REPUBLIC OF ESTONIA
ROAD ADMINISTRATION

Safety Effect of Fixed Speed Cameras on State Roads in Estonia

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Introduction

Fixed speed cameras aim at reducing speeds and as a result crashes, especially the most serious ones.

First fixed speed cameras on state roads were implemented in **2009.**

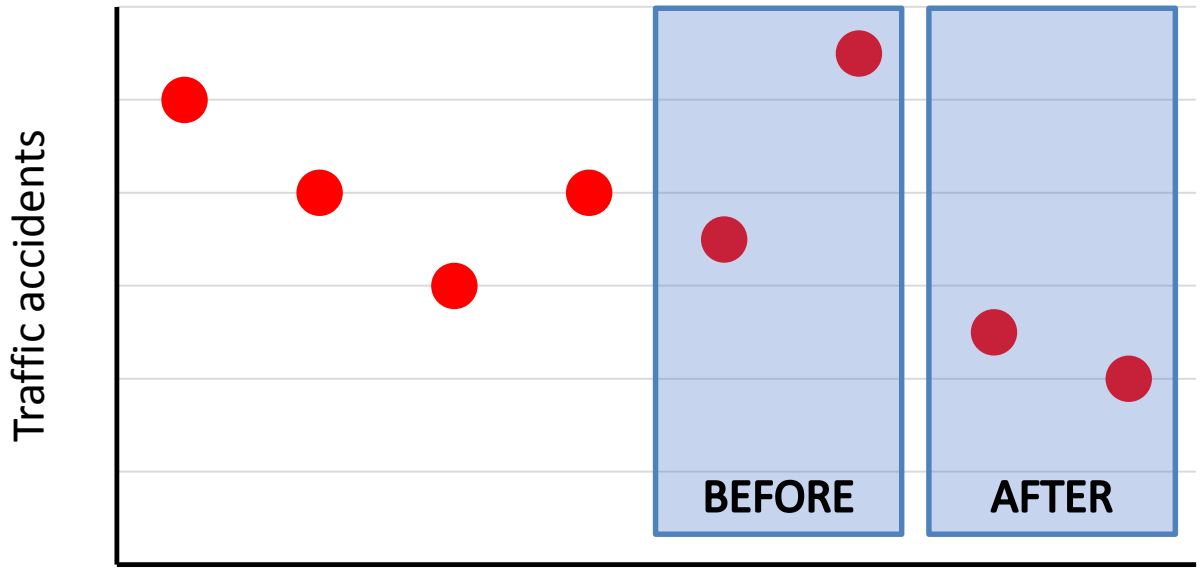
Totally on state roads **66 measuring points** and **50 cameras**.

All camera sites are equipped with **information signs** and speed limit **road markings**.

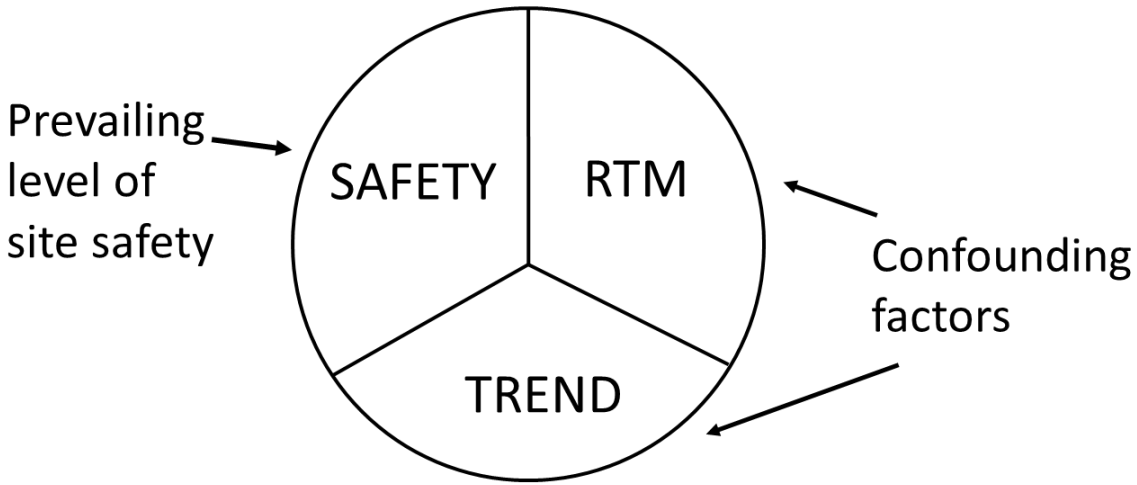
Installation criteria: 5 year casualty rate, traffic volume, actual speeds, road environment (curves, intersections) and technical characteristics (e.g. electricity).

The aim of the study: investigate the effects of fixed speed cameras installed between **2009 - 2014** on injury crashes, accounting for RTM and trend.

