Supporting information for the manuscript:

Origin and dynamics of Rare Earth Elements during flood events in contaminated river basins: Sr-Nd-Pb isotopic evidence.

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S1

Table S1: Recovery of REE concentrations evaluated using two certified reference materials. ERM CC690 is a calcareous soil and NCS ZC73001 a brown loamy soil. Standard deviation was always <4% of the obtained average value.

certified reference material		**La**	**Ce**	**Pr**	**Nd**	**Sm**	**Eu**	**Gd**	**Tb**	**Dy**	**Ho**	**Er**	**Tm**	**Yb**	**Lu**
								μg g^{-1}							
ERM CC690	reference value	24.4	49.1	-	19.1	-	3.5	0.5	3.2	2.9	-	-	0.2	1.6	-
	average measured value (n=3)	26.4	52.5	-	20.8	-	3.8	0.5	3.6	2.9	-	-	0.2	1.5	-
NCS ZC73001	reference value	35.5	70.0	8.5	32.0	1.3	6.0	0.8	5.2	4.7	1.0	2.8	0.4	2.8	0.5
	average measured value (n=16)	34.7	73.3	8.2	30.3	1.3	6.0	0.8	5.5	4.2	0.9	2.6	0.4	2.5	0.3

S2

Table S2a: dissolved organic carbon (DOC) and REE concentrations of the dissolved load collected during punctual sampling campaigns in the upper Alzette River basin. Q is the average daily river discharge. The site names refer to Figure 1.

site		period	Q	DOC	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
			$m^3 s^{-1}$	$mg L^{-1}$	$ng L^{-1}$													
anthropogenic sources	S1	low flow	-	4.3	2.0	4.0	1.0	3.0	0.6	<DL	101.0	<DL	1.0	<DL	2.0	<DL	4.0	1.0
	S2	low flow	-	3.8	6.0	7.0	2.0	11.0	3.3	0.9	45.0	1.1	8.0	2.0	6.0	1.0	6.0	1.0
	S3	low flow	-	10.0	3.0	8.0	1.0	5.0	1.4	0.4	790.0	0.4	3.0	1.0	3.0	<DL	13.0	1.0
	S4	low flow	-	6.0	2.0	6.0	1.0	3.0	0.6	<DL	294.0	<DL	1.0	<DL	1.0	<DL	5.0	<DL
remote Alzette	AS*	low flow	-	0.5	8.8	11.3	2.2	8.2	2.0	1.8	2.3	<DL	1.4	0.3	0.9	<DL	0.8	<DL
remote tributaries	T1*	low flow	-	4.7	16.6	36.1	5.7	28.2	6.0	1.0	7.4	1.0	6.7	1.9	7.7	1.4	11.6	2.1
	T2*	low flow	-	4.7	6.9	10.9	1.7	8.1	2.0	0.3	2.2	0.3	1.9	0.5	1.6	<DL	1.7	<DL
	T4*	low flow	-	1.4	11.4	15.4	2.9	13.2	3.0	2.0	3.3	0.3	2.1	0.3	1.3	<DL	1.0	<DL
polluted tributaries	T1	low flow	0.022	4.1	24.0	56.0	7.0	29.0	5.0	1.0	18.0	0.8	5.0	1.0	4.0	1.0	3.0	1.0
	T3	low flow	0.037	5.7	9.0	14.0	2.0	7.0	1.4	0.3	4.0	0.3	2.0	1.0	2.0	<DL	3.0	<DL
	T4	low flow	0.170	3.2	10.0	17.0	2.0	10.0	2.0	0.5	5.0	0.4	3.0	1.0	2.0	<DL	2.0	<DL
	T1	high flow	9.317	6.5	133.0	316.0	46.0	206.0	46.0	11.0	46.0	6.0	30.0	6.0	17.0	2.0	14.0	2.0
	T3	high flow	4.879	6.1	54.0	119.0	21.0	101.0	30.0	8.0	30.0	4.0	22.0	5.0	13.0	2.0	11.0	2.0
	T4	high flow	12.830	5.8	101.0	218.0	34.0	150.0	42.0	11.0	40.0	5.0	28.0	6.0	16.0	2.0	14.0	2.0
polluted Alzette	UA	low flow	1.780	5.2	12.0	20.0	2.0	15.0	2.9	0.7	53.0	0.6	4.0	1.0	4.0	1.0	5.0	1.0
	UA	high flow	13.005	3.6	18.0	40.0	6.0	27.0	15.0	5.0	9.0	1.0	7.0	1.0	5.0	1.0	4.0	1.0
	AO	low flow	1.850	5.5	6.6	12.4	1.7	7.4	2.0	0.3	36.9	0.3	2.1	0.5	1.8	<DL	3.0	<DL
	AO	high flow	26.345	7.5	17.0	32.5	6.5	29.0	13.5	5.0	16.0	1.5	8.5	2.5	5.5	1.0	5.5	2.0

Table S2b: REE concentration of the suspended load collected during punctual sampling campaigns in the upper Alzette River basin. Q is the average daily river discharge. The analyses performed on the waste incinerator dust (WI) are also given. The site names refer to Figure 1.

