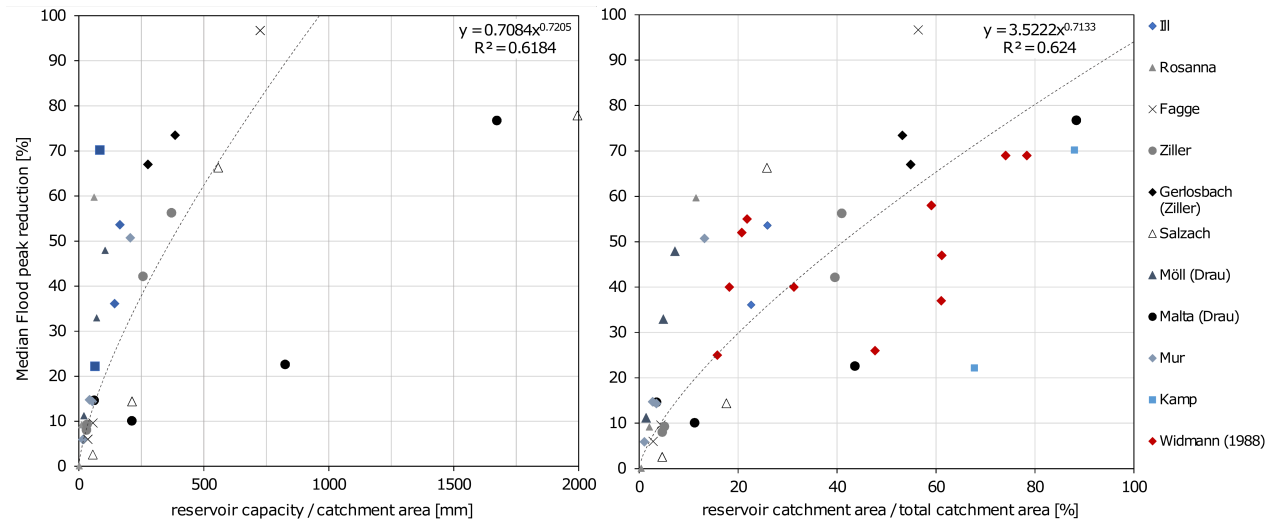
Figure 6 Relationship of return periods and the flood peak reduction

Negative flood peak reductions, indicating an increase of the discharge peak of the respective event due to the operation of storage reservoirs, were found at few river 405 basins. Most events with negative ratios are thereby found at the river Kamp (Figure 5; Stiefern gauge (207993)). Generally, the majority of these events show low return periods ($<$ HQ₅) and are therefore events exhibiting negligible flood risk. These events would not cause flooding along the river reaches. Generally, negative ratios decrease 410 with increasing return periods. Only three extreme events with return periods larger than 30 years show small negative values (-2.7, -0.7, -0.4 %).

3.3 Flood Peak Reduction as a function of catchment and reservoir characteristics

415 Based on the results, a decreasing flood peak reduction with increasing distance and
catchment area is apparent. Some studies focusing on single flood events also showed
this effect (Ganahl, 1988; Hofer et al., 2013; Kugi & Weissel, 1986). Relative variables
calculated based on various reservoir features, including the reservoir and catchment
area, the total reservoir capacity and the mean annual discharge can be helpful to
420 identify similar behaviours of reservoirs and their possible impact on flood events
(Schöberl, 2005). Apart from the storage volume existing at the time of an event, the
percentage of the entire catchment controlled by the reservoir contributes to the
improved flood control at any location downstream (Pircher, 1990). Other relative
variables used to describe the possible impact of reservoirs on floods are the ratio
425 between mean annual discharge (recorded before the construction) and the reservoir
size (Graf, 2006), the geographic location, operation rules and the ratio between the
reservoir capacity and the drainage area (Graf, 2006; Mei et al., 2017)

In this study the ratio between the reservoir capacity and the catchment area of the
respective gauges are related to the respective FPR_{median} values. Additionally, the ratio
430 of the reservoir catchment and total catchment area is related to the FPR_{median} . The
scatter plots including all river basins are shown in Figure 7. FPR_{median} values increase
with increasing ratios between the reservoir capacity and the catchment area (Figure
7, left). Likewise, higher FPR_{median} values are found when ratios between the reservoir
catchment and the total catchment area increase (Figure 7, right). This indicates that
435 catchment with high ratios have a stronger flood control potential and here reservoirs
strongly reduce flood hazard and flood risks downstream. Thus, flood risk reduction is
especially significant in the headwaters and the flood control potential of reservoirs
decreases with increasing catchment area and distance from the reservoir.



440 *Figure 7 Relationship of flood peak reduction with catchment and reservoir characteristics. left: Relationship between the reservoir capacity/catchment area ratio. Right: Relationship between the reservoir catchment /catchment area ratio*

On the right scatter plot, values provided by Widmann (1988), also covering the Ill, Salzach, Ziller and Fagge, are additionally shown. These flood peak reductions correspond to events with a return period of 100 years (Widmann, 1988). In general, 445 the independent data shows a good agreement with our findings.

4 Discussion

More complex methods exist to calculate the flood peak reduction FPR. For example, given the knowledge of inflow and other boundary conditions, the application of a hydraulic model to simulate the retention within a reservoir and the following 450 deformation of the flood wave downstream would allow for a more detailed analysis. This approach would be feasible for single events and hydropower stations, given the availability of necessary data. The objective of this contribution is however to analyse the general characteristics of FPR by reservoirs for a larger domain and the application of detailed models would not be feasible.

455 The assumption of spatial proximity for the reference catchment, the scaling of peak discharge events based on the catchment area and precipitation ratios are important factors for the estimation of a possible flood in the affected catchment prior to the setup of the dam. It is thereby assumed that hydrological processes are comparable between the different catchments. The applied methodology and its assumptions are clearly 460 subject to some degree of uncertainty. Plausibility checks and comparison of our findings with published data are therefore important.

In the Montafon Valley (Ill River Basin) flood peaks from a 33 year period have been reduced by 26 to 82 %, due to hydropower reservoirs (Pircher, 1990). Downstream of the Montafon Valley, at the Beschling gauge, FPR values presented in this study range from 5.7 % to 77.3 %. With 53.6 %, the FPR_{median} is well within the range of the published values. Results from the Rosanna river basin are highly uncertain due to the short time series available. The uncertainty is also obvious, when comparing mean annual peak discharges from pre- and post-dam construction. At the gauge St. Anton (201251), a mean flood peak reduction of about 31 % is found, which is lower compared to the calculated FPR_{median} (59.7 %) value.

At the gauge Platz-Loch (202119) downstream of the Gepatsch reservoir, the estimated FPR_{median} is 96.7 %. Pircher (1990) reports a flood peak reduction of the flood in July 1987 of 90 % and 92 %. Analysing the flood of August 2005, Hofer et al. (2013) mentions a discharge reduction from 37.3 m³/s to 8.2 m³/s, which corresponds to a FPR of 78 %. Following the flood event of 2005, flood storage volumes were defined for the Gepatsch reservoir and the single-purpose character (hydropower generation) of the reservoir was changed to include flood control (Hofer et al., 2013). The higher values found in our results may therefore also be explained by the consideration of flood storage volumes.

The impacts of the power plant group Zemm-Ziller and the Durlaßboden reservoir was investigated by Ganahl (1988) based on single flood events from 1973 to 1987. Flood peak reductions at the Hart im Zillertal (201780) range from 26 to 40 %. In the past, the largest reduction of 40 % was determined for the flood event in August 1987, reducing the peak from a possible 852 m³/s to 507 m³/s. At this gauge the estimated FPR_{median} is 42.15 %, a value well in the range of previously published data.

The flood of 1985 in the Malta valley was analysed by Kugi & Weissel (1986). They stated that the flood peak was reduced at the Pflügelhof (212498) and the Sandriesen (212498) gauge by 42 % and 45 %, respectively. Based on the comparison of mean annual peak discharges, derived from the comparison of pre and post-dam discharge records, the reduction at the Pflügelhof and Sandriesen gauges is 74 % and 58 %, respectively. Here, results from this study suggest a similar FPR_{median} of 76.75 % at the Pflügelhof gauge. At the same time, the resulting FPR values seem to be underestimated at the Sandriesen gauges ($FPR_{\text{median}} = 22.6 \%$). For other gauges in the study areas literature values are lacking.

495 In general, the comparison of our data with the published data (e.g. Ganahl, 1988; Kugi & Weissel, 1986; Pircher, 1990) shows that the estimated FPR values for most gauges are in the same range. At some gauges, e.g. St. Anton the estimated reductions might however be overestimated. For other gauges, the strong influence could be confirmed (e.g. Platz-Loch).

500 Published data also indicate the decreasing trend of the possible flood peak reduction downstream. This is also indicated by the relationship of the estimated FPR_{median} values in this study with the ratio of the reservoir catchment and the total catchment area. By comparing the results from this study to event-based investigations from the past (Widmann, 1988), a comparable decrease of the flood reduction with decreasing
505 catchment ratios is found. At the same time our results show that the influence and peak reductions due to the hydropower reservoirs can strongly influence densely populated downstream areas and thus reduce flood risk. Examples here are the Inn, Salzach or Drau, where flood peak reductions of up to around 15% are found.

Results also indicate that flood events with lower return periods (HQ_{10} - HQ_{30}) are less
510 reduced compared to events with higher return periods ($< HQ_{10}$). Extremes events, with return periods larger than 30 years show a mean flood peak reduction of over 33 %. Most hydropower companies operate inflow forecasting systems, which are based on a hydrological model driven by precipitation and temperature forecasts. The strong reduction of possible extreme floods might therefore result from an anticipatory
515 preparation and lowering of reservoir levels, providing more retention space. Results from Widmann (1988) also indicate strong flood peak reductions ranging from 26 to 69 % of extreme events (HQ_{100}).

5 Summary and Conclusion

Generally, most dams and reservoirs in Austria serve to generate hydropower (ICOLD,
520 2021). Storage and pump- storage facilities provide about 28 % of the national hydropower generation (Wagner et al., 2015), but such reservoirs also alter the hydrological conditions downstream (e.g. Magilligan & Nislow 2005, Catherine et al. 2011, Moschen & Lauffer 1977). Internationally, the impact on peak flows has been studied by various authors (e.g. Batalla et al. 2004, Verbunt et al. 2005, Graf, 2006).
525 In Austria, the effect of hydropower reservoirs has been studied in the past, however only for single events and reservoirs (e.g. Ganahl, 1988; Hofer et al., 2013; Pircher, 1990; Widmann, 1988).

In this study, the aim was to systematically quantify the general reduction of flood peaks based on long-term annual peak discharges as suggested by Widmann (1988) for all main storage hydropower schemes in Austria, thereby covering eight rivers basins. Due to the lack of discharge data recorded prior to dam construction in most river basins, unaffected (natural) annual peak flows were estimated by the transposition of data from reference catchments. This approach assumes similar hydroclimatic and hydrogeological conditions and hydrological processes in the reference and the affected catchment.

Along all reservoir influenced rivers and streams, a reduction of annual peak discharges could be found. They range from over 96 % to 47.9 % at affected gauges close to the reservoirs and from 14.6 % to 0.1 % at gauges further downstream. On average, the reduction of estimated unaffected flood peaks at gauges directly downstream of the reservoirs is 63.5 %. Those results correspond quite well with previous event-based investigations (e.g. Hofer et al., 2013).

Results also indicate that the peak discharge reduction decreases with increasing catchment size and the distance from the water reservoir. This is also shown by relating the reduction with the ratio of the reservoir catchment and the total catchment area. The results align well with previous investigations from Widmann (1988). On the other hand, single events showed negative FPR's, leading to an increase of the respective annual peak discharge. These events mostly show low return periods smaller than five years and do therefore not lead to increased flood risk or flood damages along the riparian and downstream communities. Events with return periods between 10 and 30 years show a mean FPR of 22.9 %. Another result is that rare maximum annual discharges with low return probabilities ($> HQ_{30}$) are reduced by 33 % on average. Hence, potential flooding due to these events may have been prevented. Overall, the results show that reservoirs in the headwaters of a river basin can considerably reduce peak discharges within the entire basin, also contributing to mitigate flood risk downstream.

Diversions and inter-basin water transfer can lead to reduction of flood peaks (e.g. Bui et al., 2020; Hofer et al., 2013) but was not considered in the current study. Further research investigating the impact of hydropower reservoirs on flood risk should therefore also include diverted streams. Generally, the analysis with higher temporal resolution discharge data or the application of detailed hydraulic models might also

lead to an improved quantification of the flood reduction potential of water reservoirs. These approaches however are more data intensive and the question of the feasibility for the application on a larger domain remains.

565 Man-made lakes have distinct hydrological, biological or social impacts. Here, we analysed the effect of reservoirs on flood peaks downstream. Although the reservoirs were mostly built for the single purpose of hydropower generation, clear positive effects and a downstream reduction of flood hazard are found. A higher flood peak reduction potential is available, if operation rules would be adopted to explicitly consider a flood storage volume. This however contrasts the interests of the hydropower plant operators and does, at least in Austria, not have a legal basis for implementation. At 570 the same time, further investigations could evaluate the overall potential in flood hazard reduction, if the reservoirs were operated in a manner, which puts more weight in the retention of floods.

6 Author contributions

575 MH and GS designed the study, established the methodological framework and performed all analyses. GS prepared the figures. GS and MH drafted and compiled the manuscript.

7 Competing interests

The authors declare that they have no conflict of interest.

580 8 Acknowledgment

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585 9 Data Availability Statement

The study was performed using openly available primary input data. All intermediate and final data that were generated in this study are available in the appendix and upon request to the corresponding author.

