Modelling Inland Responses

IAH (Irish Group) CPD Course – 14th January 2026

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Modelling Inland Responses
Flood Flow Estimation

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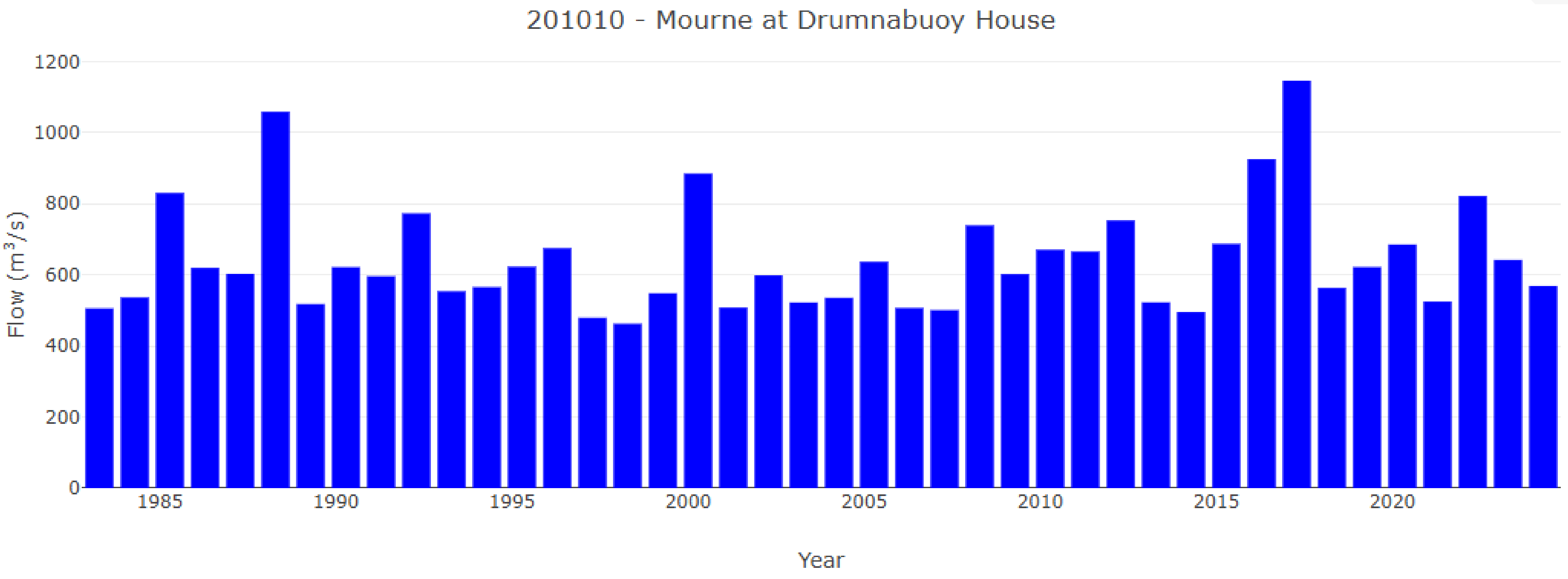
Estimating Flood Frequency on the Mourne River



Mourne River at Drumnabuoy House

42 years of
AMAX data listed in:
Table 1: Chronological Order
Table 2: Ranked from highest to lowest

What is the Index Flood Flow (Qmed)?

Table 1: Chronological Order

Year	AMAX (m^3/s)	Year	AMAX (m^3/s)
1982	505.4	2003	535.1
1983	536.5	2004	636.5
1984	830	2005	506.5
1985	619.5	2006	501
1986	603	2007	739
1987	1058.6	2008	602.3
1988	517.7	2009	670.6
1989	621.5	2010	665.6
1990	595.8	2011	752.8
1991	773.1	2012	522.3
1992	553.9	2013	495
1993	565.7	2014	687.1
1994	622.8	2015	925.5
1995	674.8	2016	1145.4
1996	479.1	2017	563.3
1997	462.7	2018	621.8
1998	547.9	2019	685.2
1999	884.9	2020	524.9
2000	507.5	2021	821.8
2001	598.3	2022	642.2
2002	521.9	2023	568.6

Re-ordered from smallest to largest

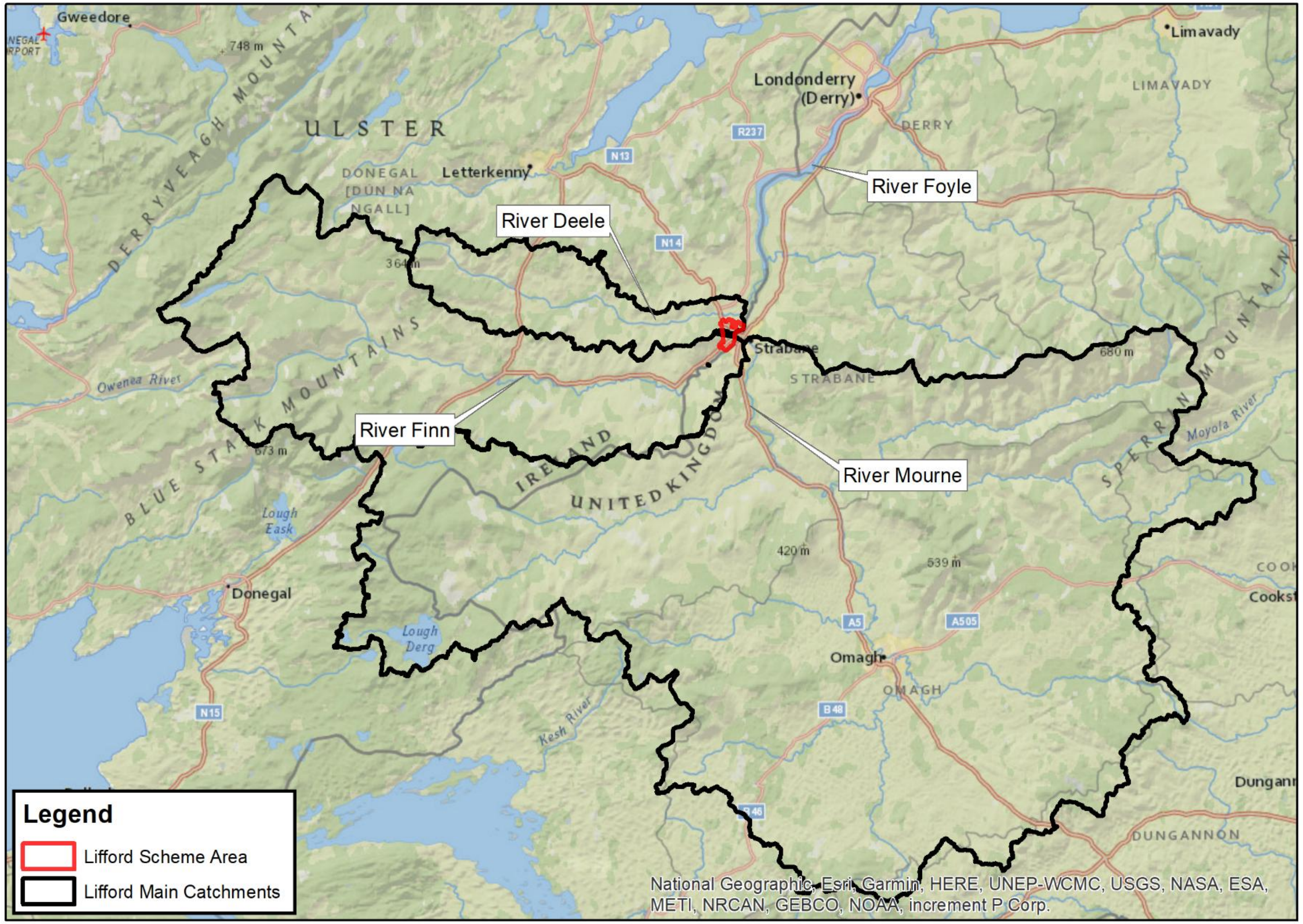
Table 2: Ranked from high to low

Rank	Ranked AMAX	Rank	Ranked AMAX
1	1145.4	22	602.3
2	1058.6	23	598.3
3	925.5	24	595.8
4	884.9	25	568.6
5	830.0	26	565.7
6	821.8	27	563.3
7	773.1	28	553.9
8	752.8	29	547.9
9	739.0	30	536.5
10	687.1	31	535.1
11	685.2	32	524.9
12	674.8	33	522.3
13	670.6	34	521.9
14	665.6	35	517.7
15	642.2	36	507.5
16	636.5	37	506.5
17	622.8	38	505.4
18	621.8	39	501.0
19	621.5	40	495.0
20	619.5	41	479.1
21	603.0	42	462.7

Estimating Flood Frequency on the Mourne River

Main Catchments

	Mourne	Finn	Deele
Area (km^2)	1,862	502	134
BFI	0.448	0.334	0.402
SAAR (mm)	1287	1730	1290
FARL	0.978	0.976	1
URBEXT (%)	0.6	0.9	0.9
Qmed	**602**	**256**	**51**