site		period	Q	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
			$m^3 s^{-1}$							$\mu g\ g^{-1}$							
anthropogenic sources	S1	low flow	-	3.13	6.23	0.72	2.74	0.63	0.34	0.68	0.10	0.55	0.10	0.28	0.10	0.33	0.10
	S2	low flow	-	14.88	32.26	3.73	14.46	2.76	0.76	2.87	0.39	2.27	0.44	1.26	0.19	1.35	0.18
	S3	low flow	-	2.95	6.04	0.70	2.78	0.53	0.23	0.62	0.09	0.49	0.09	0.30	0.10	0.26	0.10
	S4	low flow	-	41.55	578.31	9.42	36.41	9.42	2.57	11.57	1.29	6.00	1.29	3.43	0.43	3.43	0.43
	WI	-	-	8.50	13.77	1.40	5.10	0.81	0.35	0.87	0.14	0.62	0.12	0.33	0.05	0.34	0.05
remote Alzette	AS*	low flow	-	2.53	4.51	0.10	2.94	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
remote tributaries	T1*	low flow	-	34.61	81.60	8.64	33.48	6.44	1.43	5.89	0.77	4.86	0.92	2.50	0.38	2.52	0.37
	T2*	low flow	-	13.89	30.06	3.62	14.46	2.67	1.40	2.59	0.33	1.97	0.37	0.99	0.14	0.91	0.12
	T4*	low flow	-	52.74	105.45	14.25	57.88	10.62	2.41	9.28	1.18	6.99	1.26	3.22	0.44	2.82	0.37
polluted tributaries	T1	low flow	0.022	41.53	92.40	10.95	42.34	8.28	1.88	8.13	1.18	6.44	1.21	3.60	0.48	3.07	0.46
	T3	low flow	0.037	49.58	109.17	12.76	51.52	10.29	2.21	10.63	1.57	8.46	1.61	4.66	0.65	4.01	0.58
	T4	low flow	0.170	30.29	203.50	6.76	26.48	5.19	1.17	5.32	0.83	4.37	0.84	2.46	0.34	2.21	0.33
	T1	high flow	9.317	46.96	100.99	11.46	44.58	8.32	1.86	7.94	1.16	6.12	1.16	3.37	0.45	3.02	0.45
	T3	high flow	4.879	54.16	117.87	13.89	53.65	10.98	2.50	11.01	1.61	8.58	1.63	4.66	0.62	3.99	0.59
	T4	high flow	12.830	53.99	111.00	13.18	50.61	9.96	2.25	10.44	1.42	7.50	1.44	4.21	0.57	3.70	0.55
polluted Alzette	UA	low flow	1.780	39.82	89.41	10.60	55.13	8.76	1.96	9.84	1.49	8.06	1.55	4.59	0.62	4.03	0.59
	UA	high flow	13.005	39.51	85.59	10.16	53.14	7.86	1.79	8.40	1.25	6.61	1.22	3.71	0.50	3.24	0.47
	AO	low flow	1.850	27.75	119.41	6.80	24.88	4.85	1.07	4.74	0.70	3.70	0.70	2.04	0.30	1.88	0.27
	AO	high flow	26.345	42.64	101.55	11.21	43.44	7.82	1.74	7.70	1.16	5.98	1.16	3.18	0.47	2.91	0.46

S4

Table S3a: dissolved organic carbon (DOC) and REE concentrations of the dissolved load collected during the four selected flood events from 2011 to 2013 at the outlet of the upper Alzette River basin (AO in Figure 1). Q is the measured river discharge.