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770 12 Appendix

Table Appendix 1 Gauges used in this study

River basin Nr.	ID	Name	River	Catchment area [km ²]
1	231688	Beschling	Ill	1118.6
	200147	Gisingen	Ill	1281
	2473	Diepoldsau (CH)	Rhein	6119
2	201251	St. Anton am Arlberg-Moos	Rosanna	130.6
	202036	Landeck-Bruggen	Sanna	727
	201319	Imst	Inn	3842
3	202119	Platz-Loch	Fagge	191.5
	201194	Prutz	Inn	2461.5
	201319	Imst	Inn	3842
4	201749	Mayerhofen	Ziller	610.9
	201780	Hart	Ziller	1094.7
	201806	Brixlegg	Inn	8503.6
	201889	Kirchbichl-Bichlwang	Inn	9310
	201970	EW-Gmünd	Gerlosbach	141
	201772	Rohr	Gerlosbach	196.8
5	203554	Uttendorf	Stubache	127.9
	203109	Kaprun	Kaoruner Ache	88.6
	203125	Bruck	Salzach	1168.7
	204297	Salzburg	Salzach	4425.7
6	213124	Flattach	Möll	705.3
	212399	Kolbnitz a.d. Tauernautobahn	Möll	1043.8
	213199	Drauhofen	Drau	3674.4
	212472	Pflügelhof	Malta	131.3
	212498	Sandriesen	Malta	266
	212530	Spittal (Fasan)	Lieser	1035.5
	213215	Amlach	Drau	4789.6
7	203745	Muhr	Mur	75.7
	203752	St. Michael i. Lg.	Mur	289.2
	203794	Mörtelsdorf	Mur	366.9
	203976	Kendlbruck	Mur	955
8	207985	Rosenburg	Kamp	1150.2
	207993	Stiefern	Kamp	1493.3

Table Appendix 2 Topographic features of the affected and reference catchment/gauge

ID	Name	Catchment Topography			Gauge altitude [m]	Diff. Gauge altitude [m]	Diff. Mean catchment altitude [m]	Centroid catchment distance (ref/aff) [km]
		min. altitude [m]	max. altitude [m]	mean altitude [m]				
231688	Beschling	485,9	3301,3	1661,6	489,2	-247	56	16.27
200105	Garsella	729,6	2701,3	1606,1	736,5			
201251	St.Anton am Arlberg-Moos	1306,6	3145,3	2257,1	1386,9	650	651	25.99
200105	Garsella	729,6	2701,3	1606,1	736,5			
202119	Platz-Loch	1227,2	3526,8	2502,7	1227,1	-665	-309	7.94
230300	Gepatschalm	1876,7	3526,8	2811,9	1891,9			
201749	Mayrhofen	623,6	3500,6	2133,4	629,3	-257	-165	30.05
203034	Sulzau	884,8	3656,1	2298,1	885,8			
201970	EW-Gmünd	1192,9	3281,9	1960,9	1193,0	307	-337	16.50
203034	Sulzau	884,8	3656,1	2298,1	885,8			
203554	Uttendorf (Summenpegel)	786,2	3425,7	1974,3	844,2	-42	-324	25.83
203034	Sulzau	884,8	3656,1	2298,1	885,8			
203109	Kaprun	766,0	3534,2	2052,7	767,5	-118	-245	34.86
203034	Sulzau	884,8	3656,1	2298,1	885,8			
213124	Flattach	688,6	3793,4	1995,7	692,9	-484	-45	20.95
212381	Mallnitz	1175,4	3318,7	2040,6	1176,5			
212472	Pflüglhof	848,7	3343,0	2224,6	851,5	-325	184	13.55
212381	Mallnitz	1175,4	3318,7	2040,6	1176,5			
203745	Muhr	1121,0	3061,5	2048,1	1121,2	22	230	21.96
203778	Weißpriach	1099,0	2610,7	1818,1	1099,7			
207985	Rosenburg	262,8	1051,1	672,0	281,8	-237	-76	11.51
207944	Zwettl-Bahnbrücke	508,0	1051,1	747,8	519,1			

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Table Appendix 3 Detailed results of the flood peak estimations for all gauges, (*)...Precipitation ratio outside the defined thresholds for transfer; (-) ... No precipitation in the affected or reference catchment

231688 Beschling [III]						
<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1985	06.08.1985	53.6	165.0	355.5	0.98	2.5
1986	19.05.1986	57.4	84.9	199.5	0.53*	2.8
1987	01.07.1987	39.0	186.0	304.8	0.55*	27.9
1988	20.05.1988	54.4	105.0	230.1	0.85	1.2
1989	01.08.1989	70.2	63.0	211.7	0.83	1.1
1990	08.07.1990	64.6	96.3	272.1	0.71	3.1
1991	17.06.1991	47.7	160.0	305.9	0.86	2.4
1992	29.11.1992	67.8	58.9	183.2	0.61*	1.4
1993	15.07.1993	58.1	102.0	243.3	0.7*	2.2
1994	25.05.1994	55.7	85.2	192.3	0.65*	1.4
1995	01.06.1995	52.3	148.0	310.4	0.87	2.3
1996	28.05.1996	57.0	87.0	202.5	0.68*	1.4
1997	06.07.1997	44.2	155.0	277.7	0.76	2.6
1998	17.09.1998	55.7	58.4	131.8	0.57*	1.1
1999	22.05.1999	18.9	375.0	462.6	0.83	29.2
2000	06.08.2000	30.4	226.0	324.8	0.91	2.4
2001	05.09.2001	75.3	62.7	254.2	0.66*	3.3
2002	11.08.2002	68.7	111.0	354.4	0.81	5.9
2003	09.10.2003	59.7	134.0	332.6	0.82	4.2
2004	03.06.2004	62.6	63.0	168.7	0.77	1.0
2005	23.08.2005	5.7	445.0	472.1	0.77	61.0
2006	29.05.2006	49.1	143.0	280.9	0.64*	5.9
2007	19.01.2007	77.4	37.3	165.1	0.73	1.0
2008	14.07.2008	39.1	146.0	239.7	0.89	1.2
2009	18.07.2009	59.8	90.1	223.9	0.78	1.3
2010	06.08.2010	34.2	157.0	238.7	0.78	1.5
2011	18.06.2011	61.7	90.2	235.8	0.79	1.4
2012	10.10.2012	29.1	153.0	215.8	0.76	1.3
2013	02.06.2013	23.9	204.0	268.0	0.81	1.8
2014	11.07.2014	64.4	86.7	243.2	0.76	1.7
2015	03.05.2015	61.7	84.1	219.4	0.64*	2.1
2016	17.06.2016	47.0	196.0	369.8	0.94	3.5
2017	26.07.2017	60.3	147.0	370.6	0.77	10.1
200147 Gisingen [III]						
<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1985	07.08.1985	29.2	281.0	397.1	0.93	4.2
1986	22.05.1986	23.6	220.0	288.1	0.76	2.1
1987	01.07.1987	29.9	278.0	396.8	0.55*	4.0
1988	20.05.1988	37.8	206.0	331.1	0.85	1.8
1989	01.08.1989	49.9	149.0	297.7	0.83	1.2
1990	10.07.1990	43.5	188.0	332.8	0.81	1.5
1991	17.06.1991	36.9	250.0	395.9	0.86	2.9

1992	16.05.1992	-	176.0	-	-	1.4
1993	20.07.1993	31.1	182.0	264.2	0.73	1.5
1994	07.07.1994	37.1	163.0	259.0	0.98	1.3
1995	01.06.1995	42.1	223.0	385.4	0.87	2.1
1996	11.07.1996	35.2	168.0	259.2	0.71	1.3
1997	06.07.1997	37.7	203.0	325.7	0.76	1.7
1998	12.06.1998	38.4	124.0	201.2	0.87	1.1
1999	22.05.1999	16.3	449.0	536.6	0.83	43.4
2000	06.08.2000	25.4	291.0	389.8	0.91	4.8
2001	19.06.2001	12.6	228.0	261.0	0.65*	2.2
2002	12.08.2002	-12.6	350.0	310.8	0.76	10.6
2003	09.10.2003	52.2	182.0	380.6	0.82	1.5
2004	11.06.2004	34.4	175.0	266.6	1.19	1.4
2005	23.08.2005	4.7	548.0	575.1	0.77	183.3
2006	29.05.2006	40.0	207.0	344.9	0.64*	1.8
2007	10.07.2007	10.0	164.0	182.2	0.84	1.3
2008	14.07.2008	28.6	234.0	327.7	0.89	2.4
2009	18.07.2009	45.2	162.0	295.8	0.78	1.3
2010	06.08.2010	26.2	230.0	311.7	0.78	2.3
2011	10.10.2011	47.7	162.0	309.9	0.88	1.3
2012	04.06.2012	7.4	256.0	276.4	0.74	3.1
2013	02.06.2013	16.9	314.0	378.0	0.81	6.5
2014	31.07.2014	44.8	207.0	374.8	0.89	1.8
2015	06.05.2015	47.7	168.0	321.4	0.90	1.3
2016	17.06.2016	36.1	308.0	481.8	0.94	6.0
2017	26.07.2017	52.5	202.0	425.6	0.77	1.7

2473 Diepoldsau(CH) Rhein

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1985	26.08.1985	7.2	1079.2	1163.1	0.76	3.1
1986	22.05.1986	13.4	896.7	1035.1	1.06	2.0
1987	19.07.1987	7.0	2027.6	2180.5	0.91	55.5
1988	06.07.1988	12.3	708.3	808.0	1.09	1.4
1989	12.07.1989	9.4	493.1	544.3	0.88	1.1
1990	06.06.1990	23.3	662.4	864.0	0.86	1.3
1991	17.06.1991	-	1560.4	-	-	12.6
1992	16.05.1992	11.8	763.2	865.3	0.84	1.5
1993	13.10.1993	3.3	1159.3	1199.2	1.16	3.8
1994	15.09.1994	5.4	781.5	826.4	0.87	1.6
1995	01.06.1995	12.4	838.0	956.4	0.75	1.7
1996	08.07.1996	20.1	731.1	915.5	1.04	1.4
1997	30.06.1997	4.8	858.2	901.2	0.90	1.8
1998	08.06.1998	9.9	612.3	679.6	0.83	1.2
1999	22.05.1999	6.6	1624.6	1739.1	0.87	15.4
2000	07.08.2000	-0.8	1138.8	1129.6	1.07	3.6
2001	11.06.2001	3.6	1281.9	1329.2	0.76	5.4
2002	12.08.2002	11.1	1188.7	1337.1	1.34*	4.2
2003	09.05.2003	6.8	505.3	542.3	0.82	1.1
2004	09.07.2004	8.6	813.7	890.3	0.77	1.7
2005	23.08.2005	-2.7	1914.1	1864.5	0.64*	38.7

2006	29.05.2006	25.2	660.9	883.4	0.84	1.3
2007	10.07.2007	4.0	618.5	644.1	0.89	1.2
2008	14.07.2008	5.3	1104.5	1166.9	0.78	3.3
2009	18.07.2009	20.7	822.9	1037.6	1.06	1.7
2010	13.06.2010	4.3	721.6	754.4	0.82	1.4
2011	19.06.2011	12.9	613.1	703.9	0.74	1.2
2012	04.06.2012	3.3	1142.3	1180.9	0.81	3.7
2013	02.06.2013	13.5	970.0	1121.2	1.08	2.3
2014	14.08.2014	8.2	715.8	779.9	0.93	1.4
2015	20.05.2015	18.3	697.9	854.2	0.94	1.4
2016	17.06.2016	7.2	1580.6	1703.0	0.81	13.4
2017	01.09.2017	25.3	671.0	898.0	1.13	1.3

201251 St. Anton am Arlberg-Moos [Rosanna]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
2006	29.05.2006	1,4	27,5	27,9	0,55*	5,9
2007	19.01.2007	74,3	10,5	40,9	1,55*	1,0
2008	14.07.2008	20,9	17,2	21,7	0,69*	1,2
2009	18.07.2009	55,0	10,2	22,7	0,67*	1,3
2010	06.08.2010	17,2	13,8	16,7	0,47*	1,5
2011	18.06.2011	26,9	11,4	15,6	0,45*	1,4
2012	10.10.2012	4,1	21,6	22,5	0,68*	1,3
2013	02.06.2013	31,4	12,7	18,5	0,48*	1,8
2014	11.07.2014	42,5	13,5	23,5	0,63*	1,7
2015	03.05.2015	57,8	11,4	27,0	0,67*	2,1
2016	17.06.2016	17,8	25,0	30,4	0,66*	3,5
2017	26.07.2017	59,7	17,1	42,4	0,76	9,9

202036 Landeck [Sanna]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
2006	19.05.2006	-5,3	133,0	126,4	1,13	4,1
2007	30.08.2007	-0,3	94,5	94,3	1,14	1,9
2008	29.05.2008	-	131,0	-	-	4,0
2009	24.05.2009	38,9	92,4	151,3	4,55*	1,8
2010	11.06.2010	-12,8	96,2	85,3	0,43*	1,9
2011	08.08.2011	15,8	44,5	52,8	0,96	1,1
2012	04.06.2012	-8,4	116,0	107,1	0,58*	2,8
2013	20.06.2013	-19,2	104,0	87,2	0,19*	2,2
2014	14.08.2014	9,2	62,0	68,3	1,25	1,2
2015	08.06.2015	9,4	131,0	144,6	2,3*	4,0
2016	17.06.2016	4,9	104,0	109,4	0,66*	2,2
2017	31.05.2017	15,5	78,1	92,4	1,69*	1,4

201319 Imst (Bahnhof) [Inn]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
2006	19.05.2006	-1.8	379.0	372.4	1.13	1.6
2007	10.07.2007	-1.2	285.0	281.7	0.75	1.1
2008	30.05.2008	3.8	533.0	554.1	1.99*	6.0
2009	25.05.2009	16.3	422.0	504.3	6.39*	2.2
2010	11.06.2010	-2.3	482.0	471.1	0.43*	3.7
2011	19.06.2011	0.6	249.0	250.5	0.51*	1.0