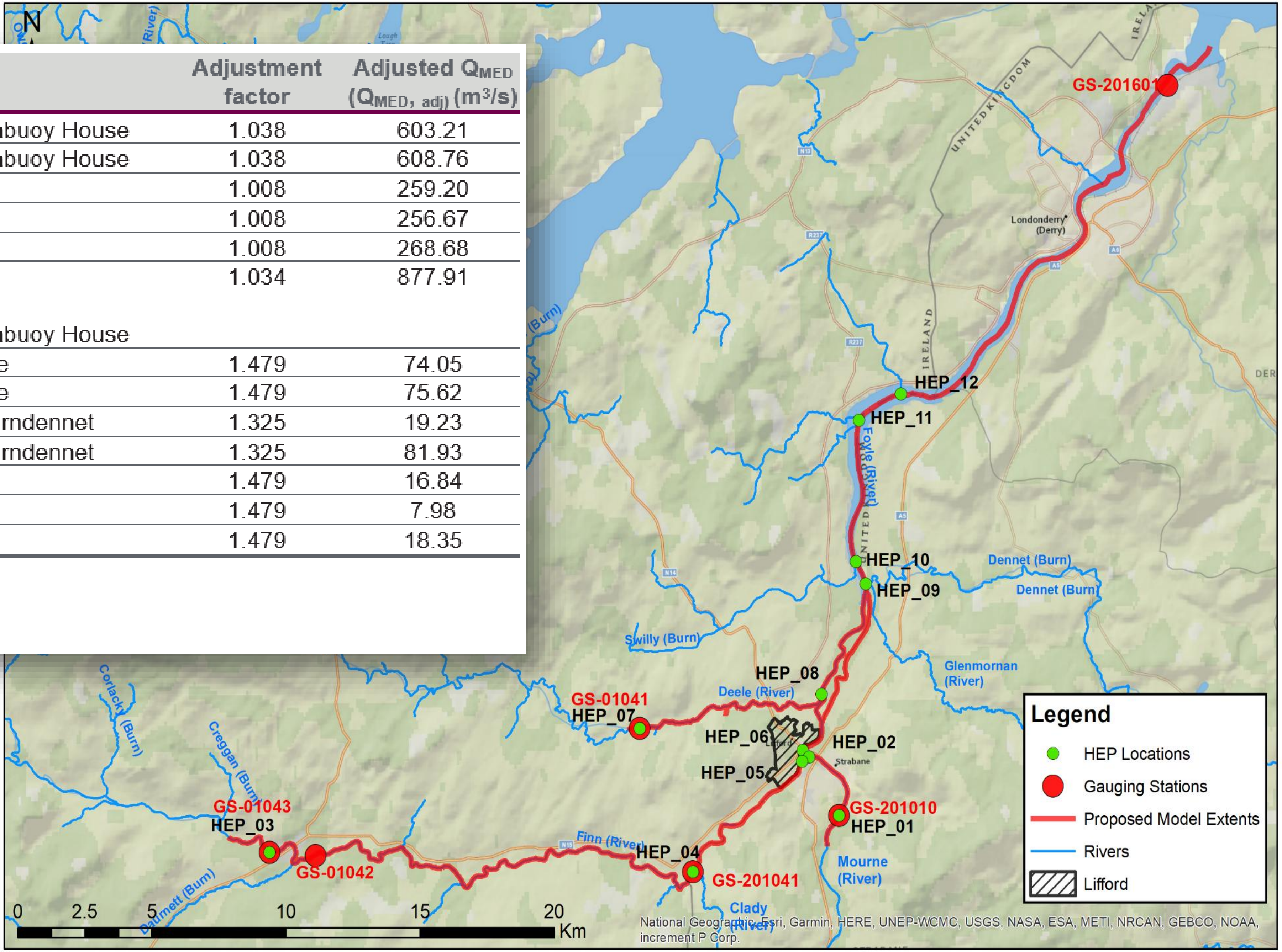
Hydrological Estimation Points

HEP	Method	$Q_{MED, cd}$	Pivotal Site	Adjustment factor	Adjusted Q_{MED} ($Q_{MED, adj}$) (m^3/s)
HEP01*	FEH	581.17	201010 Mourne at Drumnabuoy House	1.038	603.21
HEP02	FEH	586.52	201010 Mourne at Drumnabuoy House	1.038	608.76
HEP03**	FSU	257.07	01043 Finn at Ballybofey	1.008	259.20
HEP04	FSU	254.56	01043 Finn at Ballybofey	1.008	256.67
HEP05	FSU	266.48	01043 Finn at Ballybofey	1.008	268.68
HEP06	FEH	849.42	Area weighted average of: 01043 Finn at Ballybofey 201010 Mourne at Drumnabuoy House	1.034	877.91
HEP07***	FSU	50.05	01041 Sandy Mills at Deele	1.479	74.05
HEP08	FSU	51.12	01041 Sandy Mills at Deele	1.479	75.62
HEP08A	FEH	14.51	201007 Burn Dennet at Burndennet	1.325	19.23
HEP09	FEH	61.82	201007 Burn Dennet at Burndennet	1.325	81.93
HEP10	FSU	11.38	1041 Sandy Mills at Deele	1.479	16.84
HEP11	FSU	5.40	1041 Sandy Mills at Deele	1.479	7.98
HEP12	FSU	12.40	1041 Sandy Mills at Deele	1.479	18.35

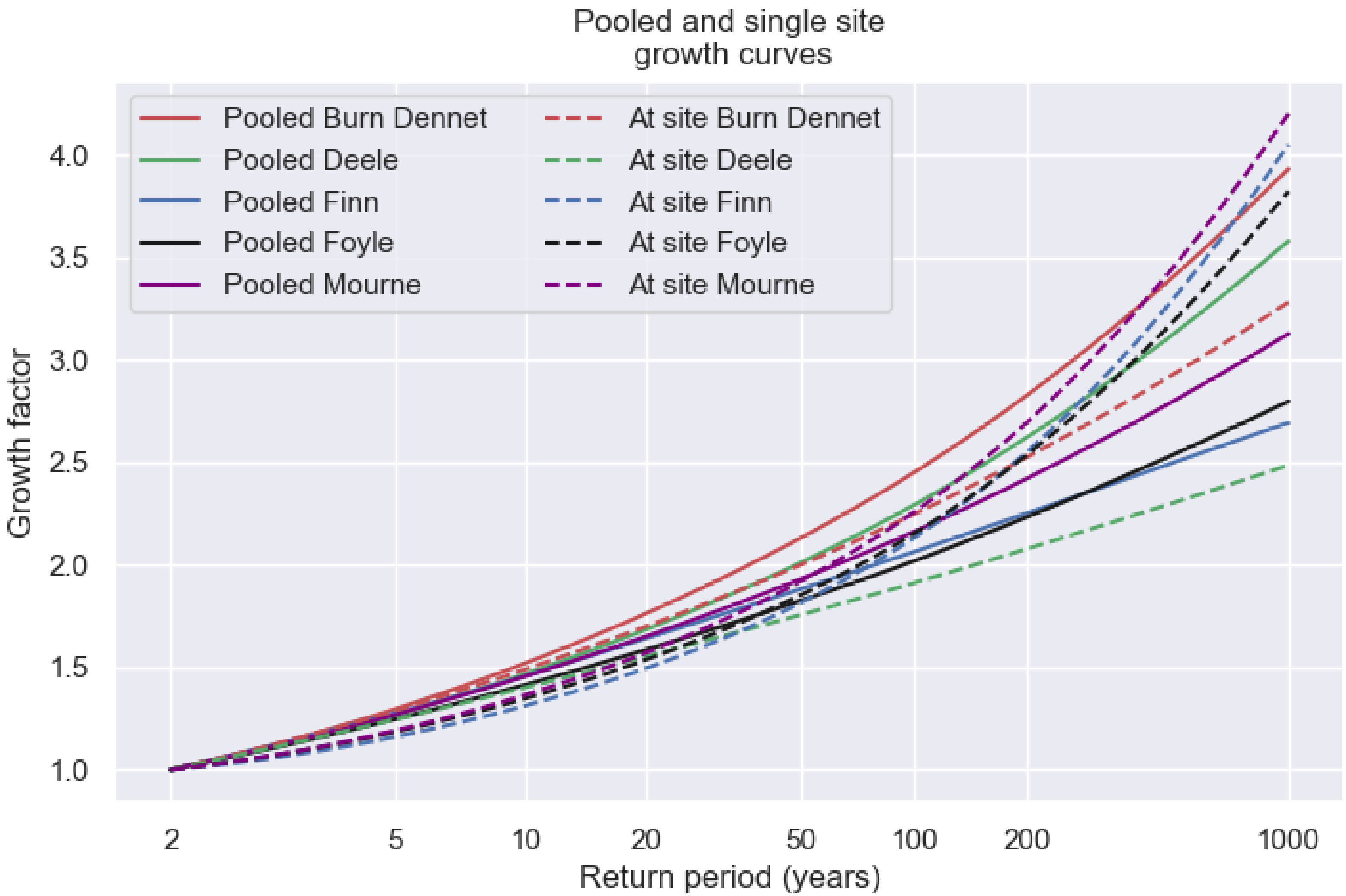
**HEP located at the Mourne at Drumnabuoy House gauging station*

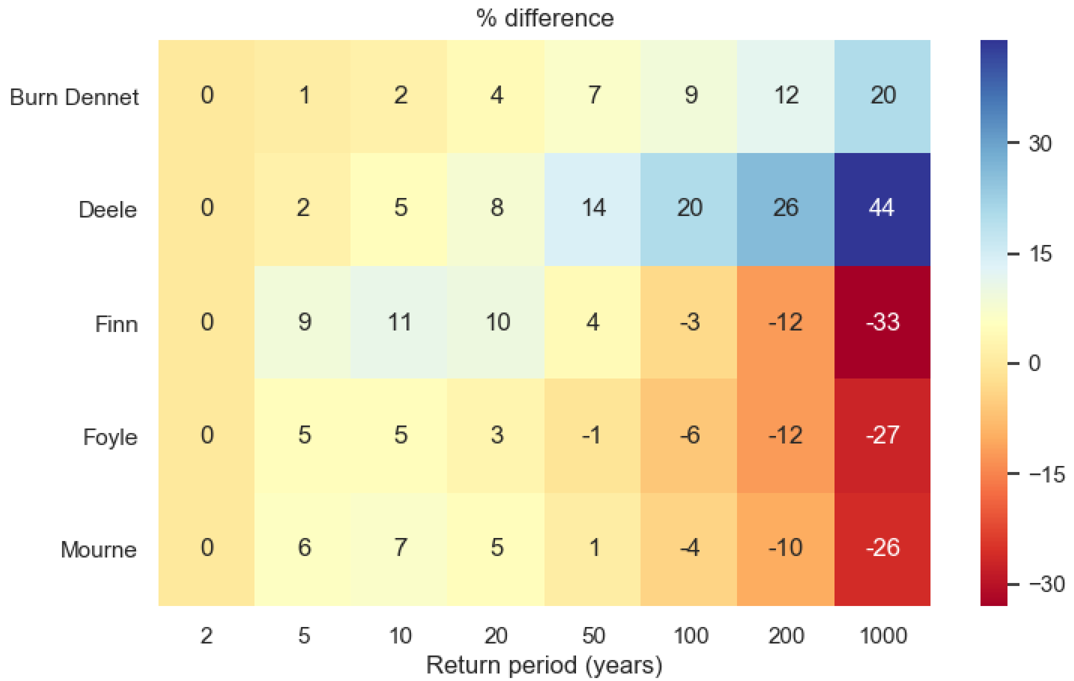
***HEP located at the Finn at Ballybofey gauging station*

