

2014 European Workshop
AFB20 (2) Roadside Safety Design
International Research Activities Subcommittee

ROAD ACCIDENT PREDICTION

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*From Descriptive Methods to Predictive Analyses
into Roadway Safety Management Processes*



Trafficlabb

PROGETTO LAB
studio associato di progettazione integrata



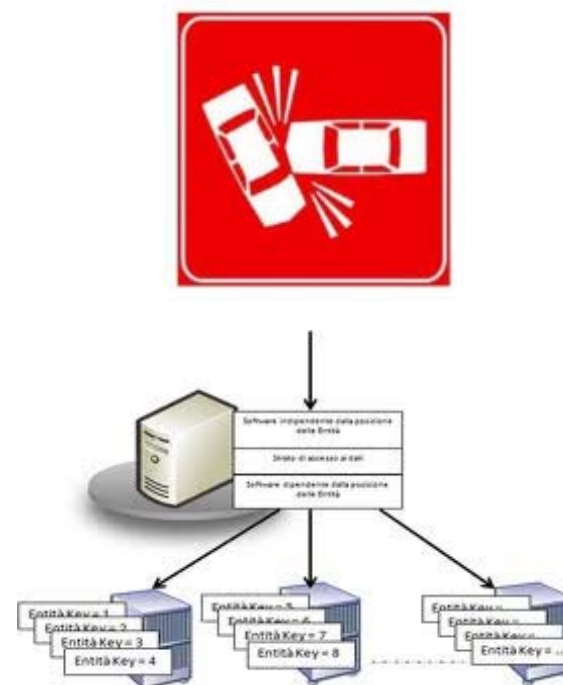
- Road design
- Road safety
- Traffic monitoring
- Road accident analysis
- Training courses



Road safety accident analysis

*“The available European **road safety data** and knowledge have been integrated and made publicly available on the Internet [...]. **This is essential for monitoring the application of road safety policies, evaluating their impact and devising new initiatives**”*

Commission Communication to the European Parliament: “Towards a European road safety area: policy orientations on road safety 2011-2020”

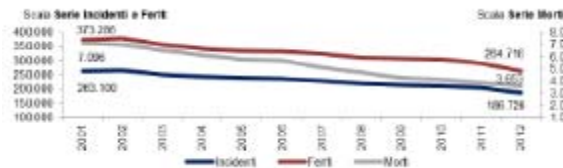


Main methods of road safety accident analysis

	Method	Description
Traditional	Statistics	• Descriptive statistics • Inferential statistics
	Geographic Information Systems Spatial analysis	• Graphics representation • Network Kernel Density Estimation • Planar Kernel Density Estimation
	Accident reconstruction	• Physics approach
Innovative	Prediction models	• Crash Modification Factor • Traffic Conflict Techniques • Safety Performance Function

Traditional methods

Statistics

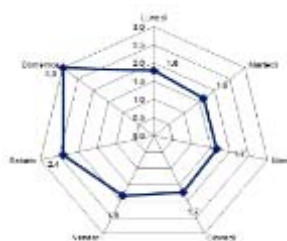
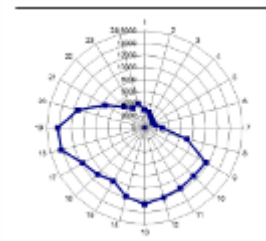
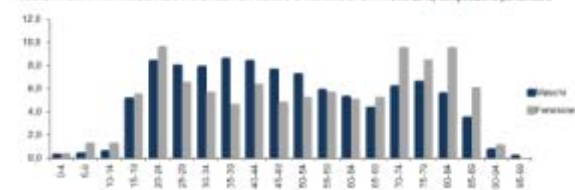


PROSPETTO 3. INCIDENTI STRADALI CON LESIONI A PERSONE SECONDO LA CATEGORIA DELLA STRADA
Anno 2012, valori assoluti, indice di mortalità e variazioni percentuali 2012/2011