site	Date/time	Q	DOC	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		$m^3 s^{-1}$	$mg L^{-1}$							$ng L^{-1}$							
flood 1	06/01/2011 00:00	1.576	4.2	13.0	25.0	4.0	19.0	3.4	0.7	56.0	0.6	4.0	1.0	2.0	<DL	4.0	1.0
flood 1	06/01/2011 03:00	1.700	4.5	12.0	25.0	3.0	16.0	2.8	0.6	51.0	0.5	3.0	1.0	2.0	<DL	4.0	1.0
flood 1	06/01/2011 03:45	1.894	4.5	16.0	31.0	5.0	21.0	3.7	0.8	52.0	0.6	4.0	1.0	3.0	<DL	5.0	1.0
flood 1	06/01/2011 04:30	2.693	4.3	14.0	27.0	5.0	19.0	3.7	0.8	59.0	0.7	5.0	1.0	3.0	1.0	5.0	1.0
flood 1	06/01/2011 06:45	5.682	4.3	19.0	32.0	6.0	26.0	4.6	1.0	50.0	0.8	5.0	1.0	4.0	1.0	4.0	1.0
flood 1	06/01/2011 07:30	7.911	4.5	21.0	39.0	7.0	29.0	5.2	1.1	55.0	0.9	6.0	1.0	4.0	1.0	5.0	1.0
flood 1	06/01/2011 08:15	10.656	4.7	23.0	48.0	7.0	31.0	5.5	1.1	40.0	0.9	6.0	1.0	4.0	1.0	5.0	1.0
flood 1	06/01/2011 09:45	16.179	4.6	36.0	78.0	12.0	55.0	9.8	2.1	42.0	1.7	11.0	2.0	5.0	1.0	6.0	1.0
flood 1	06/01/2011 11:15	22.826	5.1	60.0	127.0	19.0	80.0	13.8	2.8	31.0	2.2	14.0	3.0	7.0	1.0	8.0	1.0
flood 1	06/01/2011 12:00	26.812	5.3	77.0	165.0	23.0	104.0	18.1	3.7	42.0	3.0	19.0	4.0	10.0	1.0	9.0	2.0
flood 1	06/01/2011 14:15	35.725	5.6	102.0	212.0	32.0	139.0	34.0	9.0	39.0	4.0	24.0	4.0	12.0	2.0	12.0	2.0
flood 1	06/01/2011 15:00	37.428	5.5	113.0	239.0	35.0	144.0	35.0	9.0	39.0	4.0	26.0	5.0	13.0	2.0	12.0	2.0
flood 1	06/01/2011 16:30	39.464	5.7	120.0	240.0	36.0	159.0	37.0	10.0	41.0	5.0	27.0	5.0	14.0	2.0	14.0	2.0
flood 1	06/01/2011 18:00	40.950	5.6	104.0	202.0	34.0	151.0	33.0	9.0	37.0	4.0	25.0	5.0	12.0	2.0	13.0	2.0
flood 1	06/01/2011 19:30	44.628	5.5	131.0	273.0	40.0	181.0	42.0	10.0	40.0	5.0	29.0	6.0	15.0	2.0	15.0	2.0
flood 1	06/01/2011 21:00	46.844	5.8	98.0	218.0	32.0	147.0	35.0	9.0	33.0	4.0	23.0	5.0	14.0	2.0	13.0	2.0
flood 1	06/01/2011 22:30	49.114	6.2	85.0	184.0	27.0	120.0	30.0	7.0	31.0	3.0	20.0	4.0	11.0	2.0	11.0	2.0
flood 1	06/01/2011 23:15	50.767	5.7	105.0	208.0	32.0	146.0	32.0	8.0	33.0	4.0	23.0	5.0	12.0	2.0	12.0	2.0
flood 1	07/01/2011 00:00	50.767	5.6	105.0	228.0	35.0	160.0	35.0	8.0	36.0	4.0	26.0	5.0	13.0	2.0	13.0	2.0
flood 1	07/01/2011 01:30	51.101	5.6	278.0	444.0	53.0	208.0	34.0	9.0	35.0	5.0	25.0	5.0	14.0	2.0	13.0	2.0
flood 1	07/01/2011 03:00	50.767	5.5	107.0	212.0	34.0	151.0	34.0	9.0	36.0	4.0	26.0	5.0	12.0	2.0	11.0	2.0
flood 1	07/01/2011 04:30	50.434	5.7	97.0	192.0	32.0	141.0	33.0	8.0	34.0	4.0	24.0	4.0	13.0	2.0	12.0	2.0
flood 1	07/01/2011 06:00	49.442	5.9	98.0	188.0	31.0	144.0	32.0	9.0	32.0	4.0	23.0	5.0	13.0	2.0	13.0	2.0