Best practice and know-how

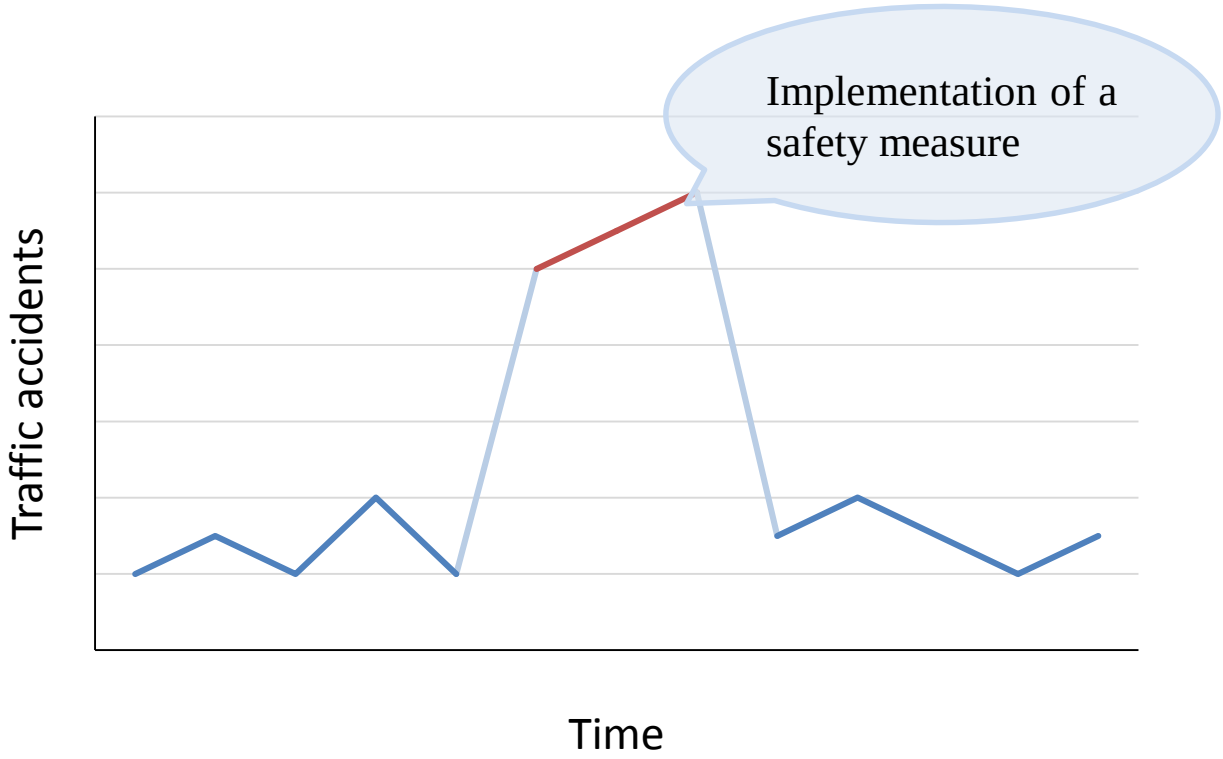


Total observed frequency (100%)



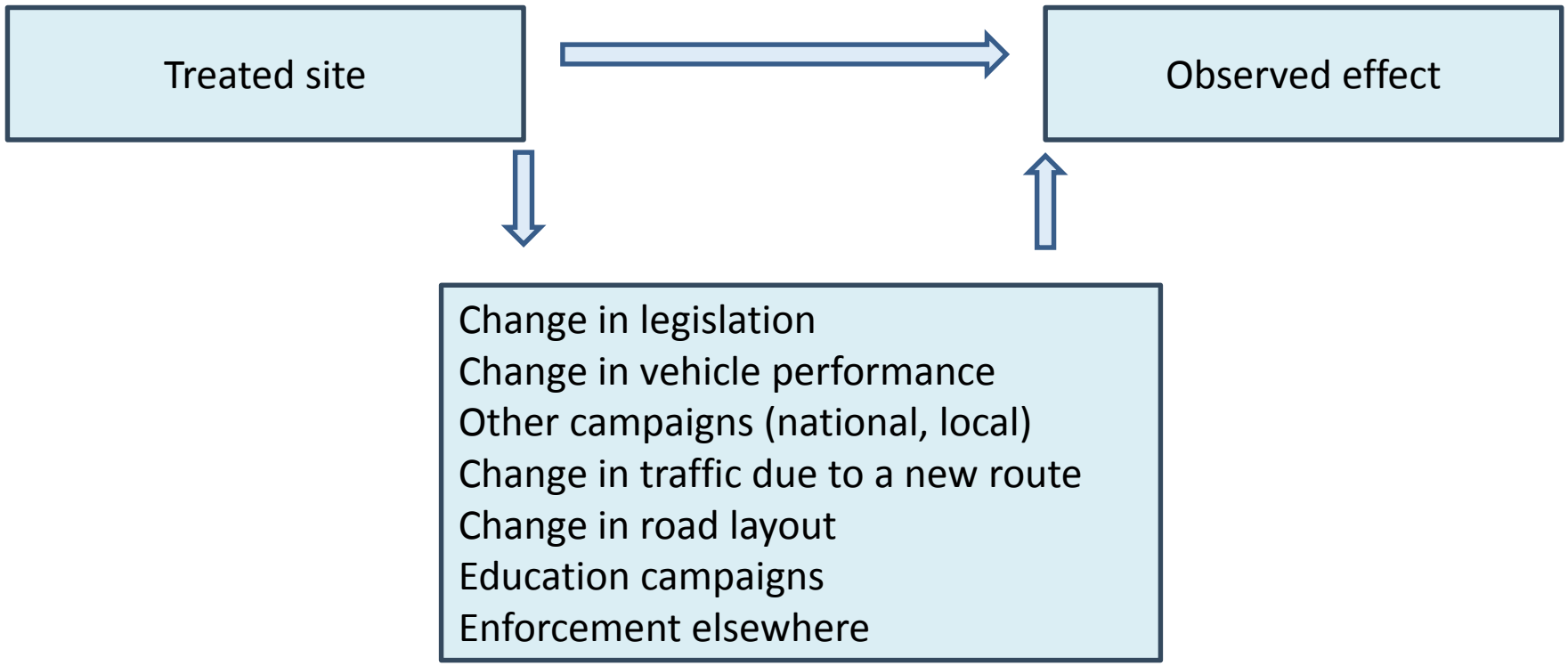
Variation over time and between sites

Regression to the Mean



The phenomenon by which **extreme examples** from any set of data are likely to be followed by examples which are **less extreme**, a tendency towards the average of any sample.

Trend as a confounding factor



Effectiveness of fixed speed cameras

- Literature analysis;
- Choice of the best suitable before-after method;
- Data gathering;
- Data analysis;
- Results and limitations of the study.