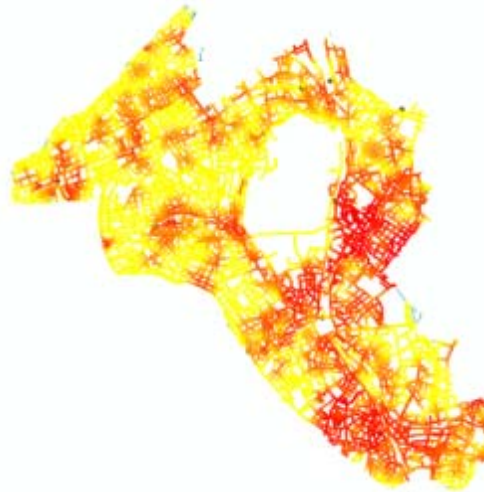
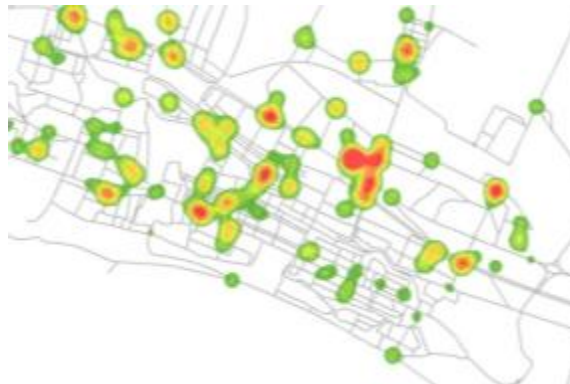
CATEGORIA DELLA STRADA	Incidenti	Morti	Feriti	Indice di mortalità (2)	Variazione percentuale Incidenti 2012/2011	Variazione percentuale Morti 2012/2011	Variazione percentuale Feriti 2012/2011
Strade urbane	121.719	1.842	181.871	1,18	-6,7	-0,4	-10,1
Autostrade e raccordi	9.798	336	18.892	3,51	-14,6	-2,4	-14,8
Altre strade (3)	35.613	1.781	57.543	4,94	-6,3	-1,8	-6,2
Totale	166.726	3.853	264.716	1,96	-6,2	-0,4	-8,3

(1) Rapporto tra il numero dei morti e il numero degli incidenti con lesioni a persone, moltiplicato 100.
(2) Sono indicate nelle categorie "Altre strade" le strade Statali, Regionali e Provinciali fuori dell'abitato e Comunità montane.

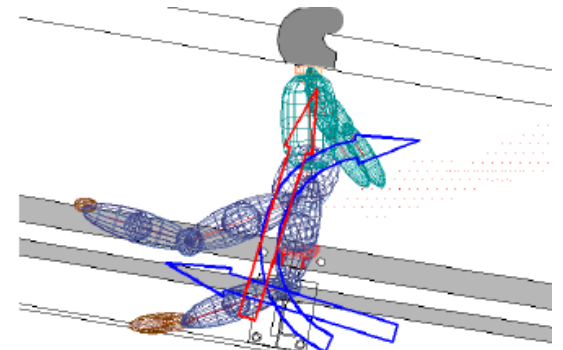
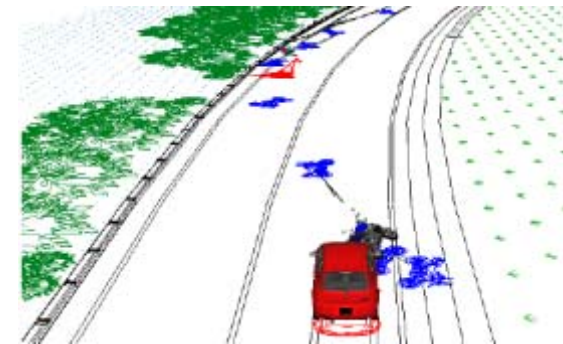
FIGURA 7. MORTI IN INCIDENTE STRADALE PER SESSO E CLASSE DI ETÀ. Anno 2012, composizione percentuale



