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Ecological flow estimation in Latvian – Lithuanian transboundary river basins (ECOFLOW) LLI-249

Case study sites and hydrographs for Lielupe river basin district, in Latvia

Riga, 2018

Ecoflow

LVĢMC

1 Case-studies in the Lielupe River Basin within Latvian territory

The case study of regulated rivers have been selected taking into account severity of hydrological regime' alterations or number of HPPs on the river, fish species existence and water body type.

In Lielupe RBD 3 type specific case studies were selected for assessment of HPP impact on river ecosystem and E-flow evaluation: Bērze, Auce and Islīce rivers (Fig. 1).

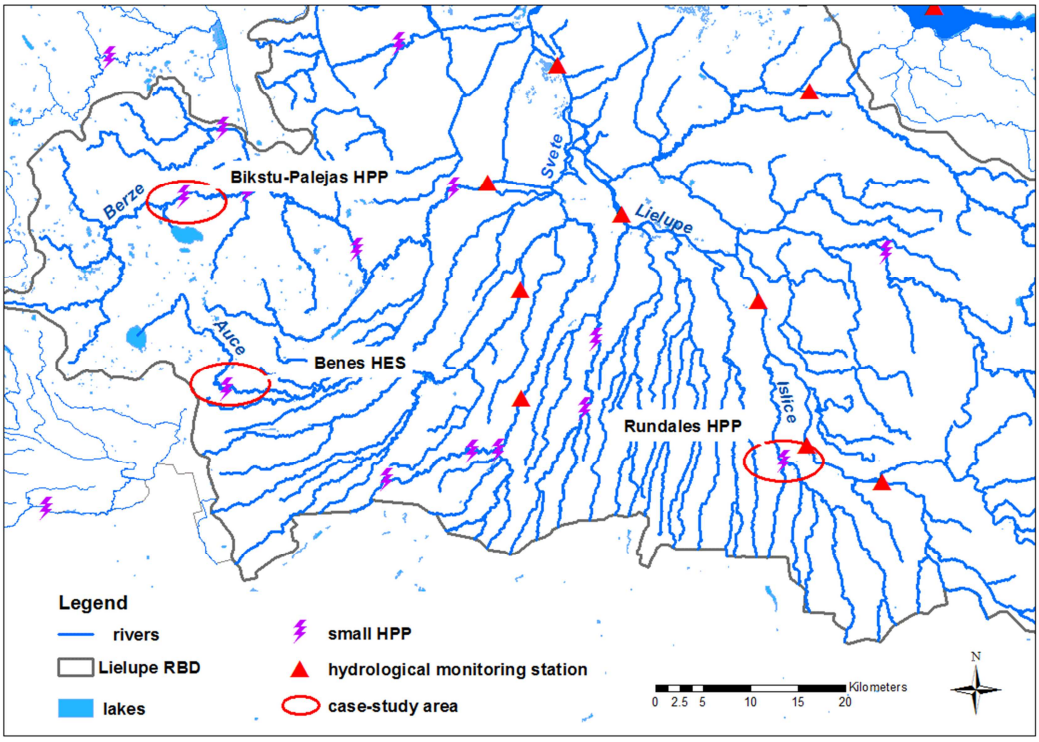

Figure 1. Case study territories in Lielupe RBD, Latvia

2 Hydrographs for selected case study sites

1.Berze River

Berze River outflows from a bog nearby Lielauce Lake and inflows to Svete River. River basins is 1180 km^2. It is 85 km long, river bed gradient is 1.6 m/km in upper stretch and 0.7 m/km in down stretch. Elevation is 3 – 107 m LAS.

Berze River has two water bodies that are classified as water body of 3-d and 4-th types.

River has predominance U shape valley, 150 – 250 m width.

Floodplain is 40-50 m width, has clay-loam and sandy-loam soil, covered by brush and meadow vegetation, inundated. River bed substrates are varies from boulders, cobbles and gravel in upper/middle stretches to gravel, sand and mud in lower stretches.

Channel is sinuous, 2-10 m width in average, depth increases from 0.1 to 2.7 m in a river mouth stretch. There are small sand-gravel islands in a stream that are under water only during flood.

River bed substrate: boulders, cobbles and gravel. In upper stretches river bed is covered by merged vegetation during summer season.

4 hydropower plants are located in stream:

HPP Berze that was constructed in 1996.

Dobele HPP is operated from 2002,

Annenieki HPP is operated from 2002 and

Bikstu-Paleja HPP is operated from 1999.

All of 4 HPPs have reservoirs, and all of them are working in inflow regime.

Hydrological regime is characterised by spring flood, summer low flow and rain flood during winter and autumn seasons. Water runoff data of Berze-Balozi monitoring stations (MS) for period of 1961-2015 were analysed taking into consideration the Berze River hydrological regime regulations by hydropower plants. Tervete – Bramberge MS with data series for period 1985-2017 and reference conditions was used as analogue for calculation of Berze' streamflow series upstream Bikstu-Paleja HPP (river basin area is 257 km^2). The Hydrograph of Berze River water flow upstream Bikstu-Paleja HPP is shown in