flood 1	07/01/2011 09:20	47.165	5.8	163.0	332.0	51.0	220.0	48.0	12.0	46.0	6.0	33.0	7.0	19.0	3.0	17.0	3.0
flood 1	07/01/2011 12:00	44.628	5.4	82.0	161.0	27.0	113.0	29.0	8.0	27.0	3.0	19.0	4.0	11.0	2.0	10.0	2.0
flood 1	07/01/2011 15:00	40.651	5.6	107.0	227.0	35.0	142.0	35.0	10.0	35.0	4.0	24.0	5.0	13.0	2.0	12.0	2.0
flood 1	07/01/2011 22:00	30.330	5.7	95.0	198.0	30.0	128.0	32.0	9.0	34.0	4.0	21.0	4.0	11.0	2.0	12.0	2.0
flood 1	08/01/2011 07:00	17.538	5.5	80.0	172.0	26.0	108.0	29.0	8.0	31.0	3.0	19.0	4.0	11.0	2.0	10.0	2.0
flood 1	08/01/2011 16:00	12.095	5.4	95.0	202.0	28.0	118.0	30.0	9.0	31.0	3.0	21.0	4.0	10.0	2.0	11.0	2.0
flood 2	03/12/2011 13:00	0.479	6.4	11.0	21.0	3.0	15.0	2.9	0.7	185.0	0.6	4.0	1.0	3.0	1.0	6.0	1.0
flood 2	03/12/2011 17:00	1.475	6.5	13.0	25.0	4.0	18.0	3.5	0.8	236.0	0.7	5.0	1.0	4.0	1.0	6.0	1.0
flood 2	03/12/2011 21:00	2.821	6.0	13.0	28.0	4.0	20.0	3.8	0.8	154.0	0.8	5.0	1.0	3.0	1.0	6.0	1.0
flood 2	04/12/2011 05:00	1.331	5.5	22.0	47.0	7.0	44.0	7.4	1.5	115.0	1.1	7.0	1.0	4.0	1.0	6.0	1.0
flood 2	04/12/2011 10:00	0.917	5.7	18.0	37.0	6.0	35.0	6.0	1.2	107.0	1.0	6.0	2.0	5.0	1.0	6.0	1.0
flood 2	04/12/2011 15:00	2.283	5.3	15.0	28.0	4.0	22.0	4.1	0.9	82.0	0.8	5.0	1.0	4.0	1.0	5.0	1.0
flood 2	04/12/2011 17:00	5.268	4.3	10.0	20.0	3.0	16.0	3.0	0.7	65.0	0.6	4.0	1.0	3.0	1.0	4.0	1.0
flood 2	04/12/2011 18:00	6.888	3.8	22.0	49.0	8.0	33.0	6.2	1.4	43.0	1.2	8.0	1.0	4.0	1.0	4.0	1.0
flood 2	04/12/2011 20:00	6.099	4.2	23.0	53.0	8.0	33.0	5.7	1.2	41.0	0.9	6.0	1.0	4.0	1.0	4.0	1.0
flood 2	04/12/2011 22:00	10.196	3.9	19.0	40.0	6.0	30.0	5.1	1.0	27.0	0.8	5.0	1.0	4.0	1.0	4.0	1.0
flood 2	05/12/2011 02:00	15.614	3.2	13.0	29.0	5.0	23.0	13.0	5.0	20.0	1.0	4.0	1.0	3.0	1.0	3.0	1.0
flood 2	05/12/2011 10:00	7.831	5.1	89.0	223.0	31.0	153.0	35.0	10.0	39.0	4.0	21.0	4.0	12.0	2.0	11.0	2.0
flood 2	06/12/2011 02:00	2.409	7.1	13.0	22.0	4.0	21.0	20.0	7.0	30.0	1.0	5.0	1.0	4.0	1.0	4.0	1.0
flood 2	07/12/2011 02:00	1.348	6.7	11.0	18.0	4.0	16.0	3.3	0.8	58.0	0.7	5.0	1.0	4.0	1.0	5.0	1.0
flood 2	07/12/2011 14:00	4.062	6.3	15.0	27.0	4.0	20.0	3.8	0.8	59.0	0.8	5.0	1.0	5.0	1.0	6.0	1.0
flood 2	07/12/2011 18:00	4.386	5.5	13.0	26.0	4.0	20.0	3.8	0.8	46.0	0.8	5.0	1.0	4.0	1.0	4.0	1.0
flood 2	08/12/2011 02:00	2.553	7.0	28.0	61.0	9.0	40.0	7.4	1.6	45.0	1.4	9.0	2.0	5.0	1.0	5.0	1.0
flood 2	08/12/2011 10:00	1.681	6.9	21.0	42.0	6.0	30.0	5.6	1.2	58.0	1.1	7.0	1.0	5.0	1.0	5.0	1.0