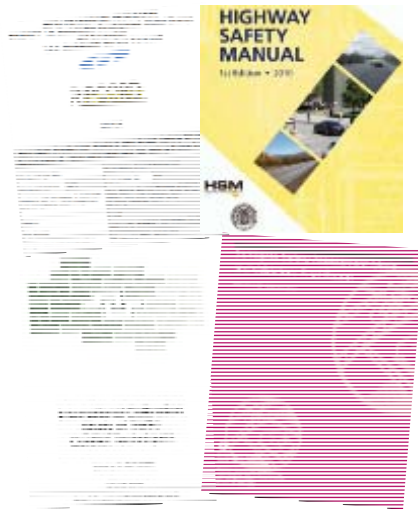
Spatial analysis



Accident reconstruction



Road accident prediction model



*“The new techniques and knowledge in the HSM reflect the evolution in safety analysis **from descriptive methods to quantitative, predictive analyses.**»*

AASHTO Highway Safety Manual – Introduction Overview



- Crash Modification Factor
- Traffic Conflict Techniques
- Safety Performance Function



What is it?
How do they work?
Case study
Advantages/Disadvantages

Crash Modification Factor

A crash modification factor (CMF) is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site.

Crash Modification Factor
Crash Modification Function
Crash Reduction Factor
Crash Reduction Function

Factors can change by traffic volume, crash type or crash severity.

Crash Modification Factor

- Under the **base conditions** (i.e., with no change in the conditions), the value of a CMF is **1.00**.
- CMF values **less than 1.00** indicate the alternative treatment **reduces** the estimated average crash frequency in comparison to the base condition.
- CMF values **greater than 1.00** indicate the alternative treatment **increases** the estimated crash frequency in comparison to the base condition.

$$\text{Crash Reduction Factor} = 100\% \times (1.00 - \text{CMF})$$



<http://www.cmfclearinghouse.org>



There were **3'513** CMFs !

Cuneo's case study

- Convert high-speed rural intersection to roundabout

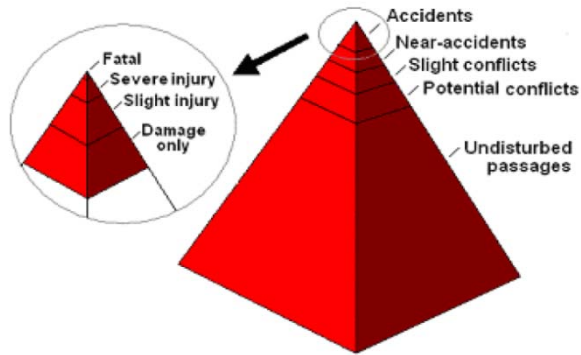
CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type	Reference
0.33	67	★★★★☆	All	All	Not Specified	Rural	Isebrands, 2009
0.11	89	★★★★☆	All	Fatal,Serious injury,Minor injury	Not Specified	Rural	Isebrands, 2009
0.14	86	★★★★☆	Angle	All	Not Specified	Rural	Isebrands, 2009
4.2	-320	★★★☆☆	Fixed object	All	Not Specified	Rural	Isebrands, 2009
2.4	-140	★★★☆☆	Frontal and opposing direction sideswipe,Sideswipe	All	Not Specified	Rural	Isebrands, 2009
0.81	19	★★★★☆	Rear end	All	Not Specified	Rural	