2012	04.06.2012	-2.0	455.0	446.1	0.58*	2.9
2013	18.06.2013	-4.2	436.0	418.6	0.11*	2.5
2014	14.08.2014	1.4	451.0	457.3	1.25	2.8
2015	08.06.2015	2.4	544.0	557.6	2.3*	6.6
2016	17.06.2016	0.9	591.0	596.4	0.66*	10.7
2017	31.05.2017	4.4	314.0	328.3	1.69*	1.2

202119 Platz (Loch) [Fagge]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1986	05.08.1986	98.7	1.0	71.9	1.35*	1.4
1987	19.07.1987	95.6	4.5	102.6	0.84	207.0
1988	03.08.1988	98.4	1.2	77.2	0.89	12.7
1989	08.07.1989	94.1	3.9	65.7	0.90	4.4
1990	01.07.1990	91.6	3.3	39.5	0.86	1.1
1991	14.07.1991	96.7	1.8	55.4	0.88	2.3
1992	08.08.1992	97.3	1.2	43.9	0.86	1.3
1993	24.08.1993	97.7	1.3	53.3	1.03	1.3
1994	10.08.1994	97.7	0.9	38.1	0.76	1.3
1995	22.07.1995	93.2	2.6	37.6	0.67*	1.6
1996	29.07.1996	95.9	1.4	33.1	0.86	1.0
1997	08.08.1997	95.7	2.0	45.7	1.06	1.1
1998	04.08.1998	97.6	1.4	55.7	0.89	2.2
1999	06.07.1999	95.6	2.4	54.7	0.96	1.6
2000	25.07.2000	95.2	1.9	40.4	0.81	1.2
2001	10.08.2001	96.5	2.2	62.9	0.97	2.6
2002	24.06.2002	96.9	2.1	68.2	0.97	3.7
2003	29.08.2003	98.6	0.8	61.2	0.99	2.1
2004	09.07.2004	96.6	2.3	67.2	0.85	7.0
2005	30.07.2005	97.6	1.1	45.9	0.88	1.3
2006	28.06.2006	96.2	2.1	56.3	0.84	3.0
2007	21.07.2007	99.8	1.5	601.7	12.52*	1.2
2008	07.07.2008	96.7	2.0	62.0	0.84	4.9
2009	17.07.2009	97.7	1.1	49.1	0.80	2.1
2010	13.06.2010	97.1	2.1	71.6	1.01	3.8
2011	22.08.2011	98.0	1.0	51.7	0.86	2.0
2012	03.07.2012	96.9	1.7	54.7	0.78	3.6
2013	21.06.2013	94.5	2.6	47.3	0.64*	4.7
2014	13.08.2014	95.7	3.1	72.8	0.94	6.2
2015	08.06.2015	92.9	3.1	44.5	0.86	1.3
2016	12.07.2016	96.4	2.6	72.0	0.95	5.6
2017	09.08.2017	97.3	2.0	72.3	1.24	1.8

2011 94 Prutz [Inn]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1986	22.05.1986	11.9	305.0	346.2	1.52*	2.5
1987	19.07.1987	15.7	551.0	653.6	0.84	79.5
1988	14.07.1988	27.7	198.0	273.9	0.93	1.1
1989	08.07.1989	21.2	244.0	309.7	0.90	1.4
1990	02.07.1990	11.1	231.0	259.7	0.83	1.3
1991	17.06.1991	9.3	429.0	473.0	0.82	13.2
1992	03.06.1992	6.1	298.0	317.2	0.72	2.3

1993	14.10.1993	2.5	254.0	260.4	0.54*	1.5
1994	15.09.1994	4.2	250.0	261.0	0.76	1.5
1995	22.06.1995	7.9	278.0	301.9	0.99	1.9
1996	29.08.1996	5.9	207.0	219.9	0.79	1.1
1997	30.06.1997	6.9	350.0	375.8	0.74	4.4
1998	08.06.1998	7.9	249.0	270.3	0.75	1.5
1999	03.06.1999	10.7	371.0	415.2	0.91	5.8
2000	25.07.2000	12.3	288.0	328.4	0.81	2.1
2001	28.06.2001	7.4	386.0	416.8	0.84	7.2
2002	06.06.2002	8.5	256.0	279.7	0.80	1.5
2003	05.06.2003	16.4	239.0	285.8	1.08	1.3
2004	09.07.2004	18.9	289.0	356.2	0.85	2.1
2005	23.08.2005	9.4	312.0	344.2	0.99	2.7
2006	19.05.2006	8.3	204.0	222.6	0.90	1.1
2007	10.07.2007	13.7	174.0	201.5	0.98	1.0
2008	30.05.2008	7.2	418.0	450.3	0.62*	11.3
2009	25.05.2009	7.6	300.0	324.7	0.96	2.4
2010	11.06.2010	4.0	371.0	386.6	0.3*	5.8
2011	27.05.2011	12.1	170.0	193.3	0.92	1.0
2012	22.06.2012	17.8	284.0	345.6	0.97	2.0
2013	18.06.2013	-	304.0	-	-	2.5
2014	14.08.2014	11.5	350.0	395.3	0.91	4.4
2015	08.06.2015	10.7	371.0	415.5	0.86	5.8
2016	17.06.2016	5.8	409.0	434.0	0.91	9.9
2017	06.06.2017	10.9	194.0	217.8	0.82	1.1

201319 Imst (Bahnhof) [Inn]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1986	22.05.1986	8.3	422.0	460.4	1.52*	2.2
1987	19.07.1987	13.0	659.0	757.1	0.84	21.6
1988	15.06.1988	4.5	302.0	316.3	0.94	1.1
1989	12.07.1989	13.9	343.0	398.3	1.12	1.3
1990	10.07.1990	12.6	344.0	393.6	1.17	1.3
1991	17.06.1991	7.2	536.0	577.8	0.82	6.1
1992	03.06.1992	3.8	423.0	439.6	0.72	2.2
1993	27.05.1993	7.3	313.0	337.8	1.08	1.2
1994	07.07.1994	9.3	349.0	384.9	0.79	1.4
1995	22.06.1995	4.5	429.0	449.1	0.99	2.3
1996	29.08.1996	3.5	277.0	287.1	0.79	1.1
1997	30.06.1997	4.9	452.0	475.1	0.74	2.8
1998	08.06.1998	5.8	323.0	342.9	0.75	1.2
1999	03.06.1999	6.2	591.0	630.2	0.91	10.7
2000	07.08.2000	3.9	405.0	421.5	0.94	1.9
2001	11.06.2001	2.1	498.0	508.9	0.97	4.3
2002	06.06.2002	5.4	383.0	404.7	0.80	1.7
2003	06.06.2003	10.1	353.0	392.9	0.96	1.4
2004	12.06.2004	7.8	392.0	425.1	0.91	1.8
2005	23.08.2005	3.2	788.0	814.0	0.99	84.5
2006	19.05.2006	4.1	379.0	395.0	0.90	1.6
2007	10.07.2007	8.1	285.0	310.1	0.98	1.1

2008	30.05.2008	5.2	533.0	562.2	0.62*	6.0
2009	25.05.2009	5.1	422.0	444.9	0.96	2.2
2010	11.06.2010	2.7	482.0	495.5	0.3*	3.7
2011	19.06.2011	8.5	249.0	272.2	0.91	1.0
2012	04.06.2012	4.6	455.0	477.1	0.90	2.9
2013	18.06.2013	-	436.0	-	-	2.5
2014	14.08.2014	8.5	451.0	493.2	0.91	2.8
2015	08.06.2015	7.1	544.0	585.4	0.86	6.6
2016	17.06.2016	3.7	591.0	613.4	0.91	10.7
2017	31.05.2017	8.2	314.0	341.9	1.12	1.2

201749 Mayrhofen [Ziller]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1976	28.07.1976	69.5	46.4	152.1	1.15	1.2
1977	21.07.1977	72.6	54.8	200.0	1.20	1.5
1978	08.08.1978	41.1	69.6	118.2	0.75	1.4
1979	26.06.1979	28.3	103.0	143.6	0.81	1.6
1980	06.08.1980	65.5	76.7	222.2	1.4*	1.4
1981	18.07.1981	9.8	123.0	136.4	0.88	1.4
1982	12.06.1982	37.2	83.1	132.4	0.92	1.3
1983	02.08.1983	33.0	75.6	112.9	0.96	1.2
1984	12.07.1984	-	78.5	-	-	1.3
1985	06.08.1985	22.7	173.0	223.9	0.96	2.5
1986	24.06.1986	56.4	66.0	151.5	0.85	1.6
1987	25.08.1987	74.6	199.0	785.0	1.14	339.4
1988	12.07.1988	74.4	56.2	219.5	1.09	1.9
1989	09.07.1989	79.0	54.4	258.8	1.04	2.9
1990	10.07.1990	51.0	106.0	216.3	0.96	2.3
1991	17.06.1991	49.4	173.0	342.1	0.91	10.5
1992	08.08.1992	-223.2	42.5	13.1	0.09*	1.4
1993	23.06.1993	67.9	49.9	155.6	0.99	1.4
1994	21.06.1994	58.3	42.7	102.5	0.64*	1.4
1995	03.07.1995	55.5	83.2	187.0	1.05	1.6
1996	08.07.1996	56.8	76.3	176.5	1.09	1.5
1997	12.06.1997	46.6	74.4	139.4	0.76	1.7
1998	03.07.1998	52.9	65.1	138.3	0.80	1.6
1999	03.06.1999	51.3	76.9	157.8	0.79	1.9
2000	08.07.2000	80.3	45.8	232.8	1.24	1.7
2001	29.06.2001	64.4	80.3	225.3	1.26	1.6
2002	12.08.2002	52.0	93.3	194.4	0.86	2.4
2003	01.08.2003	97.1	12.5	428.1	2.09*	2.0
2004	09.07.2004	67.7	103.0	319.0	1.17	3.6
2005	11.07.2005	74.0	143.0	550.4	1.5*	9.3
2006	29.06.2006	72.5	93.5	339.9	1.4*	2.7
2007	09.07.2007	58.7	51.9	125.8	0.68*	1.7
2008	08.08.2008	66.5	89.2	266.5	1.11	2.6
2009	04.09.2009	59.5	71.4	176.2	0.65*	3.5
2010	11.06.2010	-	81.9	-	-	2.7
2011	23.06.2011	64.0	57.9	160.7	0.68*	2.6
2012	22.06.2012	56.1	94.5	215.4	1.02	2.1

2013	19.06.2013	-	89.6	-	-	1.9
2014	31.07.2014	72.5	129.0	469.2	0.74	186.2
2015	07.06.2015	84.3	34.2	218.5	1.08	1.9
2016	12.07.2016	47.1	109.0	206.0	0.82	2.9
2017	19.08.2017	73.9	56.7	217.7	0.82	3.3

201780 Hart im Zillertal [Ziller]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Mayrhofen)</i>	<i>P_{ratio}</i> <i>(Gerlosbach)</i>	<i>Return</i> <i>Period</i>
1976	14.09.1976	8.5	115.0	125.7	1.01	0.57*	1.3
1977	01.08.1977	31.1	215.0	311.9	0.98	1.14	8.1
1978	05.07.1978	21.8	179.0	228.9	1.22	1.04	3.7
1979	21.05.1979	49.2	168.0	330.5	2.13*	1.54*	2.9
1980	09.07.1980	-6.2	190.0	178.9	0.74	0.78	4.6
1981	18.07.1981	13.0	198.0	227.5	0.88	0.93	5.5
1982	24.05.1982	-12.4	155.0	137.9	0.99	0.86	2.3
1983	03.08.1983	27.8	128.0	177.3	1.00	1.11	1.5
1984	15.06.1984	33.8	118.0	178.3	1.55*	1.55*	1.3
1985	06.08.1985	20.7	303.0	382.0	0.96	1.04	65.6
1986	22.05.1986	-9.4	123.0	112.4	0.45*	0.52*	1.4
1987	25.08.1987	69.7	318.0	1049.9	1.14	1.01	94.4
1988	14.07.1988	42.0	110.0	189.8	0.83	0.91	1.2
1989	03.07.1989	32.2	136.0	200.5	1.00	0.93	1.7
1990	10.07.1990	50.5	153.0	309.2	0.96	1.09	2.2
1991	17.06.1991	49.3	220.0	434.0	0.91	0.81	9.1
1992	03.06.1992	44.0	130.0	232.3	1.30	0.55*	1.5
1993	20.07.1993	49.3	112.0	220.8	0.96	0.92	1.2
1994	05.07.1994	82.9	102.0	596.7	4.9*	1.31*	1.1
1995	14.07.1995	16.9	137.0	164.9	0.75	0.93	1.7
1996	08.07.1996	54.3	107.0	234.2	1.09	0.97	1.2
1997	28.06.1997	38.2	161.0	260.5	1.27	0.62*	2.6
1998	08.06.1998	42.3	123.0	213.2	1.22	1.14	1.4
1999	03.06.1999	39.3	150.0	246.9	0.79	0.77	2.1
2000	11.05.2000	4.7	141.0	147.9	0.88	0.58*	1.8
2001	11.06.2001	12.2	162.0	184.6	0.81	0.81	2.6
2002	12.08.2002	46.8	154.0	289.2	0.86	1.06	2.2
2003	18.06.2003	68.8	106.0	339.5	1.8*	1.23	1.2
2004	12.06.2004	46.1	157.0	291.1	0.87	0.96	2.4
2005	11.07.2005	62.4	294.0	782.8	1.5*	1.59*	52.7
2006	29.06.2006	69.2	131.0	424.7	1.4*	0.99	1.6
2007	18.09.2007	26.6	113.0	154.0	0.73	0.83	1.3
2008	16.08.2008	49.7	156.0	310.3	1.4*	1.27	2.3
2009	04.08.2009	60.6	124.0	314.4	0.83	1.02	1.4
2010	06.08.2010	44.4	123.0	221.1	1.4*	1.20	1.4
2011	08.08.2011	54.8	108.0	238.9	0.82	0.90	1.2
2012	22.06.2012	51.0	147.0	299.8	1.02	1.00	2.0
2013	20.06.2013	63.0	127.0	342.9	1.47*	0.55*	1.5
2014	31.07.2014	67.1	227.0	690.3	0.74	1.11	10.6
2015	10.06.2015	50.7	125.0	253.6	1.38*	0.92	1.4
2016	05.08.2016	46.5	174.0	325.0	1.17	1.10	3.3