Other studies on effect of fixed speed cameras

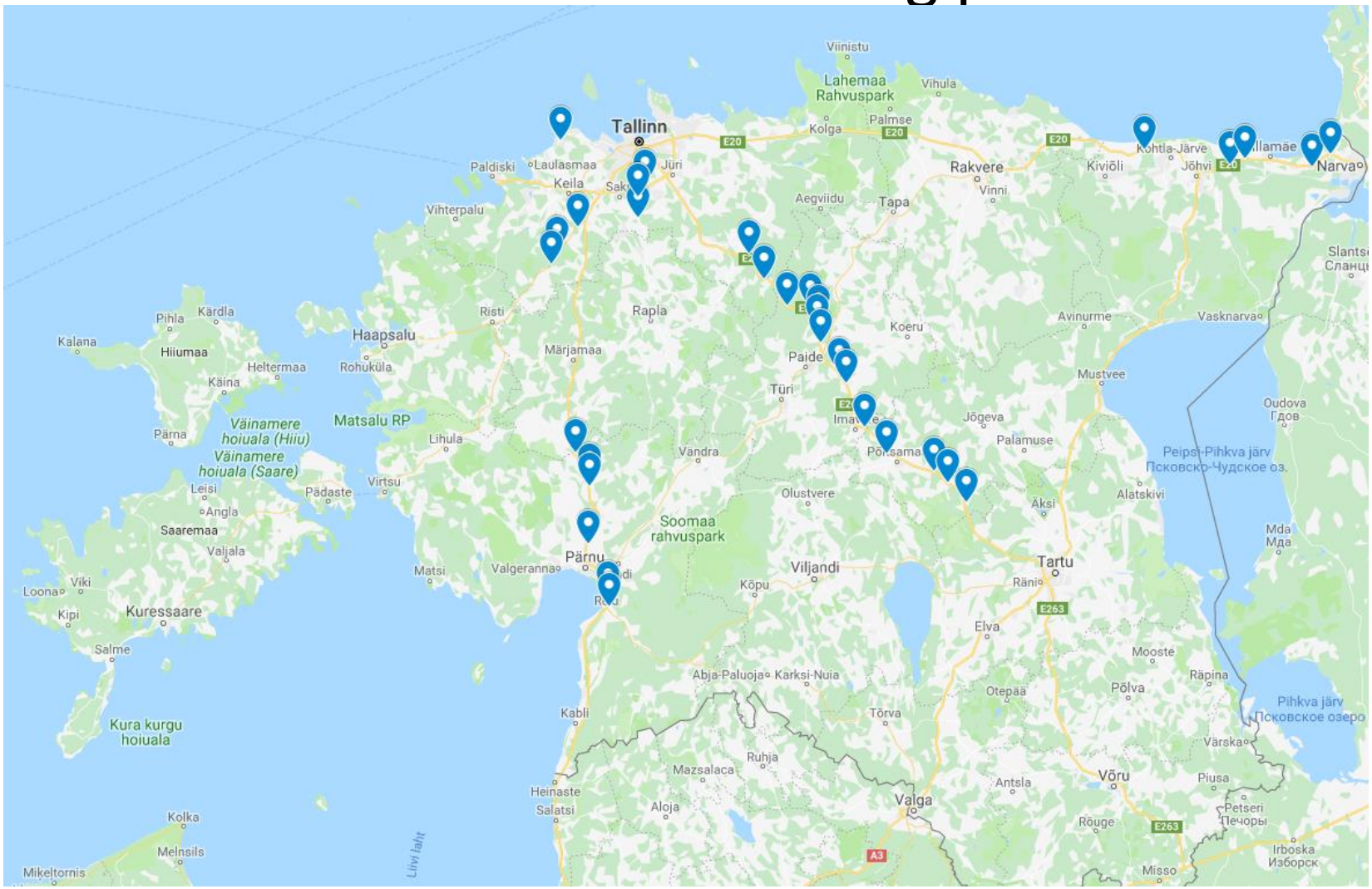
FIXED SPEED CAMERAS				
Høye, 2014a (meta-analysis), Several countries (15 studies included)	**Crashes of unspecified severity**	**/**	**- 20% [-28; -10]**	↗
	Injury crashes	**/**	**-20% [-26; -12]**	↗
	KSI crashes	**/**	**-15% [-24; -6]**	↗
	Fatal crashes	**/**	**-51% [-72; -12]**	↗
Høye, 2015a, Norway	Injury crashes	Long segments (100m upstream – 3km downstream)	-5% [-12; +2]	/
		Medium segments (100m upstream – 1km downstream)	-22% [-30; -14]	↗
		Short segments (100m upstream – 100m downstream)	+1% [-36; +37]	/
	KSI crashes	Long segments (100m upstream – 3km downstream	-17% [-47; +14]	/
		Medium segments (100m upstream – 1km downstream)	-24% [-72; +24]	/
		Short segments (100m upstream – 100m downstream)	-14% [-92; + 65]	/
Hu & McCart, 2016, United States	Crash severity – likelihood of incapacitating or fatal injury	Treatment sites	-19.4% [Significant at α=0.05; CI not reported]	↗
		Spillover sites	-17.2% [not significant at α=0.05; CI not reported]	/
Li & Graham, 2016, United Kingdom	Injury crashes	/	-25.9% [Significant at α=0.05; CI not reported]	↗
	KSI crashes	/	-4.5% [not significant at α=0.05; CI not reported]	/

Source: De Ceunynck, T. (2017), Installation of section control & speed cameras, European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu on 04.01.2019

Data (1)

- Speed cameras installation data

32 camera sites and 51 measuring points



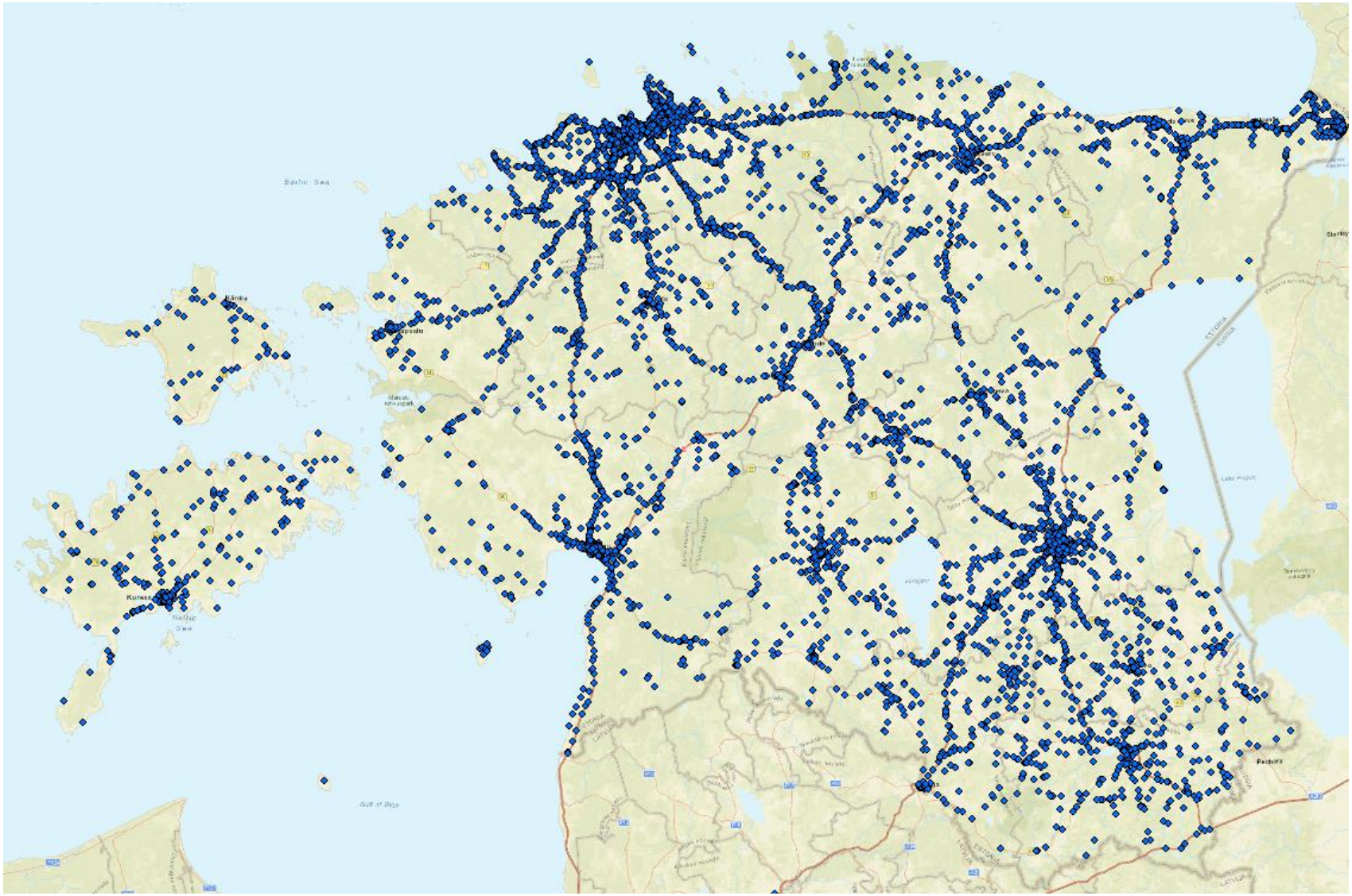
Data (2)