site	Date/time	Q	DOC	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		$m^3 s^{-1}$	$mg L^{-1}$							$ng L^{-1}$							
flood 3	14/12/2012 16:00	1.102	5.5	5.0	9.0	2.0	7.0	1.4	0.3	122.0	0.3	2.0	1.0	2.0	0.0	4.0	1.0
flood 3	14/12/2012 18:00	1.540	5.6	11.0	15.0	3.0	14.0	3.3	0.8	128.0	0.9	6.0	2.0	5.0	1.0	7.0	1.0
flood 3	14/12/2012 19:00	2.576	5.2	13.0	18.0	3.0	17.0	3.4	0.8	156.0	0.7	5.0	1.0	4.0	1.0	7.0	1.0
flood 3	14/12/2012 21:00	5.670	5.9	16.0	24.0	5.0	23.0	4.4	1.0	105.0	0.9	6.0	1.0	4.0	1.0	6.0	1.0
flood 3	14/12/2012 23:00	9.672	6.2	25.0	43.0	8.0	38.0	7.1	1.6	50.0	1.4	9.0	2.0	6.0	1.0	7.0	1.0
flood 3	15/12/2012 00:00	11.719	7.0	33.0	61.0	11.0	48.0	8.9	1.9	44.0	1.7	11.0	2.0	7.0	1.0	7.0	1.0
flood 3	15/12/2012 01:00	13.747	7.1	31.0	53.0	10.0	47.0	8.5	1.8	41.0	1.5	10.0	2.0	6.0	1.0	7.0	1.0
flood 3	15/12/2012 04:00	16.543	7.9	40.0	74.0	13.0	63.0	22.0	6.0	35.0	2.0	13.0	3.0	8.0	1.0	8.0	1.0
flood 3	15/12/2012 07:00	16.160	8.7	44.0	75.0	15.0	69.0	22.0	7.0	35.0	2.0	15.0	3.0	9.0	1.0	8.0	1.0
flood 3	15/12/2012 08:00	15.446	8.2	73.0	146.0	22.0	101.0	29.0	8.0	43.0	3.0	19.0	4.0	11.0	2.0	11.0	1.0
flood 3	15/12/2012 11:00	13.641	8.6	56.0	107.0	19.0	86.0	26.0	7.0	34.0	3.0	18.0	4.0	10.0	1.0	9.0	1.0
flood 3	15/12/2012 19:00	9.687	8.6	43.0	74.0	14.0	69.0	22.0	7.0	30.0	2.0	14.0	3.0	8.0	1.0	9.0	1.0
flood 3	16/12/2012 01:00	7.818	8.5	48.0	95.0	16.0	72.0	24.0	7.0	31.0	2.0	15.0	3.0	8.0	1.0	9.0	1.0
flood 3	16/12/2012 03:00	9.349	7.8	50.0	89.0	16.0	74.0	24.0	6.0	31.0	3.0	15.0	3.0	9.0	1.0	9.0	2.0
flood 3	16/12/2012 05:00	10.333	7.9	160.0	359.0	49.0	207.0	52.0	14.0	57.0	7.0	39.0	7.0	20.0	3.0	17.0	3.0
flood 3	16/12/2012 07:00	11.980	7.6	38.0	62.0	13.0	64.0	21.0	6.0	25.0	2.0	14.0	3.0	9.0	1.0	8.0	1.0
flood 3	16/12/2012 09:00	11.914	7.9	46.0	74.0	15.0	73.0	22.0	6.0	25.0	2.0	14.0	3.0	8.0	1.0	8.0	1.0
flood 3	16/12/2012 17:00	7.818	8.0	34.0	56.0	11.0	52.0	21.0	7.0	22.0	2.0	11.0	2.0	7.0	1.0	7.0	1.0
flood 3	17/12/2012 05:00	5.546	7.5	38.0	63.0	11.0	54.0	21.0	6.0	22.0	2.0	12.0	2.0	7.0	1.0	8.0	1.0
flood 3	17/12/2012 10:55	5.670	7.5	35.0	63.0	11.0	50.0	19.0	6.0	20.0	2.0	10.0	2.0	6.0	1.0	7.0	1.0
flood 3	17/12/2012 17:00	6.099	7.3	50.0	98.0	16.0	68.0	24.0	7.0	21.0	2.0	13.0	3.0	8.0	1.0	8.0	1.0
flood 3	17/12/2012 19:00	6.603	7.5	35.0	61.0	11.0	50.0	20.0	6.0	18.0	2.0	11.0	2.0	8.0	1.0	8.0	1.0
flood 3	17/12/2012 21:00	7.965	7.5	46.0	89.0	14.0	66.0	22.0	6.0	25.0	2.0	13.0	3.0	8.0	1.0	9.0	1.0
flood 3	17/12/2012 23:00	9.985	7.3	34.0	59.0	11.0	54.0	19.0	6.0	21.0	2.0	12.0	2.0	7.0	1.0	7.0	1.0
flood 3	18/12/2012 01:00	10.609	7.6	44.0	74.0	14.0	67.0	21.0	6.0	21.0	2.0	14.0	3.0	8.0	1.0	8.0	1.0
flood 3	18/12/2012 13:00	5.546	7.3	31.0	53.0	10.0	49.0	8.8	1.9	24.0	1.5	10.0	2.0	6.0	1.0	7.0	1.0
flood 3	19/12/2012 16:50	3.256	6.8	21.0	36.0	7.0	30.0	5.6	1.2	31.0	1.1	7.0	2.0	4.0	1.0	5.0	1.0
flood 4	24/12/13 14:00	2.545	5.3	11.9	19.0	3.8	19.1	3.0	0.5	15.4	0.9	4.2	1.1	3.8	0.4	4.4	0.7
flood 4	24/12/13 18:00	2.748	5.3	39.8	85.0	12.8	56.5	10.0	2.3	23.1	2.0	10.1	2.4	6.8	0.7	6.4	1.2
flood 4	24/12/13 19:00	2.976	5.5	11.6	22.2	4.1	18.7	3.1	0.6	14.9	0.7	4.3	1.1	3.7	<DL	4.1	0.7
flood 4	24/12/13 21:00	3.273	5.9	10.8	21.3	3.4	17.9	2.9	0.8	16.7	1.0	4.1	1.1	3.6	0.3	4.2	0.7
flood 4	25/12/13 0:00	4.139	5.6	14.1	25.5	4.5	23.9	4.8	0.6	16.8	0.9	6.1	1.4	3.7	0.3	4.9	0.8
flood 4	25/12/13 2:00	5.268	5.7	17.8	32.1	5.8	29.2	6.4	1.5	22.5	1.1	7.0	1.5	4.9	0.4	5.2	1.1
flood 4	25/12/13 4:00	7.269	5.9	20.7	36.9	7.3	35.9	7.9	1.6	23.4	1.3	8.1	1.7	5.2	0.5	5.1	0.8
flood 4	25/12/13 6:00	11.735	5.9	28.4	51.8	10.5	51.3	10.8	2.3	19.4	1.7	9.9	2.0	6.4	0.6	6.1	1.1
flood 4	25/12/13 7:00	14.458	6.4	53.3	113.1	18.7	82.6	17.7	3.6	26.0	2.6	15.7	3.2	9.3	1.0	8.4	1.0
flood 4	25/12/13 9:00	19.238	6.4	62.6	117.6	19.6	91.0	19.7	3.8	25.9	2.8	15.4	3.4	9.2	1.1	8.2	1.2
flood 4	25/12/13 12:00	20.930	6.1	30.8	48.0	11.5	55.3	11.1	2.1	17.3	1.8	10.9	2.1	6.6	0.7	5.9	1.0
flood 4	25/12/13 14:00	20.097	6.1	31.0	48.1	11.1	55.5	11.3	2.3	16.5	1.9	11.0	2.3	6.4	0.7	6.2	1.1
flood 4	25/12/13 16:00	17.027	6.4	33.4	53.1	11.7	58.9	12.5	2.7	17.6	2.1	11.1	2.4	6.3	0.8	6.3	1.1
flood 4	25/12/13 18:00	13.173	6.3	36.3	57.6	12.5	61.3	13.1	2.5	18.0	2.1	12.1	2.7	7.0	0.8	6.8	1.1
flood 4	25/12/13 20:00	10.578	6.2	31.8	51.3	11.3	55.9	12.0	2.4	18.1	2.1	11.1	2.2	7.1	0.7	6.0	1.0
flood 4	25/12/13 22:00	8.763	6.0	69.6	152.9	23.4	103.7	22.0	4.7	27.7	3.3	19.0	4.0	10.5	1.3	9.3	1.5
flood 4	26/12/13 2:00	6.555	5.8	28.3	42.3	9.9	47.4	9.6	1.4	15.6	1.6	9.3	2.2	6.0	0.8	6.2	1.1
flood 4	26/12/13 10:00	4.417	5.5	26.4	42.0	9.2	39.8	8.1	1.7	15.8	1.5	9.3	1.8	5.3	0.8	5.4	1.1
flood 4	26/12/13 22:00	3.247	5.3	151.8	376.9	51.9	216.9	43.4	9.2	54.1	6.4	35.5	7.4	19.2	2.5	15.8	2.2
flood 4	27/12/2013 10:00	2.599	4.9	17.6	29.7	6.0	27.8	5.0	0.6	14.9	1.1	5.1	1.4	4.1	0.4	4.2	0.8