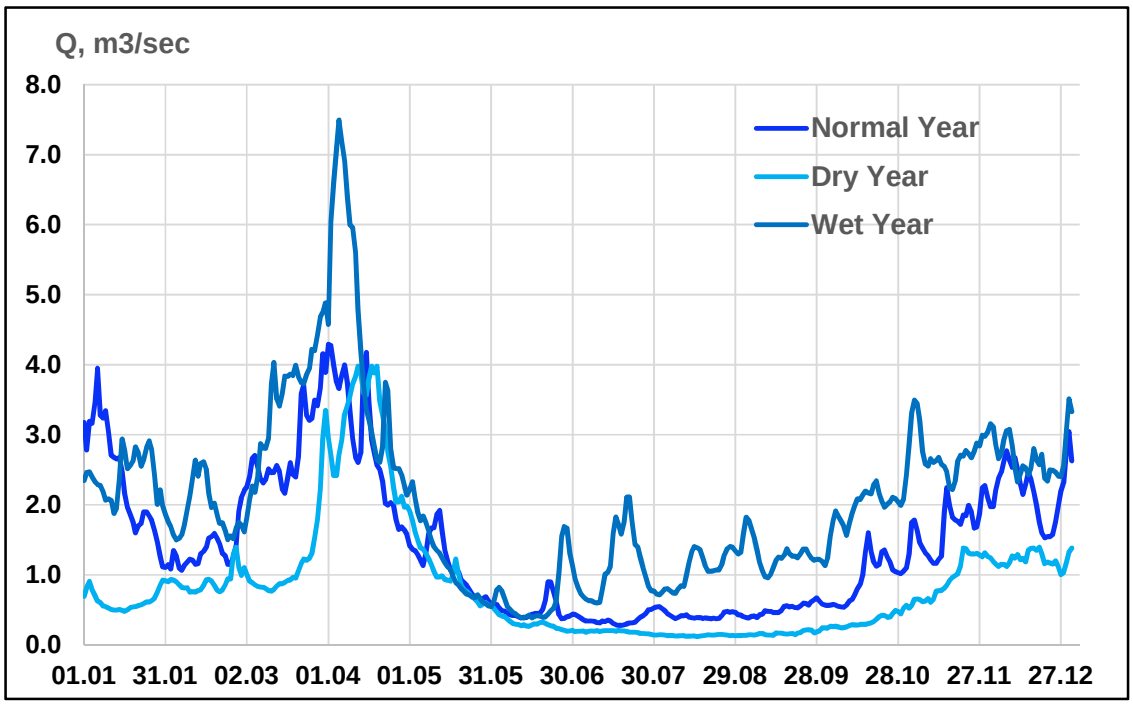

Figure 2. Wet, Normal and Dry Years Hydrographs of Berze River

Figure 2.

For the Hydrograph of Wet Year daily discharge data of 7 years with runoff module coefficient 1.25 – 1.56 were averaged. For calculation of Normal Year' Hydrograph data of 12 years with water runoff module coefficient 0.92-1.07 were taken into account, but for Dry Year' Hydrograph – data of 12 years with water runoff module coefficients 0.44-0.69. Data tables in Annex include daily discharge of Wet (Table 1), Normal (Table 2) and Dry (Table 3) Years.

2. Auce River

Auce River upper stretch is classified as water body of 3-d type bet river middle and down stretches delineated as water body of 4-th type.

River has small U- and V- shaped (in upper reach) valley.

Slopes are sandy, moderate, overgrown with conifer forest.

Floodplain is also sandy, covered by meadow vegetation.

Channel is sinuous bet highly regulated in the upper stretch, and in the down stretch river bed is modified to the channel (before modification Auce River flowed to Berze River).

River bed substrate: cobbles, gravel and sand.

2 hydropower plants are located in stream:

HPP Bene that was constructed in 1996.

Kronauce HPP is operated from 2002,

All of HPPs have reservoirs, and all of them are working in inflow regime.

Hydrological regime is characterised by spring flood, summer low flow and rain flood during winter and autumn seasons. Water runoff data series upstream Bene HPP was calculated using Auce – Brakski MS data for period 1975-1987 and Tervete – Bramberge MS data for period 1988-2017 as well as Berze-Balozi MS data series for period 1961-1974 were used as analogue for calculation of Auce River' streamflow series upstream Bene HPP (river basin area is 44,0 km^2). The Hydrograph of Auce River water flow upstream Bene HPP is shown in Figure 3.

For Hydrograph of Wet Year daily discharge data of 12 years with runoff module coefficient 1.27 – 1.99 were averaged. For calculation of Normal Year' Hydrograph data of 15 years with water runoff module coefficient 0.93-1.11 was taken into account, but for Dry Year' Hydrograph – data of 12 years with water runoff module coefficients 0.40-0.68. Data tables in Annex include daily discharge of Wet (Table 4), Normal (Table 5) and Dry (Table 6) Years.

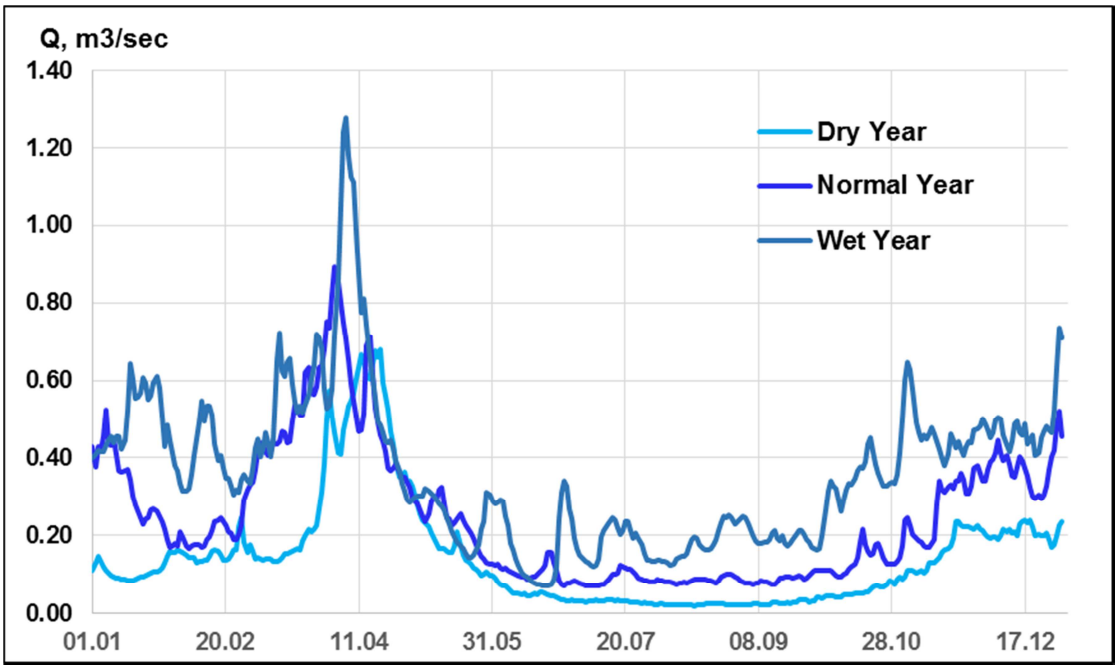

Figure 3. ***Wet, Normal and Dry Years Hydrographs of Auce River***

3. Islice River

The Islice River originates on eastern slopes of the Eastern Kurzeme Upland and flows into the Lielupe River.

Catchment area of the Islice River is 623 km^2 and 210 km^2 of this area is located in Latvia. River length is 70 km (49 km in Latvia); stream gradient varies from 0.6 m/km in lower and middle reaches to 1.6 m/km in upper reach. Elevation is 3.4 – 50.0 m above sea level (LAS).

Water body *Islice* V153 is classified as a river of the 4-th type (medium potomal-type river).

Channel is mainly sinuous, only in upper course it is straight. Average width of the Islice River is 5-8 m and average depth 0.4-0.8 m.