- Injury accident data for 2006 – 2017

Length of Before and After Period 3 years;

Year	Injury accidents	Plotted collisions (with GPS coordinates)	Share of plotted collisions	Collisions without GPS coordinates in urban area
2006	2585	1185	45,84%	74
2007	2450	1128	46,04%	107
2008	1869	783	41,89%	75
2009	1505	662	43,99%	69
2010	1348	1347	99,93%	0
2011	1508	1507	99,93%	1
2012	1384	1383	99,93%	1
2013	1364	1360	99,71%	3
2014	1413	1410	99,79%	2
2015	1376	1374	99,85%	1
2016	1468	1432	97,55%	18
2017	1406	1270	90,33%	59

Data (3)



Data (3)

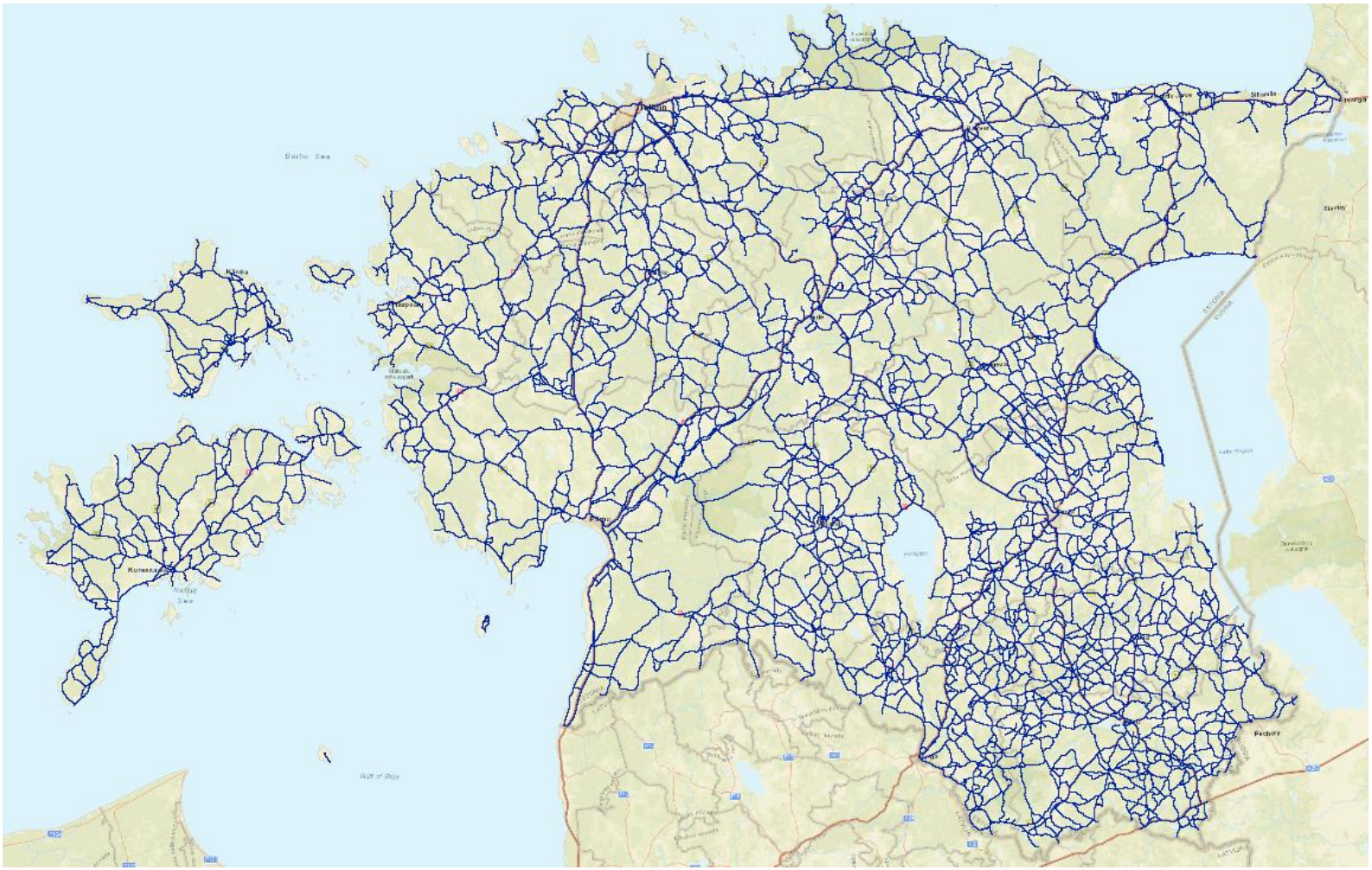
- Traffic volume (AADT) and speed limits