****HEP located at the Deele at Sandy Mills gauging station*

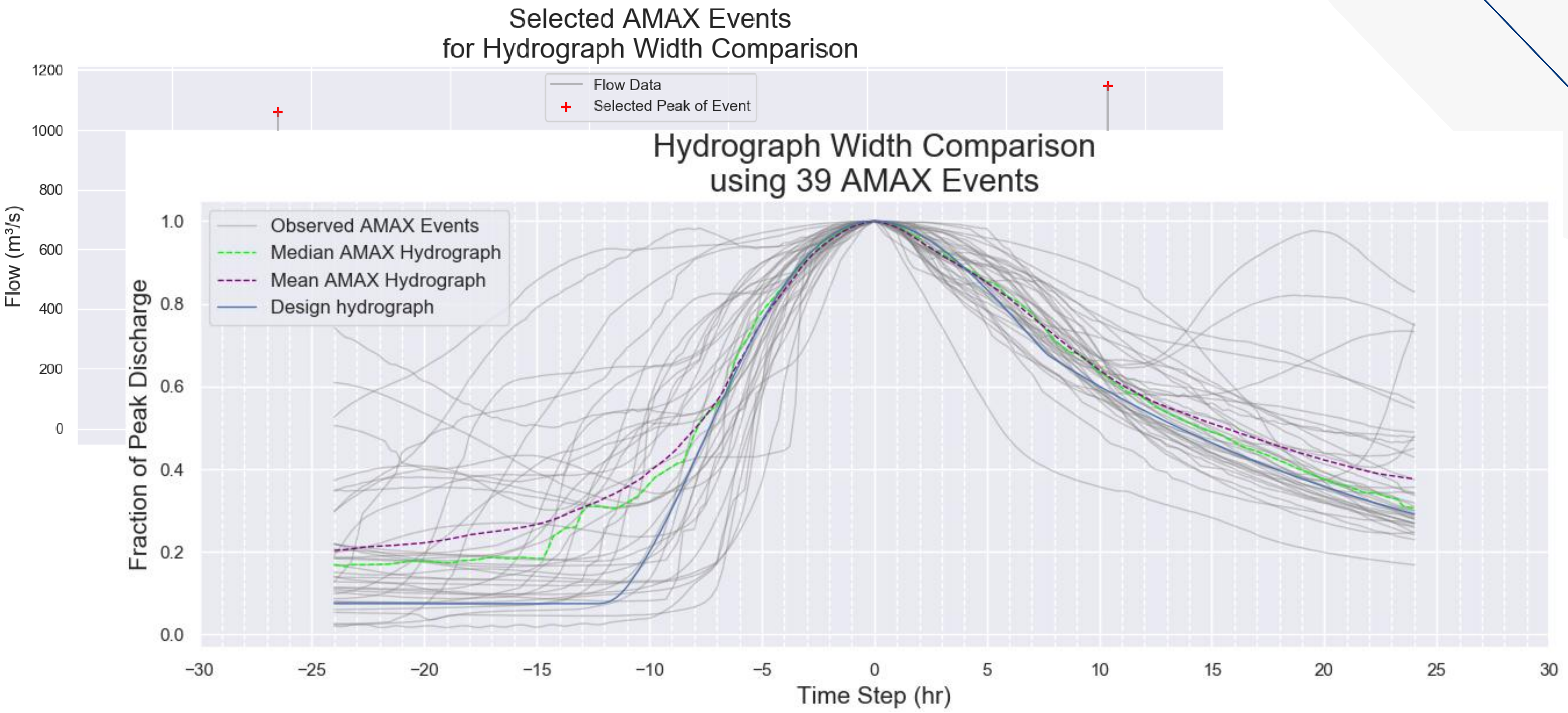


Growth Curves

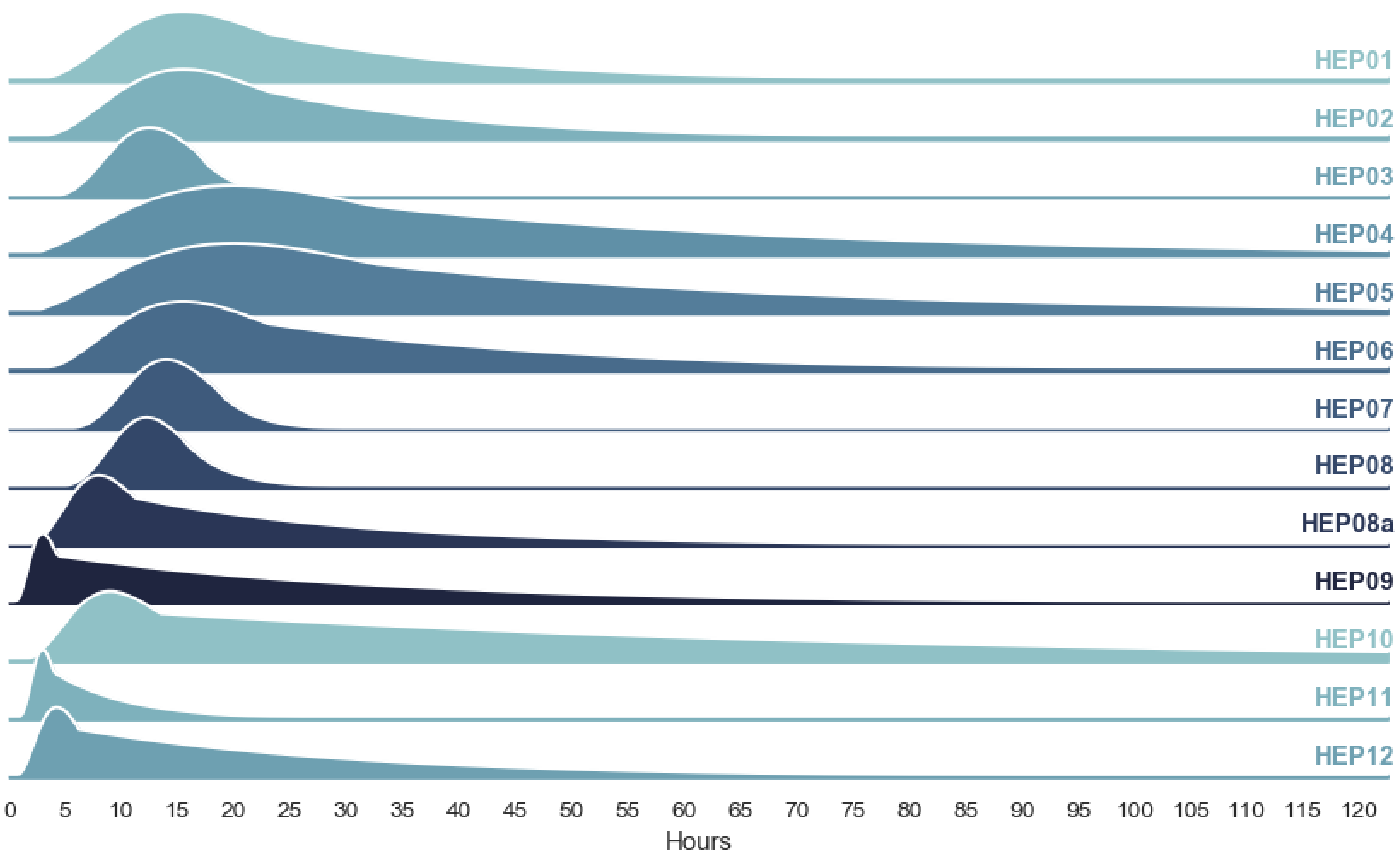




Hydrograph Development



Hydrograph Development

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Modelling Inland Responses

Low Flow Estimation

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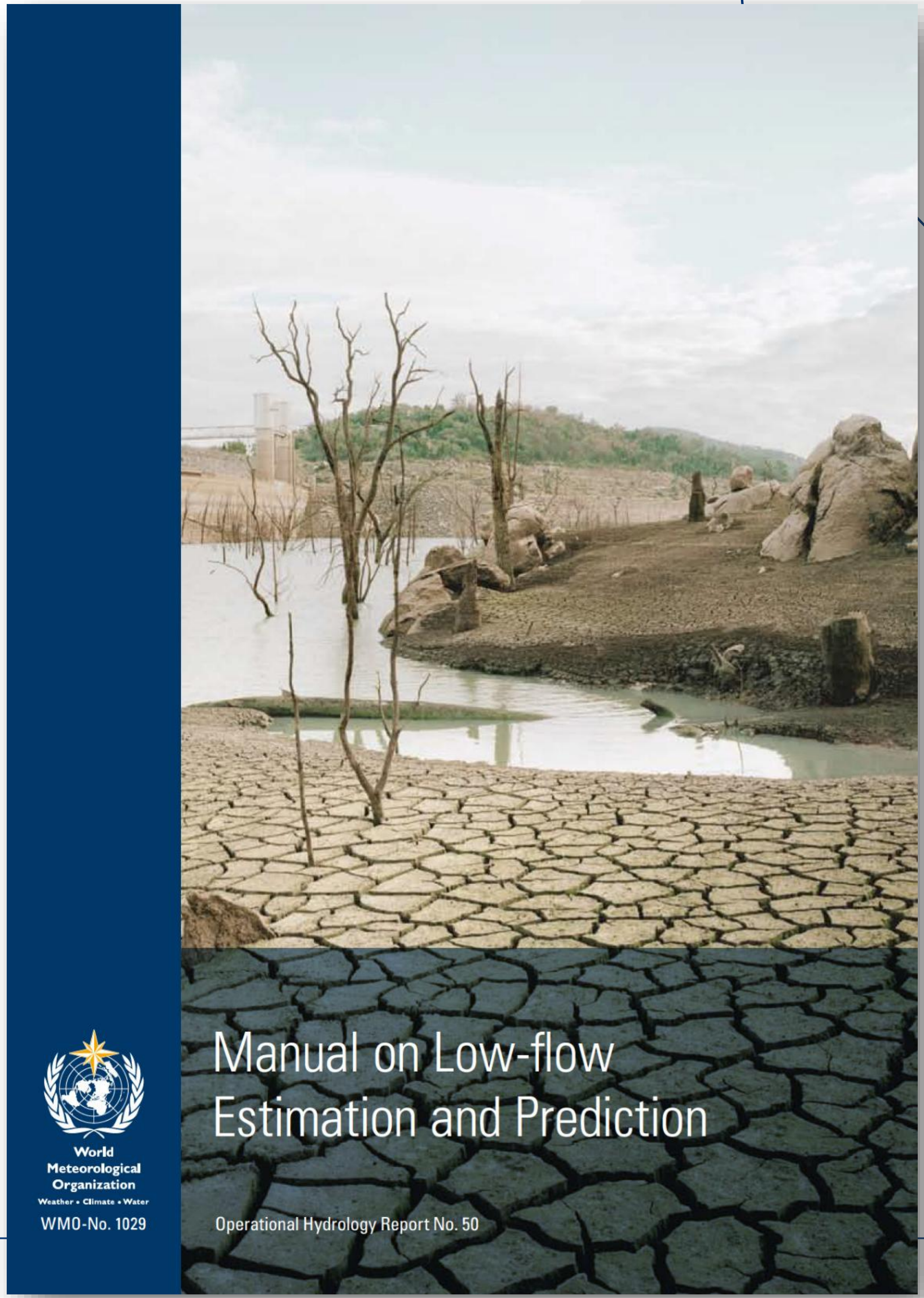
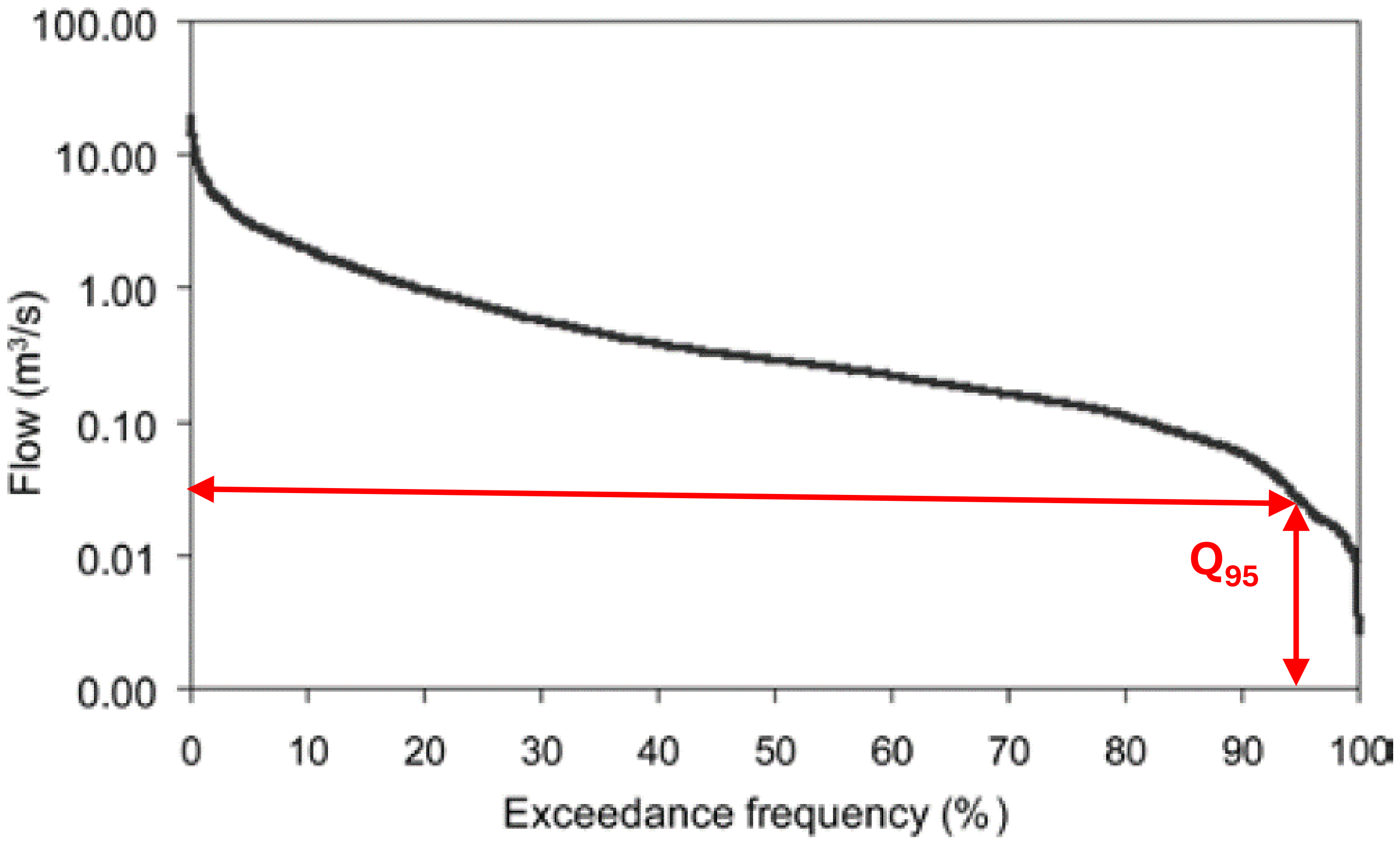
Low Flow Hydrology

- Based on statistical analysis of the full range of flows (not just extreme events) – the Flow Duration Curve