River slopes of riverbanks are moderate steep to steep, covered by meadow vegetation.

Riverbed substrate: boulders, cobbles, gravel and sand.

There is one hydropower plant located in a stream: Rundale HPP. The HPP is operated from 1999, it was constructed on already created reservoir. Rundale HPP has a hydropeaking regime.

Hydrological regime of the Islice River is characterized by spring flood, summer low flow and rainfall flood during autumn and winter seasons. Water runoff data of hydrological monitoring station 'Islice River, nearby Tiltsargi' (catchment area 330 km^2) for the period 1961-1987 and Musa-Bauska MS data series for the period 1988-2015 were used and analysed in creating of hydrographs of the Islice River upstream Rundale HPP (Fig. 4).

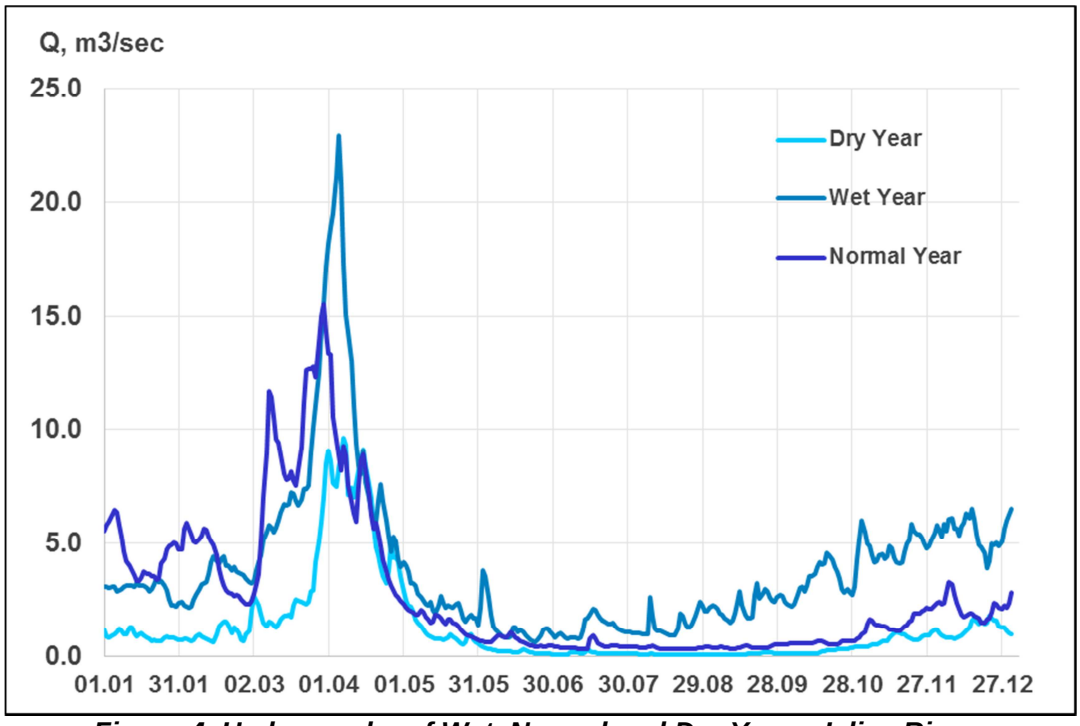

Figure 4. Hydrographs of Wet, Normal and Dry Years, Islice River

Hydrograph of Wet Year for Islice River was prepared on the base of daily discharge data for 18 years with water runoff module coefficient 1.21-2.09. There are high spring floods from the beginning of March till early-May and rainfall floods during summer, autumn and winter.

Hydrograph of Normal Year was created using daily discharge data for 13 years with runoff module coefficient 0.90-1.14. Spring flood in normal years lasts about 2 months (as in wet years) but rain floods are not so frequent - from mid-October till December.

Hydrograph of Dry Year is based on daily discharge data of 14 years with runoff module coefficient 0.11-0.62. The Dry Year is characterized by spring flood from the end of March till May, followed by low flow period, which in turn continues until late autumn almost without rains.

Data tables in Annex include daily discharge of Wet (Table 7), Normal (Table 8) and Dry (Table 9) Years for Islice River.

ANNEX

Table 1. Wet Year daily discharge (m^3/s), Berze River – Bikstu-Paleja HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	2.35	1.76	1.61	4.58	2.22	0.62	0.94	0.71	1.58	1.13	2.86	3.16
2	2.46	1.69	1.81	6.04	2.33	0.79	0.82	0.75	1.82	1.23	3.31	3.11
3	2.47	1.57	2.07	6.59	2.10	0.82	0.73	0.80	1.78	1.55	3.49	2.86
4	2.39	1.50	2.27	7.08	1.89	0.77	0.69	0.80	1.66	1.77	3.44	2.66
5	2.33	1.52	2.18	7.49	1.77	0.66	0.65	0.77	1.52	1.91	3.21	2.73
6	2.29	1.57	2.39	7.18	1.84	0.55	0.63	0.74	1.35	1.84	2.76	2.93
7	2.28	1.71	2.87	6.91	1.75	0.50	0.63	0.73	1.18	1.76	2.58	3.06
8	2.18	1.93	2.81	6.40	1.63	0.46	0.61	0.80	1.06	1.69	2.55	3.08
9	2.07	2.12	2.81	6.00	1.49	0.44	0.60	0.84	0.97	1.57	2.66	2.84
10	2.08	2.39	2.95	5.96	1.40	0.41	0.61	0.83	0.96	1.74	2.61	2.55
11	2.06	2.64	3.74	5.60	1.35	0.39	0.79	0.99	1.00	1.87	2.63	2.32
12	1.87	2.41	4.04	4.79	1.31	0.38	1.01	1.18	1.10	1.98	2.67	2.44
13	1.95	2.59	3.51	4.19	1.24	0.40	1.04	1.34	1.21	2.09	2.58	2.55
14	2.37	2.62	3.41	3.71	1.17	0.42	1.12	1.40	1.25	2.08	2.55	2.52
15	2.94	2.51	3.59	3.35	1.11	0.39	1.60	1.38	1.24	2.14	2.47	2.43
16	2.77	2.16	3.84	3.21	1.07	0.41	1.83	1.36	1.28	2.20	2.24	2.52
17	2.52	1.96	3.83	3.05	0.98	0.41	1.71	1.24	1.37	2.17	2.22	2.80
18	2.56	2.02	3.86	2.83	0.89	0.41	1.58	1.12	1.30	2.15	2.34	2.64
19	2.63	1.85	3.85	2.65	0.85	0.39	1.75	1.05	1.26	2.29	2.63	2.57
20	2.83	1.73	3.99	2.61	0.80	0.40	2.11	1.05	1.27	2.34	2.71	2.72
21	2.74	1.74	3.83	2.83	0.76	0.44	2.11	1.06	1.24	2.16	2.69	2.38
22	2.55	1.63	3.74	3.75	0.72	0.49	1.75	1.07	1.30	2.05	2.77	2.34
23	2.64	1.50	3.73	3.63	0.71	0.52	1.43	1.07	1.37	1.96	2.73	2.50
24	2.81	1.56	3.86	2.80	0.69	0.62	1.39	1.15	1.37	2.01	2.67	2.49
25	2.91	1.51	3.94	2.53	0.67	1.03	1.25	1.28	1.30	2.04	2.77	2.47
26	2.78	1.67	4.22	2.51	0.71	1.55	1.10	1.37	1.24	2.10	2.88	2.41
27	2.42	1.74	4.20	2.51	0.66	1.69	0.96	1.40	1.21	2.09	2.84	2.41
28	2.01	1.70	4.42	2.43	0.61	1.67	0.84	1.39	1.22	2.04	2.99	2.56
29	2.21		4.68	2.27	0.59	1.30	0.77	1.34	1.22	1.99	2.98	3.07
30	1.99		4.75	2.14	0.55	1.13	0.77	1.29	1.19	2.08	3.04	3.51
31	1.86		4.89		0.54		0.72	1.32		2.42		3.33