2017	06.08.2017	67.0	129.0	391.2	1.41*	1.07	1.5
201806 Brixlegg [Inn]							
<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Mayrhofen)</i>	<i>P_{ratio}</i> <i>(Gerlosbach)</i>	<i>Return</i> <i>Period</i>
1976	30.09.1976	6.5	565.0	604.4	1.59*	1.01	1.0
1977	15.06.1977	5.2	921.0	971.5	0.84	1.31*	2.4
1978	10.06.1978	5.1	929.0	978.5	0.78	0.98	2.5
1979	31.05.1979	59.2	965.0	2365.6	11.73*	0.59*	2.9
1980	15.06.1980	12.1	989.0	1124.7	1.14	1.43*	3.2
1981	19.07.1981	3.3	986.0	1019.2	0.89	1.00	3.2
1982	12.06.1982	6.7	888.0	951.5	0.92	0.90	2.1
1983	10.06.1983	3.5	859.0	890.5	1.06	0.97	1.8
1984	22.06.1984	2.2	782.0	799.9	0.90	0.88	1.4
1985	07.08.1985	-0.8	1345.0	1334.3	0.97	1.03	22.2
1986	22.05.1986	-1.2	875.0	864.3	0.45*	0.51*	2.0
1987	19.07.1987	11.3	1525.0	1719.8	1.22	0.94	62.5
1988	15.07.1988	-5.2	698.0	663.3	0.63*	0.76	1.2
1989	12.07.1989	14.3	848.0	989.3	1.35*	1.41*	1.8
1990	10.07.1990	14.7	903.0	1059.1	0.96	1.09	2.2
1991	18.06.1991	5.1	1160.0	1222.1	0.90	0.83	7.9
1992	03.06.1992	10.4	881.0	983.3	1.30	0.55*	2.0
1993	20.07.1993	13.9	675.0	783.8	0.96	0.92	1.1
1994	07.07.1994	11.9	690.0	782.8	0.71	1.03	1.1
1995	04.07.1995	6.8	955.0	1024.9	0.89	0.71	2.8
1996	07.06.1996	65.2	563.0	1616.3	7.97*	8.91*	1.0
1997	30.06.1997	12.9	921.0	1057.5	1.09	0.98	2.4
1998	08.06.1998	10.8	743.0	833.3	1.22	1.14	1.3
1999	03.06.1999	6.9	1310.0	1406.9	0.79	0.77	18.2
2000	07.08.2000	15.0	895.0	1052.6	1.19	1.00	2.1
2001	11.06.2001	2.2	1008.0	1030.6	0.81	0.81	3.6
2002	21.06.2002	31.4	772.0	1125.2	2.3*	1.16	1.4
2003	06.06.2003	11.6	709.0	802.0	0.74	1.6*	1.2
2004	09.07.2004	22.6	901.0	1164.3	1.17	0.95	2.2
2005	23.08.2005	8.8	1494.0	1638.5	1.12	1.10	52.3
2006	19.05.2006	5.2	749.0	790.3	0.59*	0.69*	1.3
2007	10.07.2007	6.7	647.0	693.4	0.68*	0.80	1.1
2008	30.05.2008	-3.8	1079.0	1039.5	0.25*	0.25*	5.1
2009	25.05.2009	1.7	864.0	878.6	0.63*	0.70	1.9
2010	14.06.2010	9.0	928.0	1019.7	0.78	0.46*	2.4
2011	19.06.2011	12.6	565.0	646.6	0.81	0.81	1.0
2012	04.06.2012	11.1	967.0	1088.1	1.14	1.19	2.9
2013	20.06.2013	18.1	1003.0	1224.9	1.51*	0.55*	3.5
2014	14.08.2014	9.3	1092.0	1203.5	0.88	0.84	5.5
2015	09.06.2015	15.0	982.0	1154.7	1.48*	0.83	3.1
2016	17.06.2016	14.5	1049.0	1226.5	1.14	0.92	4.4
2017	11.08.2017	21.5	844.0	1074.6	1.81*	1.21	1.7
201889 Kirchbichl - Bichlwang [Inn]							
<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Mayrhofen)</i>	<i>P_{ratio}</i> <i>(Gerlosbach)</i>	<i>Return</i> <i>Period</i>

1976	30.09.1976	6.5	564.0	603.4	1.59*	1.01	1.0
1977	01.08.1977	8.1	1104.0	1201.0	0.98	1.14	3.3
1978	11.06.1978	4.3	1029.0	1074.9	0.70	0.89	2.5
1979	14.06.1979	4.9	1018.0	1070.2	0.83	0.71	2.4
1980	15.06.1980	11.9	1004.0	1139.7	1.14	1.43*	2.2
1981	19.07.1981	2.6	1229.0	1262.2	0.89	1.00	5.7
1982	27.06.1982	5.0	1012.0	1064.9	0.93	0.96	2.3
1983	14.06.1983	4.3	946.0	988.9	1.07	1.34*	1.8
1984	22.06.1984	2.1	821.0	838.9	0.90	0.88	1.3
1985	07.08.1985	-0.7	1648.0	1637.3	0.97	1.03	41.6
1986	22.05.1986	-1.2	919.0	908.3	0.45*	0.51*	1.7
1987	19.07.1987	11.4	1519.0	1713.8	1.22	0.94	22.2
1988	15.07.1988	-4.9	749.0	714.3	0.63*	0.76	1.1
1989	12.07.1989	13.7	890.0	1031.3	1.35*	1.41*	1.5
1990	10.07.1990	12.6	1079.0	1235.1	0.96	1.09	3.0
1991	18.06.1991	4.4	1343.0	1405.1	0.90	0.83	9.6
1992	03.06.1992	10.0	922.0	1024.3	1.30	0.55*	1.7
1993	20.07.1993	11.4	843.0	951.8	0.96	0.92	1.4
1994	07.07.1994	11.3	728.0	820.8	0.71	1.03	1.1
1995	04.07.1995	6.5	1010.0	1079.9	0.89	0.71	2.3
1996	09.07.1996	8.3	734.0	800.1	0.96	1.06	1.1
1997	30.06.1997	12.7	938.0	1074.5	1.09	0.98	1.8
1998	08.06.1998	10.2	796.0	886.3	1.22	1.14	1.2
1999	03.06.1999	6.3	1441.0	1537.9	0.79	0.77	15.2
2000	07.08.2000	13.9	976.0	1133.6	1.19	1.00	2.0
2001	11.06.2001	1.9	1166.0	1188.6	0.81	0.81	4.3
2002	12.08.2002	12.6	940.0	1075.2	0.86	1.06	1.8
2003	06.06.2003	11.2	739.0	832.0	0.74	1.6*	1.1
2004	12.06.2004	12.1	973.0	1107.0	0.87	0.96	2.0
2005	23.08.2005	7.3	1827.0	1971.5	1.12	1.10	100.2
2006	19.05.2006	4.8	821.0	862.3	0.59*	0.69*	1.3
2007	10.07.2007	5.8	752.0	798.4	0.68*	0.80	1.1
2008	30.05.2008	-3.6	1148.0	1108.5	0.25*	0.25*	4.0
2009	27.05.2009	5.6	882.0	934.6	0.78	0.71	1.5
2010	14.06.2010	8.3	1007.0	1098.7	0.78	0.46*	2.3
2011	08.08.2011	17.2	629.0	759.9	0.82	0.90	1.0
2012	04.06.2012	10.1	1081.0	1202.1	1.14	1.19	3.0
2013	02.06.2013	3.1	1038.0	1070.8	0.77	1.08	2.5
2014	14.08.2014	8.0	1276.0	1387.5	0.88	0.84	7.0
2015	09.06.2015	14.2	1040.0	1212.7	1.48*	0.83	2.6
2016	17.06.2016	13.8	1112.0	1289.5	1.14	0.92	3.4
2017	11.08.2017	19.9	930.0	1160.6	1.81*	1.21	1.7

201970 EW Gmünd [Gerlosbach]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1976	28.07.1976	70.0	10.0	33.1	1.08	1.2
1977	21.07.1977	59.8	12.3	30.6	0.80	1.5
1978	08.08.1978	71.8	8.4	29.8	0.82	1.4
1979	26.06.1979	74.5	16.9	66.2	1.62*	1.6
1980	06.08.1980	81.4	11.5	61.7	1.68*	1.4

1981	18.07.1981	48.7	17.0	33.1	0.93	1.4
1982	12.06.1982	47.2	15.9	30.1	0.90	1.3
1983	02.08.1983	67.8	9.4	29.2	1.08	1.2
1984	12.07.1984	-	9.6	-	-	1.3
1985	06.08.1985	50.5	27.5	55.6	1.04	2.5
1986	24.06.1986	79.1	9.6	46.0	1.11	1.6
1987	25.08.1987	90.6	15.1	161.0	1.01	339.4
1988	12.07.1988	77.4	9.9	43.9	0.95	1.9
1989	09.07.1989	80.3	8.0	40.8	0.71	2.9
1990	10.07.1990	81.2	10.6	56.3	1.09	2.3
1991	17.06.1991	63.5	25.8	70.6	0.81	10.5
1992	08.08.1992	11.9	13.3	15.1	0.44*	1.4
1993	23.06.1993	77.1	8.2	36.0	1.00	1.4
1994	21.06.1994	68.4	10.5	33.2	0.90	1.4
1995	03.07.1995	62.3	13.1	34.8	0.85	1.6
1996	08.07.1996	74.5	9.2	36.2	0.97	1.5
1997	12.06.1997	78.7	9.0	42.1	1.00	1.7
1998	03.07.1998	68.6	9.7	31.0	0.78	1.6
1999	03.06.1999	45.0	19.6	35.6	0.77	1.9
2000	08.07.2000	84.6	9.0	58.3	1.34*	1.7
2001	29.06.2001	76.2	10.1	42.4	1.03	1.6
2002	12.08.2002	61.7	21.2	55.4	1.06	2.4
2003	01.08.2003	93.2	6.4	93.7	1.99*	2.0
2004	09.07.2004	79.2	12.4	59.7	0.95	3.6
2005	11.07.2005	60.4	53.3	134.4	1.59*	9.3
2006	29.06.2006	85.2	8.2	55.4	0.99	2.7
2007	09.07.2007	68.6	10.5	33.5	0.79	1.7
2008	08.08.2008	75.7	14.6	60.2	1.09	2.6
2009	04.09.2009	77.0	10.9	47.4	0.76	3.5
2010	11.06.2010	-	9.5	-	-	2.7
2011	23.06.2011	82.7	7.7	44.4	0.81	2.6
2012	22.06.2012	65.8	16.6	48.5	1.00	2.1
2013	19.06.2013	-	10.4	-	-	1.9
2014	31.07.2014	75.5	40.1	163.3	1.11	186.2
2015	07.06.2015	61.0	9.7	24.7	0.53*	1.9
2016	12.07.2016	81.1	8.3	44.2	0.77	2.9
2017	19.08.2017	72.4	14.4	52.1	0.85	3.3

201772 Rohr [Gerlosbach]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1976	28.07.1976	65.5	12.2	35.4	1.08	1.5
1977	21.07.1977	53.4	16.0	34.3	0.80	9.9
1978	08.08.1978	60.8	13.8	35.2	0.82	1.8
1979	26.06.1979	64.5	27.1	76.4	1.62*	3.3
1980	06.08.1980	75.9	15.9	66.1	1.68*	4.1
1981	18.07.1981	45.9	19.0	35.1	0.93	5.6
1982	12.06.1982	44.4	17.8	32.0	0.90	1.7
1983	02.08.1983	65.4	10.5	30.3	1.08	1.8
1984	12.07.1984	-	12.9	-	-	1.4
1985	06.08.1985	46.0	33.0	61.1	1.04	7.1

1986	24.06.1986	72.8	13.6	50.0		1.11	1.2
1987	25.08.1987	86.0	23.8	169.7		1.01	2.3
1988	12.07.1988	70.2	14.4	48.4		0.95	1.1
1989	09.07.1989	67.9	15.5	48.3		0.71	1.5
1990	10.07.1990	70.6	19.0	64.7		1.09	1.3
1991	17.06.1991	61.2	28.4	73.2		0.81	3.6
1992	08.08.1992	13.7	11.4	13.2	0.44*		1.3
1993	23.06.1993	67.4	13.4	41.2		1.00	1.3
1994	21.06.1994	61.4	14.3	37.0		0.90	1.1
1995	03.07.1995	58.0	15.7	37.4		0.85	2.0
1996	08.07.1996	68.5	12.4	39.3		0.97	1.3
1997	12.06.1997	77.0	9.9	43.0		1.00	1.5
1998	03.07.1998	65.7	11.1	32.3		0.78	1.1
1999	03.06.1999	44.6	19.9	35.9		0.77	2.9
2000	08.07.2000	75.2	16.3	65.6	1.34*		1.6
2001	29.06.2001	66.6	16.2	48.5		1.03	1.4
2002	12.08.2002	60.9	21.9	56.1		1.06	8.3
2003	01.08.2003	93.9	5.7	93.1	1.99*		1.1
2004	09.07.2004	74.1	16.5	63.8		0.95	1.6
2005	11.07.2005	58.4	57.8	138.9	1.59*		404.1
2006	29.06.2006	73.6	16.9	64.1		0.99	1.5
2007	09.07.2007	65.7	12.0	35.0		0.79	1.5
2008	08.08.2008	71.1	18.5	64.1		1.09	4.3
2009	04.09.2009	77.2	10.8	47.3		0.76	1.8
2010	11.06.2010	-	15.8	6.3	-		2.8
2011	23.06.2011	77.8	10.5	47.3		0.81	1.8
2012	22.06.2012	55.7	25.4	57.3		1.00	2.4
2013	19.06.2013	-	14.7	-	-		2.0
2014	31.07.2014	73.9	43.5	166.7		1.11	38.1
2015	07.06.2015	49.3	15.5	30.6	0.53*		3.9
2016	12.07.2016	76.8	10.8	46.6		0.77	6.4
2017	19.08.2017	69.2	16.8	54.5		0.85	2.3

