The 2011 Drought: Swiss Rivers' Sensitivity

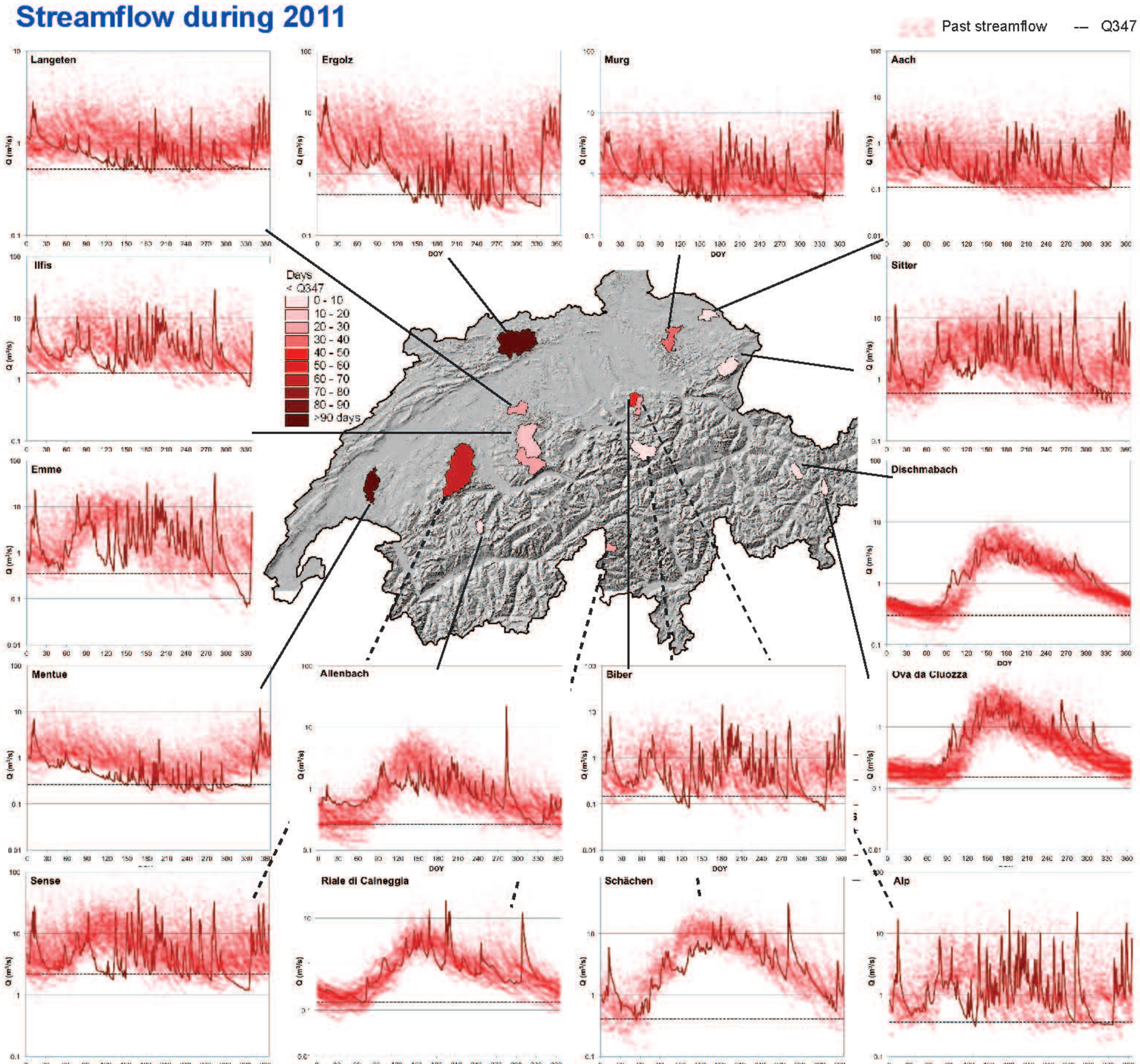
UNI FREIBURG

K. Stahl, M. Weiler, A. Gundel

J. Seibert, M. Staudinger

Universität Zürich

Streamflow during 2011



The year 2011 experienced two dry weather periods: in spring from mid-April to mid-May, and in autumn, from October to late November.

Streamflow in many Swiss rivers fell below the national minimum flow requirement (Q347) during one or both of these drought periods. Overall, spring low flows were lower relative to the seasonal norm, autumn low flows were lower in absolute terms.

How severe was the 2011 streamflow drought?

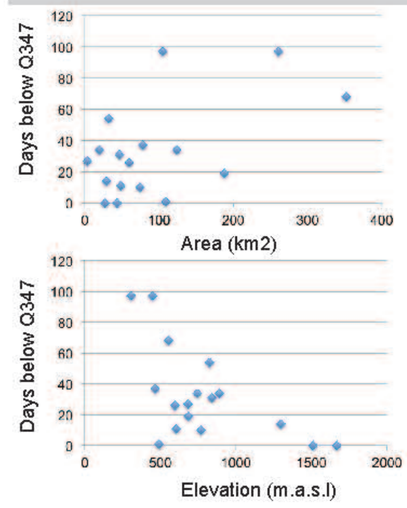
Ranks within the common available reference period 1991-2010:

2	1	3	5
5	Days below seasonal Q85 (15% quantile)		4
2			17
1	6	5	11
2	5	9	4

1	2	2	5
3	Max. annual duration below seasonal Q85 (15% quantile)		3
2			16
1	6	2	8
4	8	4	3

Rank number 1 indicates the largest number of drought days (upper) or longest drought spell (lower) below the seasonal threshold (7-day moving Q85 - i.e. the 15% quantile of the seasonal distribution).
Rank numbers are arranged according to the order of map and hydrographs to the left.

