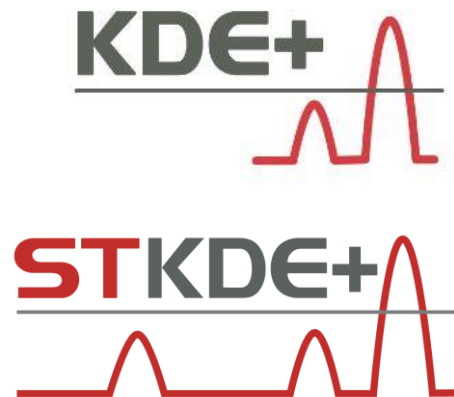


KDE+, STKDE+ a ROCA

Nástroje pro výzkum nebezpečných lokalit na pozemních komunikacích



Jiří Sedoník

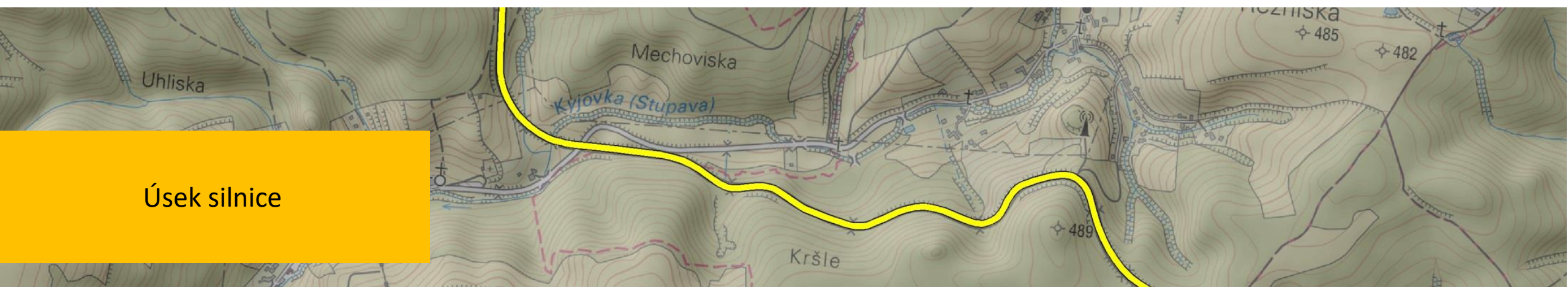
Michal Bíl

Richard Andrášik

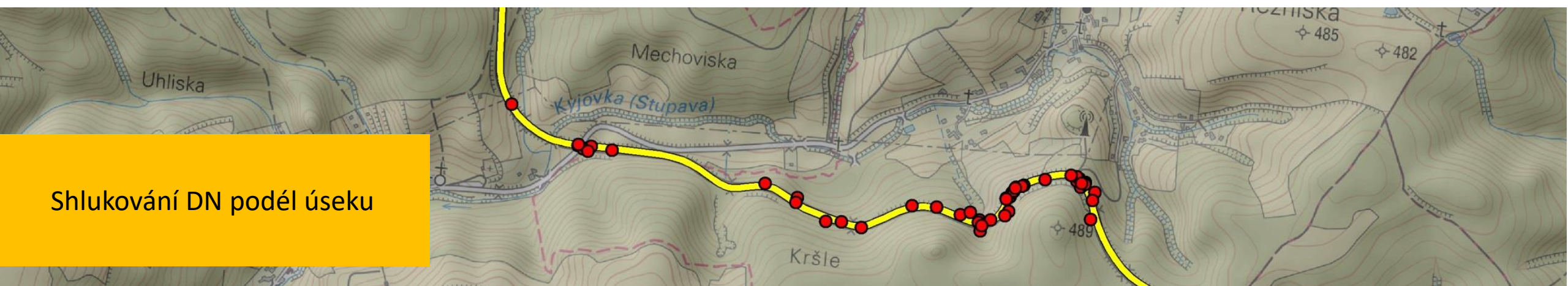
Martina Bílová



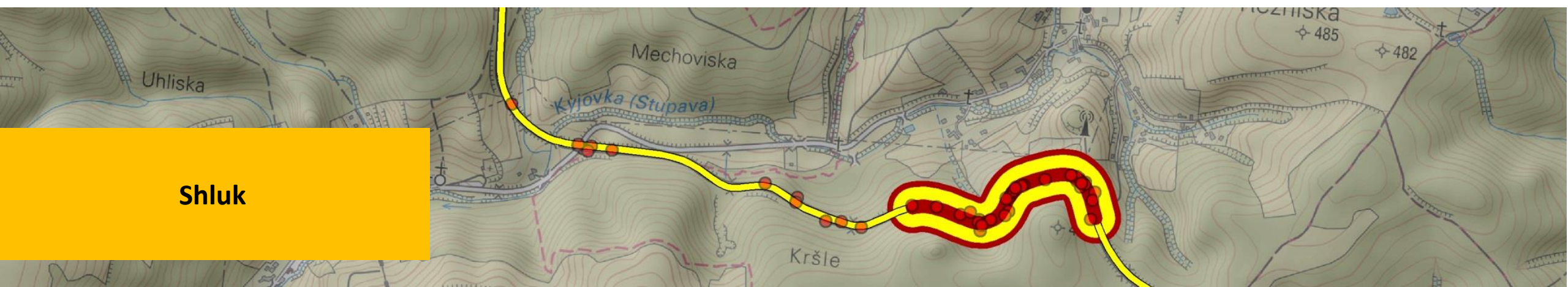
Úsek silnice



Shlukování DN podél úseku

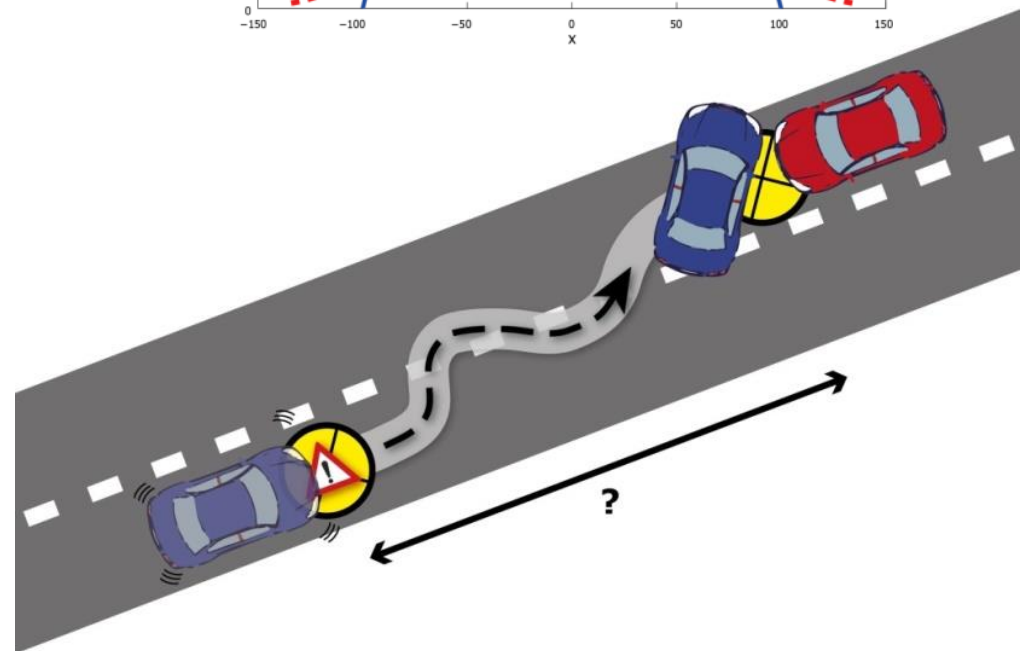
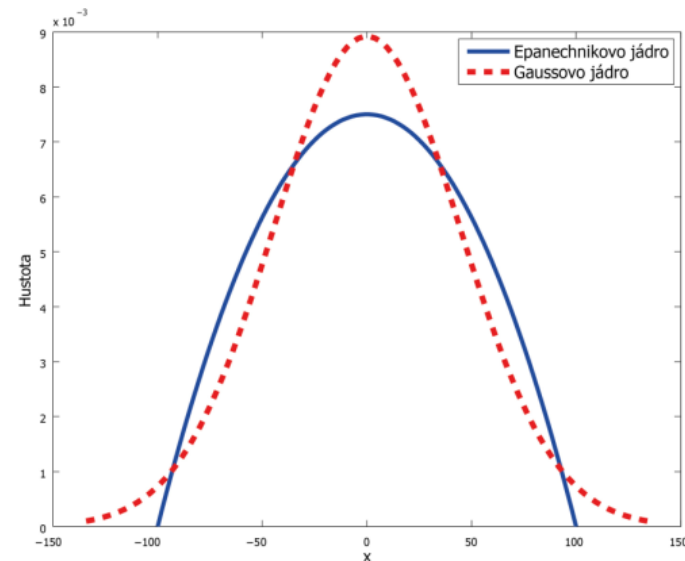
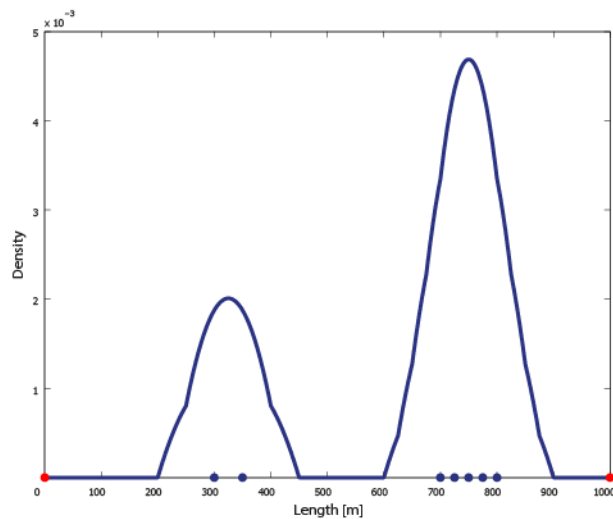