Tunnus	Väärtus
TEE2	11
Tee nr	1
Tee nimetus	Tallinn – Narva
Sõidutee	1
Algus teeosa nr	2
Algus tkaugus	0
Algus mkaugus	9240
Lõpp teeosa nr	2
Lõpp tkaugus	1791
Lõpp mkaugus	11031
Pikkus	1791
Aasta keskmine ööp. liiklus	30429
Sõiduaut.ja pakiautod (%)	91
Veoautod ja autobussid (%)	3
Autorongid (%)	6
Sõiduaut.ja pakiautod (a/ööp)	27683
Veoautod ja autobussid (a/ööp)	922
Autorongid (a/ööp)	1824
Loenduse aasta	2017

Tunnus	Väärtus
TEE2	11
Tee nr	1
Tee nimetus	TALLINN – NARVA
Sõidutee	1
Algus teeosa nr	2
Algus tkaugus	555
Algus mkaugus	10930
Lõpp teeosa nr	2
Lõpp tkaugus	855
Lõpp mkaugus	11230
Pikkus	300
Kiiruspiirangu väärtus paremal	70
Kiiruspiirangu väärtus vaskul	70
Piirangu tüüp paremal	3
TekstPAREMAL	KOHALIK KIIRUSPIIRANG
Piirangu tüüp vasakul	3
TekstVASAKUL	KOHALIK KIIRUSPIIRANG
Lisatahvel paremal suunal	8
TekstLTAHVELPAR	KIIRUSPIIRANGU MOJUPIIRKOND
Lisatahvel vasakul suunal	8
TekstLTAHVELVAS	KIIRUSPIIRANGU MOJUPIIRKOND
KPAASTA	2006

Data (4)

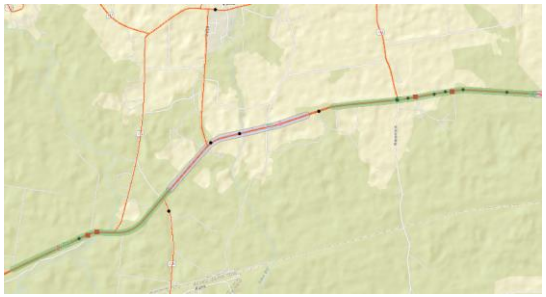
- Road network parameters.



Method (1)

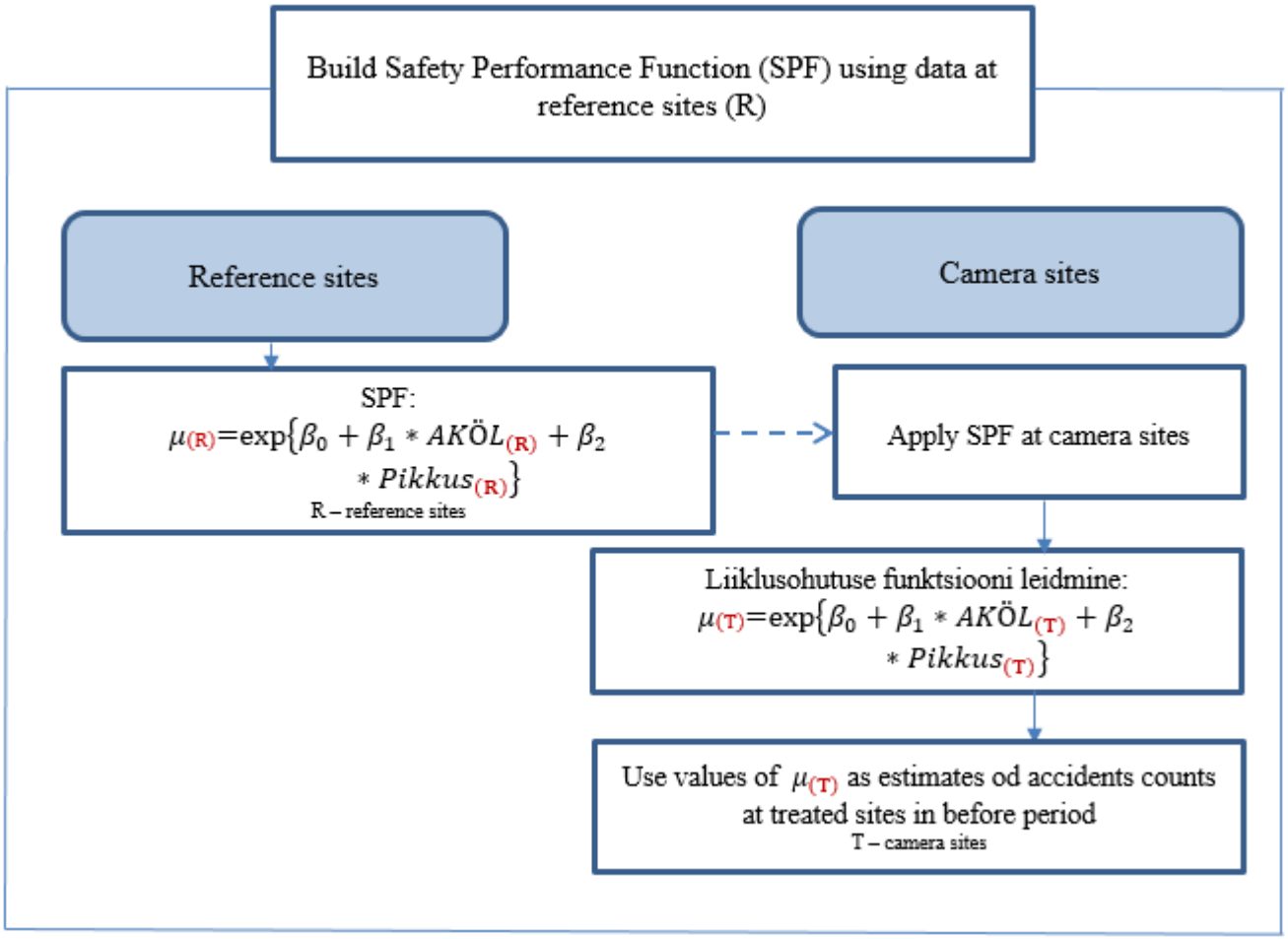
Before – after Full Bayes evaluation with control for RTM and trend