Table 2. Normal Year daily discharge (m^3/s), Berze River – Bikstu-Paleja HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	3.18	1.14	2.21	6.24	1.42	0.56	0.43	0.55	0.40	0.57	1.30	1.97
2	2.78	1.08	2.25	4.91	1.36	0.58	0.41	0.52	0.39	0.56	1.75	1.98
3	3.19	1.34	2.40	4.90	1.35	0.52	0.38	0.48	0.39	0.57	1.78	2.21
4	3.17	1.27	2.67	5.02	1.29	0.49	0.36	0.45	0.41	0.58	1.63	2.38
5	3.46	1.09	2.70	5.61	1.20	0.48	0.34	0.42	0.41	0.57	1.46	2.47
6	3.95	1.07	2.55	5.32	1.13	0.45	0.34	0.39	0.39	0.55	1.38	2.61
7	3.28	1.14	2.37	4.28	1.31	0.43	0.34	0.38	0.43	0.54	1.31	2.77
8	3.24	1.19	2.31	3.75	1.58	0.42	0.34	0.39	0.44	0.54	1.27	2.64
9	3.35	1.22	2.36	3.74	1.67	0.42	0.32	0.41	0.49	0.56	1.21	2.53
10	3.05	1.21	2.51	4.05	1.67	0.40	0.31	0.42	0.48	0.63	1.16	2.68
11	2.71	1.15	2.46	3.77	1.86	0.38	0.34	0.43	0.48	0.65	1.16	2.52
12	2.68	1.16	2.46	3.47	1.92	0.39	0.33	0.39	0.46	0.72	1.22	2.30
13	2.65	1.30	2.56	2.98	1.62	0.39	0.35	0.38	0.46	0.80	1.27	2.15
14	2.68	1.33	2.47	2.45	1.35	0.41	0.34	0.38	0.46	0.86	1.89	2.30
15	2.47	1.40	2.22	2.26	1.19	0.44	0.30	0.39	0.49	0.99	2.25	2.46
16	2.16	1.52	2.17	2.33	1.07	0.45	0.29	0.39	0.55	1.33	1.99	2.36
17	1.97	1.55	2.37	2.32	1.04	0.45	0.28	0.38	0.56	1.60	1.82	2.19
18	1.86	1.59	2.60	2.24	1.05	0.45	0.28	0.39	0.54	1.33	1.78	2.00
19	1.75	1.52	2.44	2.12	1.04	0.51	0.29	0.38	0.55	1.19	1.76	1.75
20	1.60	1.44	2.40	2.09	0.93	0.63	0.30	0.37	0.53	1.12	1.72	1.60
21	1.70	1.31	2.69	2.49	0.89	0.90	0.31	0.38	0.53	1.15	1.85	1.53
22	1.73	1.27	3.58	3.96	0.85	0.89	0.31	0.37	0.56	1.33	1.85	1.55
23	1.90	1.15	3.71	3.61	0.78	0.75	0.32	0.38	0.59	1.35	1.99	1.54
24	1.90	1.14	3.28	2.31	0.73	0.62	0.36	0.41	0.59	1.25	1.90	1.58
25	1.84	1.25	3.21	1.92	0.68	0.43	0.39	0.47	0.57	1.18	1.66	1.75
26	1.77	1.42	3.23	1.83	0.65	0.37	0.42	0.48	0.62	1.07	1.69	1.99
27	1.63	1.90	3.50	1.67	0.63	0.38	0.45	0.46	0.64	1.05	1.87	2.19
28	1.46	2.11	3.41	1.51	0.66	0.40	0.50	0.47	0.67	1.03	2.24	2.32
29	1.27		3.67	1.39	0.69	0.41	0.50	0.47	0.62	1.02	2.28	2.76
30	1.11		4.16	1.29	0.63	0.44	0.53	0.43	0.58	1.05	2.10	3.05
31	1.10		3.89		0.59		0.54	0.42		1.10		2.63