Shluk



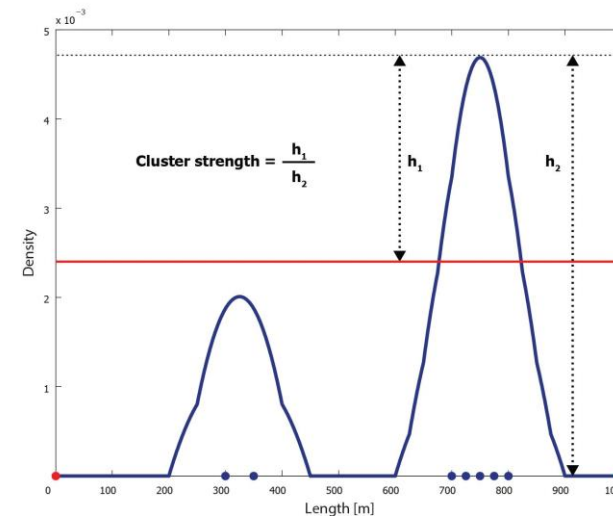
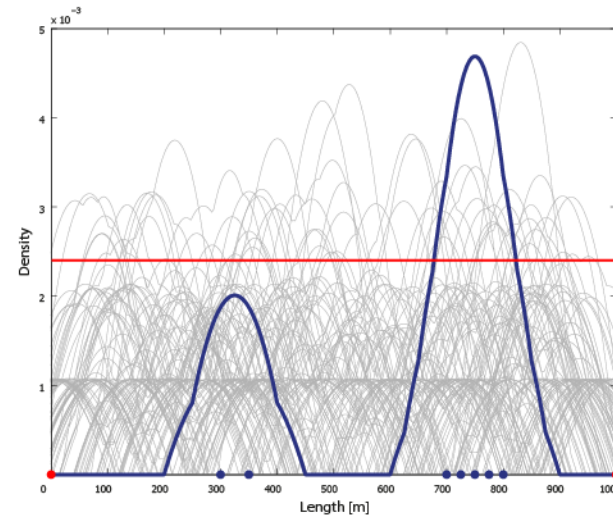
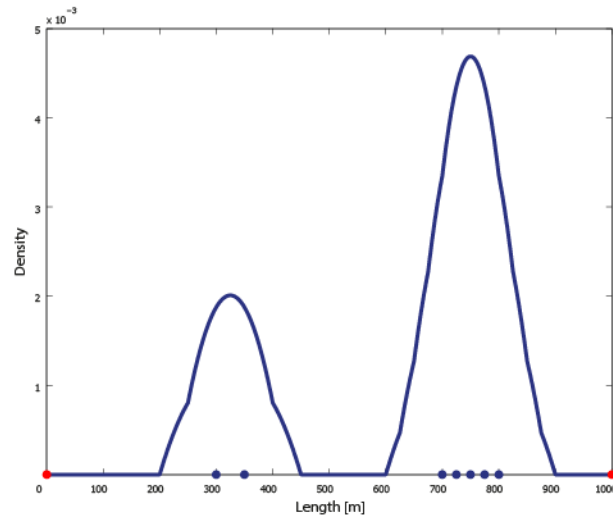
KDE

- neparametrická metoda pro odhad hustoty pravděpodobnosti
- klouzavý vážený průměr, jehož kvalita závisí především na:
 - » šířce **vyhlazovacího okna** (nejistota vstupních dat)
 - » **typu jádra**
- **vždy najde nějaké shluky**



KDE+


- určení hladiny významnosti pomocí metody statistického testování **Monte Carlo**
 - » náhodné simulace jevu (DN) – stovky opakování (>800)
 - » střední hodnota 95 percentil = **hladina významnosti** → **významné shluky** nad červenou linií
 - » počítá se pro každý úsek sítě zvlášť (konstantní intenzity dopravy)
- **síla shluku** – kvantifikace významu shluku $<0, 1>$ – lze srovnávat mezi sebou **v rámci celé sítě**



Publikace o KDE+

Identifikace kritických nehodových lokalit pomocí GIS analýzy polohy dopravních nehod

METODIKA



Michal Bíl, Richard Andrášik, Zbyněk Janoška, Jiří Sedoník a Veronika Valentová

Alfa | KDE+ | Centrum dopravního výzkumu, v. v. i. 2014 | Technologická agentura České republiky

Biological Conservation 213 (2017) 167–174

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon




Srazenazver.cz: A system for evidence of animal-vehicle collisions along transportation networks

Michal Bíl*, Jan Kubeček, Jiří Sedoník, Richard Andrášik

CDV—Transport Research Centre, Brno, Czech Republic



Landscape Ecol
DOI 10.1007/s10980-015-0265-6



PERSPECTIVE

The KDE+ software: a tool for effective identification and ranking of animal-vehicle collision hotspots along networks

Michal Bíl* · Richard Andrášik · Tomáš Svoboda · Jiří Sedoník

Received: 22 December 2014 / Accepted: 19 August 2015
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Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap




Identification of hazardous road locations of traffic accidents by means of kernel density estimation and

Michal Bíl*, Richard Andrášik, Zbyněk Janoška

Transport Research Centre, Líšeňská 33a, Brno, 636 00, Czech Republic

ARTICLE INFO



Article history:
Received 19 October 2012
Received in revised form 14 January 2013
Accepted 3 March 2013

Keywords:
Clustering
Traffic accidents
Hazardous road locations
Kernel density estimation
Monte Carlo

ABSTRACT




This paper proposes a g according to their signif significance testing of the important clusters within the significance level cor Carlo simulations. To show cluster strength and clus Moravia Region of the Cz

Journal of Environmental Management
Volume 275, 1 December 2020, 111254


Research article

The effect of wildlife carcass underreporting on KDE+ hotspots identification and importance




Michal Bíl*  , Richard Andrášik 

CDV – Transport Research Centre, Líšeňská 33a, 636 00, Brno, Czech Republic

Applied Geography
Volume 125, December 2020, 102304

Spatial analysis of wildlife-train collisions on the Czech rail network

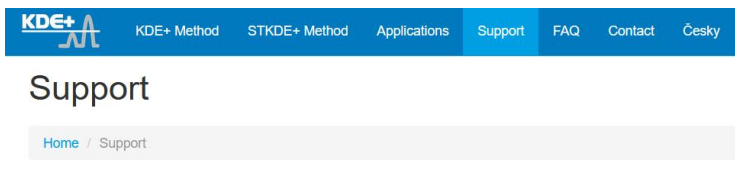
Vojtěch Nezval^{a, b}  , Michal Bíl^b 

^a Department of Physical Geography and Geoecology, Faculty of Science, University of Ostrava, Chittussiho 10, 710 00 Ostrava, Czech Republic
^b CDV – Transport Research Centre, Líšeňská 33a, 636 00 Brno, Czech Republic

KDE+ toolbox for ArcGIS

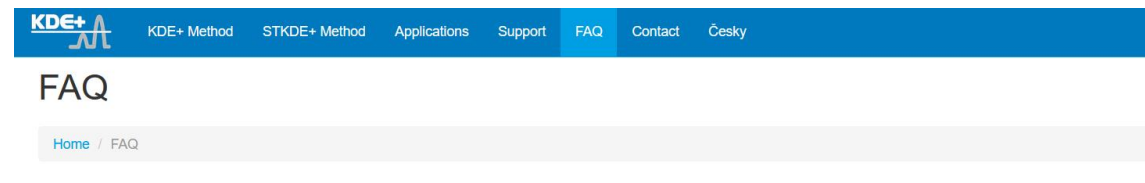
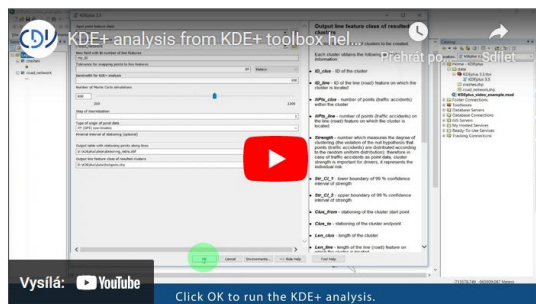


- počet uživatelů ~ **350** z **59** států
- *úprava licenční politiky*
 - » vědecko-výzkumné účely (spolupráce, zahraniční projekty)
 - » komerční zakázky
- kdeplus.cz



New to KDE+? See please the following video where the work with this software is explained:

KDE+ help video for KDE+ toolbox for ArcGIS:



What is the KDE+ method?

The KDE+ method performs cluster analysis of traffic crashes (or other point events) within a network (road, railway...). It extends the kernel density estimation (KDE) by statistical significance testing and allows for the ranking of the resulting significant clusters.

No records

A cluster is defined, in our sense, as a part of a road section around a local maximum of the probability density function which was estimated by the use of the kernel density estimation. Naturally, no records mean no clusters.

No data, no analysis

Cluster

Not statistically significant

One, two or more records at one place, form a cluster. Each cluster is statistically tested using the KDE+. Clusters which are not statistically significant could arise randomly. These clusters are therefore outside our interest.

outside the scope of KDE+ analysis

Cluster

Statistically significant = HOTSPOT

Non-random spatial concentration of records is called a hotspot (a statistically significant cluster). Usually, a **local factor** (or a combination of several local factors) induces the existence of the hotspot. Therefore, the very next step in the safety assessment process should be to **study the local factors**^{1, 2}.

Prioritization of hotspots and their **ranking**³.
KDE+ hotspots can be further ranked according to their **strength**³ or **collective risk**⁴. The resulting list of hotspots will start with the most critical one within the network in question.



1. Bartonička, T., Andrášik, R., Duša, M., Sedoník, J., Bil, M., 2018. Identification of Local Factors Causing Clustering of Animal-Vehicle Collisions. Journal of Wildlife Management 82, pp. 940–947.

2. Bil, M., Andrášik, R., Duša, M., Sedoník, J., 2019. On reliable identification of factors influencing wildlife-vehicle collisions along roads. Journal of Environmental Management 237C, 297–304.

3. Bil, M., Andrášik, R., Janoška, Z., 2013. Identification of Hazardous Road Locations of Traffic Accidents by means of Kernel Density Estimation and Cluster Significance Evaluation. Accident Analysis and Prevention 55, 265–273.

4. Favilli, F., Bil, M., Sedoník, J., Andrášik, R., Kasal, P., Agreiter, A., Strefeneder, T., 2018. Application of KDE+ software to identify collective risk hotspots of ungulate-vehicle collisions in South Tyrol, Northern Italy. European Journal of Wildlife Research 64:59.