Cuneo's case study

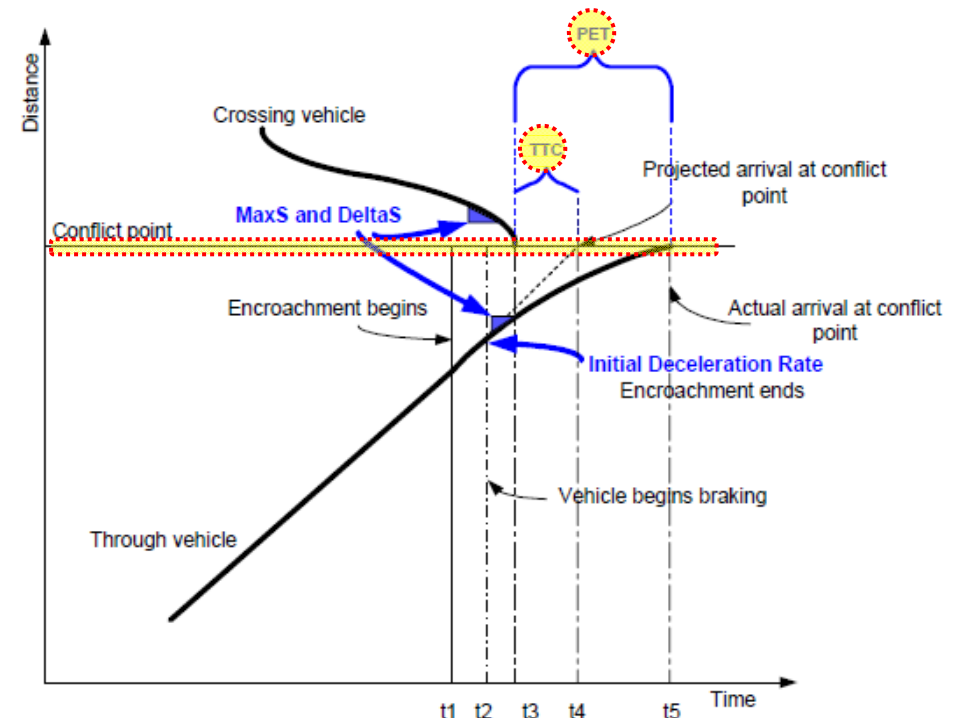
Crash type	Crash PRE	CMF	CRF	Crash POST
Sideswipe	15	0,14	86	2,1
Fixed object	3	4,20	-320	12,6
Frontal and opposing	10	2,40	-140	24
Rear end	12	0,81	19	9,72
Total	40			48,42
Total predict accident after treatment				+21,05%

Traffic Conflict Techniques



Fatal road accident are rare events.
Conflicts have more frequency and low severity.

Conflict: *An observable situation in which two or more road-users approach each other in time and space to such an extent that there is risk of collision if their movements remain unchanged.”*
(Amundsen and Hydén, 1977)