Table 3. Dry Year daily discharge (m^3/s), Berze River – Bikstu-Paleja HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.69	0.90	1.10	2.96	1.91	0.52	0.19	0.14	0.14	0.24	0.52	1.24
2	0.82	0.93	1.01	2.71	1.77	0.47	0.19	0.15	0.14	0.24	0.56	1.19
3	0.90	0.92	0.91	2.42	1.61	0.43	0.19	0.14	0.14	0.27	0.65	1.15
4	0.79	0.90	0.89	2.42	1.49	0.41	0.20	0.13	0.14	0.26	0.65	1.12
5	0.70	0.86	0.86	2.71	1.39	0.40	0.18	0.13	0.14	0.27	0.64	1.15
6	0.62	0.82	0.83	2.93	1.37	0.37	0.19	0.13	0.15	0.26	0.61	1.15
7	0.60	0.81	0.82	3.30	1.30	0.33	0.20	0.13	0.16	0.24	0.63	1.12
8	0.56	0.82	0.82	3.42	1.23	0.31	0.19	0.13	0.16	0.24	0.66	1.17
9	0.54	0.75	0.80	3.54	1.14	0.30	0.20	0.13	0.14	0.25	0.61	1.27
10	0.53	0.76	0.78	3.73	1.05	0.29	0.19	0.13	0.14	0.27	0.65	1.24
11	0.50	0.75	0.77	3.83	0.97	0.27	0.20	0.12	0.14	0.29	0.77	1.29
12	0.50	0.78	0.79	3.98	0.97	0.29	0.20	0.12	0.14	0.28	0.77	1.22
13	0.50	0.78	0.84	3.88	0.99	0.27	0.20	0.12	0.17	0.28	0.77	1.23
14	0.50	0.85	0.87	3.60	0.93	0.26	0.20	0.13	0.17	0.29	0.81	1.19
15	0.49	0.93	0.87	3.57	0.92	0.28	0.20	0.12	0.17	0.29	0.85	1.36
16	0.48	0.93	0.89	3.80	0.91	0.30	0.20	0.13	0.16	0.29	0.92	1.38
17	0.50	0.91	0.92	3.98	1.01	0.29	0.20	0.13	0.15	0.30	0.96	1.38
18	0.53	0.85	0.93	3.88	1.23	0.32	0.20	0.14	0.16	0.31	0.99	1.35
19	0.54	0.78	0.96	3.98	1.01	0.32	0.20	0.14	0.16	0.33	1.01	1.40
20	0.55	0.76	0.95	3.49	0.86	0.30	0.19	0.14	0.14	0.37	1.13	1.30
21	0.56	0.79	1.06	3.29	0.79	0.29	0.18	0.14	0.17	0.40	1.38	1.16
22	0.57	0.86	1.16	3.07	0.77	0.27	0.18	0.14	0.18	0.42	1.37	1.18
23	0.59	0.94	1.22	2.74	0.73	0.26	0.18	0.15	0.20	0.42	1.31	1.17
24	0.61	0.94	1.21	2.54	0.68	0.24	0.17	0.15	0.21	0.39	1.30	1.16
25	0.61	1.29	1.24	2.26	0.66	0.23	0.16	0.14	0.21	0.40	1.30	1.20
26	0.63	1.40	1.31	2.03	0.61	0.22	0.16	0.14	0.21	0.44	1.30	1.11
27	0.67	1.11	1.52	2.04	0.56	0.20	0.16	0.13	0.17	0.49	1.29	1.00
28	0.75	0.99	1.79	2.12	0.58	0.19	0.16	0.14	0.18	0.47	1.26	1.03
29	0.85		2.22	1.96	0.60	0.20	0.15	0.13	0.20	0.44	1.32	1.18
30	0.92		2.94	1.98	0.56	0.21	0.14	0.13	0.24	0.52	1.26	1.32
31	0.91		3.35		0.56		0.14	0.13		0.56		1.38

Table 4. Wet Year daily discharge (m^3/s), Auce River – upstream Bene HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.40	0.38	0.94	0.58	0.29	0.28	0.19	0.14	0.24	0.17	0.50	0.50
2	0.41	0.37	1.03	0.72	0.30	0.29	0.17	0.14	0.25	0.20	0.60	0.49
3	0.42	0.33	1.14	0.86	0.30	0.29	0.15	0.13	0.25	0.27	0.64	0.47
4	0.42	0.31	1.17	1.05	0.30	0.29	0.14	0.13	0.23	0.32	0.63	0.45
5	0.42	0.31	1.17	1.24	0.30	0.25	0.13	0.13	0.21	0.34	0.58	0.47
6	0.43	0.32	1.17	1.28	0.32	0.22	0.13	0.12	0.20	0.33	0.49	0.50
7	0.45	0.36	1.13	1.18	0.31	0.18	0.12	0.13	0.19	0.32	0.46	0.51
8	0.45	0.41	1.13	1.12	0.31	0.16	0.12	0.14	0.18	0.29	0.45	0.50
9	0.44	0.45	1.29	1.11	0.30	0.14	0.12	0.14	0.18	0.26	0.46	0.46
10	0.46	0.49	1.37	0.99	0.29	0.12	0.14	0.15	0.18	0.29	0.45	0.43
11	0.46	0.55	1.42	0.87	0.28	0.10	0.19	0.15	0.18	0.32	0.46	0.42
12	0.42	0.49	1.59	0.77	0.27	0.10	0.21	0.15	0.19	0.33	0.48	0.44
13	0.44	0.53	1.67	0.81	0.26	0.09	0.22	0.17	0.21	0.33	0.46	0.49
14	0.53	0.53	1.53	0.74	0.24	0.09	0.23	0.19	0.21	0.35	0.44	0.49
15	0.64	0.51	1.44	0.65	0.23	0.08	0.25	0.20	0.19	0.37	0.42	0.46
16	0.60	0.44	1.36	0.61	0.21	0.08	0.24	0.19	0.19	0.38	0.40	0.46
17	0.55	0.39	1.26	0.55	0.20	0.08	0.22	0.18	0.20	0.37	0.38	0.49
18	0.56	0.41	1.19	0.50	0.18	0.07	0.20	0.17	0.18	0.39	0.41	0.44
19	0.57	0.37	1.24	0.48	0.17	0.07	0.21	0.16	0.17	0.43	0.46	0.44
20	0.61	0.35	1.33	0.46	0.16	0.07	0.23	0.16	0.18	0.45	0.44	0.46
21	0.59	0.35	1.58	0.44	0.15	0.07	0.23	0.16	0.19	0.42	0.43	0.41
22	0.55	0.33	1.86	0.44	0.14	0.07	0.21	0.18	0.20	0.38	0.44	0.41
23	0.56	0.30	2.25	0.44	0.14	0.09	0.19	0.19	0.21	0.36	0.42	0.45
24	0.59	0.32	2.30	0.43	0.15	0.12	0.20	0.21	0.21	0.34	0.41	0.47
25	0.61	0.31	2.10	0.39	0.16	0.24	0.19	0.23	0.20	0.33	0.43	0.48
26	0.58	0.34	1.82	0.37	0.18	0.31	0.17	0.25	0.19	0.33	0.44	0.47
27	0.51	0.36	1.85	0.33	0.22	0.34	0.15	0.25	0.18	0.34	0.44	0.47
28	0.43	0.34	2.11	0.31	0.24	0.33	0.14	0.25	0.17	0.34	0.47	0.52
29	0.49		1.89	0.29	0.31	0.27	0.14	0.24	0.17	0.33	0.47	0.63
30	0.44		1.84	0.28	0.30	0.24	0.13	0.23	0.16	0.36	0.48	0.74
31	0.41		2.01		0.29		0.13	0.24		0.41		0.71

