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Analysis of low flows in selected New Zealand catchments

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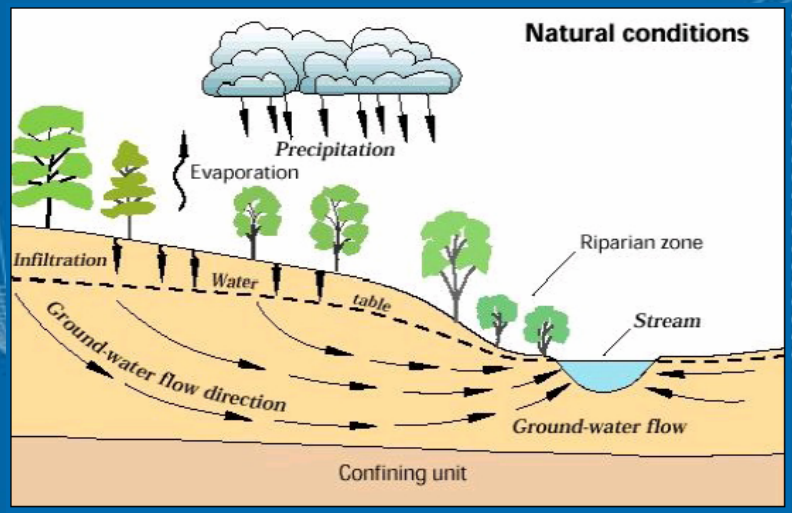
Low flow …..?

- Low flow is flow of water in a stream during prolonged dry weather.
- Low flow is a seasonal phenomenon.



What do we need to know…?

- Identify the capacity of watersheds to meet current and future water demands.

  - Water Supply Needs
  - Stream Habitat
  - Ecological Health

Limitations …

"The minimum flow for a given watercourse shall be the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area"

Methods…..

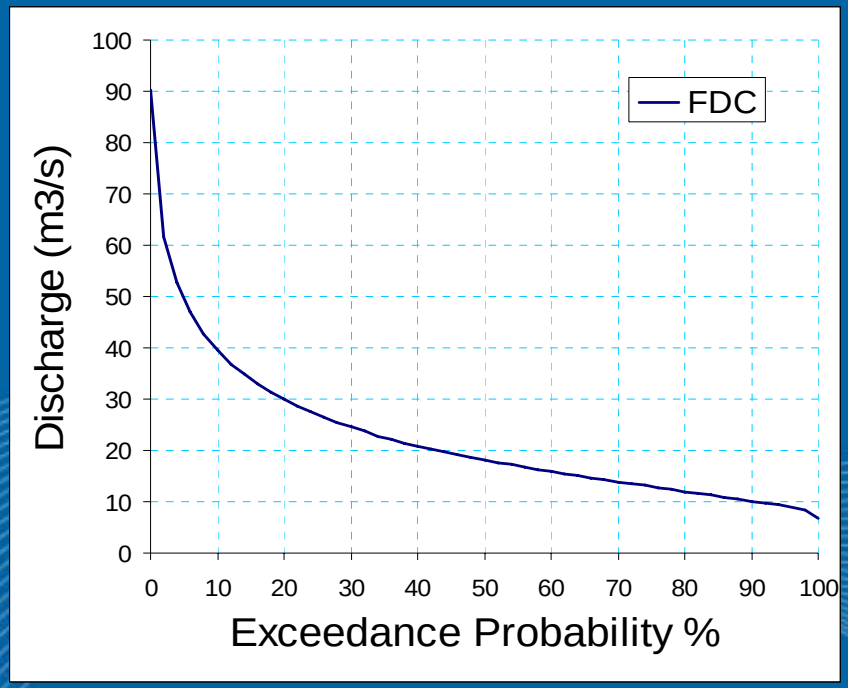
- Flow Duration
- Low-flow frequency
- Biologically based low-flow frequency

Selected rivers….