Table S3b: REE concentration of the suspended load collected during the four selected flood events from 2011 to 2013 at the outlet of the upper Alzette River basin (AO in Figure 1). Q is the measured river discharge.

site	Date/time	Q	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		$m^3 s^{-1}$							$\mu g\ g^{-1}$							
flood 1	06/01/2011 00:00	1.576	46.18	100.18	11.35	45.75	8.53	1.99	8.64	1.29	7.25	1.39	4.04	0.55	3.60	0.52
flood 1	06/01/2011 03:00	1.700	43.69	97.55	10.84	42.91	8.34	1.95	8.28	1.22	6.61	1.22	3.50	0.50	3.11	0.50
flood 1	06/01/2011 03:45	1.894	43.43	100.55	11.08	45.77	8.56	2.02	8.80	1.30	7.14	1.38	3.92	0.53	3.56	0.52
flood 1	06/01/2011 04:30	2.693	49.28	119.25	12.59	51.22	9.49	2.18	9.66	1.42	7.85	1.51	4.37	0.61	3.89	0.60
flood 1	06/01/2011 06:45	5.682	47.68	102.20	12.37	49.63	9.00	2.02	9.08	1.34	7.43	1.41	4.04	0.56	3.59	0.54
flood 1	06/01/2011 07:30	7.911	46.42	96.68	12.05	48.38	8.52	1.92	8.62	1.27	7.05	1.33	3.85	0.53	3.45	0.51
flood 1	06/01/2011 08:15	10.656	41.81	105.45	10.96	43.68	8.10	1.87	8.16	1.22	6.29	1.24	3.33	0.50	2.99	0.49
flood 1	06/01/2011 09:45	16.179	43.89	107.92	11.44	44.70	8.27	1.85	8.29	1.22	6.31	1.24	3.34	0.50	3.02	0.49
flood 1	06/01/2011 11:15	22.826	41.76	99.24	11.01	42.93	7.85	1.78	7.85	1.17	6.08	1.18	3.22	0.47	2.91	0.47
flood 1	06/01/2011 12:00	26.812	42.64	101.55	11.21	43.44	7.82	1.74	7.70	1.16	5.98	1.16	3.18	0.47	2.91	0.46
flood 1	06/01/2011 14:15	35.725	43.54	103.58	11.34	44.27	7.79	1.73	7.65	1.15	5.85	1.16	3.08	0.47	2.81	0.47
flood 1	06/01/2011 15:00	37.428	43.61	103.95	11.29	43.60	8.01	1.79	7.97	1.18	6.08	1.18	3.26	0.48	3.02	0.47
flood 1	06/01/2011 16:30	39.464	40.43	95.98	10.64	41.70	7.47	1.70	7.52	1.13	5.83	1.15	3.04	0.46	2.75	0.45
flood 1	06/01/2011 18:00	40.950	44.36	100.13	11.38	45.27	8.19	1.87	8.12	1.19	6.45	1.23	3.56	0.49	3.33	0.48
flood 1	06/01/2011 19:30	44.628	39.91	93.53	10.65	41.73	7.36	1.70	7.51	1.13	5.84	1.16	3.11	0.47	2.79	0.46
flood 1	06/01/2011 21:00	46.844	42.54	96.48	11.34	44.74	7.63	1.75	7.77	1.17	6.13	1.20	3.24	0.49	2.99	0.47
flood 1	06/01/2011 22:30	49.114	35.70	82.51	9.70	38.73	6.56	1.52	6.74	1.02	5.26	1.05	2.87	0.42	2.73	0.41
flood 1	06/01/2011 23:15	50.767	40.77	94.94	11.17	44.01	7.44	1.76	7.61	1.16	6.02	1.19	3.16	0.47	2.81	0.46
flood 1	07/01/2011 00:00	50.767	42.49	94.89	11.56	45.58	7.63	1.80	7.83	1.19	6.21	1.23	3.26	0.49	2.95	0.48
flood 1	07/01/2011 01:30	51.101	20.29	43.95	5.08	20.43	3.31	0.81	3.37	0.53	2.63	0.55	1.61	0.22	1.46	0.22
flood 1	07/01/2011 03:00	50.767	44.89	99.22	11.54	45.09	7.17	1.70	7.24	1.11	5.71	1.14	3.17	0.46	3.07	0.46
flood 1	07/01/2011 04:30	50.434	52.67	113.59	13.49	52.18	8.03	1.85	8.03	1.22	6.11	1.24	3.40	0.50	3.24	0.49
flood 1	07/01/2011 06:00	49.442	45.89	102.04	11.49	44.29	7.67	1.81	7.71	1.19	5.96	1.20	3.37	0.49	3.26	0.48
flood 1	07/01/2011 09:20	47.165	48.86	104.89	12.48	47.68	7.61	1.75	7.58	1.14	5.93	1.16	3.16	0.47	2.90	0.47
flood 1	07/01/2011 12:00	44.628	46.00	100.34	11.63	45.60	6.64	1.59	6.84	1.06	5.24	1.10	3.23	0.44	2.92	0.44
flood 1	07/01/2011 15:00	40.651	41.26	93.50	10.67	43.08	6.93	1.65	7.26	1.10	6.17	1.22	3.50	0.48	3.31	0.47
flood 1	07/01/2011 22:00	30.330	41.15	92.41	10.63	42.53	7.11	1.62	7.22	1.04	5.62	1.02	3.04	0.40	2.73	0.40
flood 1	08/01/2011 07:00	17.538	41.22	93.40	10.86	41.03	7.27	1.65	6.98	1.00	5.27	0.90	2.81	0.36	2.16	0.32
flood 1	08/01/2011 16:00	12.095	41.21	94.77	10.82	41.80	7.54	1.75	7.63	1.09	6.00	1.09	3.28	0.44	3.16	0.44
flood 2	03/12/2011 13:00	0.479	50.63	123.26	13.06	50.63	9.89	2.30	9.93	1.42	7.64	1.46	4.09	0.58	3.84	0.54
flood 2	03/12/2011 17:00	1.475	43.75	97.02	11.18	41.36	8.32	1.86	8.37	1.20	6.62	1.25	3.62	0.50	3.28	0.47
flood 2	03/12/2011 21:00	2.821	32.87	69.88	8.42	33.53	6.95	1.58	7.08	1.04	5.68	1.10	3.21	0.44	2.88	0.42
flood 2	04/12/2011 05:00	1.331	45.84	102.43	11.48	44.20	8.33	1.87	8.25	1.19	6.48	1.22	3.55	0.49	3.24	0.49
flood 2	04/12/2011 10:00	0.917	40.48	105.28	10.18	39.96	7.57	1.69	7.49	1.11	5.96	1.14	3.33	0.46	3.08	0.46
flood 2	04/12/2011 15:00	2.283	44.55	95.01	11.32	49.26	8.44	1.88	8.53	1.24	6.54	1.24	3.60	0.51	3.28	0.49
flood 2	04/12/2011 17:00	5.268	27.39	70.77	7.81	32.16	6.96	1.64	7.10	1.08	5.96	1.17	3.34	0.46	3.02	0.44
flood 2	04/12/2011 18:00	6.888	47.80	101.77	11.93	50.80	8.72	1.90	8.87	1.29	6.97	1.33	3.76	0.53	3.63	0.52
flood 2	04/12/2011 20:00	6.099	37.68	85.50	9.52	38.24	6.98	1.56	6.99	1.02	5.55	1.05	3.09	0.42	2.82	0.42
flood 2	04/12/2011 22:00	10.196	44.08	95.51	11.04	43.92	7.96	1.79	7.90	1.15	6.22	1.17	3.44	0.48	3.21	0.47
flood 2	05/12/2011 02:00	15.614	43.02	94.24	10.76	43.27	7.82	1.76	7.90	1.11	6.11	1.16	3.44	0.47	3.15	0.46
flood 2	05/12/2011 10:00	7.831	43.31	93.15	11.12	45.35	7.69	1.71	7.72	1.10	6.17	1.13	3.34	0.46	3.07	0.46
flood 2	06/12/2011 02:00	2.409	38.12	82.91	9.74	40.45	7.02	1.57	7.15	0.99	5.44	1.02	2.97	0.42	2.75	0.40
flood 2	07/12/2011 02:00	1.348	40.96	92.50	10.52	39.43	7.68	1.68	7.64	1.08	5.85	1.13	3.23	0.46	3.17	0.44
flood 2	07/12/2011 14:00	4.062	47.04	100.90	11.85	47.02	8.74	1.94	8.65	1.26	6.82	1.27	3.79	0.52	3.48	0.52
flood 2	07/12/2011 18:00	4.386	45.40	98.47	11.59	45.61	8.62	1.92	8.65	1.25	6.80	1.30	3.79	0.51	3.43	0.51
flood 2	08/12/2011 02:00	2.553	42.37	92.67	10.84	43.14	8.02	1.79	7.92	1.13	6.28	1.20	3.36	0.47	3.11	0.45
flood 2	08/12/2011 10:00	1.681	42.55	95.22	11.05	42.29	8.16	1.83	8.07	1.13	6.19	1.20	3.40	0.46	3.08	0.46