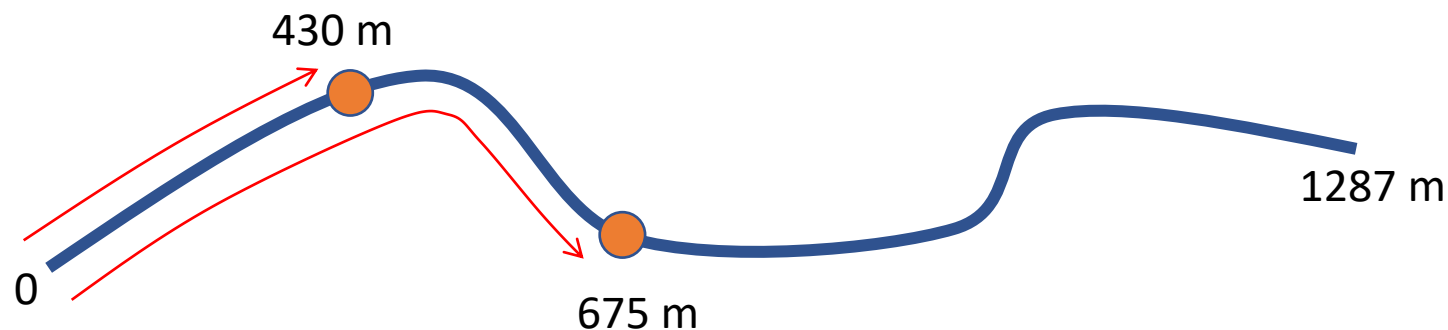
Data pro KDE+

INPUT:

- **Bodová vrstva (DN ...)**
Příprava dat - nepřesná data raději nasnapovat
Filtrovat dle typu DN (datum/čas, příčina, následky...)
- **Liniová vrstva silniční sítě (mezikřižovatkové úseky)**
Zachování konstantní **intenzity dopravy**

OUTPUT:

- Tabulka se staničením bodů podél linií
- **Liniová vrstva KDE+ hotspotů**



KDE+ toolbox (ArcMap i ArcGIS Pro)

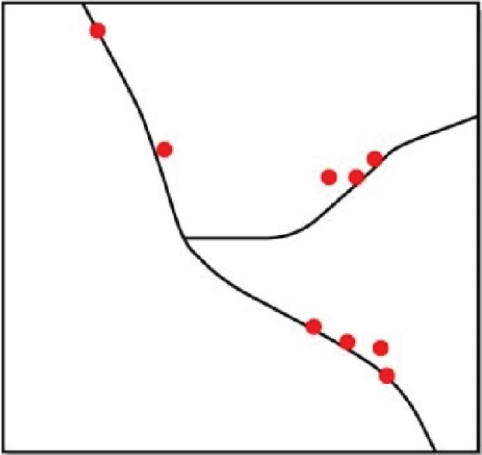
KDEplus 3.0
— □ ×

- 1 Input point feature class
- 2 Input line feature class
- 3 New field with ID number of line features
new_ID
- 4 Tolerance for snapping points to line features
50 Meters
- 5 Bandwidth for KDE+ analysis
100
- 6 Number of Monte Carlo simulations
800 (slider from 200 to 1200)
- 7 Step of discretization
1
- 8 Type of origin of point data
XY (GPS) coordinates
- 9 Output table with stationing points along lines
- 10 Output line feature class of resulted clusters

KDEplus 3.0

Kernel Density Estimation PLUS (KDE+) method analyzes point features, which are located alongline features, and finds locations (clusters) with statistically significant concentrations of these points. Results of KDE+ are returned as line features.

INPUT



OK
Cancel
Environments...
<< Hide Help
Tool Help

KDE+ hotspoty

- Liniová vrstva

- Atributy:

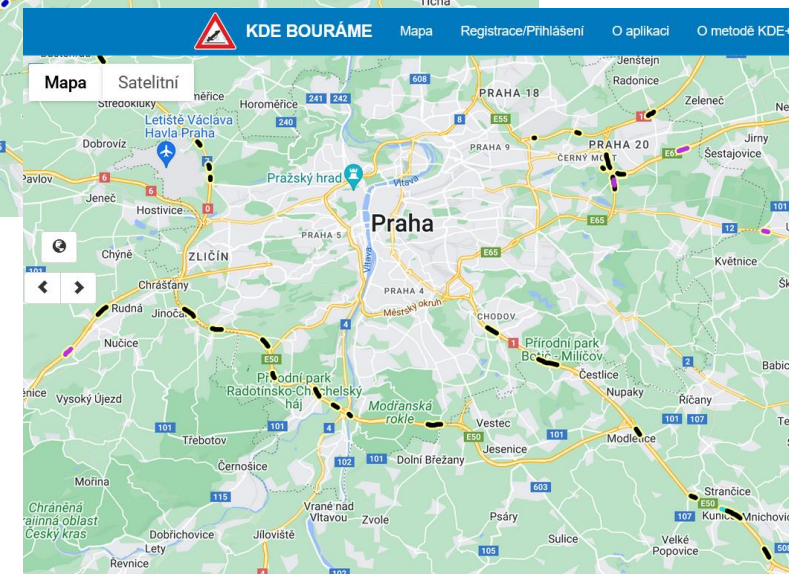
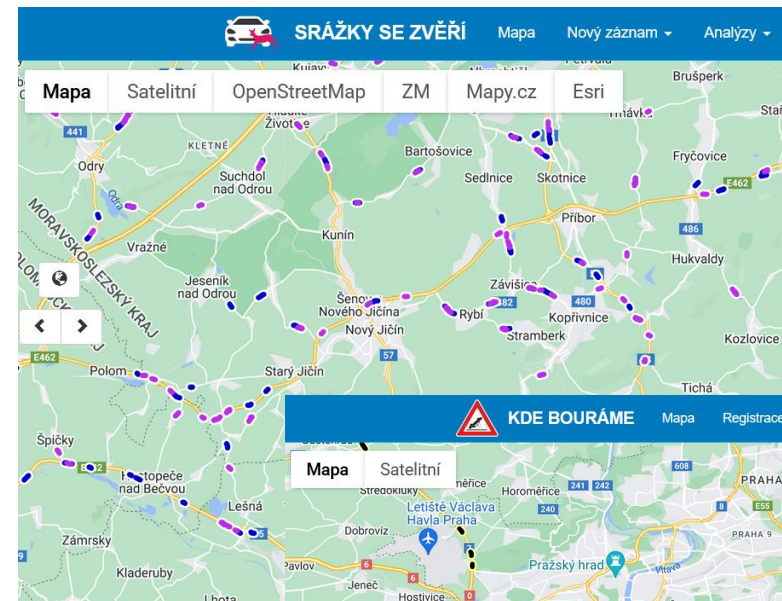
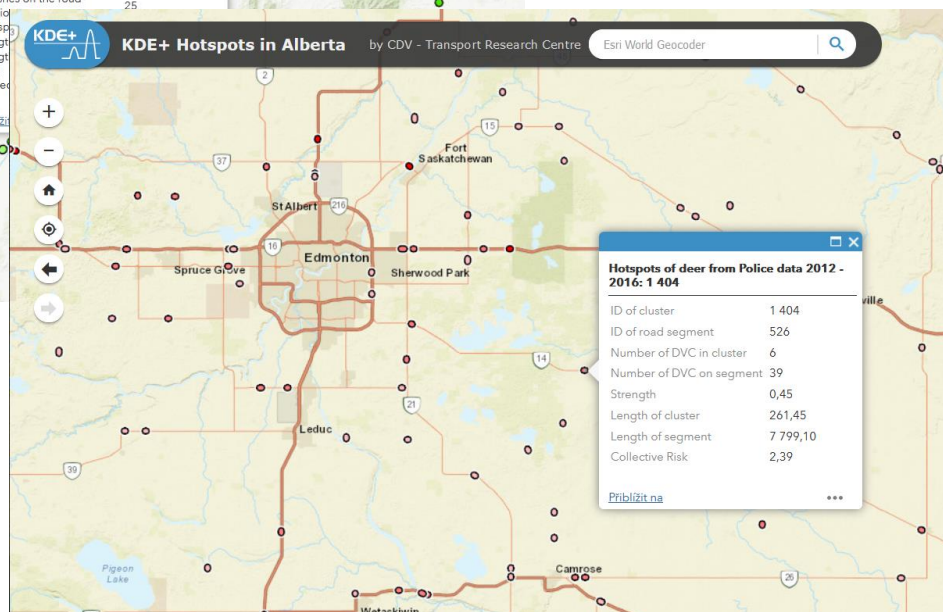
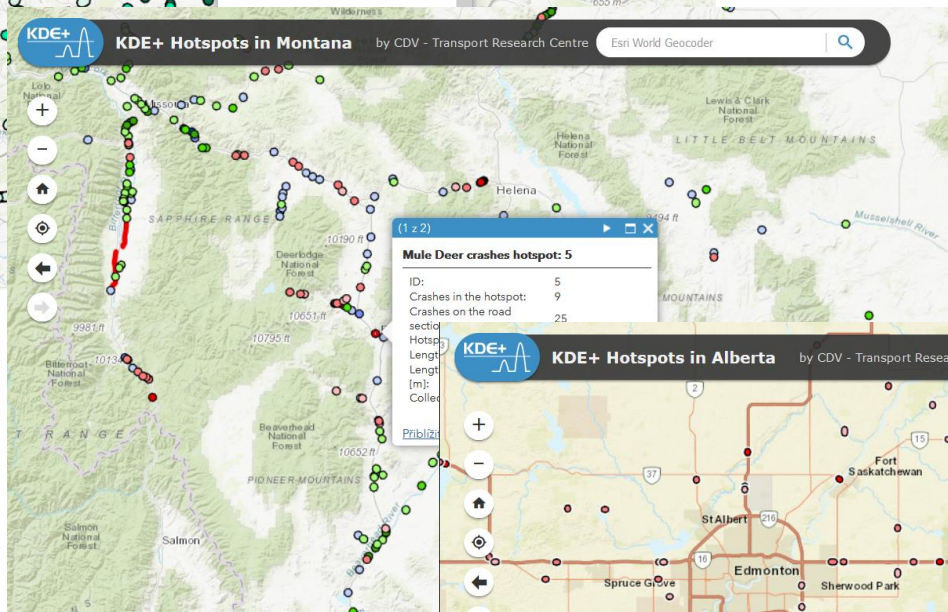
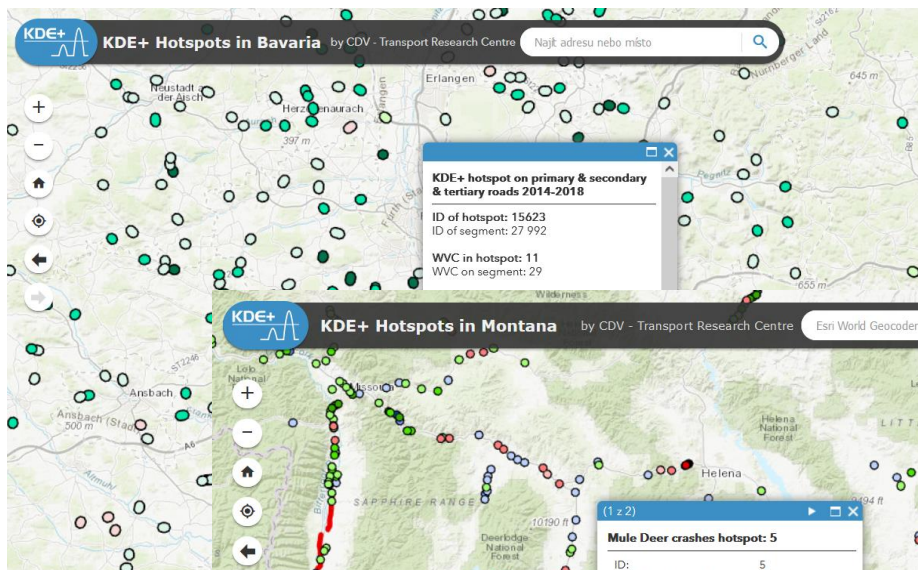
- ID_clus - ID shluku
- ID_line - ID úseku, na kterém se shluk nachází
- NPts_clus - počet DN ve shluku
- NPts_line - počet DN na úseku, na kterém se shluk nachází
- Clus_from / to - relativní staničení shluku (start / end point) na úseku
- Len_clus - délka shluku
- Dens_Point - počet DN ve shluku / 100 m

