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# Linking Rural Road Environment, Speed and Safety Factors with a 'Two-Stage' Model: A Feasibility Study

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#### INTRODUCTION

Speed in traffic is a critical issue, since it is:

- an important efficiency factor for drivers
- a key geometric design parameter (operating speed)
- the most influential risk factor (the most frequent cause of road deaths on Czech roads)

### How to study speed and safety?

- **speed models** (relating speed to design consistency factors only, mostly curve radius, although speed choice is influenced also by cross-section, road marking, vegetation, etc.
- safety models (safety performance functions: #crashes as a function of exposure and risk)
- both approaches usually carried out separately

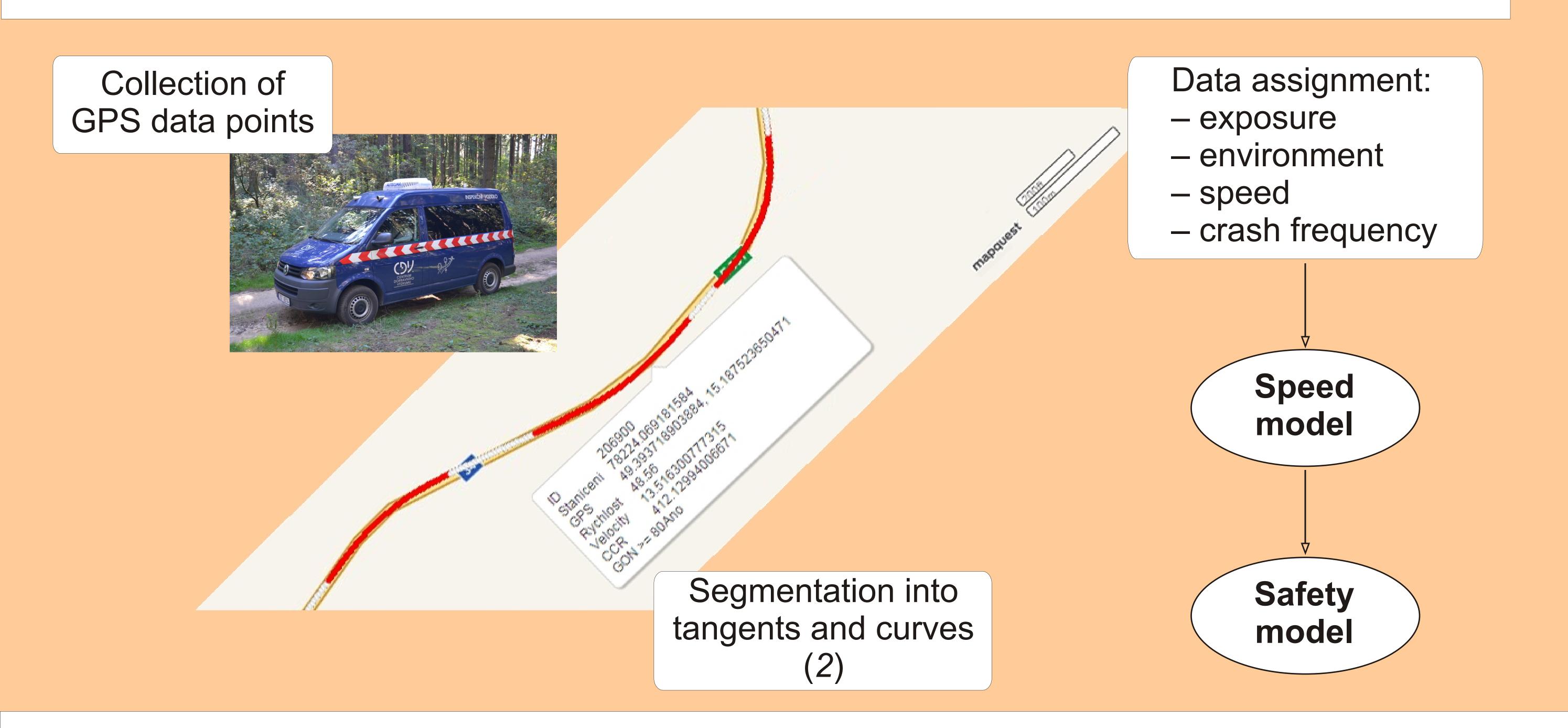
### A combination of speed and safety models?

- some SPFs involved consistency variables (computed through speed models, as a difference between tangent and curve speeds)
- development of these SPFs thus involves both models
- from SIMPLE speed models (often using radius only) to COMPLEX safety models
- some authors applied the same variables in both models at the same time

## An innovation (inspired by 1):

- an opposite variant of a 'two-stage' model
- from COMPLEX speed model to SIMPLE safety model
- consistent with the principle of parsimony

The objective: to prove feasibility of development and application of a 'two-stage' speed and safety model in the study of environment, speed and safety factors.