203554 Uttendorf [Stubache]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>	
1977	21.07.1977	56.1	15.3	34.9		1.00	1.5
1978	08.08.1978	71.1	9.9	34.1		1.04	1.4
1979	26.06.1979	50.3	18.2	36.6		0.99	1.6
1980	06.08.1980	80.9	6.0	31.6		0.95	1.4
1981	18.07.1981	41.3	14.0	23.8		0.74	1.4
1982	12.06.1982	50.5	15.5	31.3		1.03	1.3
1983	02.08.1983	57.3	8.5	19.9		0.81	1.2
1984	12.07.1984	-	11.5	-	-		1.3
1985	06.08.1985	52.3	18.0	37.8		0.78	2.4
1986	24.06.1986	76.5	12.8	54.6	1.46*		1.6
1987	25.08.1987	70.5	26.9	91.3	0.63*		324.3
1988	12.07.1988	75.8	12.0	49.6		1.18	1.9
1989	09.07.1989	72.6	12.9	47.1		0.90	2.8
1990	10.07.1990	66.6	22.7	68.0	1.44*		2.3
1991	17.06.1991	69.8	21.3	70.6		0.89	10.2

1992	08.08.1992	14.6	8.1	9.4	0.3*	1.3
1993	23.06.1993	55.5	14.0	31.5	0.96	1.4
1994	21.06.1994	61.9	11.4	29.9	0.89	1.4
1995	03.07.1995	64.6	16.0	45.2	1.21	1.6
1996	08.07.1996	77.0	11.6	50.4	1.49*	1.4
1997	12.06.1997	69.0	14.1	45.5	1.19	1.7
1998	03.07.1998	73.1	10.0	37.1	1.03	1.5
1999	03.06.1999	86.0	4.3	31.0	0.74	1.9
2000	08.07.2000	87.1	4.8	37.4	0.95	1.7
2001	29.06.2001	61.7	18.3	47.8	1.28	1.6
2002	12.08.2002	59.9	26.5	66.1	1.39*	2.3
2003	01.08.2003	82.3	10.8	61.0	1.43*	1.9
2004	09.07.2004	76.2	14.9	62.6	1.09	3.5
2005	11.07.2005	68.6	32.7	104.2	1.36*	9.0
2006	29.06.2006	72.3	18.8	67.8	1.34*	2.6
2007	09.07.2007	66.3	14.9	44.2	1.15	1.7
2008	08.08.2008	63.9	16.9	46.8	0.94	2.6
2009	04.09.2009	72.8	18.1	66.5	1.17	3.4
2010	11.06.2010	98.6	15.4	1135.4	22.46*	2.6
2011	23.06.2011	71.8	18.5	65.6	1.32*	2.5
2012	22.06.2012	80.0	12.7	63.5	1.44*	2.0
2013	19.06.2013	-	17.8	-	-	1.9
2014	31.07.2014	73.9	31.8	121.8	0.92	178.4
2015	07.06.2015	65.1	16.2	46.4	1.10	1.9
2016	12.07.2016	61.8	16.2	42.4	0.81	2.8
2017	19.08.2017	82.1	9.2	51.6	0.93	3.2

203109 Kaprun [Kapruner Ache]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	21.07.1977	78.4	6.0	27.7	1.15	1.5
1978	08.08.1978	83.8	4.2	26.2	1.15	1.4
1979	26.06.1979	68.9	9.0	29.0	1.13	1.6
1980	06.08.1980	89.4	3.4	32.1	1.39*	1.4
1981	18.07.1981	83.1	3.4	20.4	0.91	1.4
1982	12.06.1982	76.9	4.7	20.1	0.96	1.3
1983	02.08.1983	-2.4	17.3	16.9	0.99	1.2
1984	12.07.1984	-	3.1	-	-	1.3
1985	06.08.1985	59.3	14.2	34.9	1.04	2.4
1986	24.06.1986	77.6	4.8	21.6	0.83	1.6
1987	25.08.1987	58.4	32.7	78.7	0.79	324.3
1988	12.07.1988	88.5	3.3	28.7	0.99	1.9
1989	09.07.1989	84.3	4.1	26.1	0.72	2.8
1990	10.07.1990	80.7	7.5	38.7	1.19	2.3
1991	17.06.1991	78.5	9.2	42.6	0.78	10.2
1992	08.08.1992	-11.9	9.9	8.9	0.41*	1.3
1993	23.06.1993	54.0	10.3	22.4	0.99	1.4
1994	21.06.1994	82.2	3.6	20.2	0.87	1.4
1995	03.07.1995	78.8	4.5	21.2	0.82	1.6
1996	08.07.1996	49.0	10.5	20.6	0.88	1.4
1997	12.06.1997	61.3	11.6	30.0	1.13	1.7

1998	03.07.1998	80.8	4.6	23.8		0.95	1.5
1999	03.06.1999	81.2	5.3	28.1		0.97	1.9
2000	08.07.2000	82.5	5.5	31.4		1.15	1.7
2001	29.06.2001	66.2	12.9	38.2	1.47*		1.6
2002	12.08.2002	78.1	8.0	36.7		1.12	2.3
2003	01.08.2003	61.4	14.8	38.4		1.29	1.9
2004	09.07.2004	87.7	4.1	33.0		0.83	3.5
2005	11.07.2005	78.5	10.7	49.7		0.93	9.0
2006	29.06.2006	38.2	23.4	37.9		1.08	2.6
2007	09.07.2007	69.4	8.4	27.3		1.02	1.7
2008	08.08.2008	83.1	5.5	32.5		0.94	2.6
2009	04.09.2009	48.8	18.6	36.3		0.92	3.4
2010	11.06.2010	-4.9	10.2	9.7	0.28*		2.6
2011	23.06.2011	72.7	9.2	33.6		0.97	2.5
2012	22.06.2012	76.7	9.1	38.9		1.28	2.0
2013	19.06.2013	58.3	18.3	43.9	1.52*		1.9
2014	31.07.2014	90.4	10.5	109.9		1.19	178.4
2015	07.06.2015	85.3	6.7	45.5	1.55*		1.9
2016	12.07.2016	53.0	16.4	34.9		0.96	2.8
2017	19.08.2017	57.0	17.4	40.5		1.06	3.2

203125 Bruck [Salzach]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Uttendorf)</i>	<i>P_{ratio}</i> <i>(Kaprun)</i>	<i>Return</i> <i>Period</i>
1977	01.08.1977	12.7	242.0	277.4	1.08	1.01	6.6
1978	19.07.1978	8.1	164.0	178.5	1.08	1.20	1.5
1979	10.07.1979	16.2	183.0	218.4	1.36*	1.04	2.0
1980	15.06.1980	14.7	190.0	222.9	1.01	1.17	2.3
1981	19.07.1981	4.0	227.0	236.3	0.81	0.94	4.8
1982	27.06.1982	16.3	166.0	198.3	1.07	1.06	1.5
1983	14.06.1983	10.8	141.0	158.1	1.42*	1.23	1.2
1984	21.05.1984	6.1	118.0	125.7	1.38*	0.86	1.0
1985	07.08.1985	2.8	271.0	278.9	0.81	1.02	12.9
1986	24.05.1986	10.4	153.0	170.8	0.62*	1.08	1.3
1987	25.08.1987	31.9	236.0	346.4	0.63*	0.79	5.8
1988	30.08.1988	9.7	155.0	171.6	1.23	0.99	1.3
1989	03.07.1989	12.1	168.0	191.1	1.01	1.16	1.6
1990	10.07.1990	23.7	247.0	323.5	1.44*	1.19	7.4
1991	18.06.1991	10.1	246.0	273.7	1.02	0.83	7.2
1992	03.06.1992	27.2	131.0	180.0	1.72*	1.12	1.1
1993	20.07.1993	14.6	167.0	195.4	1.21	0.98	1.6
1994	21.06.1994	21.1	131.0	166.1	0.89	0.87	1.1
1995	26.06.1995	15.3	212.0	250.3	1.42*	1.14	3.5
1996	08.07.1996	28.8	121.0	169.9	1.49*	0.88	1.0
1997	19.07.1997	19.9	137.0	171.1	0.94	1.14	1.1
1998	14.07.1998	11.0	143.0	160.7	0.95	0.84	1.2
1999	03.06.1999	20.2	196.0	245.5	0.74	0.97	2.5
2000	08.07.2000	27.4	155.0	213.4	0.95	1.15	1.3
2001	11.06.2001	4.9	174.0	182.9	0.75	0.96	1.7
2002	12.08.2002	20.5	265.0	333.3	1.39*	1.12	11.2

2003	15.06.2003	24.3	133.0	175.6	0.90	1.09	1.1
2004	12.06.2004	24.0	197.0	259.1	1.01	1.12	2.6
2005	12.07.2005	15.7	356.0	422.4	1.34*	0.95	98.4
2006	29.06.2006	25.4	186.0	249.5	1.34*	1.08	2.1
2007	10.07.2007	9.1	175.0	192.5	1.11	1.04	1.8
2008	07.06.2008	17.0	164.0	197.5	1.4*	0.97	1.5
2009	18.07.2009	18.6	211.0	259.1	1.29	0.98	3.4
2010	14.06.2010	21.0	186.0	235.5	1.09	1.04	2.1
2011	09.08.2011	8.7	176.0	192.8	1.11	1.11	1.8
2012	31.08.2012	0.9	200.0	201.8	0.89	0.86	2.7
2013	02.06.2013	-3.2	260.0	252.1	0.90	1.20	10.0
2014	31.07.2014	37.3	318.0	507.4	0.92	1.19	39.3
2015	07.06.2015	27.7	180.0	249.0	1.10	1.55*	1.9
2016	13.07.2016	15.6	206.0	244.0	0.93	0.98	3.1
2017	20.08.2017	14.4	158.0	184.5	0.95	1.08	1.4

204297 Salzburg [Salzach]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Uttendorf)</i>	<i>P_{ratio}</i> <i>(Kaprun)</i>	<i>Return</i> <i>Period</i>
1977	01.08.1977	2.5	1384.0	1419.4	1.08	1.01	19.2
1978	09.09.1978	2.0	681.0	695.1	1.43*	1.13	1.7
1979	10.07.1979	4.6	737.0	772.4	1.36*	1.04	2.0
1980	15.06.1980	5.4	577.0	609.9	1.01	1.17	1.4
1981	21.07.1981	0.4	983.0	986.6	1.14	1.02	4.3
1982	24.05.1982	1.2	596.0	603.0	1.07	1.02	1.4
1983	14.06.1983	2.7	608.0	625.1	1.42*	1.23	1.5
1984	07.08.1984	5.0	471.0	495.6	0.99	1.20	1.2
1985	07.08.1985	0.6	1292.0	1299.9	0.81	1.02	13.5
1986	29.05.1986	6.2	433.0	461.6	1.29	0.97	1.1
1987	09.07.1987	4.9	611.0	642.4	0.73	0.80	1.5
1988	30.08.1988	3.2	510.0	526.6	1.23	0.99	1.2
1989	03.07.1989	3.3	675.0	698.1	1.01	1.16	1.7
1990	10.07.1990	8.1	872.0	948.5	1.44*	1.19	3.0
1991	03.08.1991	4.1	1043.0	1087.2	1.13	1.03	5.4
1992	23.11.1992	-0.4	766.0	762.9	0.90	1.16	2.2
1993	20.07.1993	4.6	586.0	614.4	1.21	0.98	1.4
1994	19.05.1994	3.2	427.0	441.0	1.27	1.09	1.1
1995	26.06.1995	3.4	1096.0	1134.3	1.42*	1.14	6.5
1996	22.10.1996	0.5	601.0	604.0	1.02	1.09	1.4
1997	19.07.1997	3.7	899.0	933.1	0.94	1.14	3.3
1998	06.09.1998	2.4	475.0	486.9	1.09	1.11	1.2
1999	23.07.1999	0.9	618.0	623.7	0.76	1.04	1.5
2000	10.03.2000	-1.2	511.0	504.8	1.01	1.18	1.2
2001	19.06.2001	-0.9	687.0	680.6	1.12	1.02	1.8
2002	12.08.2002	4.1	1588.0	1656.3	1.39*	1.12	42.3
2003	12.09.2003	-2.8	494.0	480.6	1.23	1.19	1.2
2004	12.06.2004	9.1	618.0	680.1	1.01	1.12	1.5
2005	12.07.2005	5.6	1123.0	1189.4	1.34*	0.95	7.2
2006	07.08.2006	3.7	874.0	907.7	0.87	1.35*	3.0
2007	07.09.2007	0.0	791.0	791.1	1.22	1.05	2.3