Strength = Síla shluku = individuální riziko

Str_Dens2 = Strength*Dens_point^2 = kolektivní riziko

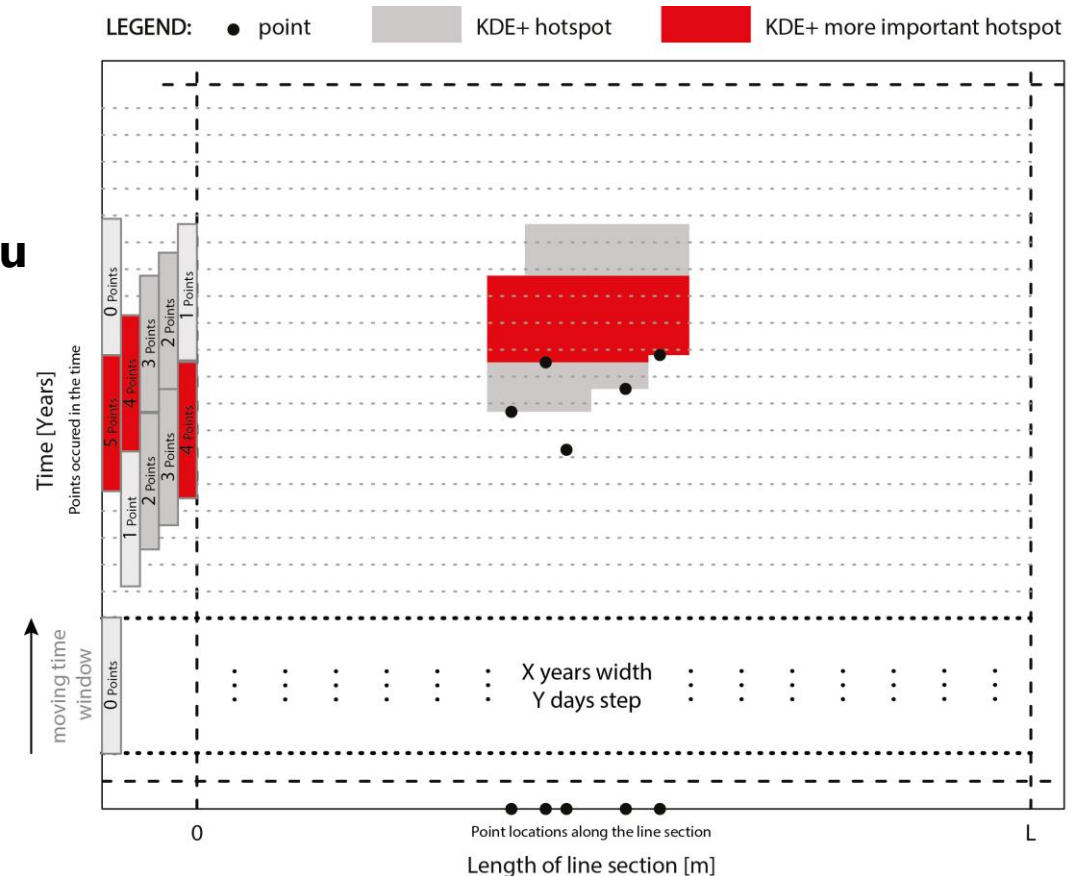
- měří kolektivní význam shluku – důležité pro správce komunikací

FID	Shape *	ID clus	ID line	NPts clus	NPts line	Strength	Clus from	Clus to	Len clus	Len line	Dens Point	Str Dens2
1151	Polyline	2264	2841	22	54	0,663138	1459	1702,131272	243,131272	1936,587911	9,04861	54,295976
1152	Polyline	3397	5209	2	2	0,663017	0	81	81	615,909464	2,469136	4,042171
1153	Polyline	1503	1669	7	25	0,662981	1055	1217	162	3982,313179	4,320988	12,378477
1154	Polyline	4382	7745	4	9	0,66287	127	332	205	5053,347503	1,95122	2,523717
1155	Polyline	5510	10806	3	55	0,662847	12807	12968	161	47366,954465	1,863354	2,301462
1156	Polyline	3815	6201	4	25	0,662746	6172,148042	6368	195,851958	14359,375925	2,042359	2,764465
1157	Polyline	409	346	15	34	0,662466	891	1142,032168	251,032168	2890,816466	5,97533	23,653073
1158	Polyline	4514	8181	3	12	0,662458	5627	5787	160	6204,704921	1,875	2,328956
1159	Polyline	4835	9386	11	12	0,662448	313,744514	448,983956	135,239442	448,983956	8,133722	43,82587
1160	Polyline	5399	10541	5	8	0,662204	796	901,024938	105,024938	901,024938	4,760774	15,008841



STKDE+ (Spatial – Temporal KDE+)

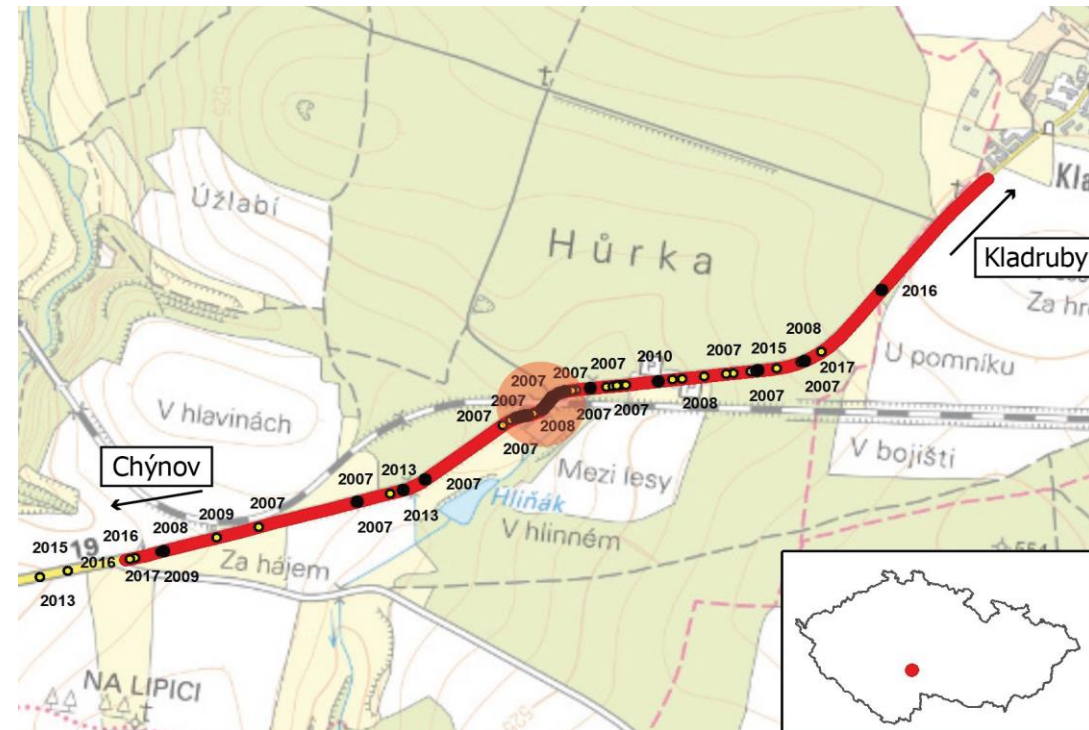
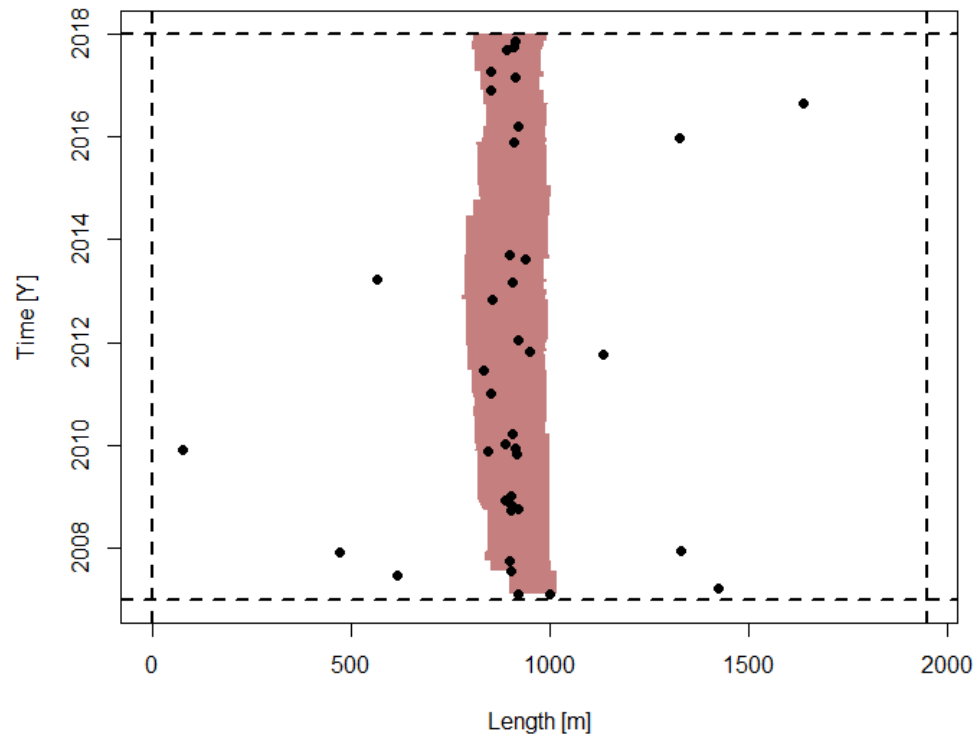
- podstata vzniku DN v místech shluku:
 - » **nenáhodné lokální příčiny** (chybějící nebo nevhodný typ osvětlení, nepřehledná lokalita, špatný povrch komunikace, migrační koridor aj.)
 - » náhodné globální příčiny (denní doba, počasí)
- **aplikace metody KDE+ (v X-letém okně) s Y-denním posunem**
- **Vývoj vzoru DN (shluků) na úsecích v čase a prostoru**
 - » **stabilní - dlouhodobě nebezpečné místo**
 - » **vzniklé v čase - zhoršení bezpečnostní situace na úseku**
 - » **zaniklé v čase – úspěšná sanace nebezpečného místa**
 - » úseky bez DN (shluků) - dlouhodobě bezpečné místo
- kdeplus.cz/cz/stmethod
- Počet uživatelů ~ **45 z 18 států**