- Methods are primarily statistical
- Certain flow statistics or indices (e.g. 95th Percentile or Q_{95}) are used
- At the lowest end (e.g. drought) Extreme Value Analysis (EVA) techniques are used



Flow Duration Curve



Important for understanding a catchments flow characteristics.

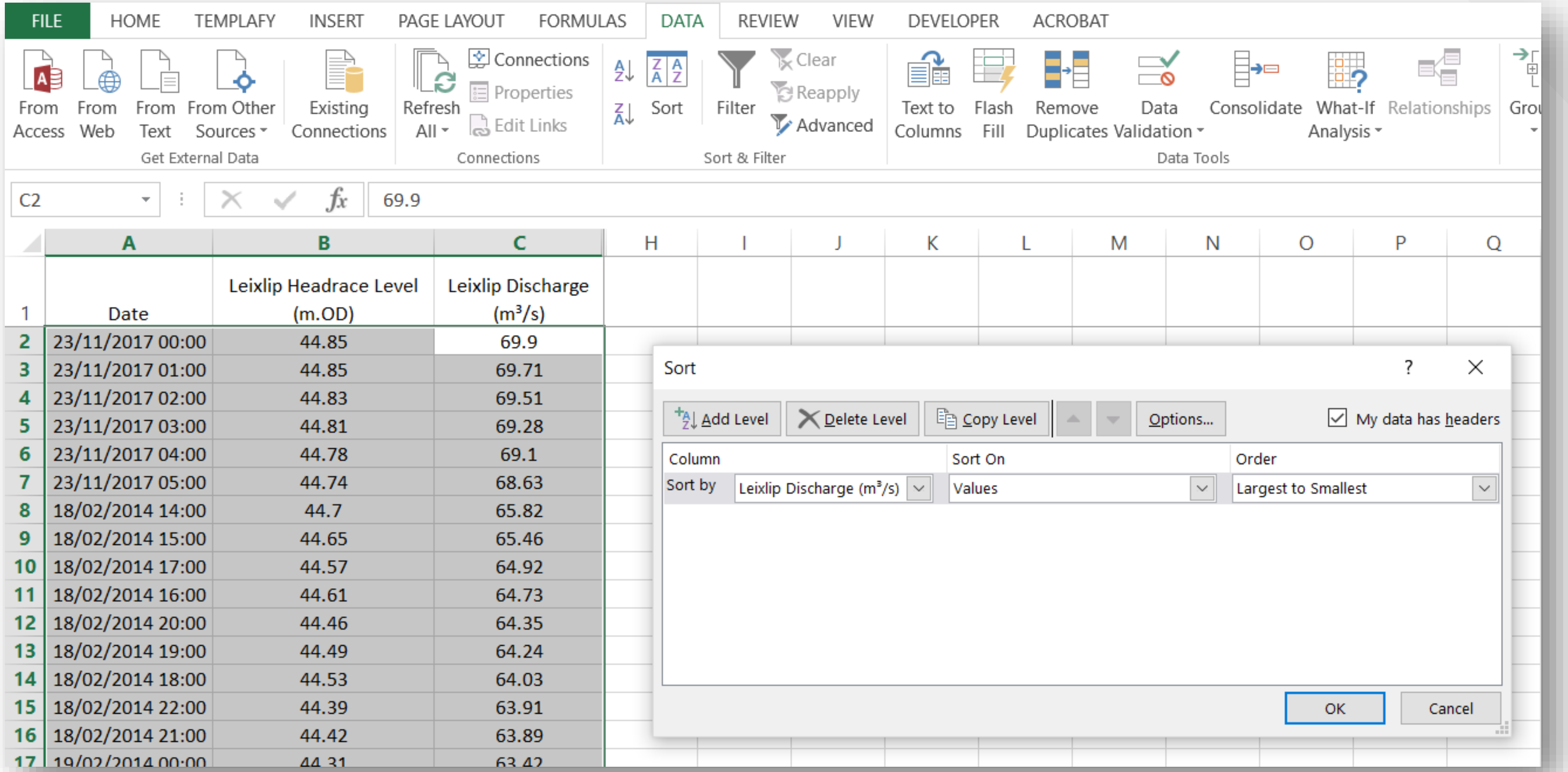
Key information that feeds into the design of water quality and hydropower projects.

Calculating a Flow Duration Curve at Leixlip

A flow duration curve can be calculated where we have continuous flow data spanning more than a hydrological year.