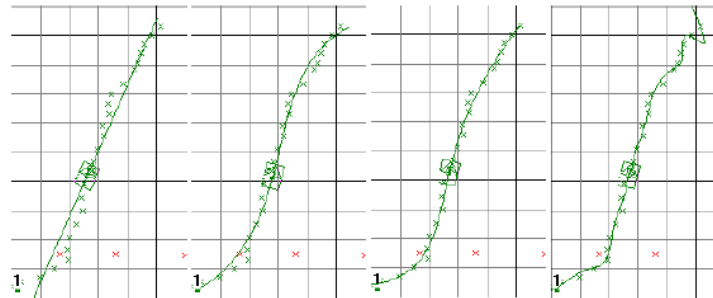


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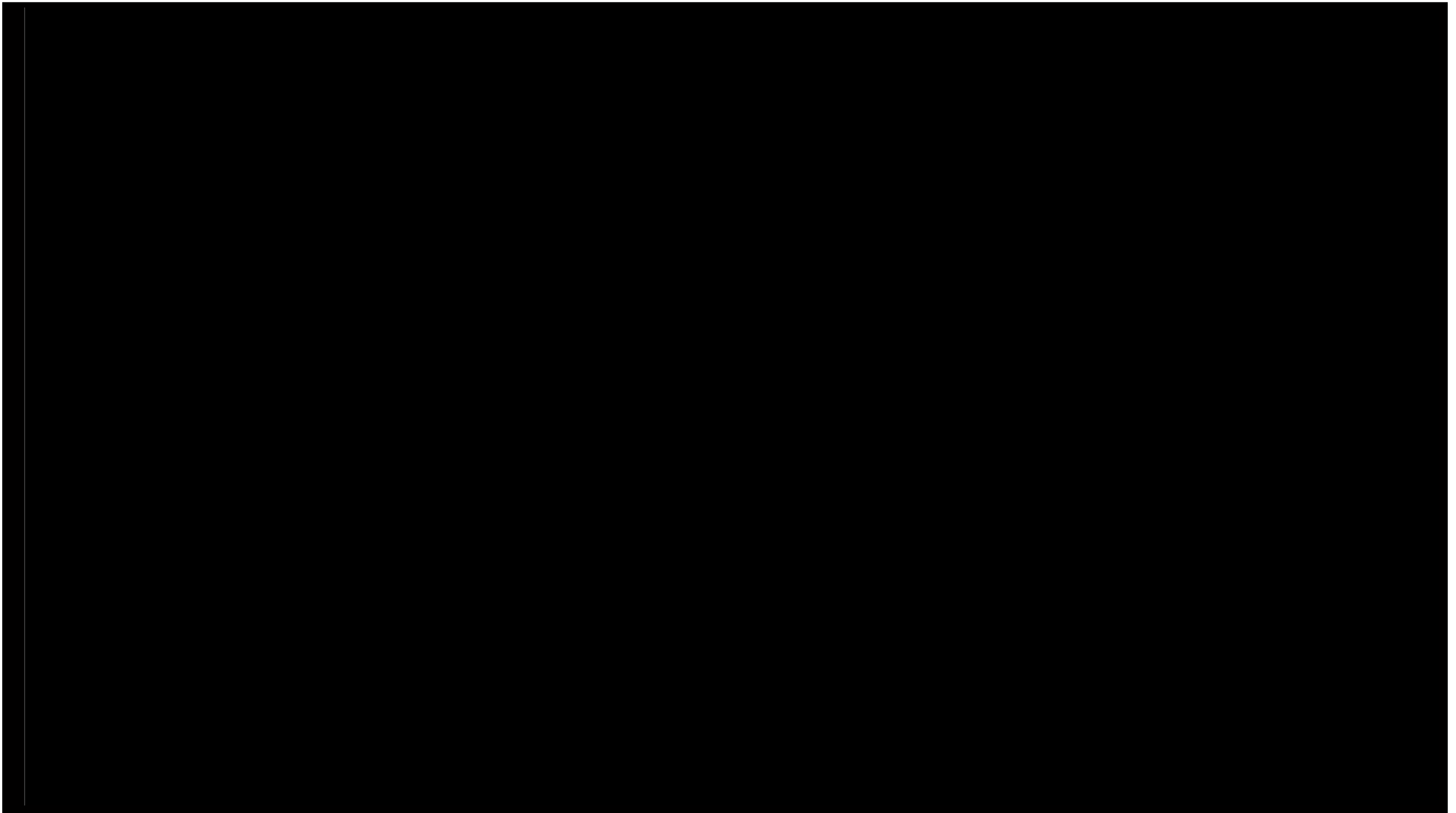
At the beginning