STKDE+ (Spatial – Temporal KDE+)

- pro každý úsek vykreslen **časoprostorový graf**
- vizuální identifikace vzorů DN

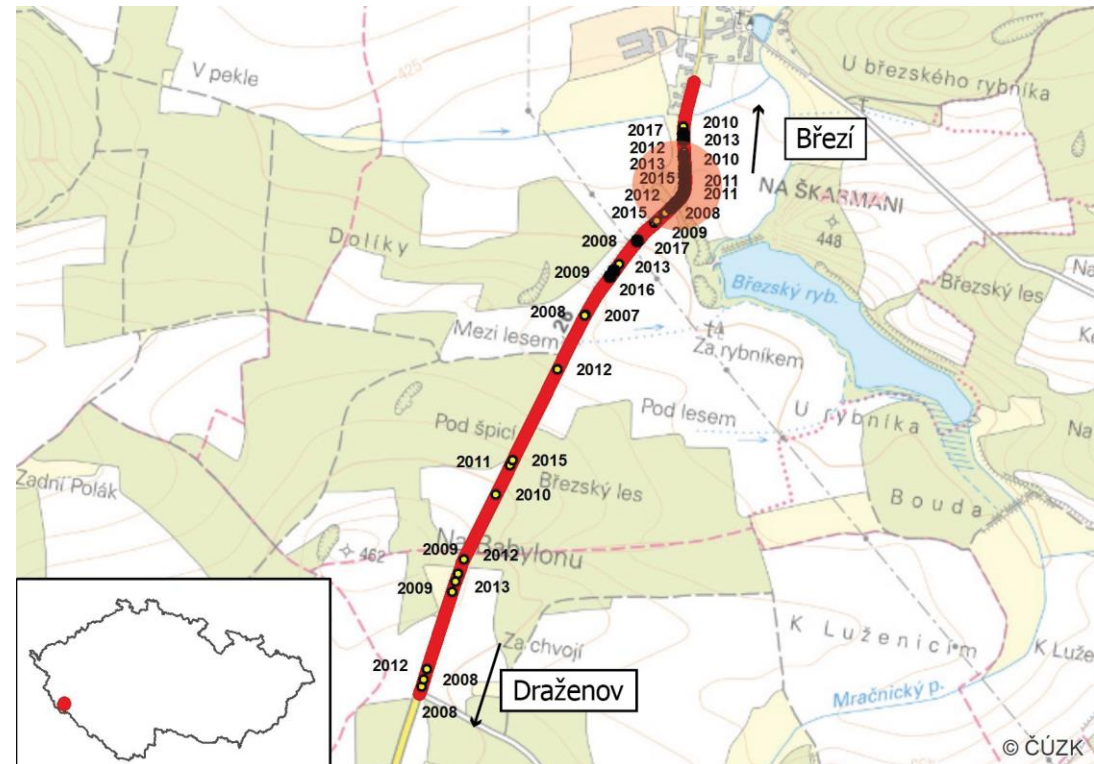
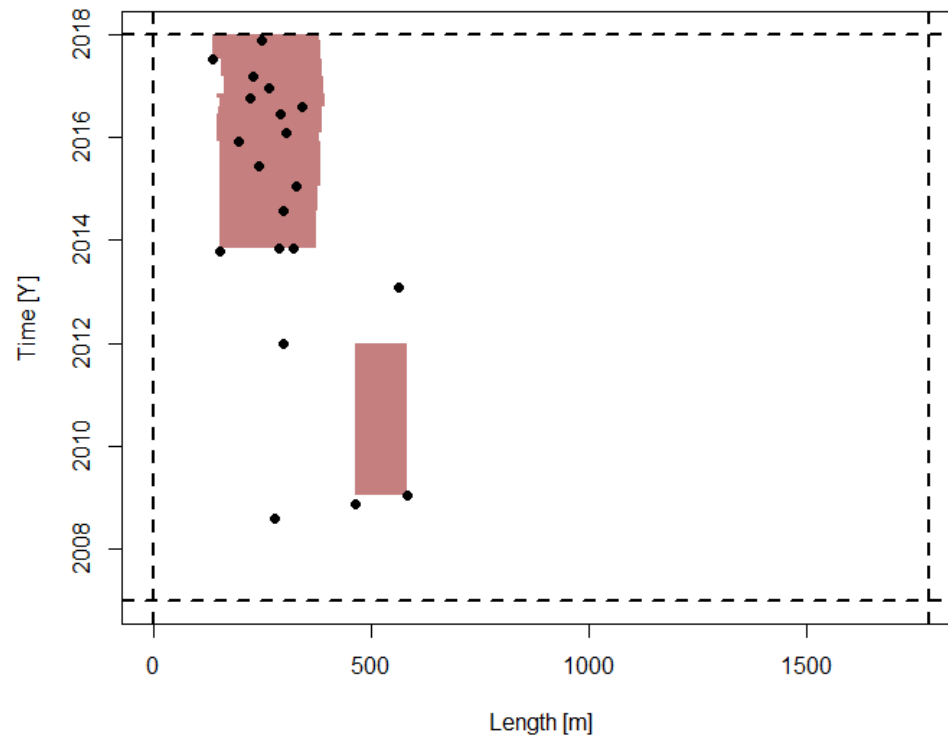
Stabilní shluk



STKDE+ (Spatial – Temporal KDE+)

- pro každý úsek vykreslen **časoprostorový graf**
- vizuální identifikace vzorů DN

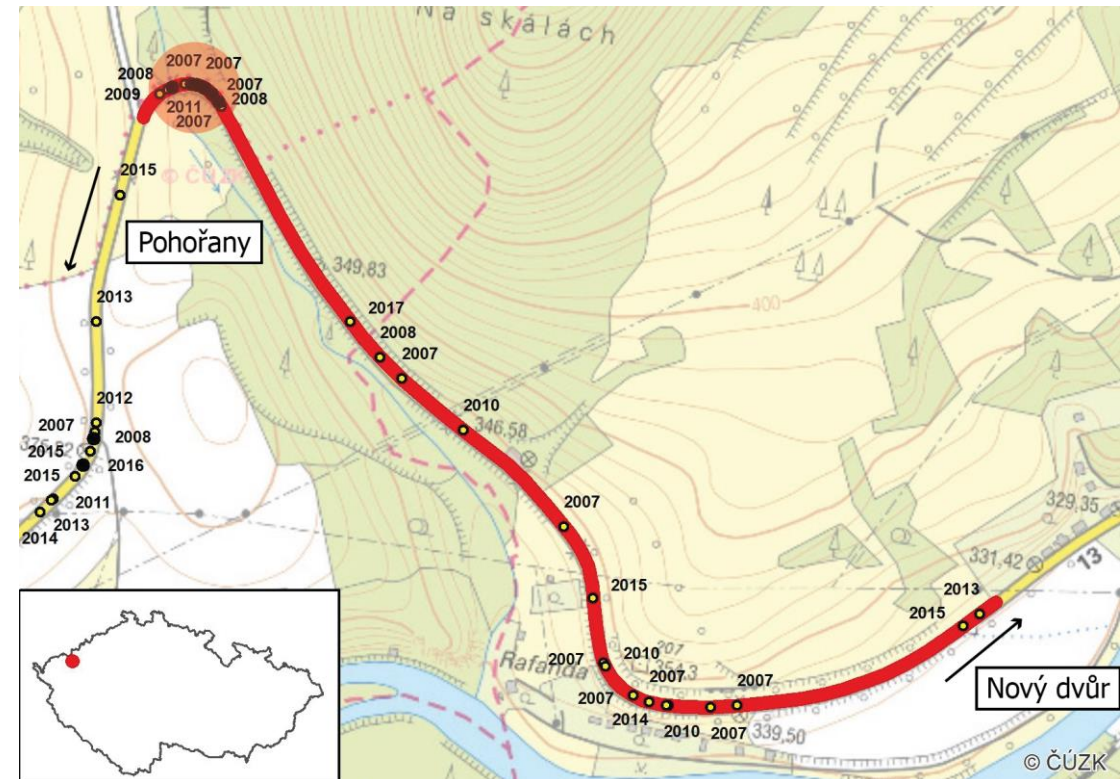
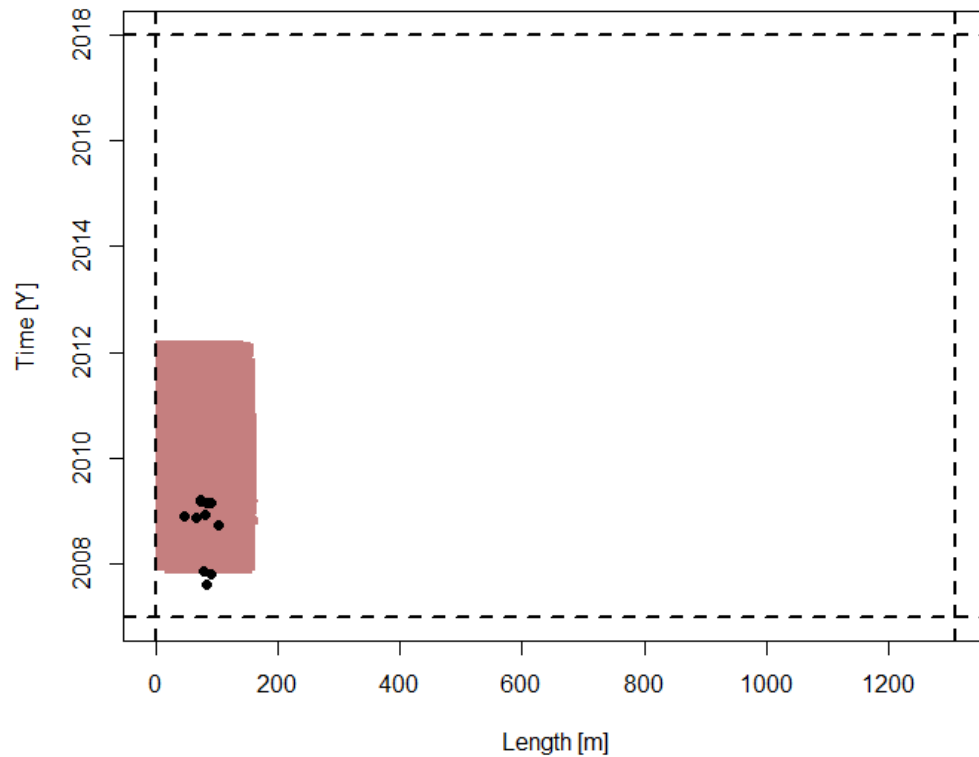
Shluk vznikl v čase (2014)