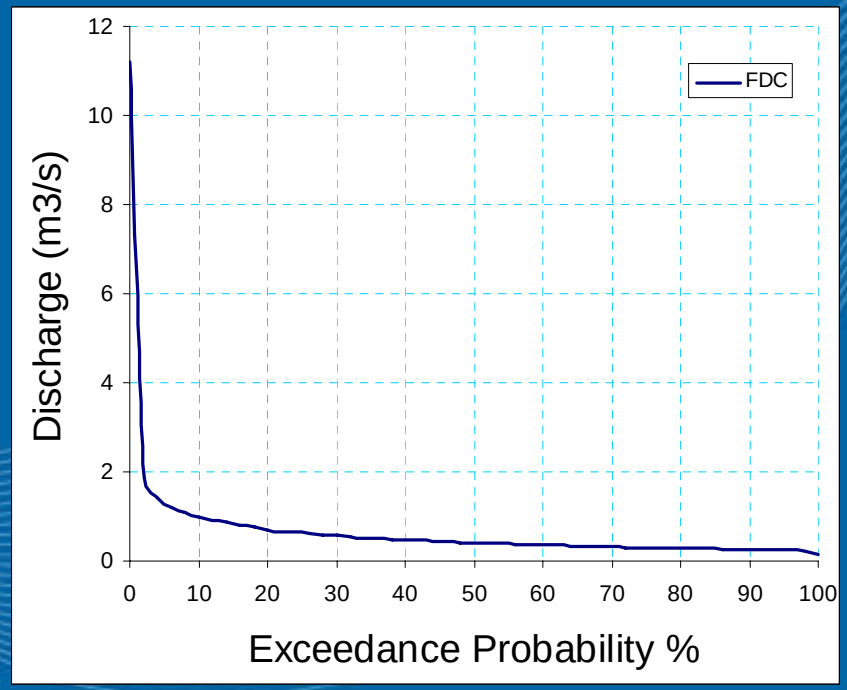
Site Name	Length of records used (Yrs)	Cat Area (km^2)	Annual mean flow (m^3/s)	Median Flow (m^3/s)
Ahuriri River at South Diadem	43	557	23.5	18.0
Mary Burn at Mount MacDonald	37	52.2	0.6	0.4

What information can we get from FDCs

Ahuriri River



Mary Burn



Low-flow frequency analysis

- Low-flow Frequency Curve (LFFC) shows the average interval in years (‘return period’ or ‘recurrence interval’) that the river falls below a given discharge.

What is low flow quantile?

- DQT - T year average lowflow of a stream over D-days
- 7Q10, D=7 days, T=10 years
- MAM7- Mean annual 7-day minimum flow.

Low-flow frequency analysis..

- Probability distributions of low flow frequency analysis.
- Non-parametric procedures for frequency analysis.

Low-flow frequency analysis..