Ultimate



Data From Sky: Advanced traffic analysis of aerial video data



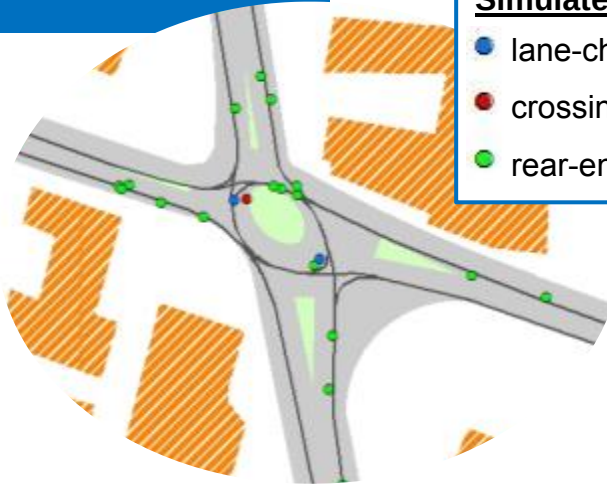
Gela's Sustainable Urban mobility Plan



SSAM

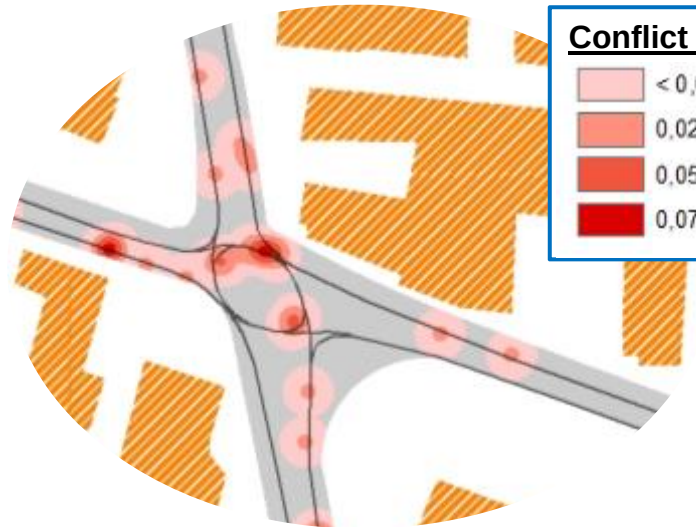
Simulated conflicts

- lane-change
- crossing
- rear-end



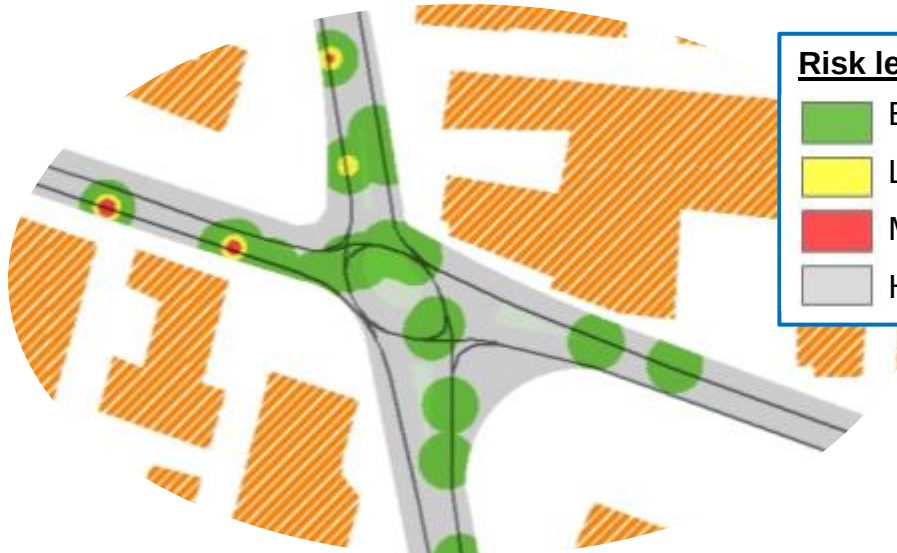
Conflict density

- < 0,025
- 0,025 - 0,05
- 0,05 - 0,075
- 0,075 - 0,1



Risk level

- Basic risk
- Low risk
- Medium risk
- High risk



Safety Performance Function

What is it?