STKDE+ (Spatial – Temporal KDE+)

- pro každý úsek vykreslen **časoprostorový graf**
- vizuální identifikace vzorů DN

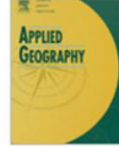
Shluk zanikl v čase



Publikace o STKDE+



Applied Geography
Volume 107, June 2019, Pages 82-90



A detailed spatiotemporal analysis of traffic crash hotspots

[Michal Bíl](#)  , [Richard Andrášik](#), [Jiří Sedoník](#)

CDV – Transport Research Centre, Lisensko

AMERICAN JOURNAL OF
PRIMATOLOGY

Official Journal of
The American Society
of Primatologists

ASP

RESEARCH ARTICLE

An effect of canopy bridges on monkey-vehicle collision hotspots: Spatial and spatiotemporal analyses

[Pamela M. K. Cunneyworth](#) , [Richard Andrášik](#), [Michal Bíl](#)

Research | [Published: 03 October 2023](#)

STKDE+ approach reveals wildlife-vehicle collision hotspots at broken fence locations

[Jiří Sedoník](#) , [Richard Andrášik](#) & [Michal Bíl](#)

[European Journal of Wildlife Research](#) **69**, Article number: 104 (2023) | [Cite this article](#)

Data pro STKDE+

INPUT:

- **Bodová vrstva (DN ...)** - časová řada delší než zvolené X-leté okno
 - Příprava dat - nepřesná data raději nasnapovat
 - Filtrovat dle typu DN (datum/čas, příčina, následky...)
- **Liniová vrstva silniční sítě (mezikřižovatkové úseky)**
 - Zachování konstantní **intenzity dopravy**

OUTPUT:

- Tabulka se staničením bodů podél linií
- **Časoprostorové grafy** (pro každý úsek!)
- **Liniová vrstva STKDE+ hotspotů** (časová platnost od- do, identifikace vzoru)

STKDE+ toolbox (ArcMap i ArcGIS Pro)



STKDEplus 1.1

Input point feature class

Input line feature class

New field with ID number of line features
new_ID

Tolerance for snapping points to line features
50 Meters

Bandwidth for KDE+ analysis
100

Number of Monte Carlo simulations
800 (range: 200 to 1200)

Step of discretization
1

Type of origin of point data
XY (GPS) coordinates

Minimal interval of stationing (optional)

Date field

Date from

Date to

Width of Time window [years]
5

Step of Time window moving [days]
1

Minimum of points along line section
3

Draw only hotspots

Output STKDE+ graph

Output table with stationing points along lines

Output line feature class of resulted hotspots

OK Cancel Environments... Show Help >>

STKDE+ hotspoty

- Liniová vrstva

- Atributy:

ID_clus - ID shluku

ID_line - ID úseku, na kterém se shluk nachází

NPts_clus - počet DN ve shluku

NPts_line - počet DN na úseku, na kterém se shluk nachází

Clus_from / to - relativní staničení shluku (start / end point) na úseku

Len_clus - délka shluku

Dens_Point - počet DN ve shluku / 100 m

Strength (Síla shluku = individuální riziko) – maximum a datum platnosti

Str_Dens2 (kolektivní riziko) – maximum a datum platnosti

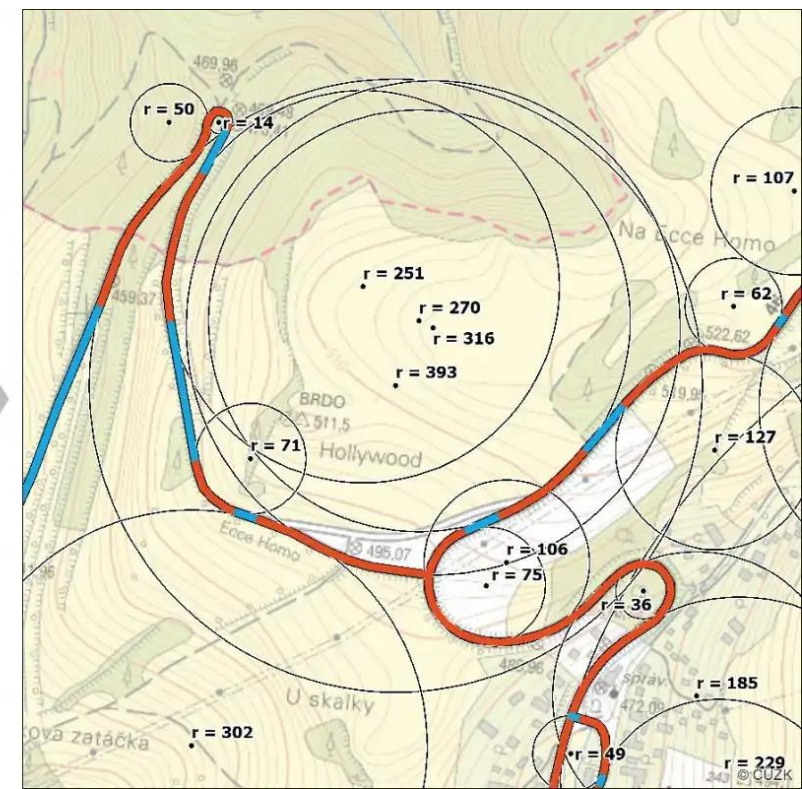
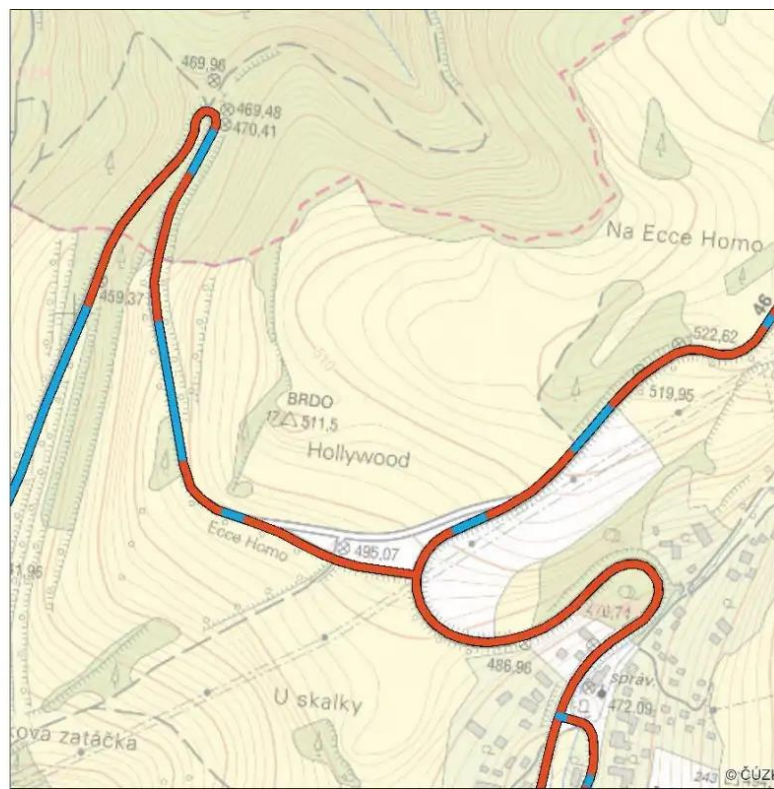
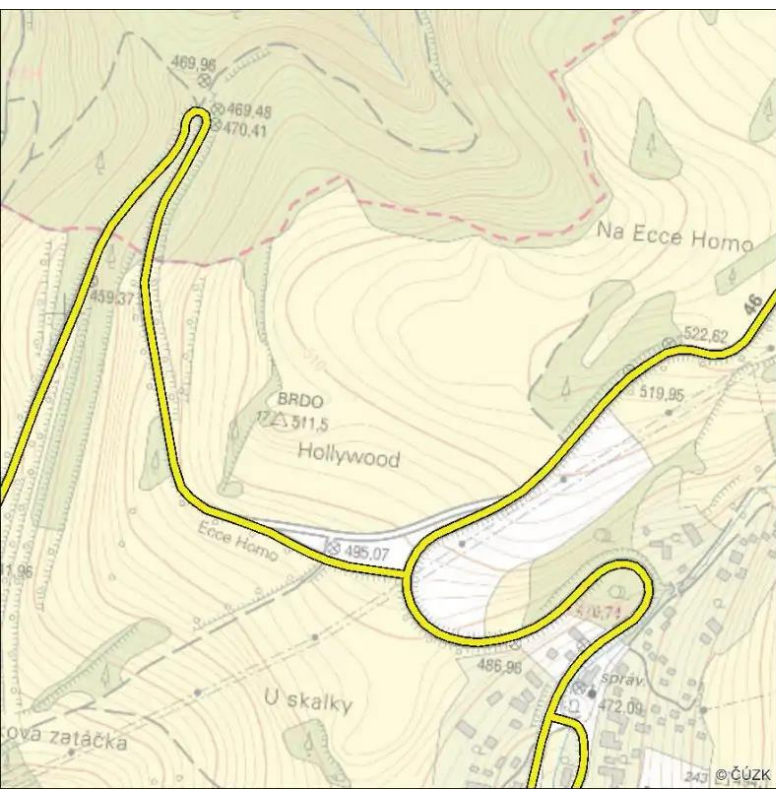
Hotspot_fr / to - časová platnost hotspotu