Date	Rank	Probability	Return Period (yr)	Flow (m3/s)
19770906	A	0.0227	44.0	6.77
19700527	B	0.0455	22.0	6.79
19920626	C	0.0682	14.7	6.87
19910711	D	0.0909	11.0	7.08
19890907	E	0.1136	8.8	7.41
19760420	F	0.1364	7.3	7.41
19950806	G	0.1591	6.3	7.63
19780317	H	0.1818	5.5	7.63
19820723	I	0.2045	4.9	7.73
20030424	J	0.2273	4.4	7.75
19850410	K	0.2500	4.0	7.85
19690619	L	0.2727	3.7	7.85
19660723	M	0.2955	3.4	7.91
19710816	N	0.3182	3.1	8.32
20010430	O	0.3409	2.9	8.33
19960828	P	0.3636	2.8	8.37
19640627	Q	0.3864	2.6	8.43
19680708	R	0.4091	2.4	8.45
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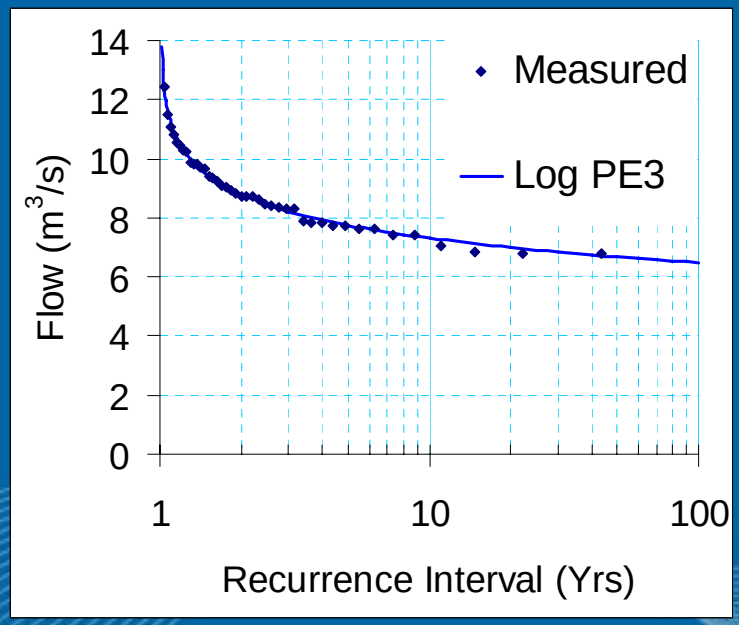
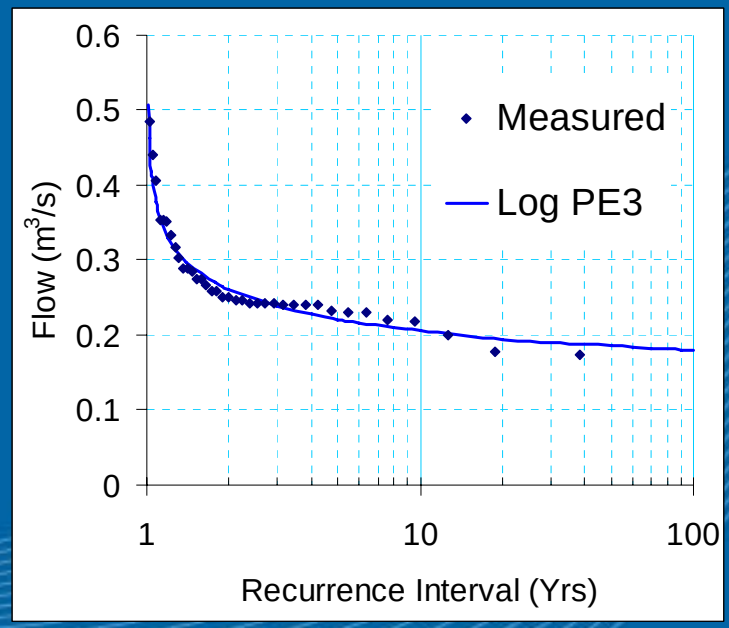
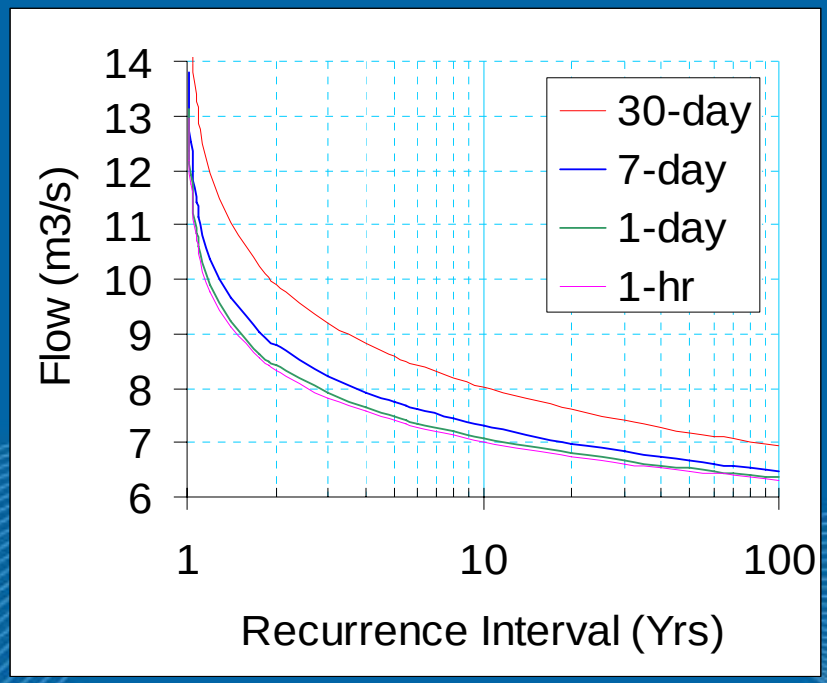
$$T = \frac{N+1}{Rank}$$