1. *Polygons creation (1 km upstream and downstream, if distance was less 1km, combined to one camera site);*
2. *Count of collisions at camera sites for before and after*
3. *AADT at camera sites (weighted by length within a polygon)*
4. *Control sites (82 sites along the same roads)*
5. *Same procedure for control sites*

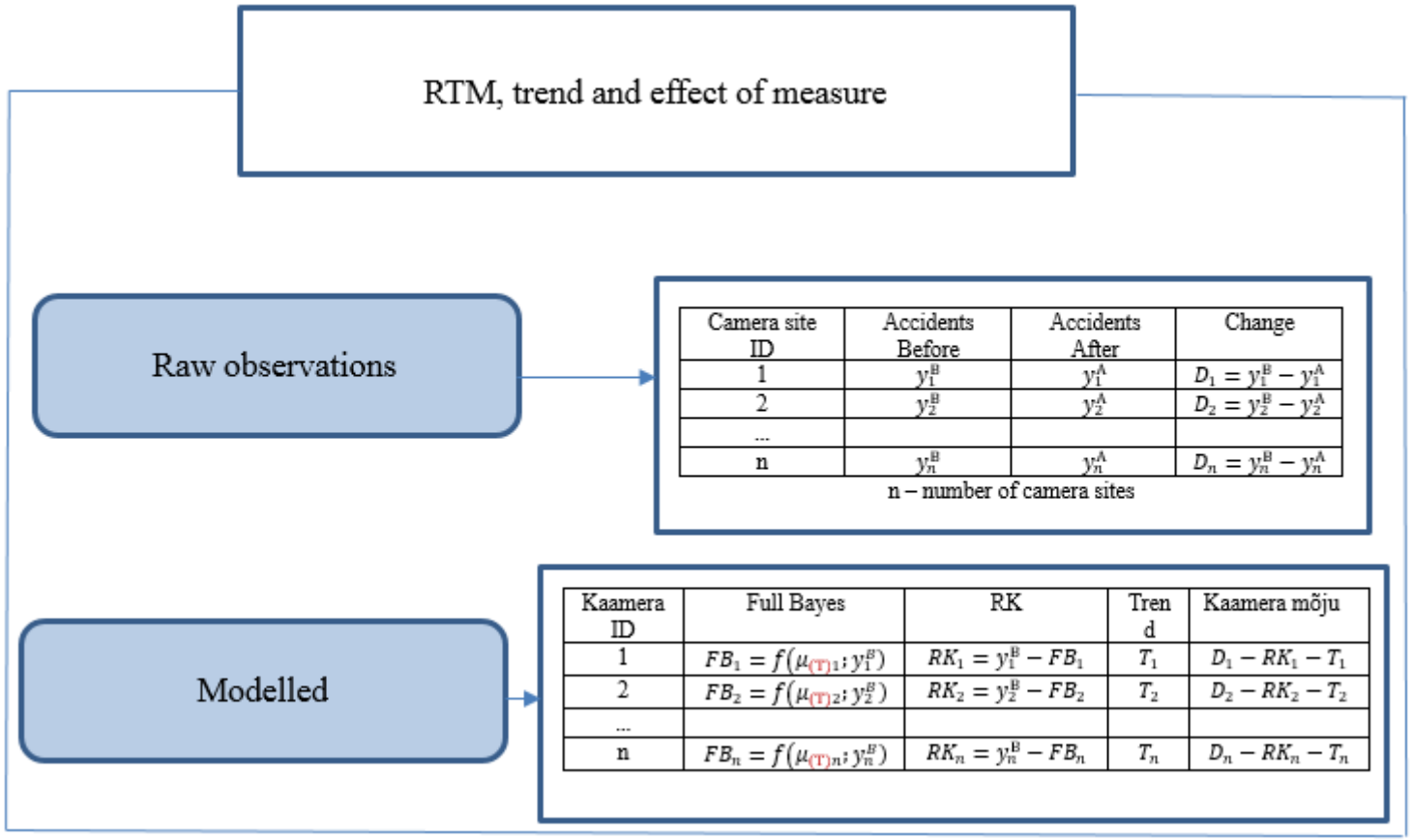


Road nr	Average installation time	3 years before	3 years after
1	31.07.2012	1.08.2009	31.07.2015
2	31.01.2010	1.02.2007	30.01.2013
4	1.12.2010	2.12.2007	30.11.2013
9	1.12.2013	2.12.2010	30.11.2016
15	1.03.2014	2.03.2011	28.02.2017
8	7.10.2016	8.10.2013	7.10.2019
11390	1.03.2014	2.03.2011	28.02.2017

Method (2)


Build Safety Performance Function (SPF) using data at reference sites (R)
Reference sites
Camera sites
SPF:
$\mu_{(R)}=\exp\{\beta_0+\beta_1*AKÖL_{(R)}+\beta_2*Pikkus_{(R)}\}$
R – reference sites
Apply SPF at camera sites
Liiklusohutuse funktsiooni leidmine:
$\mu_{(T)}=\exp\{\beta_0+\beta_1*AKÖL_{(T)}+\beta_2*Pikkus_{(T)}\}$
Use values of $\mu_{(T)}$ as estimates od accidents counts at treated sites in before period
T – camera sites

Method (3)



Camera site ID	Accidents Before	Accidents After	Change
1	y_1^B	y_1^A	$D_1 = y_1^B - y_1^A$
2	y_2^B	y_2^A	$D_2 = y_2^B - y_2^A$
...			
n	y_n^B	y_n^A	$D_n = y_n^B - y_n^A$

