LÄRM FORSCHUNG EISEN BAHN
FAHRBAHNLABOR

MÜLLER-BBM
RAIL TECHNOLOGIES

Monthly report

Railway Field Laboratory

November 2022

Güterverkehr auf der Schiene.
Mit Forschung und Investitionshilfe des Bundes.

Client:	Swiss confederation; Federal Offices for the Environment (FOEN) and Transport (FOT), CH-3003 Bern The FOEN and the FOT are offices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).
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Remarks:	This report was published on behalf the Swiss Federal Office for the Environment (FOEN) and Transport (FOT). The consultant is responsible for the content and all data displayed.
Version:	V1
Date:	15.2.2023

1. Status railway field laboratory

Construction work on the tracks:

- none

Downtimes of the measurement systems:

- Station MQ 1_3 from 12.11.2022 to 17.1.2023

Downtimes of the sensors:

- none

Maintenance and sensor exchange:

- none

Modifications to the data, database, or analysis:

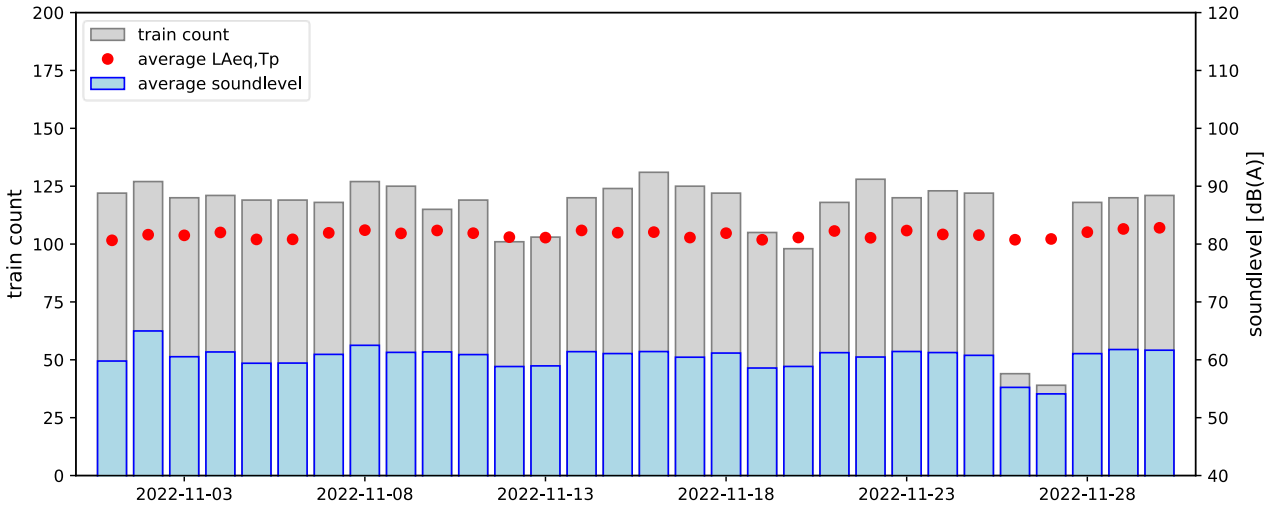
- none

Monthly data volume collected:

- 251 GB

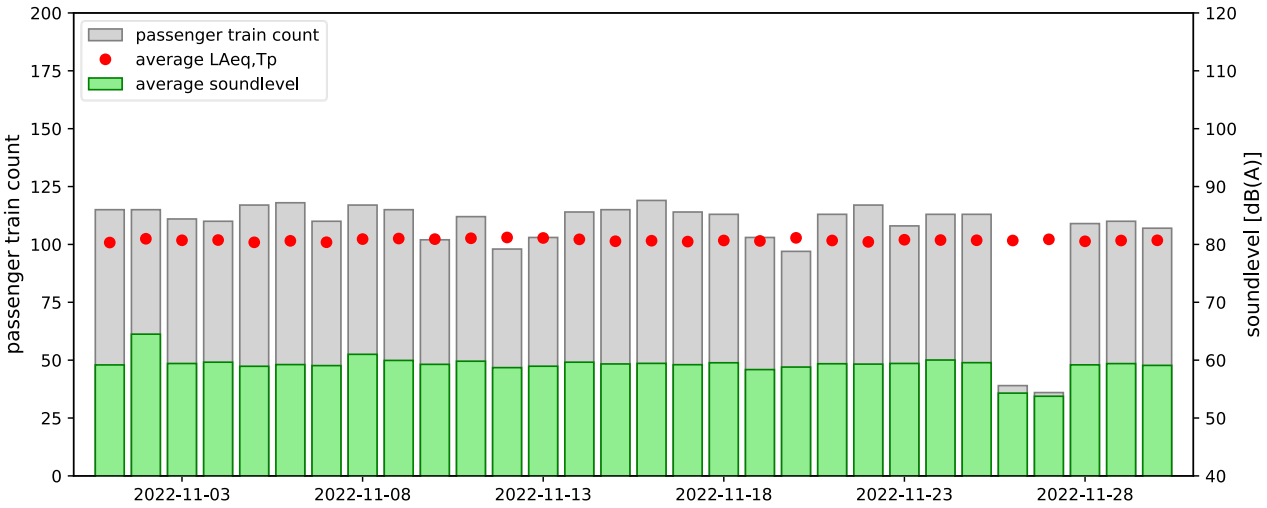
2. Measurement data

Daytime averages (24h) for all train passages at reference section (REF)



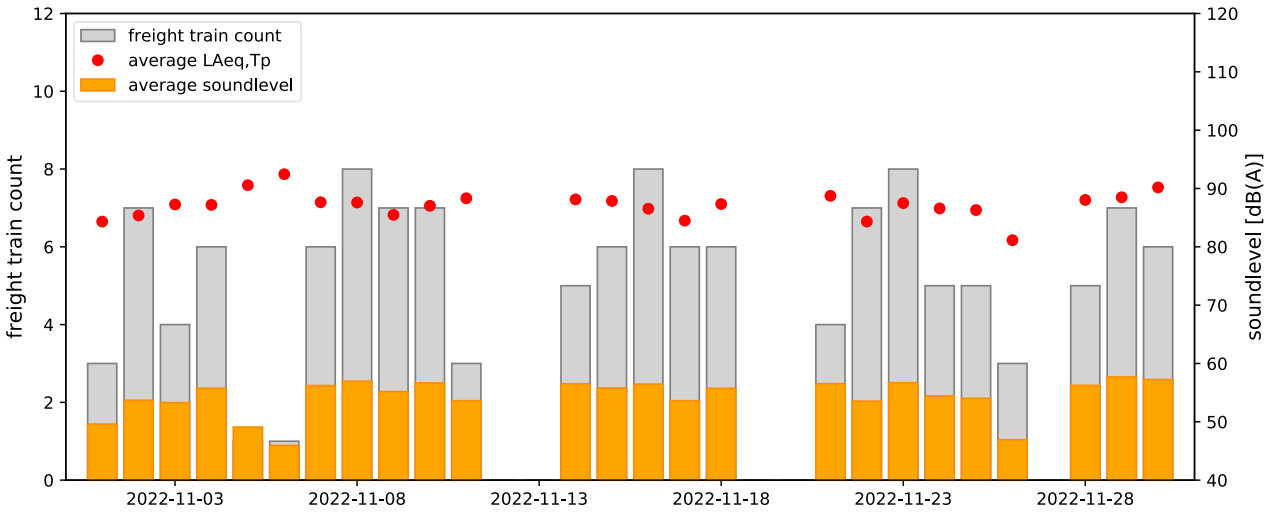
date	location	train count	passenger train count	freight train count	service train count	average LAeqTp	average soundlevel
01.11.2022	REF	122	116	3	1	80.6	59.8
02.11.2022	REF	127	115	8	1	81.6	65.0
03.11.2022	REF	120	111	5	1	81.5	60.5
04.11.2022	REF	121	110	6	1	82.0	61.4
05.11.2022	REF	119	117	1	0	80.8	59.4
06.11.2022	REF	119	118	1	0	80.8	59.4
07.11.2022	REF	118	111	6	1	81.9	60.9
08.11.2022	REF	127	117	8	1	82.4	62.5
09.11.2022	REF	125	115	7	1	81.8	61.3
10.11.2022	REF	115	102	7	1	82.3	61.4
11.11.2022	REF	119	112	3	0	81.9	60.9
12.11.2022	REF	101	98	0	0	81.2	58.8
13.11.2022	REF	103	103	0	0	81.1	59.0
14.11.2022	REF	120	114	5	0	82.4	61.4
15.11.2022	REF	124	115	6	2	82.0	61.1
16.11.2022	REF	131	119	8	2	82.1	61.4
17.11.2022	REF	125	114	6	0	81.1	60.4
18.11.2022	REF	122	113	6	0	81.9	61.2
19.11.2022	REF	105	103	0	1	80.7	58.6
20.11.2022	REF	98	98	0	0	81.1	58.9
21.11.2022	REF	118	113	4	0	82.3	61.2
22.11.2022	REF	128	117	7	1	81.1	60.5
23.11.2022	REF	120	108	8	0	82.3	61.4
24.11.2022	REF	123	113	5	2	81.7	61.3
25.11.2022	REF	122	113	5	1	81.6	60.8
26.11.2022	REF	44	39	3	0	80.7	55.2
27.11.2022	REF	39	36	0	1	80.9	54.1
28.11.2022	REF	118	109	5	2	82.1	61.1
29.11.2022	REF	120	110	7	1	82.6	61.8
30.11.2022	REF	121	107	6	2	82.8	61.7
month	**REF**	**3414**	**3186**	**136**	**23**	**81.8**	**60.8**