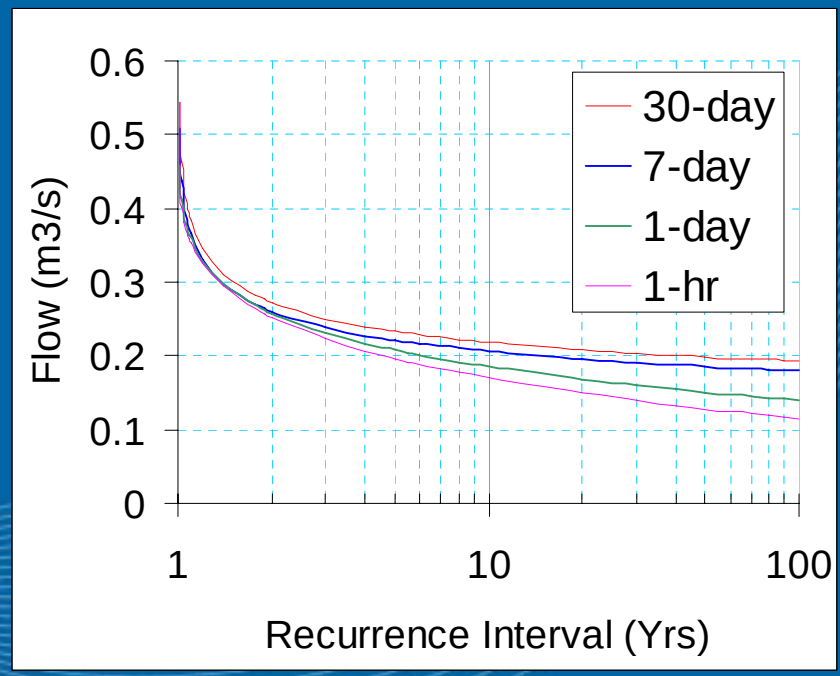
Recurrence Interval…





Comparison of averaging period…

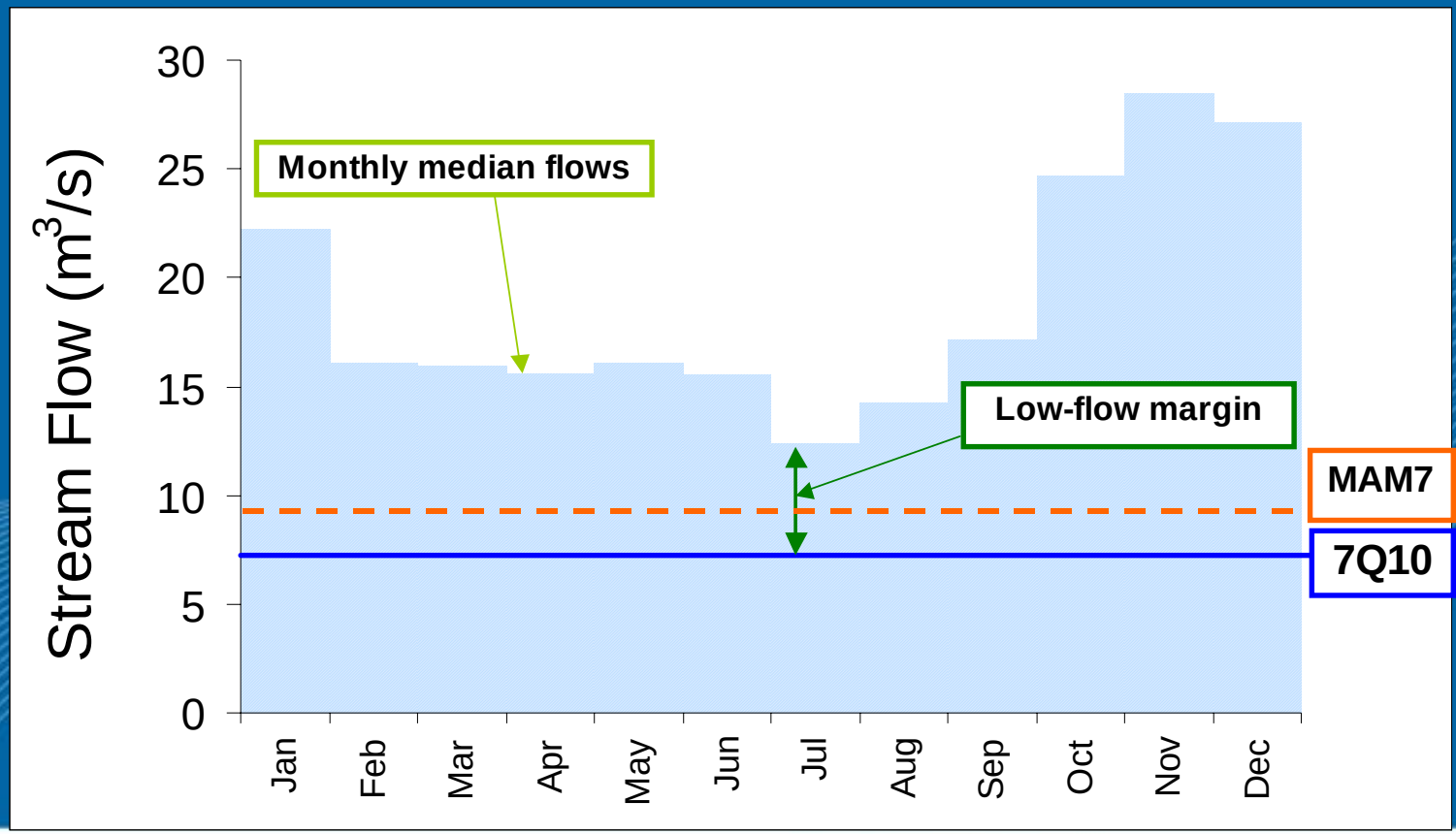




Comparison of averaging period…

Low flow quantile DQT	Ahuriri River		Mary Burn River	
	Flow (m^3/s)	$\left(\frac{Flow - 7Q10}{7Q10}\right)\%$	Flow (m^3/s)	$\left(\frac{Flow - 7Q10}{7Q10}\right)\%$
1hr. Q10	7.02	-3.8	0.169	-18.0
1Q10	7.08	-3.0	0.185	-10.2
7Q10	7.30	0.0	0.206	0.0
30Q10	8.01	9.7	0.218	5.8

Low-flow margin- Ahuriri River River



Water Quality Criteria

- The lower concentration is called the Criterion Continuous Concentration (CCC).
- The higher concentration is called the Criterion Maximum Concentration (CMC).