Table 5. Normal Year daily discharge (m^3/s), Auce River – upstream Bene HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.43	0.18	0.33	0.82	0.30	0.12	0.08	0.09	0.08	0.28	0.69	1.18
2	0.38	0.17	0.34	0.89	0.29	0.12	0.08	0.08	0.08	0.32	0.78	1.09
3	0.43	0.21	0.37	0.85	0.28	0.12	0.08	0.08	0.08	0.41	0.89	1.05
4	0.42	0.20	0.42	0.80	0.27	0.11	0.07	0.08	0.08	0.42	0.93	1.13
5	0.46	0.17	0.44	0.75	0.25	0.12	0.07	0.08	0.08	0.42	0.92	1.14
6	0.52	0.17	0.43	0.71	0.23	0.11	0.07	0.08	0.07	0.42	0.94	1.18
7	0.44	0.17	0.41	0.65	0.25	0.11	0.07	0.08	0.08	0.39	1.04	1.23
8	0.43	0.18	0.41	0.59	0.29	0.10	0.07	0.08	0.08	0.37	1.11	1.36
9	0.45	0.18	0.42	0.55	0.30	0.10	0.07	0.08	0.08	0.34	1.12	1.36
10	0.41	0.17	0.44	0.51	0.29	0.10	0.07	0.08	0.08	0.32	1.05	1.19
11	0.37	0.17	0.44	0.47	0.32	0.09	0.07	0.08	0.08	0.32	0.94	1.27
12	0.36	0.17	0.44	0.47	0.32	0.09	0.08	0.08	0.08	0.33	0.85	1.56
13	0.37	0.19	0.47	0.52	0.28	0.09	0.08	0.08	0.08	0.33	0.81	1.72
14	0.37	0.20	0.46	0.69	0.24	0.09	0.09	0.08	0.07	0.33	0.84	1.67
15	0.34	0.21	0.44	0.71	0.24	0.09	0.10	0.09	0.08	0.33	1.02	1.40
16	0.30	0.24	0.44	0.61	0.23	0.09	0.10	0.09	0.09	0.33	1.37	1.28
17	0.28	0.24	0.49	0.53	0.23	0.10	0.10	0.09	0.09	0.34	1.30	1.27
18	0.26	0.24	0.54	0.49	0.24	0.11	0.12	0.09	0.09	0.38	1.30	1.27
19	0.24	0.24	0.53	0.46	0.25	0.11	0.12	0.09	0.10	0.38	1.24	1.43
20	0.23	0.23	0.51	0.44	0.24	0.12	0.12	0.08	0.09	0.36	1.12	1.12
21	0.24	0.21	0.51	0.42	0.22	0.16	0.11	0.08	0.09	0.37	1.19	1.13
22	0.25	0.21	0.62	0.37	0.22	0.16	0.11	0.08	0.09	0.39	1.29	1.04
23	0.26	0.19	0.63	0.37	0.20	0.13	0.11	0.08	0.10	0.45	1.24	1.04
24	0.27	0.19	0.57	0.37	0.19	0.11	0.10	0.08	0.09	0.51	1.12	1.14
25	0.26	0.20	0.56	0.38	0.18	0.08	0.09	0.09	0.09	0.56	1.15	1.30
26	0.25	0.23	0.59	0.36	0.16	0.07	0.09	0.10	0.09	0.60	1.25	1.35
27	0.23	0.29	0.63	0.35	0.15	0.07	0.08	0.10	0.10	0.65	1.49	1.11
28	0.21	0.32	0.63	0.35	0.14	0.08	0.08	0.10	0.10	0.68	1.28	1.27
29	0.19		0.68	0.34	0.13	0.08	0.08	0.10	0.11	0.62	1.21	1.30
30	0.17		0.75	0.32	0.13	0.08	0.08	0.09	0.11	0.61	1.22	1.46
31	0.17		0.73		0.13		0.08	0.09		0.65		1.55

Table 6. Dry Year daily discharge (m^3/s), Auce River – upstream Bene HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.11	0.16	0.18	0.51	0.33	0.09	0.03	0.02	0.02	0.04	0.09	0.20
2	0.13	0.16	0.16	0.47	0.30	0.08	0.03	0.02	0.02	0.04	0.10	0.20
3	0.15	0.16	0.14	0.41	0.28	0.07	0.03	0.02	0.02	0.04	0.11	0.19
4	0.13	0.16	0.14	0.41	0.26	0.07	0.03	0.02	0.02	0.04	0.11	0.19
5	0.12	0.15	0.14	0.47	0.24	0.07	0.03	0.02	0.02	0.04	0.11	0.20
6	0.11	0.14	0.14	0.50	0.23	0.06	0.03	0.02	0.02	0.04	0.10	0.19
7	0.10	0.14	0.14	0.53	0.22	0.06	0.03	0.02	0.03	0.04	0.11	0.20
8	0.10	0.14	0.14	0.55	0.20	0.05	0.03	0.02	0.03	0.04	0.11	0.22
9	0.09	0.13	0.14	0.57	0.19	0.05	0.03	0.02	0.02	0.04	0.10	0.21
10	0.09	0.13	0.13	0.60	0.18	0.05	0.03	0.02	0.02	0.05	0.11	0.22
11	0.09	0.13	0.13	0.63	0.16	0.05	0.03	0.02	0.02	0.05	0.13	0.21
12	0.09	0.14	0.14	0.67	0.17	0.05	0.03	0.02	0.02	0.05	0.13	0.21
13	0.09	0.14	0.14	0.65	0.17	0.05	0.03	0.02	0.03	0.05	0.13	0.20
14	0.09	0.15	0.15	0.61	0.16	0.05	0.03	0.02	0.03	0.05	0.14	0.23
15	0.09	0.16	0.15	0.60	0.16	0.05	0.03	0.02	0.03	0.05	0.14	0.24
16	0.08	0.16	0.16	0.64	0.15	0.05	0.03	0.02	0.03	0.05	0.16	0.24
17	0.09	0.16	0.16	0.68	0.17	0.05	0.03	0.02	0.02	0.05	0.16	0.23
18	0.09	0.15	0.16	0.66	0.21	0.05	0.03	0.02	0.03	0.05	0.17	0.24
19	0.09	0.14	0.17	0.68	0.17	0.05	0.03	0.02	0.03	0.06	0.17	0.22
20	0.09	0.14	0.16	0.59	0.15	0.05	0.03	0.02	0.02	0.06	0.19	0.20
21	0.10	0.14	0.19	0.56	0.14	0.05	0.03	0.02	0.03	0.07	0.23	0.20
22	0.10	0.15	0.20	0.53	0.13	0.05	0.03	0.02	0.03	0.07	0.23	0.20
23	0.10	0.16	0.21	0.47	0.13	0.04	0.03	0.02	0.03	0.07	0.22	0.20
24	0.11	0.16	0.21	0.43	0.12	0.04	0.03	0.02	0.03	0.07	0.22	0.20
25	0.11	0.22	0.22	0.39	0.11	0.04	0.03	0.02	0.04	0.07	0.22	0.19
26	0.11	0.25	0.23	0.35	0.11	0.04	0.03	0.02	0.04	0.07	0.22	0.17
27	0.12	0.18	0.27	0.35	0.10	0.03	0.03	0.02	0.03	0.08	0.22	0.18
28	0.13	0.16	0.31	0.36	0.10	0.03	0.03	0.02	0.03	0.08	0.21	0.20
29	0.15		0.38	0.34	0.11	0.03	0.02	0.02	0.03	0.08	0.22	0.22
30	0.16		0.51	0.34	0.10	0.03	0.02	0.02	0.04	0.09	0.21	0.24
31	0.16		0.57		0.10		0.02	0.02		0.10	0.21	