Daytime averages (24h) for all passenger train passages at reference section (REF)



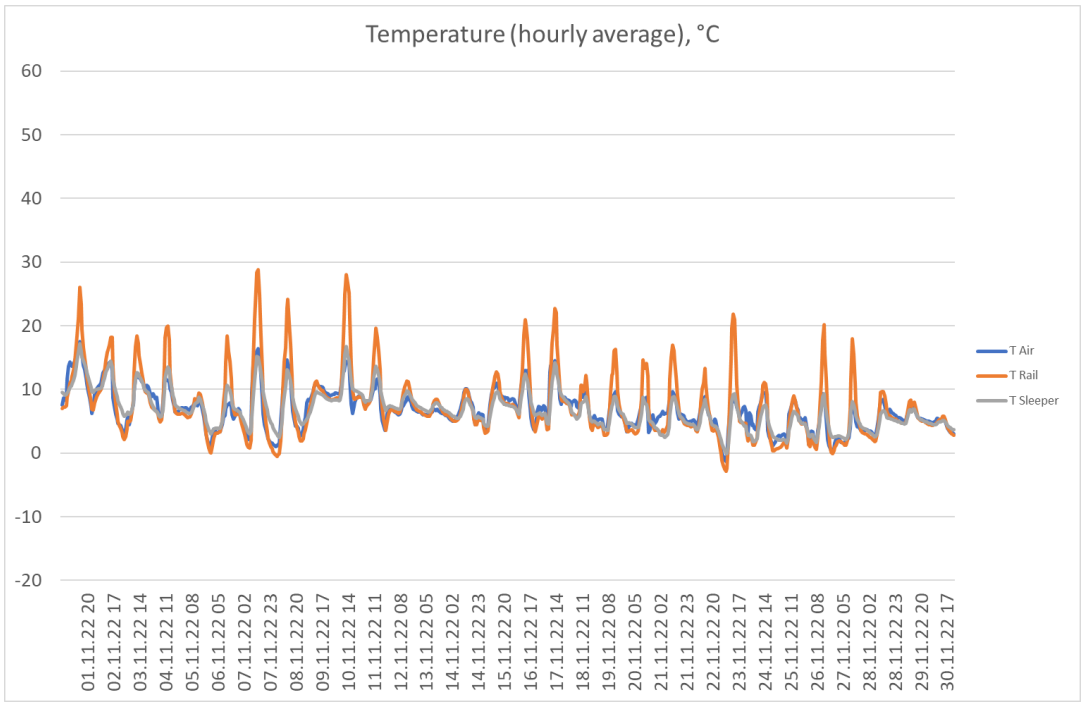
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.11.2022	REF	116	111	156	23	80.3	59.2
02.11.2022	REF	115	113	159	23	81.0	64.5
03.11.2022	REF	111	112	159	23	80.7	59.4
04.11.2022	REF	110	111	168	25	80.8	59.6
05.11.2022	REF	117	111	143	21	80.4	58.9
06.11.2022	REF	118	110	140	21	80.6	59.2
07.11.2022	REF	111	112	161	24	80.4	59.1
08.11.2022	REF	117	112	158	23	80.9	61.0
09.11.2022	REF	115	111	162	24	81.0	60.0
10.11.2022	REF	102	111	162	24	80.9	59.3
11.11.2022	REF	112	112	162	24	81.1	59.8
12.11.2022	REF	98	111	135	20	81.2	58.7
13.11.2022	REF	103	109	136	20	81.1	59.0
14.11.2022	REF	114	111	159	23	80.9	59.6
15.11.2022	REF	115	111	158	23	80.5	59.3
16.11.2022	REF	119	112	155	23	80.6	59.4
17.11.2022	REF	114	110	158	23	80.5	59.2
18.11.2022	REF	113	112	167	25	80.7	59.5
19.11.2022	REF	103	110	134	20	80.6	58.4
20.11.2022	REF	98	109	138	21	81.1	58.8
21.11.2022	REF	113	112	158	23	80.7	59.4
22.11.2022	REF	117	111	159	23	80.4	59.3
23.11.2022	REF	108	112	159	23	80.8	59.4
24.11.2022	REF	113	112	157	23	80.8	60.0
25.11.2022	REF	113	111	164	24	80.7	59.6
26.11.2022	REF	39	113	143	21	80.7	54.3
27.11.2022	REF	36	112	131	20	80.9	53.8
28.11.2022	REF	109	110	160	24	80.5	59.2
29.11.2022	REF	110	112	166	24	80.7	59.4
30.11.2022	REF	107	113	159	23	80.7	59.1
month	**REF**	3186	**111.3**	**155.2**	**22.9**	**80.7**	**59.5**