2008	16.08.2008	5.7	616.0	653.4	1.29	0.92	1.5
2009	04.08.2009	7.5	732.0	791.0	0.94	1.08	2.0
2010	03.06.2010	0.4	1088.0	1092.2	1.03	1.27	6.3
2011	14.01.2011	-1.2	634.0	626.7	0.84	1.09	1.5
2012	21.07.2012	4.6	692.0	725.6	1.10	1.02	1.8
2013	02.06.2013	-0.4	1899.0	1891.1	0.90	1.20	143.7
2014	31.07.2014	14.3	1136.0	1325.4	0.92	1.19	7.5
2015	23.05.2015	-1.9	495.0	485.9	0.79	1.54*	1.2
2016	10.08.2016	2.7	785.0	806.6	1.15	1.02	2.3
2017	03.09.2017	0.6	679.0	683.3	1.18	0.94	1.7

213124 Flattach [Möll]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	14.06.1977	47.7	62.4	112.4	0.81	1.9
1978	22.05.1978	74.2	53.4	195.0	1.10	5.8
1979	14.06.1979	59.1	61.7	142.2	1.11	1.5
1980	10.07.1980	37.4	62.3	93.7	0.63*	2.5
1981	19.07.1981	43.1	140.0	231.6	0.91	81.2
1982	12.06.1982	63.4	36.0	92.7	0.97	1.0
1983	24.05.1983	40.3	53.6	84.6	0.95	1.0
1984	22.06.1984	43.7	50.4	84.3	0.79	1.1
1985	07.06.1985	52.3	54.0	106.6	0.79	1.8
1986	22.05.1986	85.3	76.3	489.0	2.57*	8.8
1987	16.06.1987	44.1	65.3	110.1	0.64*	5.0
1988	13.10.1988	59.1	41.2	95.0	0.98	1.0
1989	05.07.1989	43.1	81.8	135.4	0.98	1.9
1990	10.07.1990	67.5	48.3	139.8	0.88	3.3
1991	18.06.1991	38.3	122.0	186.2	0.89	16.9
1992	03.06.1992	47.9	55.8	100.8	0.92	1.1
1993	20.07.1993	51.9	69.2	135.5	1.03	1.6
1994	14.09.1994	23.4	90.3	111.1	0.89	1.4
1995	26.06.1995	56.8	35.5	77.4	0.6*	1.6
1996	08.07.1996	61.6	45.3	111.2	1.01	1.2
1997	23.06.1997	53.2	64.4	129.6	0.85	2.7
1998	11.06.1998	75.8	69.2	269.2	1.15	40.0
1999	01.06.1999	19.9	49.4	58.1	0.53*	1.1
2000	13.10.2000	32.6	101.0	141.2	0.80	5.7
2001	30.05.2001	13.9	71.4	78.1	0.47*	4.2
2002	12.08.2002	58.1	43.4	97.7	0.62*	3.1
2003	15.06.2003	53.6	26.2	53.2	0.57*	1.0
2004	02.11.2004	36.0	43.5	64.1	0.66*	1.7
2005	13.07.2005	0.8	44.7	42.5	0.41*	2.5
2006	21.06.2006	49.5	49.1	91.7	0.79	2.2
2007	11.07.2007	43.6	51.5	86.0	0.96	1.9
2008	30.05.2008	-	67.1	-	-	2.7
2009	19.07.2009	62.2	54.2	135.2	1.20	6.3
2010	15.06.2010	45.5	53.6	92.6	1.07	1.3
2011	20.09.2011	18.2	40.9	47.1	0.88	1.3
2012	22.07.2012	49.6	47.1	88.0	1.14	1.7
2013	20.06.2013	81.0	65.4	324.2	2.25*	2.2

2014	07.11.2014	28.9	77.0	102.0	1.06	4.8
2015	08.06.2015	26.4	54.2	69.4	0.74	1.6
2016	18.06.2016	49.2	50.3	93.4	0.77	10.3
2017	12.08.2017	44.0	39.5	66.4	0.79	2.8

212399 Kolbnitz a.d. Tauernautobahn VHP [Möll]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	14.06.1977	36.7	98.3	155.2	0.81	1.6
1978	11.06.1978	56.5	104.0	239.1	1.18	1.9
1979	14.06.1979	47.5	98.7	187.9	1.11	1.7
1980	09.07.1980	21.7	111.0	141.8	0.69*	2.2
1981	27.05.1981	18.0	182.0	221.9	1.04	21.5
1982	13.06.1982	36.3	63.0	98.9	0.92	1.0
1983	24.05.1983	32.2	76.3	112.5	0.95	1.1
1984	21.05.1984	32.5	90.2	133.7	1.20	1.4
1985	08.06.1985	43.1	92.5	162.5	0.87	1.5
1986	22.05.1986	77.8	126.0	568.7	2.57*	3.4
1987	20.07.1987	35.6	117.0	181.5	0.86	2.6
1988	13.10.1988	46.4	69.0	128.6	0.98	1.1
1989	05.07.1989	31.0	138.0	199.9	0.98	4.9
1990	11.07.1990	55.8	72.9	165.0	0.88	1.1
1991	18.06.1991	27.4	200.0	275.6	0.89	40.5
1992	06.10.1992	34.3	92.2	140.3	1.08	1.4
1993	09.10.1993	12.1	123.0	140.0	0.78	3.1
1994	15.09.1994	13.4	133.0	153.6	0.89	4.2
1995	04.07.1995	42.5	79.7	138.6	0.95	1.2
1996	16.10.1996	50.3	111.0	223.3	1.64*	2.2
1997	28.06.1997	49.4	104.0	205.5	1.15	1.9
1998	07.10.1998	41.5	171.0	292.5	1.29	14.7
1999	21.09.1999	32.2	96.9	142.9	0.96	1.6
2000	13.10.2000	22.4	169.0	217.8	0.80	13.7
2001	11.06.2001	21.6	118.0	150.6	0.85	2.7
2002	26.11.2002	4.1	160.0	166.9	0.83	10.1
2003	07.06.2003	65.0	53.3	152.5	1.57*	1.0
2004	12.06.2004	33.4	109.0	163.7	1.12	2.1
2005	05.10.2005	22.3	164.0	211.0	1.17	11.6
2006	20.05.2006	33.7	75.2	113.4	0.79	1.1
2007	10.07.2007	45.0	92.3	167.7	0.96	1.5
2008	30.10.2008	20.9	94.2	119.0	0.79	1.5
2009	20.06.2009	44.6	143.0	258.2	1.08	5.7
2010	06.05.2010	22.1	91.1	117.0	0.79	1.4
2011	19.09.2011	32.0	99.5	146.3	0.88	1.7
2012	12.11.2012	9.5	110.0	121.6	0.89	2.2
2013	19.06.2013	72.9	104.0	383.2	2.25*	1.9
2014	06.11.2014	32.5	177.0	262.1	1.06	18.1
2015	07.06.2015	40.9	78.4	132.6	0.74	1.2
2016	17.06.2016	29.6	159.0	225.8	0.77	9.8
2017	11.08.2017	50.0	80.3	160.7	0.79	1.2

213199 Drauhofen [Drau]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
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1977	14.06.1977	11.2	449.0	505.9	0.81	2.5
1978	11.06.1978	23.4	441.0	576.1	1.18	2.4
1979	01.06.1979	11.4	507.0	571.9	1.04	4.4
1980	18.10.1980	12.0	529.0	600.9	1.47*	5.5
1981	19.07.1981	12.3	757.0	862.8	0.91	68.6
1982	13.06.1982	10.9	294.0	329.9	0.92	1.1
1983	24.05.1983	8.2	405.0	441.2	0.95	1.8
1984	21.05.1984	10.7	363.0	406.5	1.20	1.4
1985	07.08.1985	9.7	468.0	518.2	0.77	3.0
1986	22.05.1986	44.8	546.0	988.7	2.57*	6.6
1987	20.07.1987	10.6	544.0	608.5	0.86	6.5
1988	15.07.1988	13.5	318.0	367.4	0.98	1.1
1989	05.07.1989	10.8	513.0	574.9	0.98	4.7
1990	10.07.1990	20.6	385.0	485.1	0.88	1.5
1991	18.06.1991	8.8	786.0	861.6	0.89	95.4
1992	06.10.1992	10.5	412.0	460.1	1.08	1.9
1993	09.10.1993	3.4	481.0	498.0	0.78	3.4
1994	15.09.1994	4.7	413.0	433.6	0.89	1.9
1995	04.07.1995	14.3	353.0	411.9	0.95	1.3
1996	16.10.1996	21.0	423.0	535.3	1.64*	2.0
1997	28.06.1997	18.9	435.0	536.5	1.15	2.3
1998	08.10.1998	18.9	595.0	733.9	1.29	11.2
1999	21.09.1999	11.7	348.0	394.0	0.96	1.3
2000	13.10.2000	8.3	537.0	585.8	0.80	6.0
2001	31.05.2001	2.9	444.0	457.4	0.5*	2.4
2002	26.11.2002	1.4	501.0	507.9	0.83	4.2
2003	12.06.2003	42.2	253.0	437.4	2.4*	1.0
2004	09.07.2004	14.7	408.0	478.1	1.21	1.8
2005	05.10.2005	8.7	493.0	540.0	1.17	3.8
2006	20.05.2006	10.3	332.0	370.2	0.79	1.2
2007	10.07.2007	17.3	360.0	435.4	0.96	1.3
2008	30.10.2008	7.6	300.0	324.8	0.79	1.1
2009	20.06.2009	19.9	465.0	580.2	1.08	2.9
2010	14.06.2010	15.7	401.0	475.5	1.07	1.7
2011	19.09.2011	10.9	381.0	427.8	0.88	1.5
2012	12.11.2012	2.8	398.0	409.6	0.89	1.7
2013	20.06.2013	44.1	391.0	699.1	2.44*	1.6
2014	06.11.2014	14.0	523.0	608.1	1.06	5.2
2015	07.06.2015	15.0	307.0	361.2	0.74	1.1
2016	17.06.2016	12.9	450.0	516.8	0.77	2.6
2017	25.07.2017	21.2	274.0	347.9	1.19	1.0

212472 Pflügelhof [Malta]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{Obs}</i>	<i>HQ_{Est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	14.06.1977	14.0	15.6	18.1	0.66*	1.9
1978	22.05.1978	24.2	24.8	32.7	0.93	5.8
1979	14.06.1979	88.9	2.7	24.8	0.97	1.5
1980	10.07.1980	47.1	17.0	32.2	1.09	2.5
1981	19.07.1981	40.9	29.6	50.0	0.99	81.2
1982	12.06.1982	76.5	3.7	15.6	0.82	1.0

1983	24.05.1983	51.6	8.9	18.4		1.05	1.0
1984	22.06.1984	83.1	2.4	14.1	0.67*		1.1
1985	07.06.1985	83.5	4.0	24.4		0.91	1.8
1986	22.05.1986	90.1	5.6	56.2	1.5*		8.8
1987	16.06.1987	80.9	6.5	34.1		1.00	5.0
1988	13.10.1988	54.1	7.4	16.1		0.83	1.0
1989	05.07.1989	65.1	9.8	28.1		1.03	1.9
1990	10.07.1990	72.7	9.3	34.0		1.08	3.3
1991	18.06.1991	58.1	15.9	37.9		0.92	16.9
1992	03.06.1992	90.1	2.2	22.3		1.03	1.1
1993	20.07.1993	32.1	18.6	27.4		1.05	1.6
1994	14.09.1994	-16.2	23.8	20.5		0.83	1.4
1995	26.06.1995	77.0	6.4	27.9		1.09	1.6
1996	08.07.1996	10.0	18.3	20.3		0.93	1.2
1997	23.06.1997	74.7	8.4	33.2		1.10	2.7
1998	11.06.1998	84.2	8.5	53.8		1.16	40.0
1999	01.06.1999	88.5	2.0	17.7		0.82	1.1
2000	13.10.2000	56.4	14.6	33.5		0.96	5.7
2001	30.05.2001	98.6	5.2	369.2	11.21*		4.2
2002	12.08.2002	17.3	29.7	35.9		1.15	3.1
2003	15.06.2003	88.5	2.0	17.2		0.93	1.0
2004	02.11.2004	71.9	5.2	18.5		0.96	1.7
2005	13.07.2005	83.4	2.9	17.6		0.87	2.5
2006	21.06.2006	89.3	2.9	27.1		1.18	2.2
2007	11.07.2007	82.0	3.4	18.7		1.05	1.9
2008	30.05.2008	-	3.1	-	-		2.7
2009	19.07.2009	84.0	4.2	26.4		1.19	6.3
2010	15.06.2010	90.5	1.7	17.7		1.03	1.3
2011	20.09.2011	67.5	3.7	11.4		1.07	1.3
2012	22.07.2012	77.3	3.6	16.0		1.05	1.7
2013	20.06.2013	94.8	1.7	33.0		1.16	2.2
2014	07.11.2014	54.5	7.5	16.5		0.87	4.8
2015	08.06.2015	82.7	2.4	13.7		0.74	1.6
2016	18.06.2016	78.3	5.0	23.0		0.96	10.3
2017	12.08.2017	78.0	3.1	14.2		0.85	2.8

212498 Sandriesen [Malta]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	07.05.1977	-264.8	31.1	8.5	0.87	2,5
1978	22.05.1978	14.5	46.6	54.5	0.93	8,9
1979	15.10.1979	-45.9	28.2	19.3	0.80	2,1
1980	09.07.1980	-10.7	56.9	51.4	1.10	22,6
1981	19.07.1981	21.6	74.4	94.8	0.99	113,7
1982	13.06.1982	54.1	9.0	19.7	0.91	1,0
1983	24.05.1983	34.5	18.1	27.6	1.05	1,2
1984	21.05.1984	-3.5	30.9	29.8	1.13	2,5
1985	06.08.1985	-28.7	37.1	28.8	1.01	4,0
1986	22.05.1986	75.5	16.4	67.0	1.5*	1,2
1987	25.08.1987	6.4	31.4	33.5	0.87	2,6
1988	13.10.1988	36.8	14.9	23.6	0.83	1,1