Table 7. Wet Year daily discharge (m^3/s), Islice River – upstream Rundale HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	3.09	2.41	3.26	18.15	4.15	2.19	0.86	1.06	2.17	2.44	6.04	5.79
2	3.07	2.29	3.35	18.89	3.99	3.79	1.01	1.03	2.30	2.35	5.49	5.53
3	3.03	2.23	3.83	19.48	3.78	3.54	1.07	1.05	2.24	2.30	5.00	5.28
4	3.09	2.16	4.15	21.16	3.25	2.64	0.93	1.06	2.10	2.22	4.89	5.87
5	3.09	2.24	4.49	22.93	3.26	1.89	0.86	1.03	1.91	2.30	4.49	5.56
6	2.88	2.53	5.15	20.87	3.13	1.37	0.80	0.99	1.86	2.75	4.17	6.06
7	2.93	2.75	5.48	17.34	2.80	1.20	0.84	0.98	1.71	3.02	4.20	6.13
8	2.97	2.99	5.81	15.04	2.62	1.10	0.84	2.65	1.63	3.09	4.50	5.67
9	3.10	3.21	5.72	14.27	2.47	1.00	0.83	1.81	1.52	2.88	4.54	5.65
10	3.15	3.24	5.51	13.08	2.33	0.92	0.82	1.26	1.62	3.14	4.35	5.34
11	3.17	3.30	5.71	11.09	2.26	0.85	0.86	1.15	1.90	3.54	4.41	5.74
12	3.12	3.68	5.99	9.39	2.43	0.83	1.18	1.16	2.39	3.55	4.90	5.89
13	3.12	4.18	6.37	8.41	2.08	0.88	1.64	1.12	2.90	3.67	4.80	6.29
14	3.27	4.40	6.72	8.05	1.94	1.31	1.69	1.04	2.27	3.95	4.39	6.14
15	3.16	4.23	6.66	9.07	2.27	1.29	1.85	1.00	1.85	4.17	4.17	6.52
16	3.12	4.13	6.72	7.71	2.66	1.12	2.11	0.96	1.71	4.09	4.10	6.07
17	3.15	4.32	7.24	7.02	2.36	1.18	2.07	0.94	1.72	4.13	4.18	5.42
18	3.03	4.41	7.19	6.40	2.18	1.12	1.89	0.95	1.78	4.56	4.65	4.92
19	2.88	4.02	6.89	6.06	2.29	0.97	1.71	1.24	2.76	4.46	4.99	4.81
20	3.01	4.00	6.67	5.95	2.21	0.84	1.64	1.90	3.27	4.27	5.15	4.59
21	3.17	3.83	6.93	6.86	2.19	0.76	1.56	1.81	2.58	3.99	5.87	3.94
22	3.44	3.97	7.39	7.58	2.35	0.68	1.46	1.50	2.77	3.75	5.55	4.24
23	3.31	3.78	7.37	6.84	2.39	0.65	1.48	1.30	3.01	3.44	5.41	4.97
24	3.37	3.72	7.54	6.00	2.06	0.73	1.49	1.29	2.88	2.99	5.42	4.95
25	3.14	3.65	8.99	5.29	1.70	0.95	1.35	1.47	2.65	2.84	5.22	5.03
26	2.94	3.61	10.10	4.64	1.55	1.21	1.25	1.80	2.47	2.98	4.98	4.90
27	2.56	3.47	11.08	5.30	1.74	1.28	1.21	2.15	2.42	2.85	4.78	5.08
28	2.30	3.32	12.48	5.09	1.87	1.23	1.14	2.41	2.62	2.72	4.87	5.67
29	2.29		14.38	4.34	1.72	1.11	1.09	2.29	2.75	3.12	5.15	6.01
30	2.25		15.54	3.95	1.73	0.98	1.12	2.00	2.68	4.25	5.46	6.27
31	2.36		17.13		1.43		1.11	2.00		5.19		6.51