Pattern - identifikovaný vzor

FID	Shape	ID clus	ID line	NPts in	NPts line	Clus from	Clus to	Len clus	Len line	Hotspot fr	Hotspot to	Strength	Str date	ColRisk	CR date	Hotsp days	Pattern
6340	Polyline	70569	9805	18	54	317,008823	537	219,991177	3459,174258	05.09.2018	01.01.2023	0,788002	12.04.2020	56,810212	18.09.2021	1579	hotspot emergence
6347	Polyline	70680	9811	13	32	693,196981	895	201,803019	2180,562492	31.08.2018	01.01.2023	0,736069	05.07.2020	28,927564	01.01.2023	1584	hotspot emergence
6348	Polyline	70681	9811	2	32	2114	2180,562492	66,562492	2180,562492	31.08.2018	08.04.2022	0,487608	07.01.2020	4,472075	14.03.2021	1316	hotspot emergence
6350	Polyline	70718	9812	11	11	74,258588	224,095138	149,83655	224,095138	04.08.2018	01.01.2023	0,470748	13.11.2020	23,900519	01.01.2023	1611	hotspot emergence
6352	Polyline	70733	9815	25	63	1220,963159	1444,754186	223,791027	1523,392269	08.09.2018	01.01.2023	0,707869	28.06.2020	71,215167	14.07.2022	1576	hotspot emergence
6354	Polyline	70788	9816	15	20	219,516334	432,217791	212,701457	853,869027	07.09.2018	01.01.2023	0,593808	08.06.2020	23,987147	25.08.2022	1577	hotspot emergence
6359	Polyline	70824	9826	9	18	41,07351	260,386014	219,312504	1482,664081	07.09.2018	01.01.2023	0,627717	16.06.2021	9,167838	16.06.2021	1577	hotspot emergence
6537	Polyline	72122	10060	8	9	898	1068	170	1452,878914	14.04.2016	01.01.2023	0,699258	12.09.2021	9,175183	08.11.2020	2453	hotspot emergence
6538	Polyline	72133	10069	20	42	1605	1803	198	2223,441724	04.03.2015	01.01.2023	0,741823	01.01.2023	48,945771	19.01.2020	2860	hotspot stability
6539	Polyline	72134	10069	11	42	517	735	218	2223,441724	15.04.2015	01.01.2023	0,55165	27.01.2016	13,41475	20.12.2019	2818	hotspot stability
6752	Polyline	73780	10466	7	28	604	806,217402	202,217402	5449,826376	12.12.2018	01.01.2023	0,798375	20.05.2020	8,536698	20.02.2022	1481	hotspot emergence
6991	Polyline	75398	10893	4	7	555	629,585914	74,585914	629,585914	27.11.2018	01.01.2023	0,580092	01.01.2023	16,684118	01.01.2023	1496	hotspot emergence
7228	Polyline	77040	11388	10	11	89	240	151	679,142046	01.01.2019	01.01.2023	0,580785	21.07.2020	25,335098	01.01.2023	1461	hotspot emergence
7230	Polyline	77053	11395	9	17	5315	5610,565371	295,565371	5610,565371	05.12.2018	01.01.2023	0,790116	06.02.2020	7,345947	13.06.2022	1488	hotspot emergence
7406	Polyline	78570	11630	9	9	439	794	355	1094,530834	02.12.2018	01.01.2023	0,49999	01.01.2019	6,448559	01.01.2023	1491	hotspot emergence
7473	Polyline	79025	11821	12	12	0	81,516903	81,516903	181,082498	07.10.2018	01.01.2023	0,444744	29.01.2020	88,404821	01.01.2023	1547	hotspot emergence
7474	Polyline	79034	11822	3	6	0	141,163764	141,163764	254,495225	05.10.2018	21.02.2019	0,433418	11.12.2018	4,368028	11.12.2018	139	hotspot emergence
7478	Polyline	79055	11825	9	9	0	65,964047	65,964047	161,402751	15.09.2018	01.01.2023	0,36514	01.01.2023	67,971983	01.01.2023	1569	hotspot emergence

ROad Curvature Analyst

- automatická identifikace oblouků (kruhových křivek) a přímých úseků (tangent)
- technika strojového učení - **Naivní Bayesovský klasifikátor**
učení s učitelem – nutné si předpřipravit **trénovací sadu** (část dat, která odlišuje oblouky od přímých úseků)
- roca.cdvinfo.cz počet uživatelů ~ **130 z 38 států**

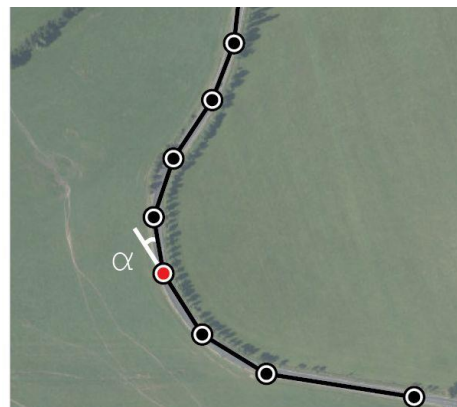


Naivní Bayesovský klasifikátor

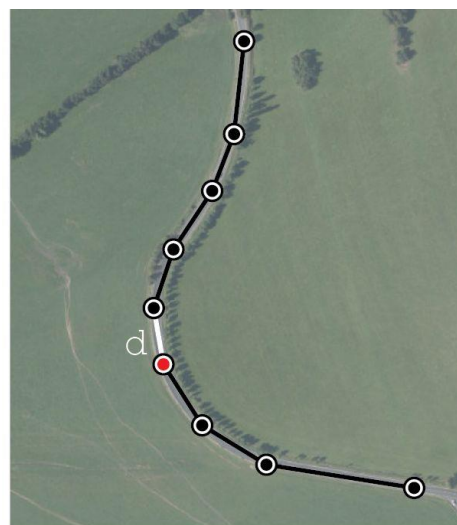
- Z trénovací sady klasifikovaných vertexů
→ výpočet **6 vysvětlujících proměnných**

id	x	y	class	
1	-540378.94	-1105517.38	0	
1	-540364.63	-1105520.88	0	
1	-540349.38	-1105525.13	1	
1	-540340.38	-1105531.88	1	
1	-540336.06	-1105541.88	1	
1	-540334.63	-1105554.25	1	
1	-540334.19	-1105567.13	1	
1	-540336.06	-1105581.88	1	
1	-540339.38	-1105595.63	1	
1	-540345.63	-1105610.38	0	
1	-540352.25	-1105626.63	1	
1	-540355.13	-1105638.00	1	
1	-540355.63	-1105650.88	1	
1	-540354.19	-1105667.63	1	
1	-540351.31	-1105687.63	1	
1	-540345.63	-1105711.38	1	
1	-540338.00	-1105732.38	0	
2	-548149.00	-1114621.25	0	
2	-548197.63	-1114580.75	0	
2	-548253.25	-1114533.63	0	
2	-548305.94	-1114489.38	0	
2	-548337.06	-1114461.13	1	
2	-548366.94	-1114427.75	0	
2	-548393.88	-1114392.63	0	
2	-548443.75	-1114333.50	1	

Úhel mezi 3 po sobě jdoucími body



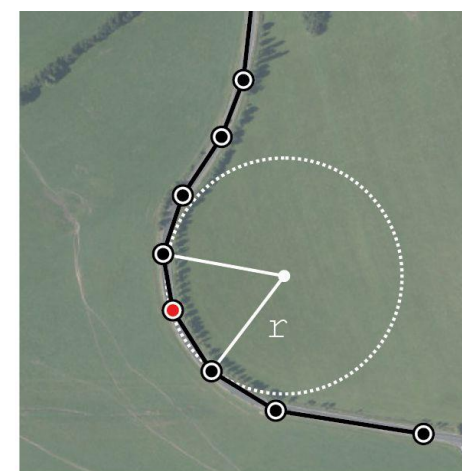
Vzdálenost mezi 2 body



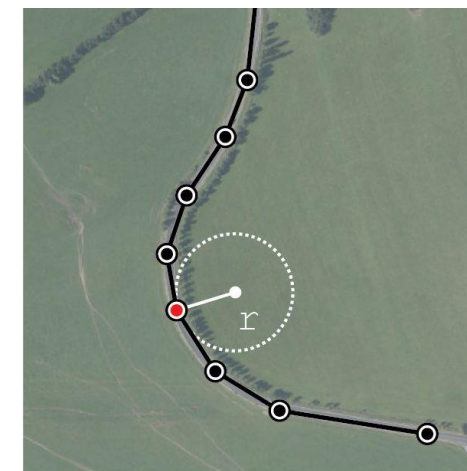
Kumulativní úhel ve 3 (5) po sobě jdoucích bodech

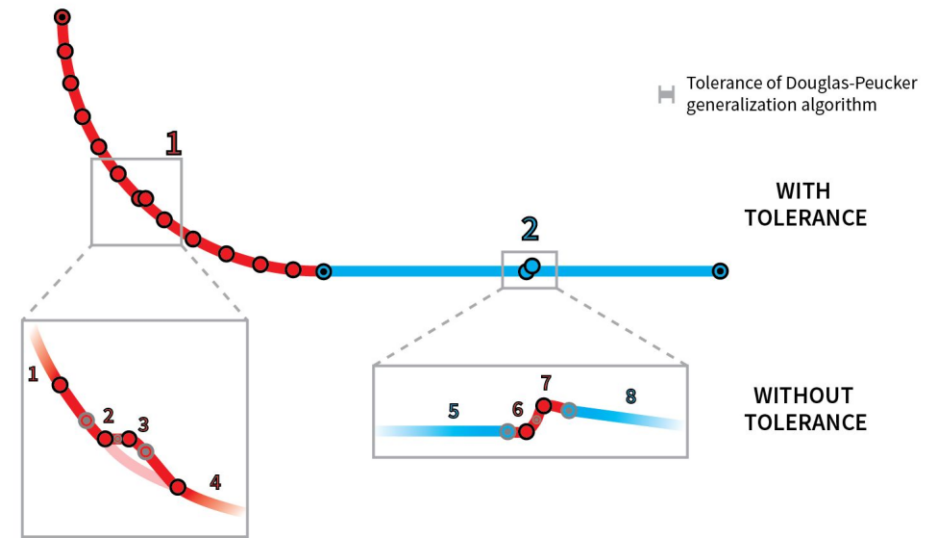
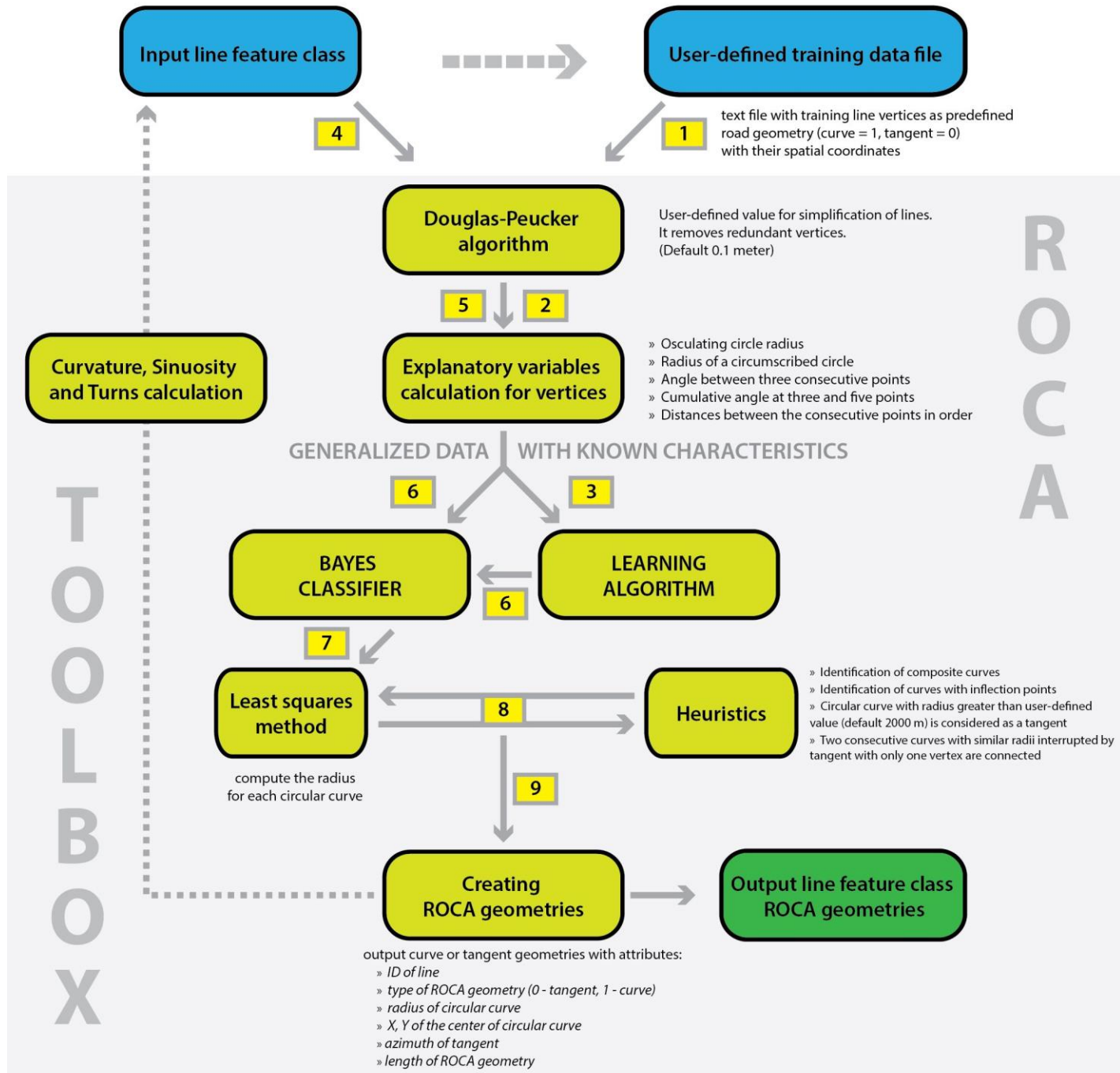