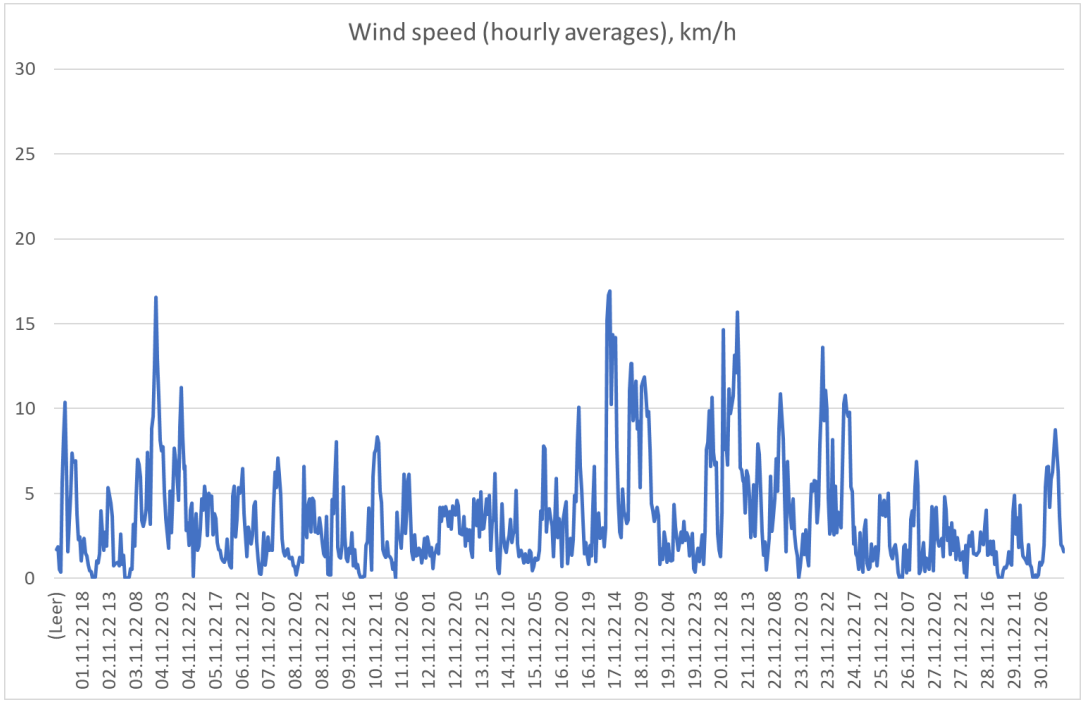
Daytime averages (24h) for all freight train passages at reference section (REF)