1989	04.07.1989	29.7	30.6	43.5	0.92	2,4
1990	02.07.1990	42.0	19.7	33.9	1.11	1,3
1991	18.06.1991	39.9	33.1	55.1	0.92	2,9
1992	05.10.1992	22.6	23.0	29.7	0.87	1,5
1993	20.07.1993	17.2	42.4	51.2	1.05	6,2
1994	14.09.1994	-10.7	34.3	31.0	0.83	3,2
1995	11.06.1995	39.7	15.6	25.9	0.82	1,1
1996	08.07.1996	6.6	28.8	30.8	0.93	2,2
1997	28.06.1997	41.9	25.6	44.1	1.03	1,8
1998	12.09.1998	6.9	51.8	55.6	1.29	14,2
1999	21.09.1999	-4.4	31.5	30.2	0.87	2,6
2000	13.10.2000	36.4	32.9	51.8	0.96	2,9
2001	11.06.2001	49.2	15.6	30.7	0.98	1,1
2002	26.11.2002	5.3	37.7	39.8	0.96	4,2
2003	20.05.2003	47.0	10.4	19.6	1.28	1,0
2004	30.10.2004	12.9	19.8	22.7	0.84	1,3
2005	05.10.2005	8.6	37.1	40.6	1.02	4,0
2006	20.06.2006	62.6	13.9	37.1	1.18	1,1
2007	10.07.2007	46.8	23.1	43.4	1.05	1,5
2008	30.10.2008	8.7	30.3	33.2	0.91	2,4
2009	18.07.2009	36.2	40.0	62.7	1.19	5,1
2010	06.05.2010	25.7	30.3	40.8	1.12	2,4
2011	19.09.2011	30.6	31.7	45.7	1.07	2,6
2012	05.11.2012	24.1	34.1	44.9	1.32*	3,2
2013	11.10.2013	37.1	14.7	23.4	1.41*	1,1
2014	06.11.2014	30.0	32.7	46.7	0.87	2,8
2015	30.07.2015	46.1	16.0	29.7	0.89	1,1
2016	17.06.2016	16.6	56.4	67.6	0.96	21,6
2017	24.07.2017	56.5	19.9	45.7	1.32*	1,3

212530 Spittal Fasan [Lieser]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	20.05.1977	-5.6	96.8	91.7	0.82	2.6
1978	22.05.1978	4.8	157.0	164.9	0.93	29.9
1979	21.05.1979	22.2	108.0	138.8	1.75*	3.9
1980	09.07.1980	-3.9	147.0	141.5	1.10	19.4
1981	19.07.1981	10.1	181.0	201.4	0.99	86.0
1982	24.05.1982	12.1	58.7	66.8	1.27	1.1
1983	24.05.1983	9.9	86.7	96.2	1.05	1.9
1984	21.05.1984	-0.8	137.0	135.9	1.13	12.6
1985	06.08.1985	-11.7	78.9	70.6	1.01	1.5
1986	30.04.1986	2.2	72.6	74.2	1.03	1.3
1987	09.06.1987	22.7	93.6	121.0	1.12	2.3
1988	15.07.1988	15.8	62.7	74.5	0.92	1.1
1989	05.07.1989	16.6	91.5	109.8	1.03	2.2
1990	26.11.1990	-0.5	79.1	78.7	1.03	1.5
1991	18.06.1991	17.3	105.0	127.0	0.92	3.4
1992	11.05.1992	13.2	80.4	92.7	1.17	1.6
1993	20.07.1993	5.9	141.0	149.8	1.05	15.0
1994	15.09.1994	4.7	94.3	98.9	0.83	2.4

1995	11.06.1995	13.2	67.9	78.2		0.82	1.2
1996	15.11.1996	2.4	88.5	90.7	1.33*		2.0
1997	23.06.1997	27.7	64.8	89.6		1.10	1.1
1998	07.10.1998	8.7	110.0	120.5		1.04	4.2
1999	21.09.1999	-2.0	68.6	67.3		0.87	1.2
2000	13.10.2000	14.5	111.0	129.9		0.96	4.3
2001	11.06.2001	19.5	62.5	77.6		0.98	1.1
2002	26.11.2002	1.7	123.0	125.1		0.96	7.0
2003	02.11.2003	2.2	56.3	57.6		0.97	1.1
2004	20.06.2004	19.3	73.9	91.6		1.16	1.3
2005	05.10.2005	3.1	107.0	110.5		1.02	3.7
2006	20.05.2006	19.4	74.2	92.1		1.12	1.4
2007	10.07.2007	19.5	84.1	104.4		1.05	1.7
2008	30.10.2008	2.7	104.0	106.9		0.91	3.3
2009	20.06.2009	15.3	102.0	120.5		0.90	3.1
2010	06.05.2010	9.2	103.0	113.5		1.12	3.2
2011	19.09.2011	15.0	79.4	93.4		1.07	1.5
2012	05.11.2012	8.3	119.0	129.8	1.32*		5.9
2013	03.05.2013	21.5	65.3	83.1		1.28	1.2
2014	06.11.2014	14.0	86.5	100.5		0.87	1.8
2015	30.07.2015	19.6	56.1	69.8		0.89	1.1
2016	17.06.2016	9.8	103.0	114.2		0.96	3.2
2017	24.07.2017	27.4	68.4	94.2	1.32*		1.2

213215 Amlach [Drau]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{ratio}</i> <i>(Flattach)</i>	<i>P_{ratio}</i> <i>(Pfügelhof)</i>	<i>Return</i> <i>Period</i>
1977	14.06.1977	22.6	498.0	643.0	1.23	1.51*	2.3
1978	05.07.1978	25.8	485.0	653.6	1.20	0.99	2.1
1979	01.06.1979	14.7	537.0	629.8	0.96	1.79*	3.1
1980	18.10.1980	-1.2	606.0	598.7	0.68*	1.28	5.8
1981	19.07.1981	17.6	837.0	1015.4	1.10	1.01	60.4
1982	27.06.1982	17.4	326.0	394.6	0.99	0.67*	1.0
1983	24.05.1983	10.3	464.0	517.1	1.05	0.95	1.8
1984	21.05.1984	2.1	449.0	458.5	0.83	0.89	1.6
1985	07.08.1985	21.3	457.0	580.6	1.30	1.04	1.7
1986	22.05.1986	3.9	524.0	545.5	0.39*	0.67*	2.8
1987	20.07.1987	19.6	558.0	693.9	1.16	1.19	3.7
1988	15.07.1988	16.0	357.0	424.8	1.02	1.09	1.1
1989	05.07.1989	12.8	571.0	654.9	1.02	0.97	4.2
1990	11.07.1990	28.0	399.0	554.2	1.14	0.96	1.2
1991	18.06.1991	15.2	879.0	1036.7	1.13	1.09	93.5
1992	06.10.1992	9.5	467.0	516.2	0.92	1.27	1.8
1993	09.10.1993	12.2	598.0	681.4	1.28	0.92	5.4
1994	15.09.1994	10.7	499.0	558.7	1.12	1.21	2.3
1995	04.07.1995	19.6	388.0	482.6	1.05	1.25	1.2
1996	16.10.1996	3.2	453.0	468.2	0.61*	1.36*	1.6
1997	28.06.1997	13.6	497.0	575.4	0.87	0.97	2.2
1998	08.10.1998	8.9	688.0	754.8	0.77	0.95	13.1
1999	21.09.1999	12.3	421.0	480.0	1.04	1.15	1.4

2000	13.10.2000	19.9	630.0	786.0	1.25	1.04	7.3
2001	11.06.2001	15.4	506.0	597.9	1.17	1.02	2.4
2002	26.11.2002	8.1	616.0	670.3	1.20	1.04	6.4
2003	12.06.2003	4.0	267.0	278.0	0.42*	0.49*	1.0
2004	12.06.2004	7.6	453.0	490.1	0.90	0.70	1.6
2005	05.10.2005	1.8	602.0	613.3	0.86	0.98	5.6
2006	20.05.2006	20.2	413.0	517.4	1.26	0.89	1.3
2007	10.07.2007	18.2	470.0	574.8	1.04	0.95	1.8
2008	30.10.2008	16.3	418.0	499.4	1.27	1.10	1.3
2009	20.06.2009	16.0	593.0	706.1	0.93	1.11	5.2
2010	06.05.2010	15.6	448.0	530.6	1.26	0.90	1.6
2011	19.09.2011	15.8	482.0	572.7	1.14	0.93	2.0
2012	21.07.2012	14.1	451.0	525.2	0.88	0.95	1.6
2013	20.06.2013	4.4	433.0	453.1	0.41*	0.86	1.5
2014	06.11.2014	13.3	580.0	669.1	0.95	1.15	4.6
2015	21.05.2015	10.0	344.0	382.3	1.19	0.95	1.1
2016	17.06.2016	25.8	552.0	743.8	1.3*	1.05	3.5
2017	25.07.2017	12.1	353.0	401.6	0.84	0.78	1.1

203745 Muhr [Mur]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1992	17.05.1992	71.6	5.9	20.9	1.14	6.7
1993	21.07.1993	52.4	5.2	11.0	0.91	1.1
1994	19.05.1994	69.1	3.7	11.8	0.87	1.3
1995	26.06.1995	44.4	13.4	24.1	1.04	7.2
1996	22.10.1996	49.0	4.1	8.0	0.71	1.9
1997	21.05.1997	60.0	8.6	21.5	1.09	3.8
1998	11.06.1998	40.7	6.9	11.7	1.29	1.1
1999	23.07.1999	2.2	11.4	11.7	0.85	1.9
2000	29.04.2000	-155.8	3.5	1.4	0.08*	9.0
2001	01.06.2001	59.3	8.5	21.0	1.25	2.5
2002	12.08.2002	29.4	25.2	35.7	1.00	55.4
2003	20.05.2003	70.8	3.4	11.5	1.31*	1.0
2004	12.06.2004	56.8	15.7	36.3	1.43*	6.0
2005	11.07.2005	55.3	17.9	40.0	1.32*	4.7
2006	20.06.2006	22.8	14.8	19.2	0.88	4.4
2007	10.07.2007	33.8	14.1	21.3	1.01	1.5
2008	30.05.2008	97.3	8.2	307.8	17.71*	3.8
2009	24.06.2009	54.6	6.9	15.2	0.83	3.8
2010	06.05.2010	68.6	10.7	34.1	1.49*	1.9
2011	11.10.2011	-14.7	7.7	6.7	0.80	1.0
2012	21.07.2012	2.0	13.0	13.3	0.68*	3.3
2013	03.05.2013	60.8	9.8	25.1	1.24	1.8
2014	02.08.2014	57.7	4.3	10.2	1.44*	1.2
2015	14.05.2015	69.6	3.1	10.3	0.65*	1.5
2016	10.08.2016	57.9	7.6	18.0	0.96	1.2
2017	06.08.2017	59.8	3.9	9.8	0.7*	3.7

203752 St. Michael i. Lg. (Mur) [Mur]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1992	17.05.1992	34.5	28.4	43.4	1.14	1.8

1993	20.07.1993	9.9	38.6	42.9		0.86	4.6
1994	15.09.1994	-5.0	21.9	20.8	1.89*		1.2
1995	26.06.1995	20.6	41.3	52.0		1.04	6.0
1996	08.07.1996	-25.3	18.7	14.9		0.96	1.1
1997	20.05.1997	-13.0	30.5	27.0	0.38*		2.2
1998	08.10.1998	29.7	25.7	36.6	2.56*		1.5
1999	30.08.1999	7.5	28.9	31.2		1.06	1.9
2000	13.10.2000	58.2	29.8	71.3	4.34*		2.1
2001	31.05.2001	23.1	32.0	41.6		1.24	2.5
2002	12.08.2002	13.1	69.7	80.2		1.00	138.9
2003	15.06.2003	5.9	17.3	18.4	2.03*		1.1
2004	12.06.2004	32.1	43.5	64.1	1.43*		7.6
2005	11.07.2005	30.7	50.0	72.1	1.32*		15.3
2006	20.06.2006	10.3	37.8	42.2		0.88	4.2
2007	10.07.2007	15.6	39.0	46.2		1.01	4.8
2008	20.05.2008	20.9	25.0	31.6	1.35*		1.5
2009	25.05.2009	-28.2	32.6	25.4	0.42*		2.6
2010	06.05.2010	43.7	30.1	53.5	1.49*		2.1
2011	24.06.2011	-13.4	19.1	16.8		1.06	1.1
2012	21.07.2012	0.9	30.9	31.2	0.68*		2.2
2013	03.05.2013	33.9	29.7	44.9		1.24	2.0
2014	14.06.2014	-24.4	23.4	18.8	0.64*		1.3
2015	13.05.2015	-7.3	19.8	18.5	0.51*		1.1
2016	17.06.2016	8.3	28.5	31.1	1.55*		1.9
2017	20.08.2017	38.1	22.5	36.4		1.27	1.3