Poloměr kružnice opsané 3 sousedícím bodům



Poloměr oskulační kružnice





ROCA analysis

Input line feature class

Input training data file

Name of new ID field
new_ID

Maximal radius of curve [m]
2100

Minimal feasible radius of curve [m]
20

Tolerance of line generalization [m]
0

Calculate curvature attributes of the input line feature class

Output line feature class of resulted ROCA geometries

OK Cancel

ROCA analysis

ROCA (Road Curvature Analyst) is a tool for automatic identification of road geometry from digital vector data. The method is capable of efficiently identifying circular curves with their radii and tangents (straight sections), which are the results of ROCA as line features. You can also calculate curvature attributes (Average Deflection Angle, Detour ratio and the Number of turns) for each input line features as new attributes.

This software utilizes a method published previously (Andrášik, R.; Bíl, M., 2016. Efficient Road Geometry Identification from Digital Vector Data. Journal of Geographical Systems 18(3), 249–264. DOI 10.1007/s10109-016-0230-1). We recommend ROCA users read this article for additional information and the theoretical background.

ROCA toolbox (ArcMap i ArcGIS Pro)

ROCA analysis

Completed

Close this dialog when completed successfully

Close

<< Details

```
Running script ROCA...
Starting...
Creating a new field new_ID
Creating variables and begin to test input data
Testing the input line features geometry
Number of analyzed input polylines is 745 with length: 299.904 km.
Number of resulted ROCA straight sections (tangents) is 1004 with length: 61.51 km.
Number of resulted ROCA curve sections is 2741 with length: 238.394 km.
WARNING!
The output feature class contains curves with radius lower than the user-defined value of Minimal feasible radius of curve.
Please, check the input feature class geometry of that curves!
Number of resulted ROCA curve sections under Minimal feasible radius of curve equal to 20 is 283 with length: 11.608 km.
ROCA analysis DONE!
```

ROCA geometrie

- Liniová vrstva

- Atributy:

- radius** - poloměr oblouku
- X /Y_center** - souřadnice středu kružnice
- G_type** - typ ROCA geometrie (0-přímka, 1-oblouk)
- Azimuth** - azimut přímého úseku
- Length** - délka ROCA geometrie

FID	Shape *	radius	X center	Y center	G type	Azimuth	Length
2497	Polyline	0	0	0	0	30,347697	33,894367
2498	Polyline	247,52468	-658449,787536	-1091443,69895	1	0	288,418321
2499	Polyline	0	0	0	0	75,956211	182,80042
2500	Polyline	674,336583	-658469,387127	-1090500,04564	1	0	310,218328
2501	Polyline	34,900661	-658015,331248	-1091045,84077	1	0	16,055073
2502	Polyline	42,310593	-660304,4058	-1087280,7295	1	0	81,7562
2503	Polyline	0	0	0	0	246,873534	632,863126
2504	Polyline	645,145039	-660744,672844	-1088202,96528	1	0	337,001338
2505	Polyline	0	0	0	0	218,015122	292,898084
2506	Polyline	209,900787	-661557,261472	-1087906,24474	1	0	326,545951
2507	Polyline	197,270554	-661597,133155	-1088309,27106	1	0	62,72169
2508	Polyline	0	0	0	0	252,018579	95,141163
2509	Polyline	123,315648	-661796,095949	-1088037,14993	1	0	86,284703
2510	Polyline	110,696843	-661877,033284	-1088257,76738	1	0	44,650512
2511	Polyline	519,040158	-660650,413817	-1087610,62937	1	0	111,003067
2512	Polyline	782,283554	-659886,784723	-1086556,42402	1	0	261,91097
2513	Polyline	963,203056	-661266,965079	-1087628,57314	1	0	283,072164
2514	Polyline	70,619654	-660688,057307	-1086780,10521	1	0	41,284184
2515	Polyline	233,485505	-660979,790647	-1086840,14241	1	0	152,855264
2516	Polyline	0	0	0	0	315,766624	49,546104

Vstupní datová sada úseků sítě

- Dopočet nových atributů křivolakosti úseků

- Atributy:

- ADA** - průměrný úhel změny směru (Average Deflection Angle)
- DR** - křivolakost úseku (Detour Ratio)
- Turns** - počet zataček na úseku

Calculate curvature attributes of the input line feature class

ADA	DR	Turns
92,936279	1,062322	33
48,329372	1,006615	11
41,748728	1,014275	11

Publikace o ROCA



PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

ROCA – An ArcGIS toolbox for road alignment identification and horizontal curve radii computation

Michal Bíl , Richard Andrášik , Jiří Sedoník, Vojtěch Cícha

Published: December 26, 2018 • <https://doi.org/10.1371/journal.pone.0208407>



Transportation Research Part A: Policy and Practice

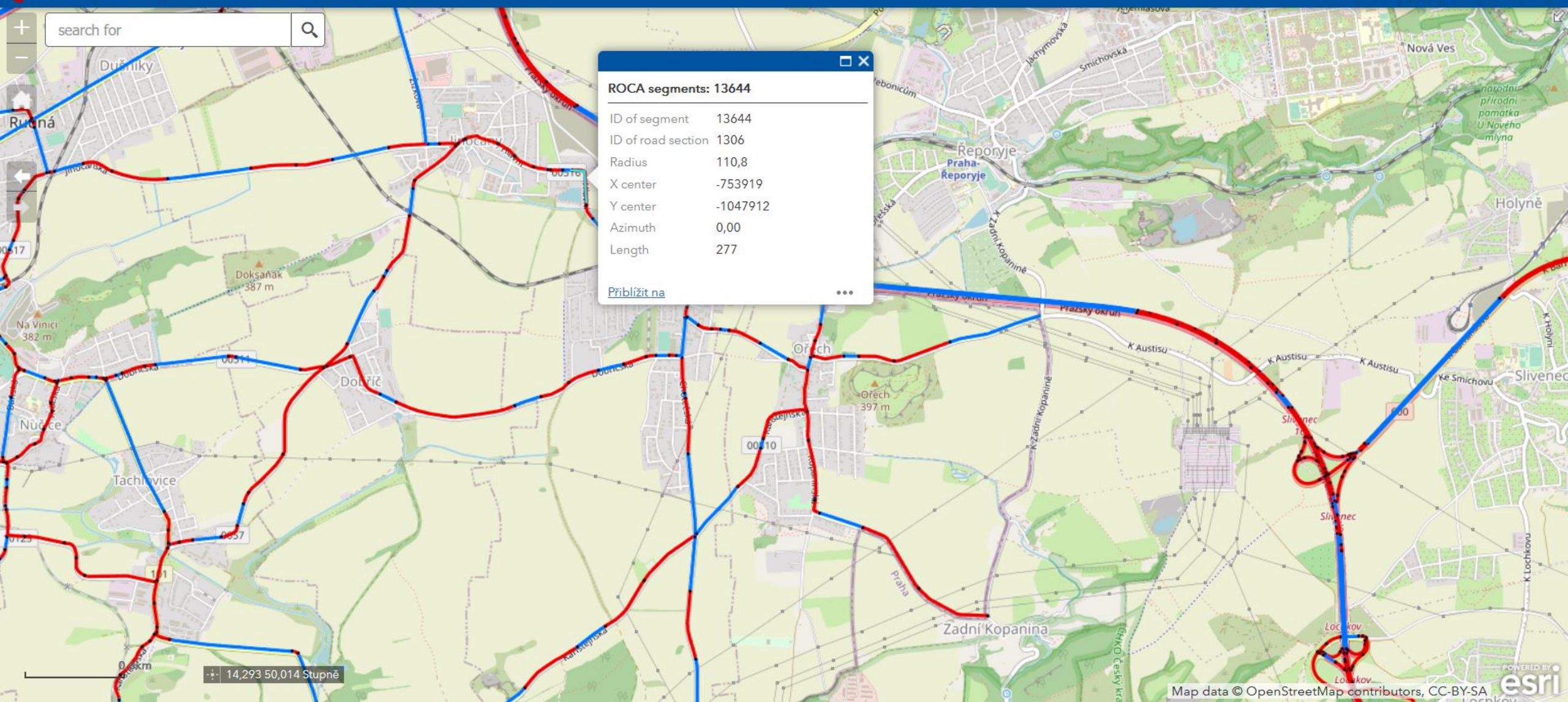
Volume 120, February 2019, Pages 252-260



Which curves are dangerous? A network-wide analysis of traffic crash and infrastructure data

[Michal Bíl](#) , [Richard Andrášik](#), [Jiří Sedoník](#)

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Děkuji Vám za pozornost.

Jiří SEDONÍK

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KDE+


STKDE+


 **ROCA**