Ranks of impact among catchments



Weak relations between streamflow drought days and catchment characteristics: area and elevation.
Apparent relation with area due to the two largest catchments Ergolz and Sense.
Apparent relation with elevation due to alpine catchments in the East, where winter snow conditions were different.

Mean seasonal Qxx (exceedance quantile)				Days below Q347	
15 April-15 May		10 Oct - 10 Nov		1 Jan - 31 Dec	
Sense	95	Mentue	95	Ergolz	97
Mentue	95	Sense	94	Mentue	97
Ilfis	95	Ergolz	88	Sense	68
Murg	95	Langeten	87	Biber	54
Langeten	94	Emme	86	Murg	37
Ergolz	94	Biber	86	Riale di Calneggia	34
Emme	94	Alp	84	Emme	34
Rietholzbach	94	Sitter	81	Alp	31
Alp	93	Murg	80	Rietholzbach	27
Sitter	92	Ilfis	79	Langeten	26
Aach	92	Aach	78	Ilfis	19
Biber	88	Rietholzbach	77	Allenbach	14
Schächenbach	86	Allenbach	73	Aach	11
Allenbach	81	Schächenbach	45	Sitter	10
Riale di Calneggia	68	Riale di Calneggia	39	Schächenbach	1
Dischma	43	Ova da Cluozza	28	Dischma	0
Ova da Cluozza	40	Dischma	27	Ova da Cluozza	0

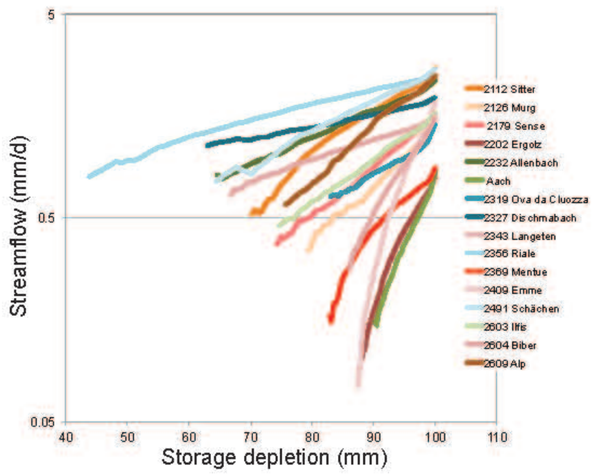
The 2011 streamflow drought was:

- the most severe drought or at par with the 2003 event in one third of the catchments, when compared to the last 20 years
- more severe in the north and west of Switzerland

Relief from a wet summer with many rain events differed among catchments: no lasting increase in baseflow in Ergolz, Langeten, Mentue, Sense.

Relation of impact to catchment storage characteristics

Mean catchment storage-outflow behaviour
(from average annual master recession below Q50)

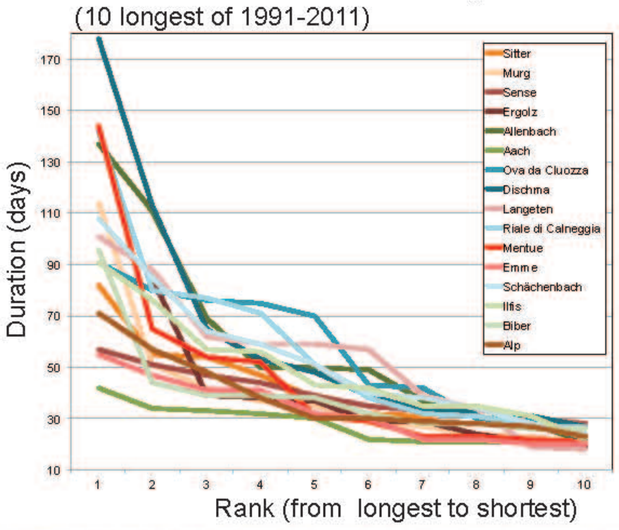


Can it explain the streamflow drought behaviour in 2011?

		Soil moisture (unsaturated zone storage)	
		fast draining	slow draining
Aquifers (saturated zone storage)	small	high vulnerability, quick recession and flow below threshold, but also quick recovery. Many short events. Pot. examples: Ergolz, Emme - both strongly affected 2011, but also Aach - not strongly affected.	medium vulnerability, long lag time, medium recession and recovery. Medium durations. Pot. examples Mentue, Sense, Murg - all strongly affected in 2011
	large	critical threshold and vulnerability depends on local exchange with groundwater, quick recession then slow. Fast recovery. Medium durations. Langeten, Sitter, Alp - strongly affected in 2011, but also Ova de la Cluozza - not strongly affected.	low vulnerability and long lag time due to slow recession. However strong persistence and slow recovery after a long drought if interaction with groundwater is strong. Riale di Carneggia, Allenbach, Schächen, Dischma, all not strongly affected in 2011.

Full explanation requires the determination of total and dynamical water storage in the catchment and the geographic variation of meteorological drought conditions, which were less severe in the Eastern part of Switzerland in 2011.

Annual maximum streamflow drought durations
(10 longest of 1991-2011)



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Workpackage 3: Analysis of critical low-flow conditions and storage characteristics of Swiss catchments