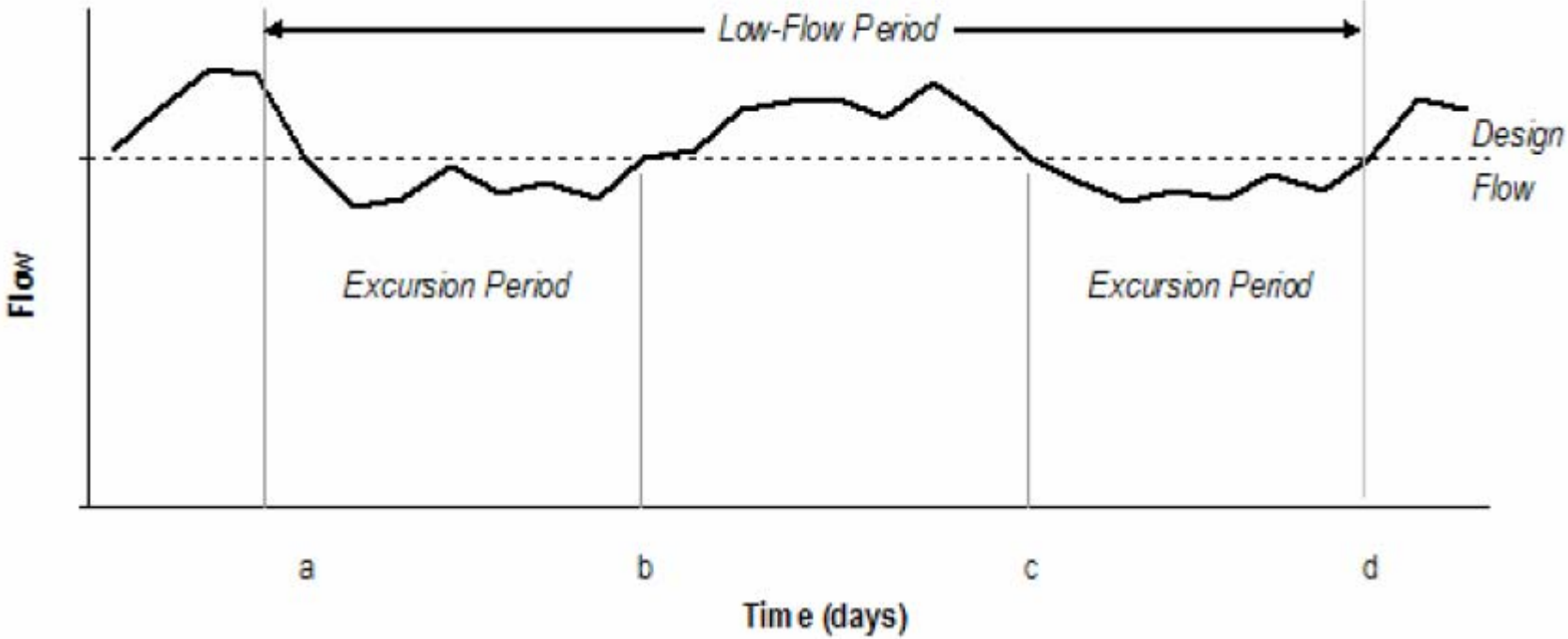
Biologically based low-flow frequency

- Computed by identification of “excursions” in the record.
- Excursion is a low-flow period that is determined to be hydrologically separate from other low-flow periods.

Ref

- EPA- Technical Guidance Manual for Performing Wasteload Allocations,Book VI:
- DFLOW (http://www.epa.gov./waterscience/dflow)

Biologically based low-flow frequency



Summery

Flow description		Ahuriri River (m^3/s)	Mary Burn River (m^3/s)
Lowest median flow		12.4	0.29
7Q10		7.3	0.21
MAM7		9.02	0.274
Low flow margin	100%	5.10	0.08
	50%	2.55	0.04
	10%	0.51	0.008
Consumptive withdrawal		Xah	Xmr
Low flow margin of safety (for 50% LFM)		2.55 - Xah	0.04 - Xmr
30Q10		8.02	0.218
30-day 3 year		9.7	0.23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