site	Date/time	Q	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		$m^3 s^{-1}$							$\mu g\ g^{-1}$							
flood 3	14/12/2012 16:00	1.102	22.71	48.93	5.62	22.74	4.37	0.98	4.29	0.63	3.51	0.67	1.88	0.27	1.74	0.25
flood 3	14/12/2012 18:00	1.540	42.37	98.94	10.80	43.86	8.46	1.92	9.12	1.36	7.57	1.48	4.19	0.59	3.87	0.56
flood 3	14/12/2012 19:00	2.576	36.78	84.81	9.21	37.42	7.19	1.57	7.40	1.10	6.13	1.17	3.43	0.47	3.03	0.46
flood 3	14/12/2012 21:00	5.670	47.39	101.38	11.81	47.10	8.68	1.94	8.81	1.29	7.06	1.36	3.99	0.55	3.59	0.54
flood 3	14/12/2012 23:00	9.672	43.66	91.48	10.92	44.14	8.02	1.79	8.05	1.18	6.41	1.23	3.60	0.50	3.29	0.48
flood 3	15/12/2012 00:00	11.719	43.21	94.87	11.26	43.96	8.09	1.85	8.16	1.20	6.53	1.25	3.60	0.50	3.29	0.48
flood 3	15/12/2012 01:00	13.747	41.19	89.80	10.28	40.09	7.41	1.68	7.45	1.10	6.03	1.17	3.40	0.47	3.12	0.47
flood 3	15/12/2012 04:00	16.543	37.79	85.35	9.98	38.71	7.13	1.60	7.09	1.02	5.62	1.05	3.05	0.42	2.80	0.42
flood 3	15/12/2012 07:00	16.160	41.22	88.38	10.49	41.61	7.55	1.71	7.41	1.09	5.90	1.11	3.20	0.45	2.95	0.43
flood 3	15/12/2012 08:00	15.446	41.68	89.15	10.78	42.17	7.90	1.82	7.97	1.17	6.41	1.20	3.42	0.48	3.10	0.46
flood 3	15/12/2012 11:00	13.641	41.12	87.98	10.39	41.17	7.49	1.71	7.40	1.07	5.94	1.12	3.30	0.44	2.98	0.45
flood 3	15/12/2012 19:00	9.687	39.66	84.28	9.69	37.56	6.87	1.56	6.79	1.01	5.35	1.02	2.95	0.42	2.71	0.39
flood 3	16/12/2012 01:00	7.818	32.58	73.01	7.95	30.87	5.59	1.26	5.37	0.80	4.32	0.82	2.35	0.31	2.09	0.30
flood 3	16/12/2012 03:00	9.349	38.60	82.16	9.32	36.46	6.51	1.45	6.41	0.96	5.21	0.99	2.90	0.39	2.62	0.39
flood 3	16/12/2012 05:00	10.333	40.79	86.67	9.97	38.82	7.14	1.62	6.96	0.99	5.39	1.03	3.02	0.42	2.68	0.39
flood 3	16/12/2012 07:00	11.980	43.56	92.80	10.72	42.00	7.55	1.73	7.41	1.09	6.04	1.14	3.29	0.45	3.02	0.44
flood 3	16/12/2012 09:00	11.914	31.70	88.75	7.91	30.63	5.47	1.25	5.29	0.79	4.35	0.80	2.32	0.33	2.12	0.31
flood 3	16/12/2012 17:00	7.818	37.16	77.49	9.03	35.20	6.27	1.42	6.07	0.92	4.94	0.92	2.67	0.37	2.49	0.36
flood 3	17/12/2012 05:00	5.546	37.89	83.51	9.34	36.32	6.52	1.53	6.52	0.96	5.26	1.03	2.90	0.39	2.58	0.38
flood 3	17/12/2012 10:55	5.670	42.10	96.36	10.22	39.30	7.19	1.68	7.03	1.04	5.58	1.07	3.11	0.42	2.77	0.41
flood 3	17/12/2012 17:00	6.099	36.91	84.18	9.55	38.15	7.15	1.62	7.14	1.03	5.58	1.05	3.02	0.42	2.71	0.39
flood 3	17/12/2012 19:00	6.603	30.60	68.57	8.09	32.39	6.14	1.42	6.17	0.90	4.89	0.92	2.67	0.36	2.43	0.35
flood 3	17/12/2012 21:00	7.965	38.87	84.57	9.83	39.32	7.14	1.65	7.04	1.01	5.33	1.00	2.89	0.39	2.59	0.38
flood 3	17/12/2012 23:00	9.985	39.91	84.51	10.23	40.61	7.42	1.69	7.32	1.07	5.84	1.10	3.19	0.45	2.90	0.43
flood 3	18/12/2012 01:00	10.609	40.15	86.61	10.35	40.68	7.27	1.65	7.12	1.03	5.56	1.04	2.99	0.41	2.68	0.39
flood 3	18/12/2012 13:00	5.546	41.84	90.93	10.53	41.62	7.70	1.75	7.57	1.10	5.86	1.09	3.16	0.43	2.82	0.42
flood 3	19/12/2012 16:50	3.256	28.17	62.64	7.17	28.65	5.22	1.21	5.32	0.79	4.28	0.81	2.40	0.34	2.19	0.32
flood 4	24/12/13 14:00	2.545	51.84	109.36	13.00	51.40	9.64	2.15	9.28	1.23	7.46	1.40	3.85	0.55	3.69	0.52
flood 4	24/12/13 18:00	2.748	45.10	94.49	11.11	45.10	7.84	1.77	7.79	1.03	6.51	1.19	3.34	0.49	3.20	0.46
flood 4	24/12/13 19:00	2.976	47.75	99.35	11.40	46.17	8.05	1.77	7.89	1.08	6.62	1.21	3.47	0.51	3.39	0.48
flood 4	24/12/13 21:00	3.273	44.36	88.98	10.73	43.75	7.63	1.70	7.62	1.01	6.35	1.18	3.27	0.48	3.12	0.45
flood 4	25/12/13 0:00	4.139	45.69	92.02	11.19	47.33	8.06	1.75	7.77	1.04	6.47	1.19	3.34	0.49	3.22	0.46
flood 4	25/12/13 2:00	5.268	47.80	94.87	11.49	45.93	8.12	1.85	7.95	1.05	6.57	1.22	3.47	0.50	3.30	0.48
flood 4	25/12/13 4:00	7.269	48.11	98.85	11.73	47.06	7.99	1.80	7.89	1.05	6.47	1.21	3.36	0.48	3.22	0.47
flood 4	25/12/13 6:00	11.735	47.83	98.98	11.67	46.44	7.93	1.77	7.69	1.02	6.32	1.17	3.26	0.47	3.12	0.45
flood 4	25/12/13 7:00	14.458	44.86	97.76	11.38	44.30	7.59	1.70	7.52	0.99	6.17	1.16	3.25	0.47	3.08	0.45
flood 4	25/12/13 9:00	19.238	43.99	94.88	11.33	43.82	7.41	1.69	7.46	0.97	6.03	1.12	3.13	0.45	3.01	0.44
flood 4	25/12/13 12:00	20.930	49.54	103.20	12.13	46.32	7.64	1.71	7.44	0.97	6.09	1.13	3.21	0.46	3.09	0.45
flood 4	25/12/13 14:00	20.097	52.32	104.51	12.37	48.31	8.16	1.82	7.77	1.03	6.41	1.20	3.32	0.49	3.23	0.47
flood 4	25/12/13 16:00	17.027	60.13	102.15	12.10	47.40	8.01	1.77	7.61	1.01	6.26	1.16	3.29	0.48	3.13	0.46
flood 4	25/12/13 18:00	13.173	51.05	97.62	11.80	46.34	8.07	1.81	7.77	1.03	6.51	1.20	3.38	0.50	3.25	0.48
flood 4	25/12/13 20:00	10.578	49.38	93.83	11.46	45.34	7.92	1.72	7.41	0.99	6.17	1.13	3.19	0.47	3.07	0.45
flood 4	25/12/13 22:00	8.763	51.69	99.96	12.19	47.78	8.23	1.84	7.84	1.04	6.48	1.20	3.34	0.49	3.22	0.47
flood 4	26/12/13 2:00	6.555	51.55	102.67	11.96	46.28	8.20	1.81	7.81	1.04	6.52	1.22	3.44	0.51	3.31	0.48
flood 4	26/12/13 10:00	4.417	46.33	92.42	10.79	42.57	7.59	1.70	7.26	0.97	6.04	1.12	3.14	0.46	3.02	0.45
flood 4	26/12/13 22:00	3.247	43.77	89.28	10.22	40.24	7.35	1.64	7.00	0.95	5.84	1.07	3.05	0.44	2.86	0.44