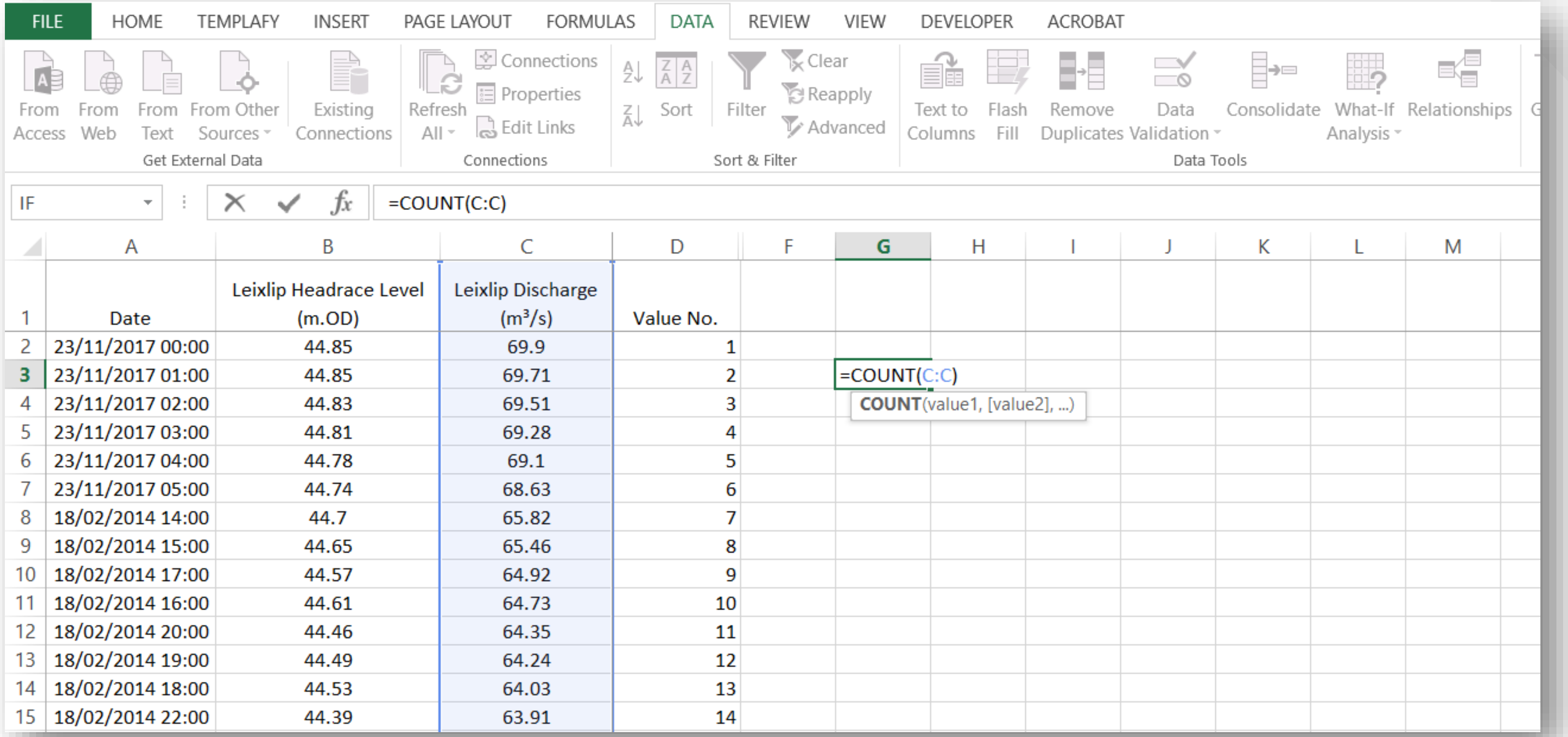
Calculating a Flow Duration Curve at Leixlip

Step 1 – Sort the data from largest to smallest



Calculating a Flow Duration Curve at Leixlip

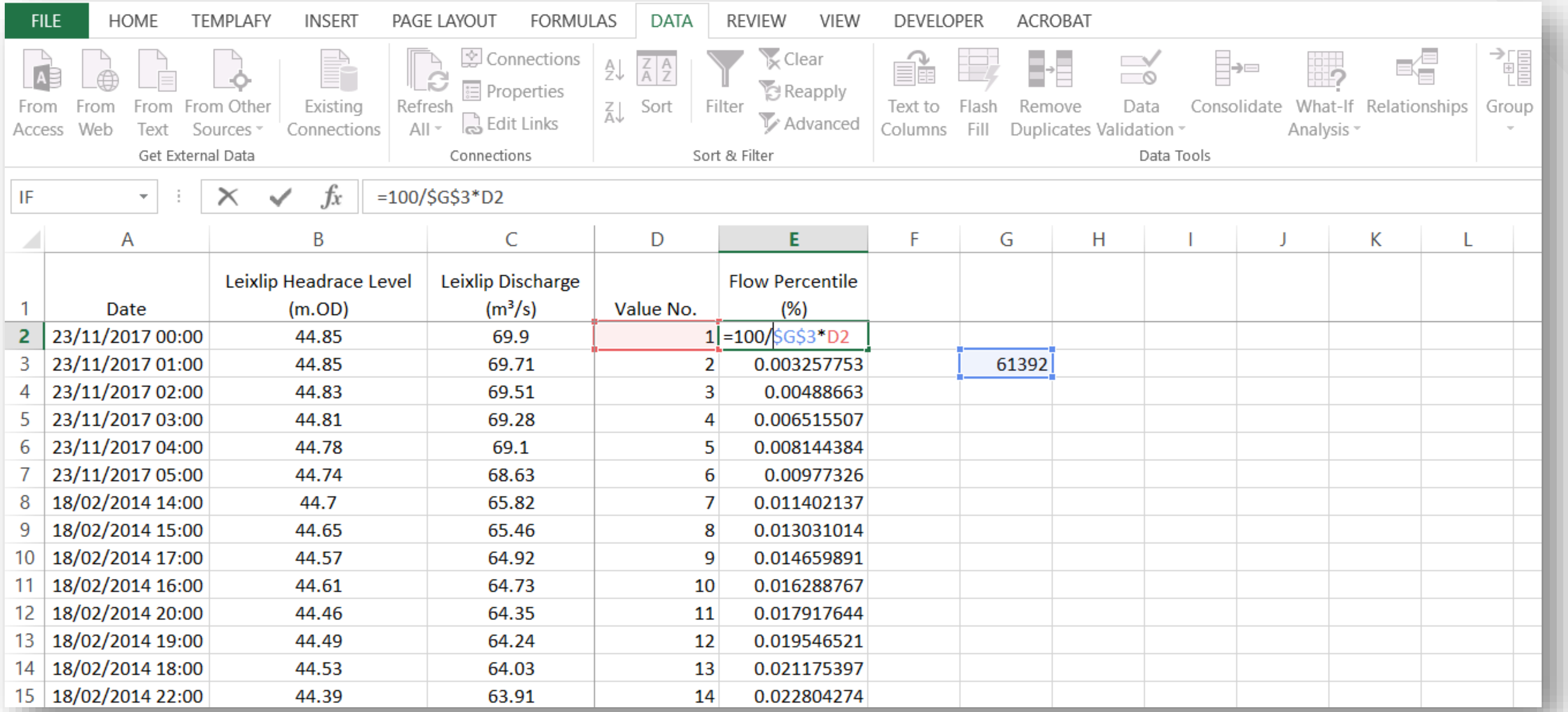
Step 2 – Number the data (Value no.) and count the number of values



	A	B	C	D	F	G
1	Date	Leixlip Headrace Level (m.OD)	Leixlip Discharge (m^3/s)	Value No.		
2	23/11/2017 00:00	44.85	69.9	1		
3	23/11/2017 01:00	44.85	69.71	2		=COUNT(C:C)
4	23/11/2017 02:00	44.83	69.51	3		
5	23/11/2017 03:00	44.81	69.28	4		
6	23/11/2017 04:00	44.78	69.1	5		
7	23/11/2017 05:00	44.74	68.63	6		
8	18/02/2014 14:00	44.7	65.82	7		
9	18/02/2014 15:00	44.65	65.46	8		
10	18/02/2014 17:00	44.57	64.92	9		
11	18/02/2014 16:00	44.61	64.73	10		
12	18/02/2014 20:00	44.46	64.35	11		
13	18/02/2014 19:00	44.49	64.24	12		
14	18/02/2014 18:00	44.53	64.03	13		
15	18/02/2014 22:00	44.39	63.91	14		

Calculating a Flow Duration Curve at Leixlip

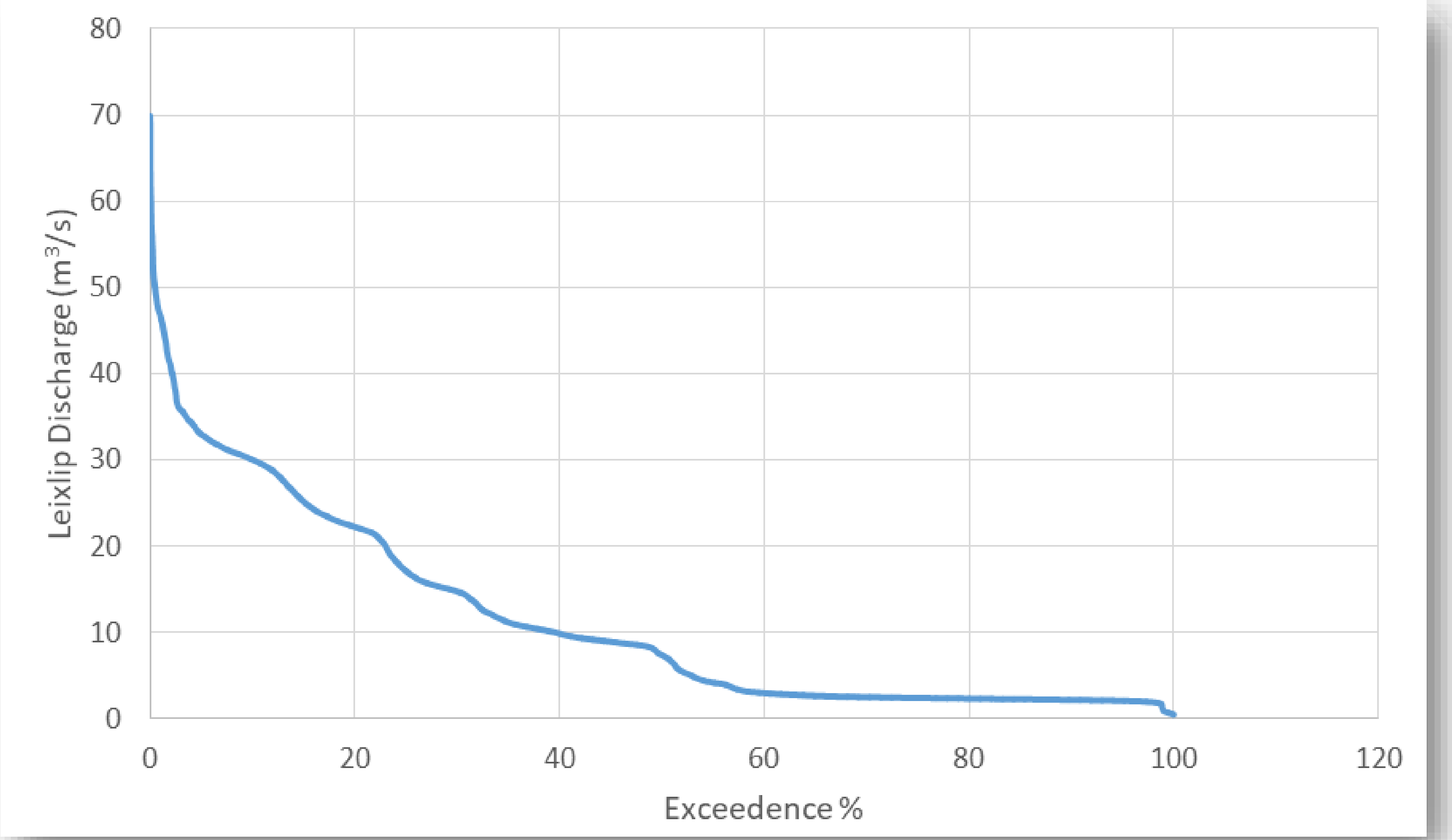
Step 3 – Calculate the percentile value for each cell by dividing value no. by the number of values multiplied x100