Table 8. Normal Year daily discharge (m^3/s), Islice River – upstream Rundale HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	5.54	4.72	2.48	13.37	2.34	0.71	0.45	0.45	0.41	0.53	0.99	2.39
2	5.78	5.64	2.77	13.32	2.16	0.69	0.43	0.44	0.41	0.54	1.10	2.45
3	5.97	5.90	3.20	10.54	2.07	0.66	0.40	0.42	0.41	0.58	1.45	2.34
4	6.24	5.64	3.68	9.53	2.02	0.63	0.39	0.40	0.40	0.60	1.66	2.35
5	6.47	5.37	5.12	8.88	1.98	0.65	0.39	0.39	0.42	0.59	1.60	2.84
6	6.36	5.09	7.04	8.21	1.88	0.74	0.40	0.39	0.42	0.61	1.47	3.32
7	5.80	5.03	8.97	9.30	1.86	0.82	0.40	0.42	0.40	0.60	1.41	3.18
8	5.31	5.17	11.67	8.87	2.10	0.96	0.41	0.46	0.38	0.59	1.38	2.74
9	4.64	5.34	11.45	7.56	1.95	0.93	0.39	0.48	0.36	0.58	1.37	2.39
10	4.23	5.65	10.55	6.81	1.74	0.90	0.36	0.43	0.35	0.60	1.34	2.13
11	4.02	5.60	9.56	6.32	1.66	0.87	0.34	0.37	0.34	0.58	1.29	1.87
12	3.80	5.29	9.45	5.98	1.53	0.97	0.33	0.35	0.36	0.59	1.22	1.77
13	3.63	5.08	8.88	7.57	1.54	1.09	0.34	0.34	0.40	0.65	1.20	1.82
14	3.34	4.92	8.04	8.64	1.86	0.99	0.34	0.33	0.44	0.68	1.19	1.92
15	3.35	4.48	7.80	8.91	1.83	0.87	0.78	0.33	0.47	0.69	1.18	1.92
16	3.53	3.88	7.87	8.27	1.73	0.78	0.95	0.34	0.46	0.67	1.13	1.83
17	3.74	3.46	8.15	7.19	1.55	0.70	0.78	0.34	0.43	0.64	1.24	1.79
18	3.68	3.15	7.76	6.22	1.47	0.63	0.61	0.34	0.39	0.60	1.37	1.73
19	3.64	2.93	7.56	5.63	1.65	0.57	0.53	0.34	0.37	0.56	1.43	1.52
20	3.54	2.86	8.20	5.89	1.69	0.53	0.48	0.34	0.37	0.54	1.54	1.50
21	3.53	2.77	9.22	5.46	1.53	0.51	0.44	0.34	0.37	0.54	1.60	1.68
22	3.41	2.68	11.19	4.88	1.44	0.49	0.45	0.34	0.39	0.55	1.91	1.72
23	3.46	2.73	12.61	4.28	1.35	0.46	0.50	0.34	0.39	0.59	1.94	1.95
24	4.10	2.70	12.68	3.74	1.21	0.45	0.51	0.34	0.40	0.68	1.91	2.40
25	4.32	2.55	12.64	3.38	1.11	0.48	0.50	0.35	0.42	0.71	2.00	2.31
26	4.74	2.44	12.75	3.14	1.01	0.46	0.47	0.35	0.47	0.71	2.08	2.17
27	4.86	2.33	12.28	2.95	0.93	0.46	0.44	0.36	0.52	0.68	2.18	2.12
28	4.96	2.31	13.91	2.75	0.87	0.47	0.43	0.39	0.53	0.68	2.13	2.28
29	5.02		15.01	2.64	0.83	0.47	0.44	0.41	0.54	0.70	2.14	2.18
30	4.97		15.49	2.48	0.81	0.46	0.43	0.42	0.54	0.79	2.25	2.37
31	4.75		14.31		0.77		0.43	0.41		0.86		2.86

Table 9. Dry Year daily discharge (m^3/s), Islice River – upstream Rundale HPP

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	1.20	0.76	2.07	9.08	2.89	0.51	0.10	0.13	0.08	0.15	0.43	1.18
2	0.92	0.80	2.68	8.62	2.48	0.45	0.09	0.12	0.08	0.15	0.44	1.07
3	0.87	0.78	2.47	7.64	2.21	0.40	0.09	0.11	0.08	0.14	0.46	0.95
4	0.92	0.75	2.28	7.48	2.24	0.35	0.09	0.10	0.09	0.14	0.48	0.90
5	1.02	0.68	1.87	8.31	2.01	0.32	0.08	0.10	0.08	0.14	0.53	0.87
6	1.09	0.76	1.49	8.89	1.67	0.30	0.10	0.10	0.08	0.14	0.55	0.83
7	1.27	0.89	1.34	9.65	1.49	0.28	0.20	0.10	0.08	0.14	0.54	0.83
8	1.16	0.98	1.55	9.35	1.35	0.26	0.20	0.12	0.08	0.14	0.61	0.80
9	0.99	0.89	1.49	7.15	1.19	0.25	0.18	0.11	0.09	0.14	0.70	0.82
10	1.00	0.84	1.40	7.42	1.06	0.22	0.17	0.10	0.10	0.15	0.68	0.87
11	1.31	0.78	1.32	7.02	0.95	0.21	0.15	0.10	0.09	0.15	0.71	0.94
12	1.30	0.74	1.44	7.65	0.92	0.21	0.13	0.09	0.09	0.15	0.85	1.03
13	1.07	0.70	1.68	8.23	0.87	0.21	0.16	0.09	0.09	0.15	0.95	1.16
14	0.88	0.64	1.84	8.67	0.80	0.20	0.37	0.08	0.09	0.16	1.07	1.29
15	0.98	1.01	1.80	9.14	0.80	0.18	0.25	0.08	0.10	0.17	1.11	1.62
16	1.05	1.36	1.86	8.43	0.78	0.18	0.19	0.08	0.11	0.23	1.07	1.72
17	0.95	1.44	1.79	7.62	0.75	0.24	0.16	0.07	0.12	0.25	1.01	1.54
18	0.87	1.58	2.25	6.99	0.81	0.34	0.14	0.08	0.12	0.28	0.97	1.47
19	0.77	1.58	2.55	5.77	0.87	0.26	0.13	0.08	0.12	0.28	0.92	1.56
20	0.69	1.39	2.46	4.86	1.00	0.21	0.12	0.08	0.13	0.31	0.86	1.48
21	0.73	1.05	2.41	4.49	0.92	0.19	0.11	0.07	0.15	0.31	0.81	1.49
22	0.71	1.33	2.39	3.98	0.81	0.17	0.11	0.07	0.17	0.31	0.75	1.81
23	0.69	1.21	2.34	3.54	0.70	0.16	0.11	0.07	0.17	0.31	0.73	1.73
24	0.68	1.06	2.43	3.26	0.59	0.16	0.11	0.07	0.17	0.32	0.81	1.60
25	0.83	0.76	2.87	3.83	0.54	0.15	0.11	0.07	0.16	0.33	0.90	1.60
26	0.90	0.67	2.93	4.97	0.62	0.14	0.11	0.07	0.16	0.36	0.97	1.37
27	0.83	1.00	4.17	4.38	0.97	0.13	0.11	0.07	0.16	0.38	0.93	1.30
28	0.83	1.15	5.11	4.39	1.01	0.12	0.11	0.08	0.15	0.41	0.93	1.28
29	0.87		5.96	4.22	0.76	0.11	0.11	0.08	0.15	0.43	1.08	1.13
30	0.81		7.02	3.53	0.63	0.10	0.12	0.09	0.15	0.43	1.21	1.04
31	0.74		8.51		0.58		0.12	0.08		0.43		0.98