date	location	freight train count	average speed	average length	average axle count	average LAeqTp	average soundlevel
01.11.2022	REF	3	74	190	35	84.3	49.6
02.11.2022	REF	8	76	161	35	85.4	53.7
03.11.2022	REF	5	89	203	53	87.3	53.3
04.11.2022	REF	6	81	214	47	87.2	55.7
05.11.2022	REF	1	97	166	38	90.6	49.1
06.11.2022	REF	1	90	49	8	92.5	46.0
07.11.2022	REF	6	91	249	53	87.6	56.2
08.11.2022	REF	8	85	203	47	87.6	57.0
09.11.2022	REF	7	88	262	53	85.5	55.2
10.11.2022	REF	7	83	247	60	87.0	56.7
11.11.2022	REF	3	95	253	63	88.3	53.6
12.11.2022	REF	0					
13.11.2022	REF	0					
14.11.2022	REF	5	76	250	60	88.1	56.5
15.11.2022	REF	6	91	212	43	87.9	55.8
16.11.2022	REF	8	88	243	57	86.5	56.5
17.11.2022	REF	6	81	248	60	84.5	53.6
18.11.2022	REF	6	91	228	51	87.3	55.7
19.11.2022	REF	0					
20.11.2022	REF	0					
21.11.2022	REF	4	91	283	63	88.7	56.5
22.11.2022	REF	7	76	204	46	84.3	53.5
23.11.2022	REF	8	87	211	46	87.5	56.7
24.11.2022	REF	5	90	234	52	86.6	54.4
25.11.2022	REF	5	76	217	50	86.3	54.0
26.11.2022	REF	3	65	144	37	81.1	46.9
27.11.2022	REF	0					
28.11.2022	REF	5	83	254	60	88.0	56.2
29.11.2022	REF	7	88	224	52	88.5	57.7
30.11.2022	REF	6	85	167	32	90.2	57.2
month	REF	136	84.5	220.6	49.6	87.2	54.3

3. Weather data





Appendix: measurement quantities

Transit Exposure Level *TEL*

A-weighted sound pressure level of a single train pass-by as energetic average over the entire exposure duration *T* and averaged over the pass-by duration T_p.

$$TEL = 10\,log\left(\frac{1}{T_p}\int_0^T \frac{p_A^2(t)}{p_0^2}dt\right) \quad (1)$$

Where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p0 = 20\,\mu Pa$ (reference pressure), [Pa]

$Tp = T_2 - T_1$ = pass-by duration of the train, time interval during which a train is within the measurement cross-section and which starts with the entry time T_1into the measurement cross-section and ends with the exit time T_2, [s]

T = time interval which starts when the smoothed sound pressure level (sound pressure level smoothed as a function of time with the frequency weighting A and a time weighting F („fast“) or averaging over a duration period of time, e.g. 100 ms) is for the last time 10 dB below that prevailing at the time of entering the measurement cross-section and which ends when the smoothed sound pressure level is for the first time 10 dB below the one at the time of leaving the measurement cross-section. [s]

A-weighted equivalent sound pressure level of the train pass-by $L_{Aeq,Tp}$

The A-weighted equivalent sound pressure level equals the (energetic) average of the sound pressure level over the train pass-by time T_p according to the following equation:

$$L_{Aeq,Tp} = 10\,log\left(\frac{1}{T_p}\int_{T_1}^{T_2} \frac{p_A^2(t)}{p_0^2}dt\right) \quad (2)$$

where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p0 = 20\,\mu Pa$ (reference sound pressure), [Pa]

$Tp = T_2 - T_1$ = pass-by duration of the train, [s]

Sound Exposure Level *SEL*

The sound exposure level *SEL* references the acoustic energy of the entire pass-by event to one second. The SEL is used in calculating average sound level contributions from trains over longer periods of time (i.e. days/months/year). The SEL is related to the transit exposure level TEL through:

$$SEL = \mathrm{TEL} - 10\log(T_0/T_p) \quad (3)$$

where

T_0 = 1 [s]

Tp = pass-by duration of the train, [s]

Average sound level (period)

Average (energetic) A-weighted sound pressure level measured over a given period of time.

For the average sound level contributions from train pass-byes this equals the sum (energetic) of all sound exposure levels during the period for a given measurement position:

$$average\ soundlevel = 10 \cdot log10\left(\sum 10^{\frac{SEL}{10}}\right) - A1 \quad (4)$$

where

A1 = $10 \cdot log10(n \cdot 24 \cdot 3600)$ for a 24-hour period

SEL (see equation 3) taken from measurement data

n = number of days being averaged over

Average $L_{Aeq,Tp}$

Average (energetic) sound level of all the A-weighted sound pressure levels from the individual equivalent sound level of all train pass-byes in a given period of time (day/month/year).

Calculated per train category and per period day/night, month, year, etc. and per measurement location:

$$average\ L_{Aeq,Tp} = 10 \cdot log10\left(\sum T_p \cdot 10^{\frac{L_{Aeq,Tp}}{10}}\right) + 10 \cdot log10\left(\frac{1}{\sum T_p}\right) \quad (5)$$

where

Tp = pass-by duration of the train [s]

$L_{Aeq,Tp}$ (see equation 2) is calculated directly from the measurement data