203794 Mörtelsdorf [Mur]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>	
1992	17.05.1992	32.8	30.7	45.7		1.14	1.7
1993	20.07.1993	7.9	49.9	54.2		0.86	8.4
1994	19.05.1994	28.2	20.7	28.8		0.87	1.1
1995	26.06.1995	21.9	38.2	48.9		1.04	2.9
1996	18.11.1996	16.8	22.1	26.6	1.47*		1.1
1997	20.05.1997	-13.7	29.2	25.7	0.38*		1.5
1998	08.10.1998	28.7	27.0	37.9	2.56*		1.3
1999	30.08.1999	6.4	34.3	36.6		1.06	2.1
2000	13.10.2000	59.9	27.8	69.3	4.34*		1.4
2001	31.05.2001	23.0	32.3	41.9		1.24	1.8
2002	12.08.2002	12.4	74.1	84.6		1.00	96.3
2003	20.05.2003	28.8	20.1	28.2	1.31*		1.1
2004	12.06.2004	33.0	41.9	62.5	1.43*		4.0
2005	11.07.2005	30.2	51.1	73.2	1.32*		9.4
2006	20.06.2006	9.7	40.8	45.2		0.88	3.6
2007	10.07.2007	11.1	57.3	64.5		1.01	17.4
2008	20.05.2008	19.4	27.5	34.1	1.35*		1.4
2009	20.06.2009	1.4	42.2	42.8		0.78	4.1
2010	06.05.2010	38.0	38.1	61.5	1.49*		2.9
2011	24.06.2011	-10.2	24.4	22.1		1.06	1.2
2012	21.07.2012	0.6	41.9	42.2	0.68*		4.0
2013	03.05.2013	30.0	35.5	50.7		1.24	2.3

2014	03.09.2014	17.1	27.8	33.5		1.25	1.4
2015	13.05.2015	-6.3	22.6	21.3	0.51*		1.1
2016	17.06.2016	7.0	34.1	36.7	1.55*		2.1
2017	20.08.2017	30.2	32.0	45.9		1.27	1.8

203976 Kendlbruck [Mur]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1992	17.05.1992	12.6	104.0	119.0	1.14	2.5
1993	20.07.1993	2.8	150.0	154.3	0.86	11.8
1994	19.05.1994	11.1	65.2	73.3	0.87	1.1
1995	26.06.1995	9.9	97.1	107.8	1.04	2.0
1996	18.11.1996	5.6	74.7	79.2	1.47*	1.3
1997	20.05.1997	-4.5	82.0	78.5	0.38*	1.4
1998	11.06.1998	6.6	66.9	71.6	1.29	1.1
1999	30.08.1999	2.4	95.8	98.1	1.06	2.0
2000	24.04.2000	40.6	88.1	148.3	3.93*	1.6
2001	31.05.2001	9.9	87.2	96.8	1.24	1.6
2002	12.08.2002	5.2	192.0	202.5	1.00	56.7
2003	20.05.2003	12.2	58.4	66.5	1.31*	1.1
2004	12.06.2004	15.8	110.0	130.6	1.43*	3.0
2005	05.10.2005	-0.4	149.0	148.4	1.08	11.3
2006	20.06.2006	4.0	104.0	108.4	0.88	2.5
2007	10.07.2007	4.8	142.0	149.2	1.01	8.8
2008	30.05.2008	78.6	81.4	381.0	17.71*	1.4
2009	20.06.2009	0.5	113.0	113.6	0.78	3.3
2010	06.05.2010	18.6	102.0	125.4	1.49*	2.3
2011	24.06.2011	-3.8	62.2	59.9	1.06	1.1
2012	21.07.2012	0.2	165.0	165.3	0.68*	20.5
2013	03.05.2013	13.2	100.0	115.2	1.24	2.2
2014	01.09.2014	7.5	85.8	92.8	1.03	1.5
2015	14.05.2015	9.7	66.7	73.8	0.65*	1.1
2016	10.08.2016	8.9	106.0	116.4	0.96	2.6
2017	06.08.2017	5.5	101.0	106.9	0.7*	2.3

207985 Rosenberg [Kamp]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	04.03.1977	41.8	46.7	80.3	1.15	2.0
1978	18.06.1978	83.5	4.7	28.2	0.99	1.4
1979	28.04.1979	45.6	40.1	73.8	1.20	1.8
1980	01.05.1980	47.4	39.8	75.7	1.33*	1.8
1981	12.03.1981	81.6	10.6	57.7	0.78	2.1
1982	06.01.1982	25.3	31.5	42.1	0.64*	1.9
1983	05.01.1983	81.9	4.6	25.6	0.85	1.4
1984	17.09.1984	86.4	5.3	38.5	0.99	1.5
1985	07.08.1985	29.5	96.5	136.9	1.03	4.6
1986	20.01.1986	59.2	13.0	31.8	0.73	1.5
1987	27.03.1987	81.5	11.8	63.9	0.83	2.2
1988	26.03.1988	45.6	34.9	64.2	0.81	2.2
1989	01.05.1989	75.3	7.6	30.9	1.09	1.4
1990	26.05.1990	32.8	13.3	19.8	0.89	1.3
1991	03.08.1991	69.5	31.7	104.1	0.98	3.2

1992	22.03.1992	72.6	9.2	33.6	0.92	1.5
1993	18.03.1993	85.5	9.2	63.3	0.73	2.5
1994	18.04.1994	69.6	21.9	72.1	1.12	1.9
1995	25.12.1995	51.1	18.7	38.3	0.77	1.6
1996	14.05.1996	11.6	163.0	184.4	0.95	11.4
1997	13.02.1997	78.8	10.5	49.4	0.78	1.9
1998	18.03.1998	68.8	10.0	31.9	0.88	1.5
1999	10.07.1999	90.3	7.2	73.7	0.94	2.2
2000	30.03.2000	48	19.0	36.6	0.77	1.6
2001	18.09.2001	75.6	7.6	31.3	0.97	1.4
2002	13.08.2002	27.8	338.0	468.3	0.93	1572.5
2003	13.03.2003	82.3	4.9	27.5	0.79	1.4
2004	04.06.2004	64.2	16.4	45.8	0.96	1.6
2005	11.07.2005	44.6	80.1	144.5	0.91	6.8
2006	29.03.2006	68.5	58.6	185.9	0.95	11.7
2007	07.09.2007	90.6	11.8	126.2	0.96	4.5
2008	16.08.2008	70.2	14.1	47.4	0.91	1.7
2009	24.06.2009	17	95.3	114.8	0.99	3.6
2010	03.08.2010	47.8	34.8	66.7	0.79	2.4
2011	14.01.2011	80.5	10.0	51.2	0.79	1.9
2012	13.06.2012	76.8	19.3	83.2	0.92	2.6
2013	04.06.2013	53.6	42.8	92.3	0.90	3.0
2014	29.05.2014	71.6	11.1	39.1	0.96	1.5
2015	11.01.2015	73.4	9.1	34.1	0.90	1.5
2016	03.07.2016	72.4	12.2	44.2	1.00	1.6
2017	23.02.2017	88.7	4.1	36.1	0.84	1.5

207993 Stiefen [Kamp]

<i>year</i>	<i>date</i>	<i>FPR_{Ratio}</i>	<i>HQ_{obs}</i>	<i>HQ_{est}</i>	<i>P_{Ratio}</i>	<i>Return Period</i>
1977	05.03.1977	9.3	102.0	112.4	1.19	4.0
1978	22.02.1978	-94.3	18.2	9.4	1.02	1.6
1979	29.04.1979	9.3	57.1	62.9	1.17	2.3
1980	30.04.1980	27.8	66.9	92.7	1.28	2.6
1981	10.01.1981	-34.2	26.9	20.0	0.56*	1.7
1982	31.01.1982	25.2	63.3	84.6	0.88	2.5
1983	03.04.1983	34.8	22.0	33.7	1.02	1.6
1984	15.11.1984	-	16.7	-	-	1.6
1985	07.08.1985	30.8	91.0	131.4	1.03	3.5
1986	14.03.1986	87.1	20.3	157.2	11.55*	1.6
1987	11.04.1987	-8.4	62.6	57.7	0.86	2.5
1988	26.03.1988	39.4	45.0	74.3	0.81	2.1
1989	19.06.1989	14.7	20.6	24.2	0.93	1.6
1990	26.05.1990	27.6	17.0	23.5	0.89	1.6
1991	04.08.1991	-2.8	57.3	55.8	1.01	2.3
1992	09.04.1992	93.3	18.0	267.2	15.79*	1.6
1993	25.03.1993	22.6	24.0	31.0	0.70	1.7
1994	19.04.1994	49.8	26.2	52.2	1.11	1.7
1995	25.12.1995	47.3	21.8	41.4	0.77	1.6
1996	15.05.1996	-14	173.0	151.7	0.96	10.2
1997	08.07.1997	35.8	35.5	55.3	0.91	1.9

1998	20.03.1998	8.5	17.8	19.4	0.89	1.6
1999	01.04.1999	-50.7	28.3	18.8	0.92	1.7
2000	06.04.2000	-20.7	29.6	24.5	0.73	1.8
2001	22.04.2001	30.3	20.6	29.5	0.92	1.6
2002	08.08.2002	7.8	562.0	609.7	0.94	2800.8
2003	28.01.2003	-30	32.4	24.9	0.73	1.8
2004	26.03.2004	-38.3	41.6	30.1	0.93	2.0
2005	12.07.2005	22.2	77.0	99.0	0.91	2.9
2006	02.04.2006	14.6	99.4	116.4	0.82	3.8
2007	06.09.2007	41.4	32.1	54.8	0.95	1.8
2008	17.08.2008	45.4	16.5	30.2	0.94	1.6
2009	24.06.2009	15.2	109.0	128.5	0.99	4.3
2010	07.08.2010	6.2	105.0	111.9	1.19	4.1
2011	14.01.2011	71.9	16.1	57.3	0.79	1.6
2012	13.06.2012	72.1	24.7	88.6	0.92	1.7
2013	08.06.2013	-73.3	59.2	34.2	0.65*	2.4
2014	14.09.2014	30.5	24.6	35.4	1.03	1.7
2015	13.01.2015	-6.2	18.4	17.3	0.87	1.6
2016	13.07.2016	22.2	21.8	28.0	0.98	1.6
2017	03.01.2017	-176.9	15.3	5.5	0.67*	1.6

Table Appendix 4 Flood peak (HQ100) reduction based on (Widmann, 1988)

River	Gauge	Reservoir	Catchment area			HQ ₁₀₀		reduction [%]
			Reservoir [km ²]	Gauge [km ²]	Ar/Ag [-]	pre-dam [m ³ /s]	post-dam [m ³ /s]	
Seeache	Jaßsteg	Achensee	105	172	0.61	88	55	37
Kapruner Ache	Kaprun	Wasserfallboden	42	88.1	0.48	90	67	26
		Mooserboden						
Ziller	Mayrhofen	Schlegeiß	127	612	0.21	579	280	52
	Zell am Ziller	Stillup		696.9	0.18	630	377	40
	Straß (Hart)	Durlaßboden		173	1095	0.16	700	527
Möll	Ranigroß	Margeritze	44	74.5	0.60	103	43	58
Ill	Partenen	Partenen	63	103	0.61	264	140	47
Faggenbach	Platz	Gepatsch	150	191.5	0.78	58	18	69
Finstertal	Kühtai	Finstertal	6	8.1	0.74	7	2	69
Malta	Gmünd	Kölnbrein	58	266	0.22	300	165	55
Gerlos	Gmünd	Durlaßboden	45	144	0.31	101	101	40

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Table Appendix 5 Distribution of CORINE land cover classes (Level 1) for the affected and reference catchments [%]

		ARTIFICIAL SURFACES	AGRICULTURAL AREAS	FOREST AND SEMI NATURAL AREAS	WETLANDS	WATER BODIES
AFFECTED CATCHMENTS	Beschling	5.2	5.8	88.3	0.2	0.5
	St. Anton	1.2	0.2	98.0	0.3	0.2
	Platz-Loch	0.2	1.9	96.5	0.0	1.4
	Mayerhofen	1.5	4.9	92.9	0.0	0.7
	EW Gmünd	4.9	7.9	85.7	0.1	1.3
	Uttendorf	0.1	5.5	92.4	0.0	2.0
	Kaprun	3.5	3.1	90.0	0.0	3.4
	Flattach	1.2	6.6	91.8	0.0	0.4
	Pflügelhof	0.0	0.4	97.6	0.0	2.1
	Muhr	1.4	5.0	93.4	0.0	0.2
	Rosenburg	2.6	48.7	48.0	0.1	0.6
REFERENCE CATCHMENTS	Garsella	0.4	5.6	94.0	0.0	0
	Gepatschalm	0.0	0.0	100.0	0.0	0
	Sulzau	0.0	1.2	98.8	0.0	0
	Mallnitzbach	1.8	2.8	95.3	0.0	0
	Weißpriach	1.5	3.1	94.7	0.7	0
	Zwettl (Bahnbrücke)	2.9	48.6	48.3	0.2	0

Table Appendix 6 Differences of CORINE land cover classes (Level 1) between the affected and reference catchments [%]

AFFECTED CATCHMENT	REFERENCE CATCHMENT	ARTIFICIAL SURFACES	AGRICULTURAL AREAS	FOREST AND SEMI NATURAL AREAS	WETLANDS	WATER BODIES
Beschling	Garsella	4.8	0.2	-5.7	0.2	0.5
Rosanna	Garsella	0.8	-5.3	4.0	0.3	0.2
Platz-Loch	Gepatschalm	0.2	1.9	-3.5	0.0	1.4
Mayrhofen	Sulzau	1.5	3.7	-5.8	0.0	0.7
EW Gmünd	Sulzau	4.9	6.7	-13.0	0.1	1.3
Uttendorf	Sulzau	0.1	4.3	-6.4	0.0	2.0
Kaprun	Sulzau	3.5	1.9	-8.8	0.0	3.4
Flattach	Malnitz	-0.6	3.8	-3.6	0.0	0.4
Pflügelhof	Malnitz	-1.8	-2.5	2.2	0.0	2.1
Muhr	Weißpriach	-0.1	1.9	-1.3	-0.7	0.2
Rosenburg	Zwettl (Bahnbrücke)	-0.3	0.1	-0.3	-0.1	0.6