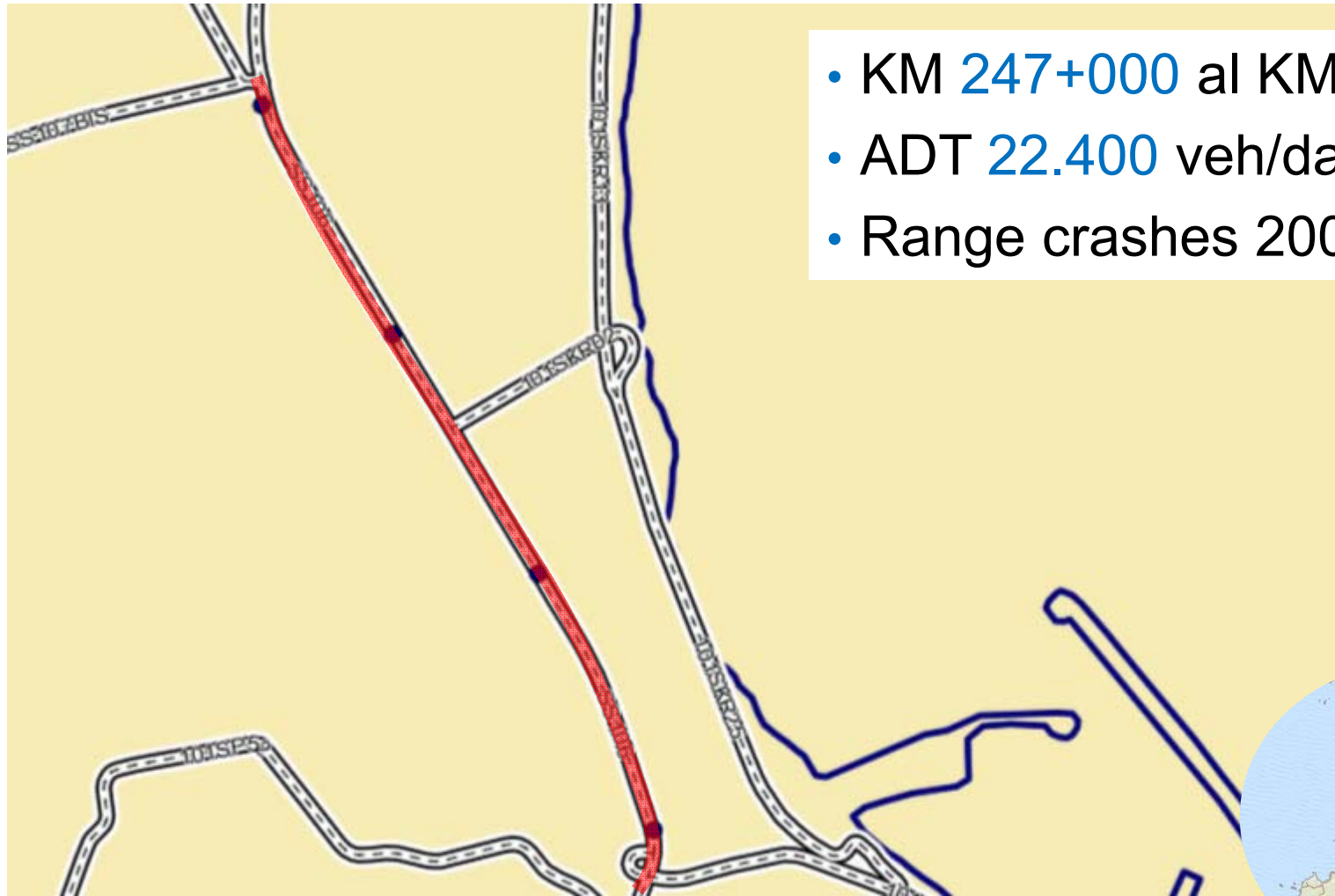
Statistical “base” models are used to estimate the average crash frequency for a facility type with specified base conditions. The SPF are regression equations that estimate the average crash frequency for a specific site type (with specified base conditions).

Type of models	Input data
Deterministic models	Geometric data (horizontal alignment, vertical alignment, lane, median, shoulder section, cross slope, design speed, driveway density, lighting, automatic speed enforcement)
Stochastic models	Traffic data (AADT, ADT, phf)
Bayesian models	Historical data crash database

$$N_{\text{predicted}} = N_{\text{spf } x} \times (CMF_{1x} \times CMF_{2x} \times \dots \times CMF_{yx}) \times C_x$$

Case Study: Road IT 106 «Ionica»