	A	B	C	D	E	F	G
1	Date	Leixlip Headrace Level (m.OD)	Leixlip Discharge (m³/s)	Value No.	Flow Percentile (%)		
2	23/11/2017 00:00	44.85	69.9	1	=100/G3*D2		
3	23/11/2017 01:00	44.85	69.71	2	0.003257753		61392
4	23/11/2017 02:00	44.83	69.51	3	0.00488663		
5	23/11/2017 03:00	44.81	69.28	4	0.006515507		
6	23/11/2017 04:00	44.78	69.1	5	0.008144384		
7	23/11/2017 05:00	44.74	68.63	6	0.00977326		
8	18/02/2014 14:00	44.7	65.82	7	0.011402137		
9	18/02/2014 15:00	44.65	65.46	8	0.013031014		
10	18/02/2014 17:00	44.57	64.92	9	0.014659891		
11	18/02/2014 16:00	44.61	64.73	10	0.016288767		
12	18/02/2014 20:00	44.46	64.35	11	0.017917644		
13	18/02/2014 19:00	44.49	64.24	12	0.019546521		
14	18/02/2014 18:00	44.53	64.03	13	0.021175397		
15	18/02/2014 22:00	44.39	63.91	14	0.022804274		

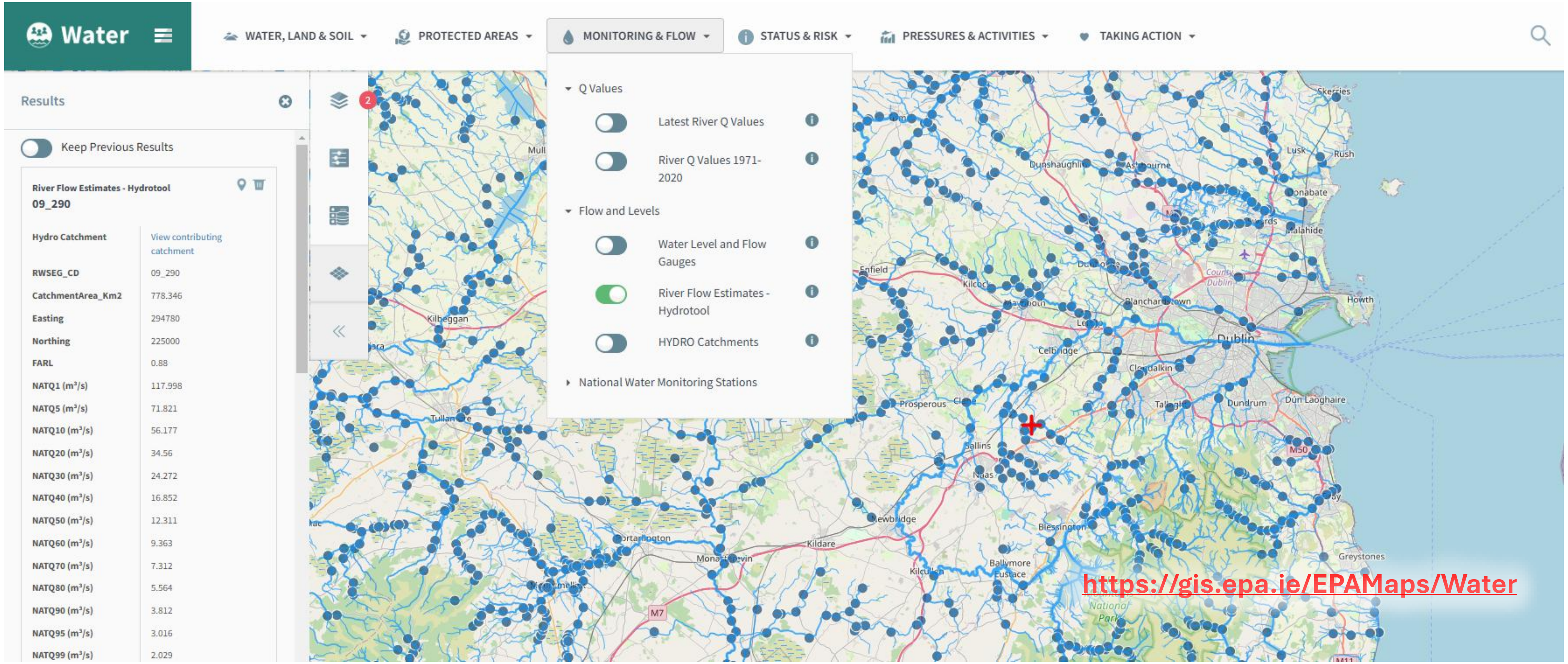
Calculating a Flow Duration Curve at Leixlip

Step 4 – Plot the Flow / Discharge v Flow Percentile (%)



Flow Duration for Ungauged Catchments

- Rely on statistical methods to link flow percentiles (e.g. Q_{50}, Q_5, Q_{95}) to catchment descriptors.



https://gis.epa.ie/EPAMaps/Water

Modelling Inland Responses
Observations of Climate Change

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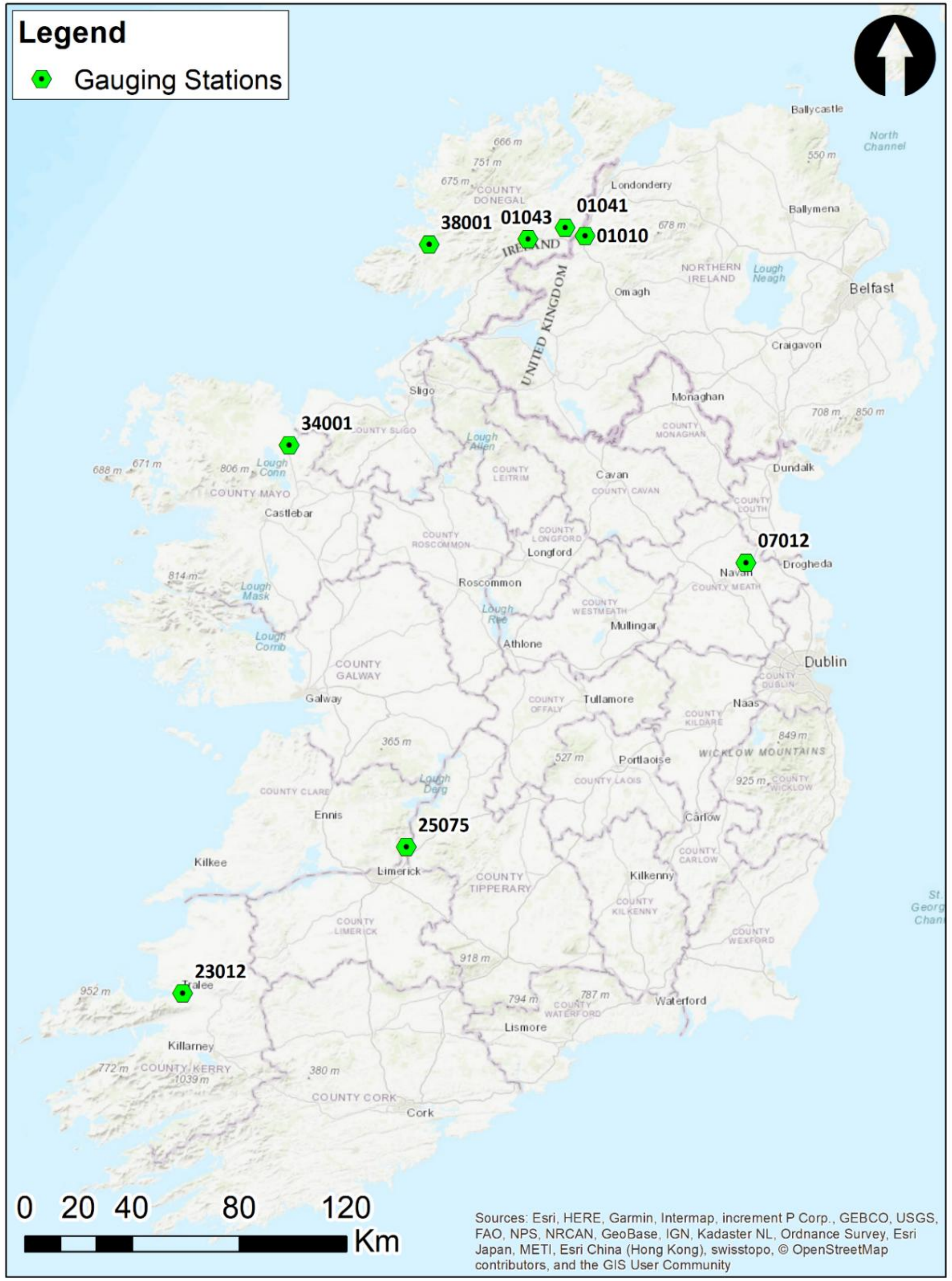
Climate Change