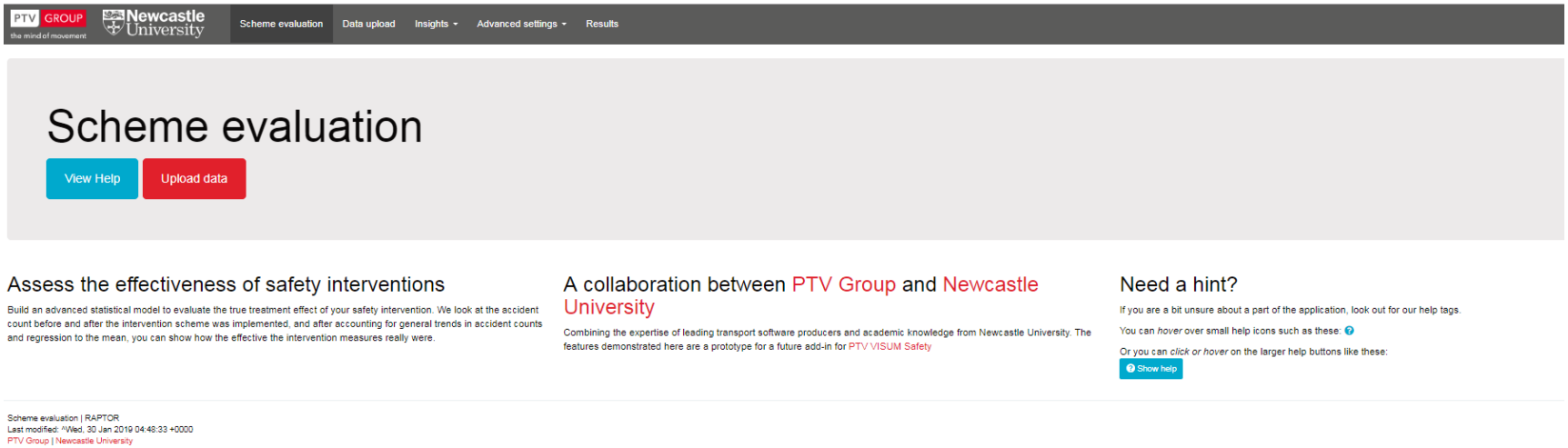
n – number of camera sites

Kaamera ID	Full Bayes	RK	Trend	Kaamera mõju
1	$FB_1 = f(\mu_{(T)1}; y_1^B)$	$RK_1 = y_1^B - FB_1$	T_1	$D_1 - RK_1 - T_1$
2	$FB_2 = f(\mu_{(T)2}; y_2^B)$	$RK_2 = y_2^B - FB_2$	T_2	$D_2 - RK_2 - T_2$
...				
n	$FB_n = f(\mu_{(T)n}; y_n^B)$	$RK_n = y_n^B - FB_n$	T_n	$D_n - RK_n - T_n$

RAPTOR

A collaboration between PTV Group and Newcastle University

https://mas-shiny.ncl.ac.uk/scheme-evaluation/#



Set prior destribution for trend (What is the largest percentage increase/decrease in casualties you believe to be realistically possible from year to year?);

β_0 Intercept destribution and the overdispersion parameter of the model.

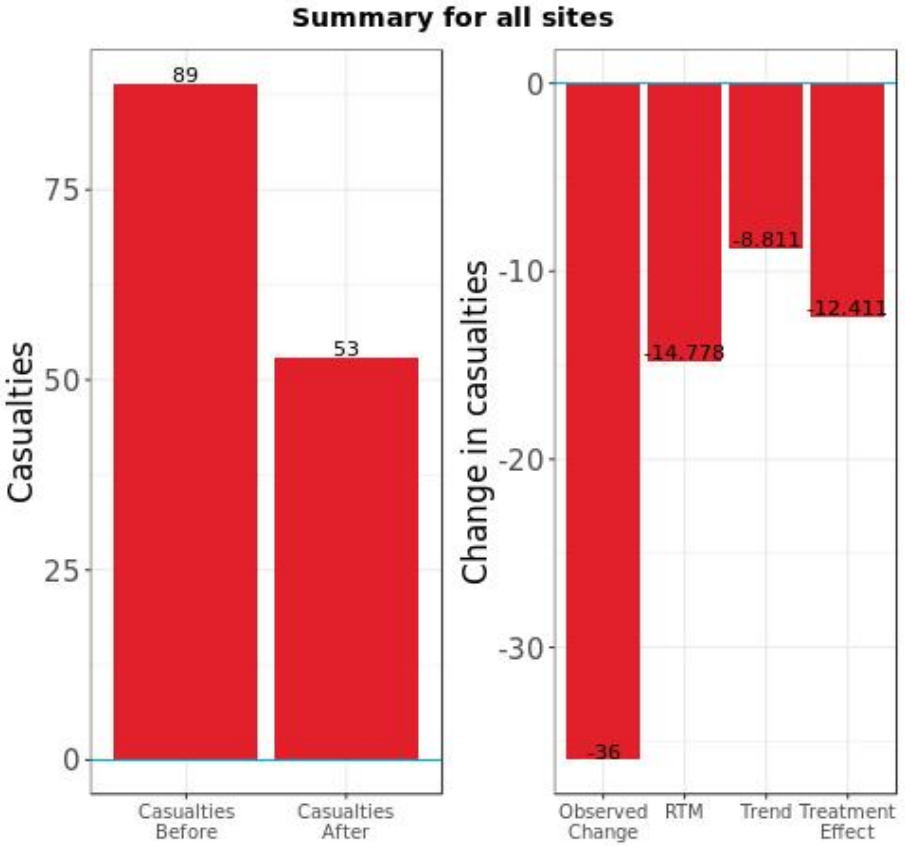
Simulation settings (number of iterations, thinning steps between iterations, burn-in steps)

Results (2)