Case study

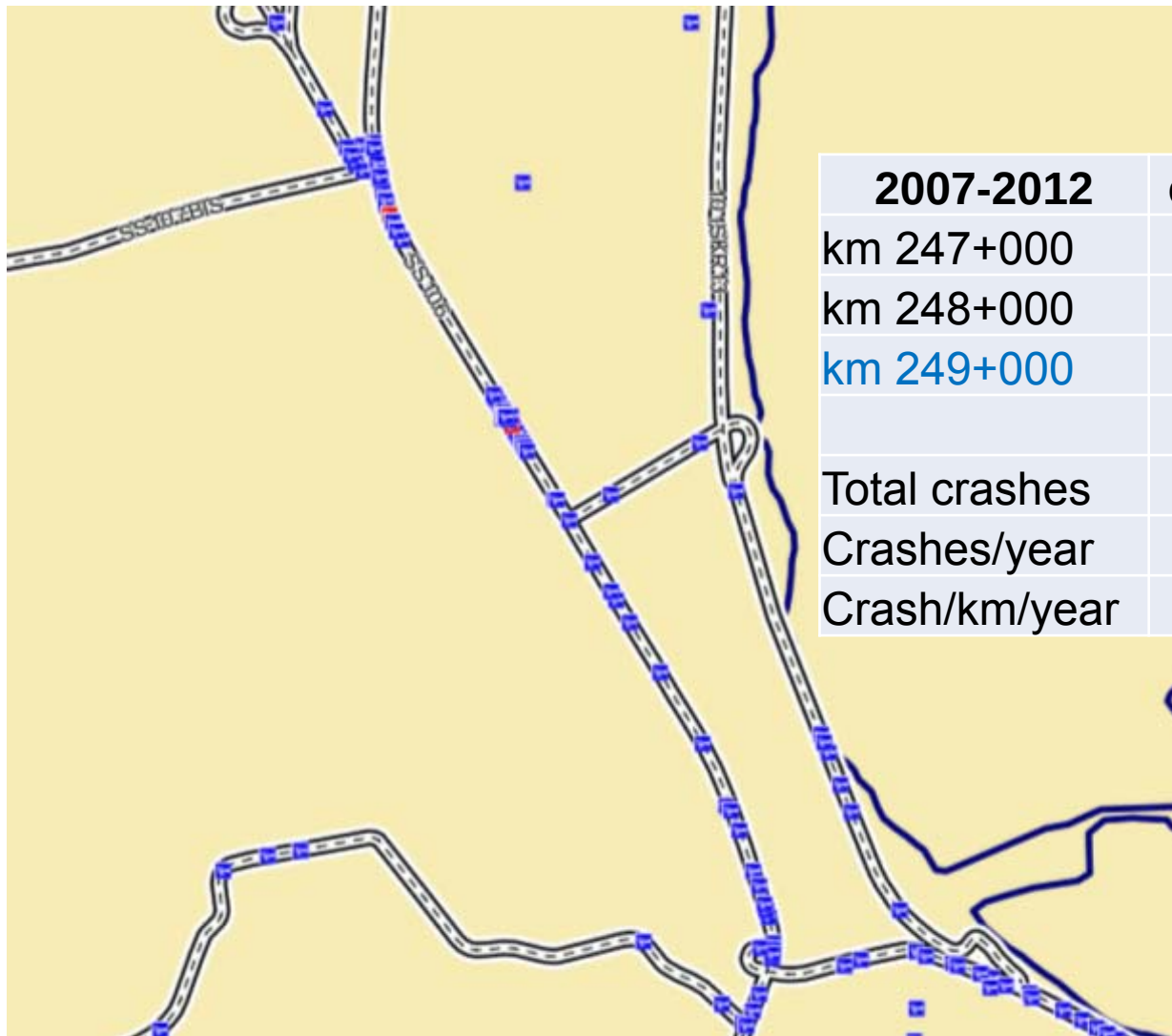


- KM 247+000 al KM 250+000
- ADT 22.400 veh/day
- Range crashes 2007-2012



Case Study: Road IT 106 «Ionica»

Case study



2007-2012	crashes/year	crash/km/year
km 247+000	9	0,50
km 248+000	10	0,56
km 249+000	21	3,50
Total crashes	40	
Crashes/year	6,67	
Crash/km/year	2,22	

Case Study: Road IT 106 «Ionica»

Case study

Table 2. Expected Highway Crash Rates and Frequencies (Section 1)

 IHSDM "Safer Roads Through Better Design"	First Year of Analysis	2014
	Last Year of Analysis	2014
	Evaluated Length (km)	3.0000
	Average Future Road AADT (vpd)	22,788
	Expected Crashes	
	Total Crashes	8.31
	Fatal and Injury Crashes	2.56
	Property-Damage-Only Crashes	5.74
	Percent of Total Expected Crashes	
	Percent Fatal and Injury Crashes (%)	31
	Percent Property-Damage-Only Crashes (%)	69
Expected Crash Rate		
	Crash Rate (crashes/km/yr)	2.7688
	Fatal and Injury Crash Rate (crashes/km/yr)	0.8548
	Property-Damage-Only Crash Rate (crashes/km/yr)	1.9140
Expected Travel Crash Rate		
	Total Travel (million veh-km)	24.95
	Travel Crash Rate (crashes/million veh-km)	0.33
	Travel Fatal and Injury Crash Rate (crashes/million veh-km)	0.10
	Travel Property-Damage-Only Crash Rate (crashes/million veh-km)	0.23

incidenti/anno 6,7

incidenti/km 2,2

Conclusions



Road accident analysis **without** road accident data.



Road design and road safety processes.



Planning of road safety inspections



Evaluation of economic **benefit** and accidents reduction.

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