Based on our experience of delivery of services to support recent flood relief schemes under the NDP at:

- Lifford (Donegal)
- Castlefinn (Donegal)
- Burnfoot (Donegal)
- Downings (Donegal)
- Glenties (Donegal)
- Raphoe (Donegal)
- Ballina (Mayo)
- Athlone (Westmeath)
- Drogheda and Baltray (Louth)
- Limerick
- Shannon (Clare)
- Tralee (Kerry)

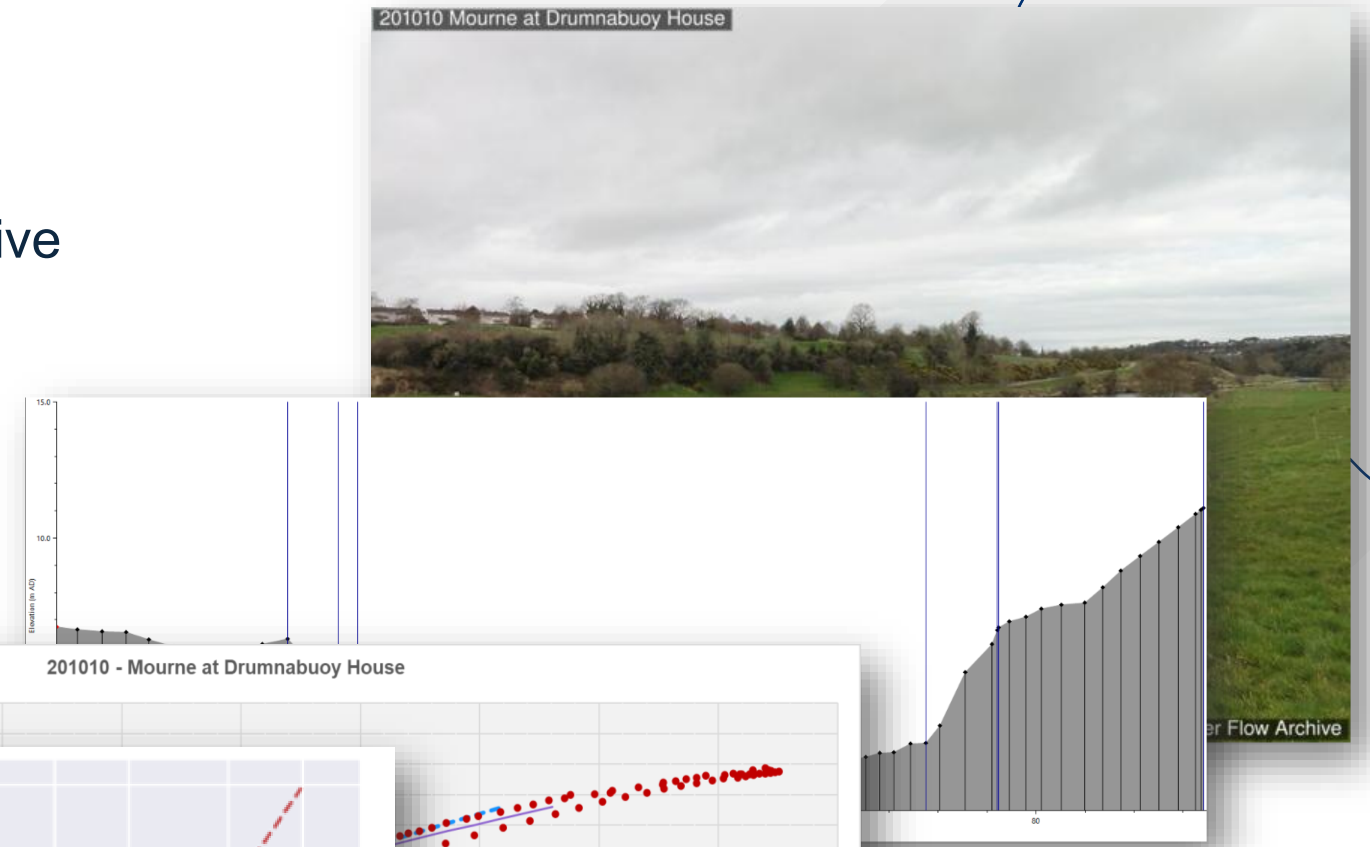
Hydrological Analysis, Hydraulic Modelling, Scheme Analysis and Development and Climate Change Adaptation Planning

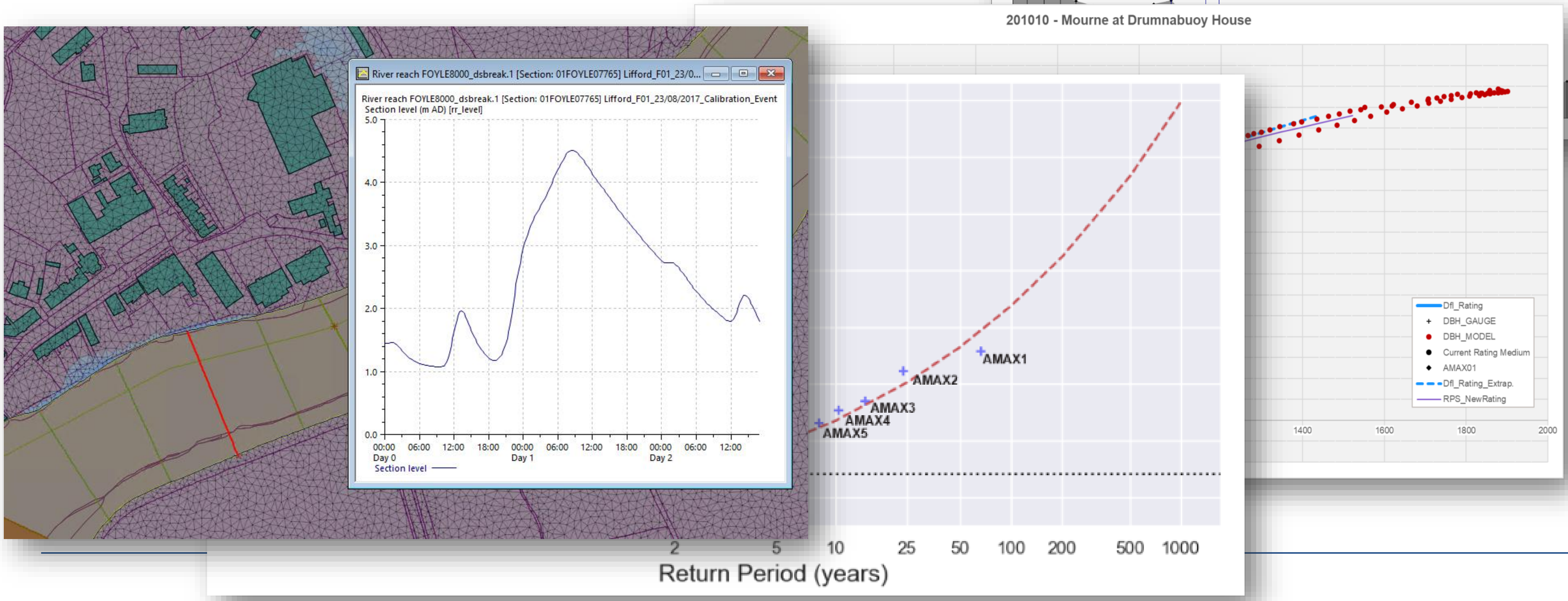


Data Preparation and Analysis

The gauges selected for analysis have undergone extensive interrogation:

- modelled rating review
- simulation and validation of flood peaks
- QA checks on the hydrometric record





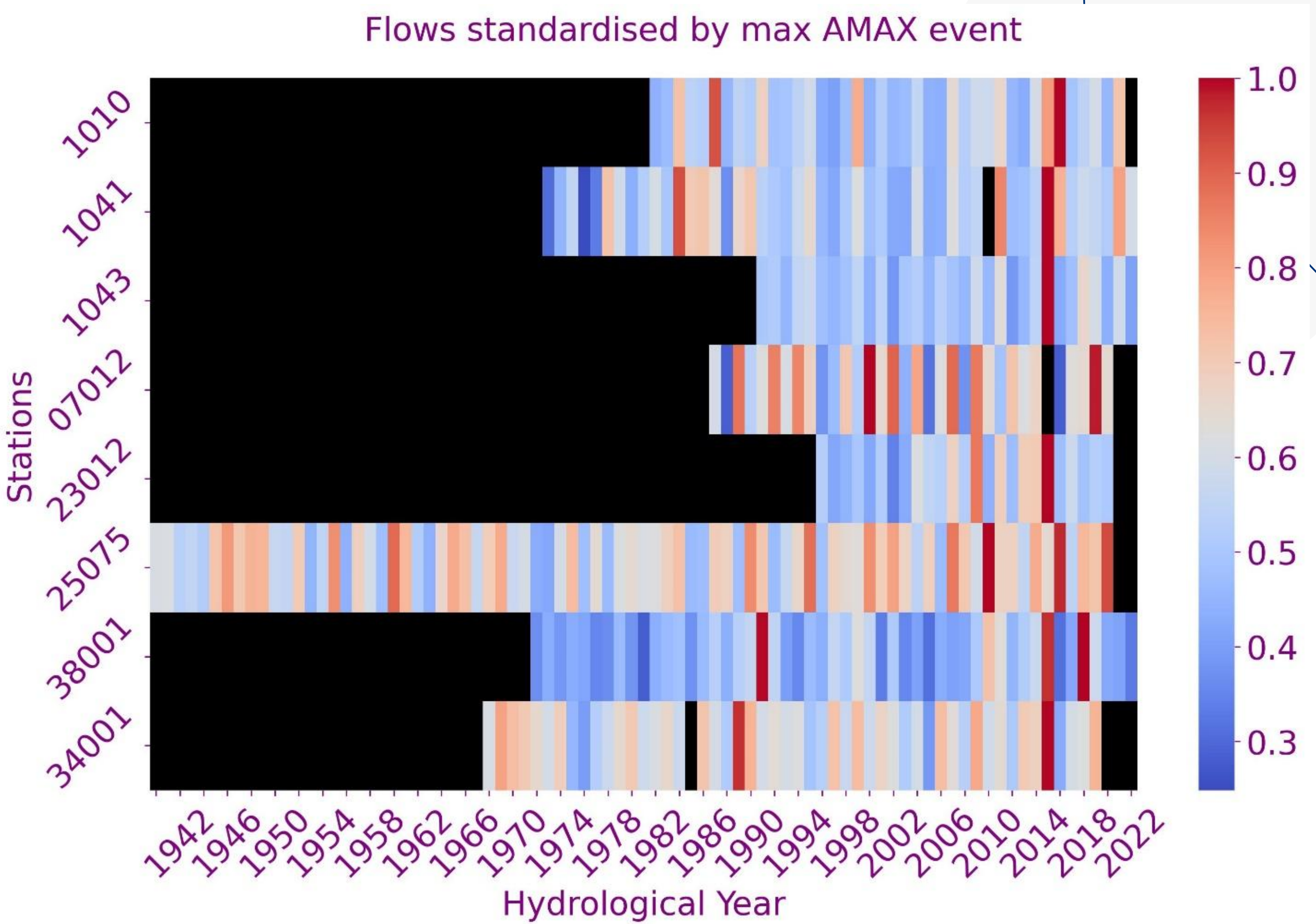
AMAX Data

Significant number of AMAX years discarded due to:

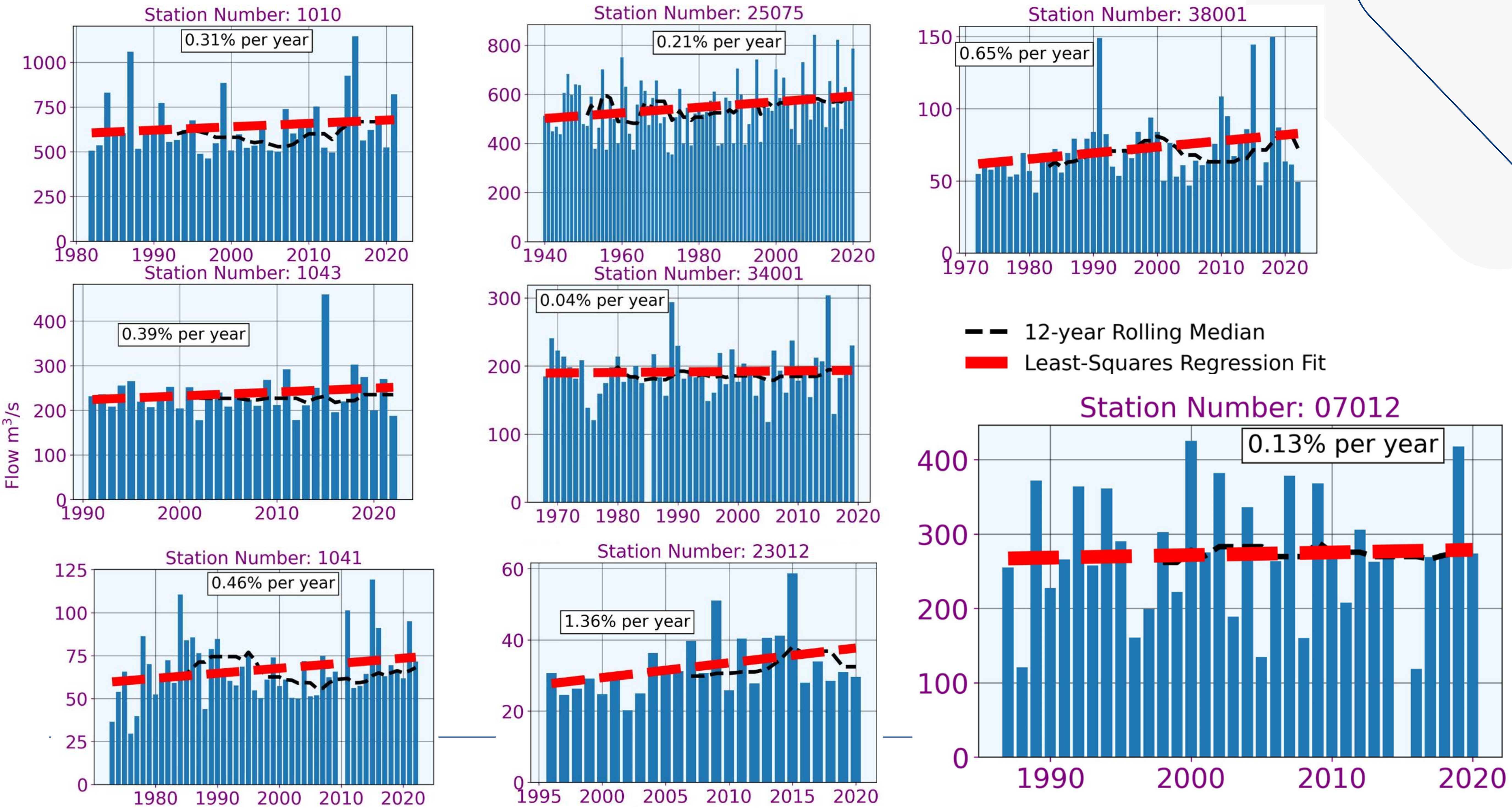
- Catchment changes
- Staff gauge zero shifts

362 AMAX years retained

All of the stations apart from the Boyne at Slane have recorded their largest AMAX in the last ten years.



AMAX Trends


Station Number: 1010
0.31% per year
Station Number: 25075
0.21% per year
Station Number: 38001
0.65% per year
Station Number: 1043
0.39% per year
Station Number: 34001
0.04% per year
12-year Rolling Median
Least-Squares Regression Fit
Station Number: 07012
0.13% per year
Flow m^3/s
Station Number: 1041
0.46% per year
Station Number: 23012
1.36% per year

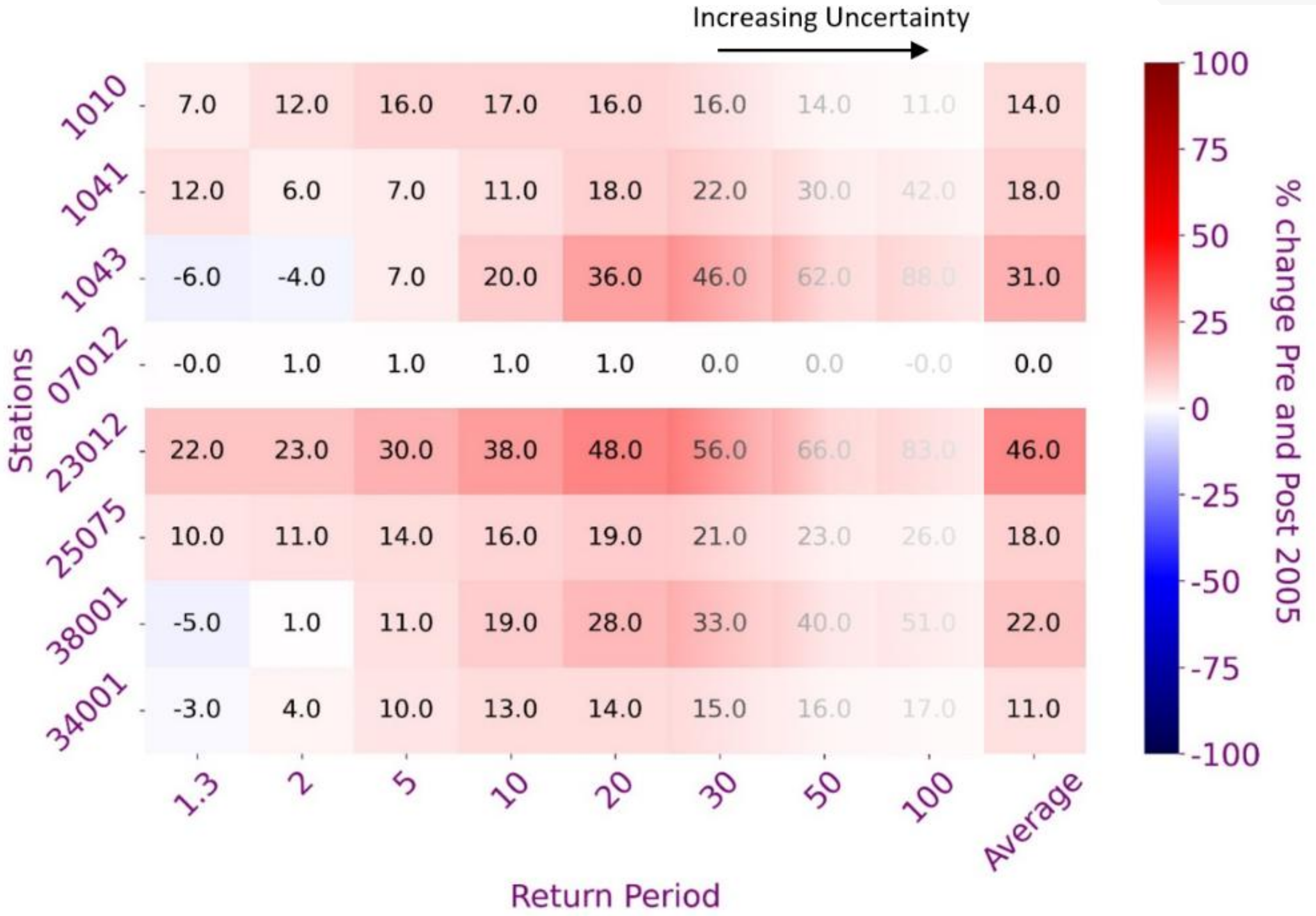
Flood Frequency

AMAX series split into pre 2005 and post 2005 records

Best practice EVA for fluvial data applied

GEV or GLO distribution fitted to both periods

Average 12.5% increase for events up to the 1 in 20 year (5% AEP event)



Conclusions for Hydrological Analysis and Design Flow

Non-stationarity (trending upwards) is present in the data. This has implications for flood frequency analysis and design flood estimation.

The upward trends cannot be attributed to climate change with confidence. Other factors include:

- Catchment changes
- Data quality issues, especially in the pre 2005 data
- Natural variation – is post 2005 simply a flood rich period?
- Bias in the stations analysed

Similar exercises carried out nationally on randomly selected stations would inform guidance for dealing with non-stationarity and fluvial climate change uplifts.