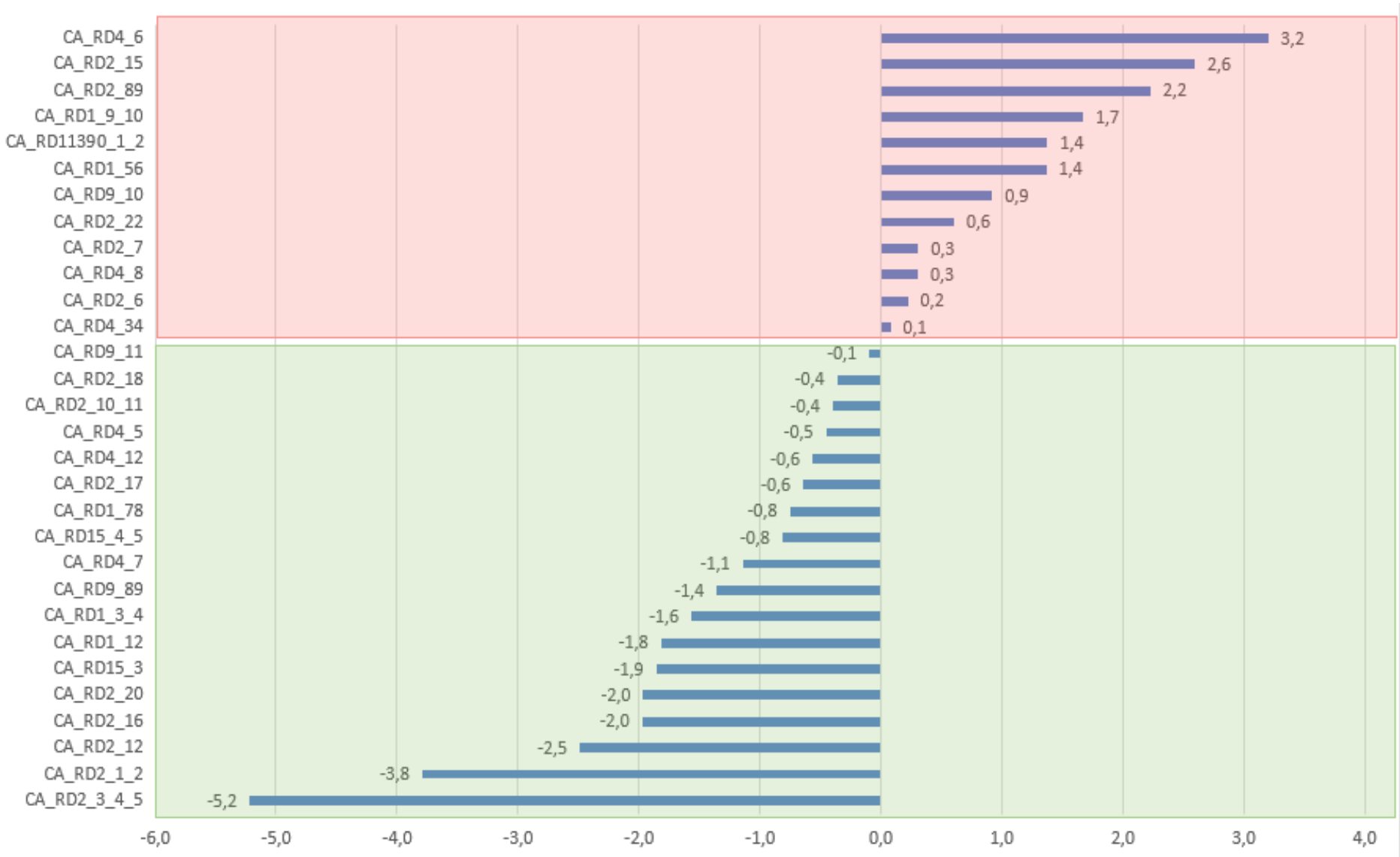
	Collisions		Change	AADT, veh/day		Change
	Before	After		Before	After	
Treated sites	89	53	-40%	6568	6453	-2%
Reference sites	110	85	-23%	6375	6496	2%

40% of reduction is due to RTM, 24% due to trend and **34%** is effect of intervention.

A statistically significant reduction of the number of injury and fatal crashes by **13%** was found.



Results: treatment effect for all sites (3)



Results: summary for all sites (4)

	Site.Number	Casualties.Before	Casualties.After	Observed.Change	RTM	Trend	Treatment.Effect	Bayes.Estimate	APM
1	CA_RD1_12	4	1	-3	-0.785	-0.396	-1.819	2.819	2.909
2	CA_RD1_56	5	3	-2	-2.87	-0.495	1.365	1.635	1.451
3	CA_RD1_78	2	1	-1	-0.048	-0.198	-0.754	1.754	1.774
4	CA_RD15_3	4	0	-4	-1.746	-0.396	-1.858	1.858	1.726
5	CA_RD2_10_11	2	4	2	2.598	-0.198	-0.4	4.4	5.732
6	CA_RD2_12	3	4	1	3.787	-0.297	-2.49	6.49	12.189
7	CA_RD2_15	1	4	3	0.507	-0.099	2.592	1.408	1.431
8	CA_RD2_16	2	0	-2	0.172	-0.198	-1.974	1.974	1.979
9	CA_RD2_17	1	1	0	0.742	-0.099	-0.643	1.643	1.689
10	CA_RD2_18	2	1	-1	-0.44	-0.198	-0.362	1.362	1.328
11	CA_RD2_20	2	0	-2	0.162	-0.198	-1.964	1.964	2.001
12	CA_RD2_22	3	2	-1	-1.305	-0.297	0.602	1.398	1.317
13	CA_RD2_3_4_5	7	2	-5	0.913	-0.693	-5.22	7.22	11.523
14	CA_RD2_6	1	2	1	0.878	-0.099	0.221	1.779	1.838
15	CA_RD2_7	2	2	0	-0.111	-0.198	0.309	1.691	1.675
16	CA_RD2_89	2	4	2	-0.028	-0.198	2.226	1.774	1.762
17	CA_RD4_12	3	1	-2	-1.138	-0.297	-0.565	1.565	1.486
18	CA_RD4_34	5	2	-3	-2.583	-0.495	0.078	1.922	1.729
19	CA_RD4_5	3	1	-2	-1.249	-0.297	-0.454	1.454	1.371
20	CA_RD4_6	3	5	2	-0.903	-0.297	3.2	1.8	1.724
21	CA_RD4_7	4	1	-3	-1.461	-0.396	-1.143	2.143	2.003
22	CA_RD4_8	2	2	0	-0.106	-0.198	0.304	1.696	1.679
23	CA_RD9_10	1	2	1	0.179	-0.099	0.92	1.08	1.086
24	CA_RD9_11	1	1	0	0.194	-0.099	-0.095	1.095	1.098
25	CA_RD9_89	1	0	-1	0.455	-0.099	-1.356	1.356	1.376
26	CA_RD11390_1_2	8	3	-5	-5.584	-0.792	1.376	1.624	1.316
27	CA_RD15_4_5	3	1	-2	-0.887	-0.297	-0.816	1.816	1.741
28	CA_RD2_1_2	3	0	-3	1.09	-0.297	-3.793	3.793	4.285
29	CA_RD1_3_4	3	0	-3	-1.136	-0.297	-1.567	1.567	1.485
30	CA_RD1_9_10	6	3	-3	-4.075	-0.594	1.669	1.331	1.128

Discussion and limitations

1) Speed camera section length;
2) Reference sites on the same roads;
3) Accident data quality;
4) Average installation time.

All above-mentioned limitations guarantee, that **13%** reduction of injury crashes is **minimum observed effect** of the evaluated speed cameras.

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Thanks for your attention!

https://www.mnt.ee/sites/default/files/survey/kokkuvotte_2019_001.pdf

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