Table S4: Sr-Nd-Pb concentrations and isotopic compositions of the dissolved (concentration in µg L^{-1} for Sr and Pb and in ng L^{-1} for Nd) and suspended (concentration in µg g^{-1}) loads collected during this study in the upper Alzette River basin. Analyses performed on the three main geologies and the waste incinerator dust (WI) are also indicated (concentration in µg g^{-1}). See Figure 1 for the location of the different sites.

site/geology		sample type	date/time/period	Q $m^3 s^{-1}$	Sr	Nd	Pb	$^{87}Sr/^{86}Sr$	$^{143}Nd/^{144}Nd$	$^{206}Pb/^{207}Pb$
geogenic sources	limestone	bedrock	-	-	491	64	4	0.70800	0.51210	1.240
	sandstone	bedrock	-	-	133	56	39	0.70824	0.51207	1.222
	marls	bedrock	-	-	87	41	20	0.72511	0.51205	1.205
anthropogenic sources	S1	dissolved load	low flow	-	385	3.0	0.04	0.70736	0.51192	-
	S2	dissolved load	low flow	-	339	11	0.05	0.70810	0.51191	-
	S4	suspended load	low flow	-	140	36	21	0.71663	0.51202	1.174
	WI	dust	-	-	212	5	2598	0.70915	0.51201	1.156
remote Alzette	AS*	dissolved load	low flow	-	242	8.2	0.01	0.70810	0.51204	1.164
remote tributaries	T1*	dissolved load	low flow	-	180	28	0.01	0.71009	0.51208	1.185
polluted tributaries	T1	dissolved load	low flow	-	392	<0.1	<0.01	0.70883	-	1.166
	T3	dissolved load	low flow	0.037	540	7.0	0.01	0.70801	0.51194	1.160
	T4	dissolved load	low flow	0.170	183	10	0.01	0.70803	0.51202	1.163
polluted Alzette	AO - flood 1	dissolved load	06/01/2011 00:00	1.576	506	19	0.09	0.70841	0.51205	1.174
	AO - flood 1	dissolved load	06/01/2011 06:45	5.682	403	26	0.11	0.70843	0.51206	1.183
	AO - flood 1	dissolved load	06/01/2011 14:15	35.725	178	0.1	0.19	0.70880	0.51205	1.185
	UA	suspended load	low flow	1.780	213	55	273	0.71168	0.51190	1.167
	AO - flood 1	suspended load	06/01/2011 00:00	1.576	116	46	90	0.71656	0.51198	1.180
	AO - flood 1	suspended load	06/01/2011 03:45	1.894	108	46	120	0.71789	0.51201	1.170
	AO - flood 1	suspended load	06/01/2011 06:45	5.682	122	50	113	0.71661	0.51200	1.173
	AO - flood 1	suspended load	06/01/2011 07:30	7.911	130	48	107	0.71596	0.51199	1.167
	AO - flood 1	suspended load	06/01/2011 08:15	10.656	138	44	115	0.71525	0.51199	1.170
	AO - flood 1	suspended load	06/01/2011 09:45	16.179	116	45	91	0.71762	0.51199	1.175
	AO - flood 1	suspended load	06/01/2011 12:00	26.812	100	43	83	0.71940	0.51201	1.177
	AO - flood 1	suspended load	06/01/2011 14:15	35.725	98	44	82	0.71932	0.51201	1.177
	AO - flood 1	suspended load	06/01/2011 18:00	40.950	95	45	85	0.71971	0.51201	1.178
	AO - flood 1	suspended load	06/01/2011 21:00	46.844	88	45	83	0.71931	0.51201	1.179
	AO - flood 1	suspended load	07/01/2011 01:30	51.101	41	20	32	0.71969	0.51202	1.181
	AO - flood 1	suspended load	07/01/2011 22:00	30.330	82	42	70	0.72053	0.51199	1.177
	AO - flood 2	suspended load	03/12/2011 21:00	2.821	123	33	114	0.71421	0.51198	1.170
	AO - flood 2	suspended load	04/12/2011 17:00	5.268	179	32	157	0.71355	0.51199	1.169