#### DATA AND METHODS

A sample of Czech two-lane rural roads (excl. intersections), approx. 100 km (60 mi)

- driven through in two weekdays, in one direction, as close as possible to free-flow speed
- 10 Hz GPS = 2.5 m @ 90 km/h (8.25 ft @ 54 mph)
- 316 segments in total (158 tangents and 158 curves)
- Speed (V) and curvature change rate (CCR) calculated for each segment

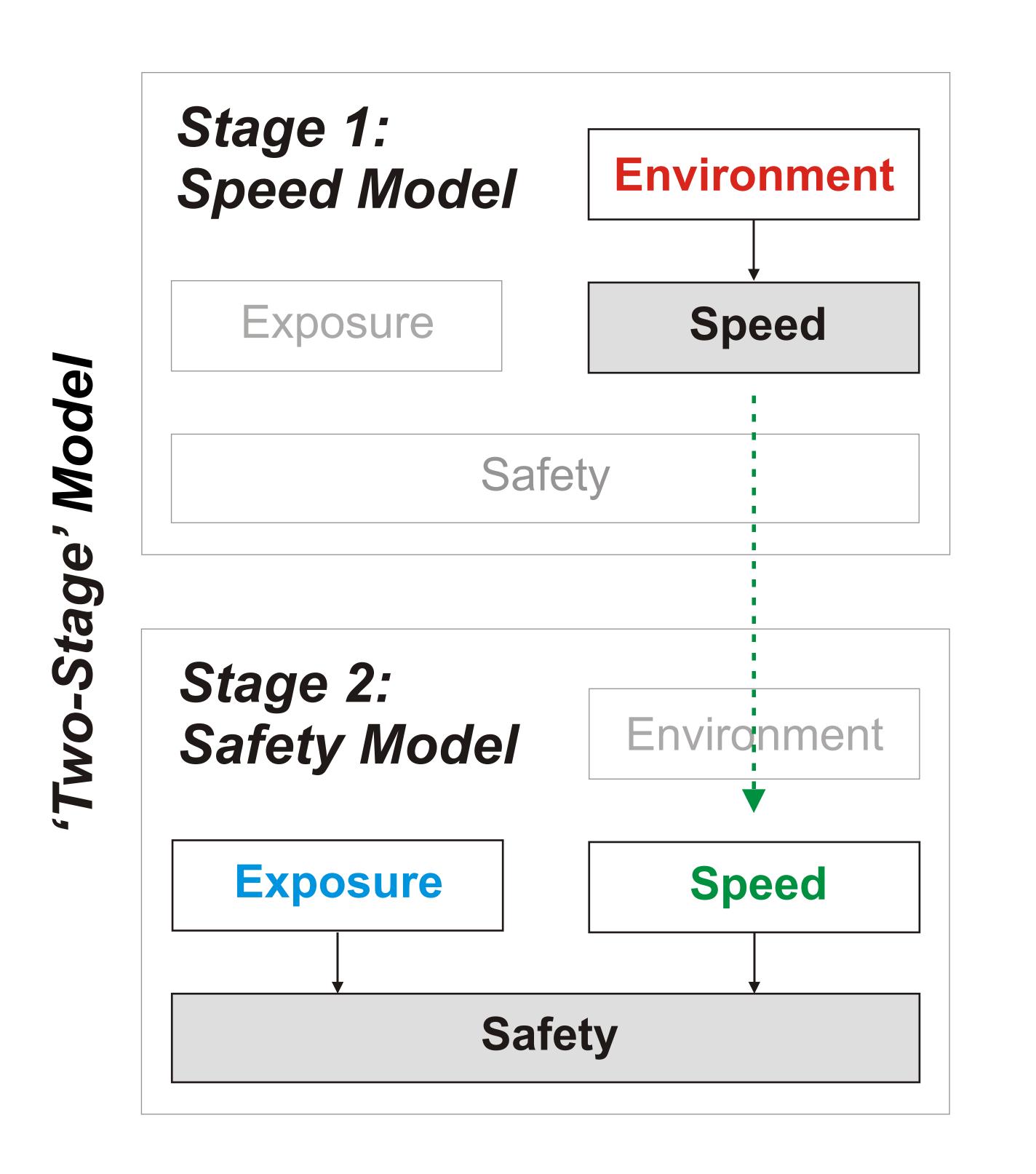
## Environment data (from Google Maps or road database):

- Roadside vegetation: none or bushes / single trees / trees in a row or forest
- Road marking (separation of driving directions): no line or broken line / solid line
- Delineator posts: absent / present
- Guardrails: absent / present
- Vertical grade: absent (flat) / present (slope)
- Roadway width: 7.5 m or less / 7.6 9.5 m / 9.6 11.5 m / 11.6 m or more.

## **Exposure data:**

- Traffic volume (AADT) from the National Traffic Census 2010
- Lengths obtained from GPS points

Safety: 5-year crash frequency from Police data (2009 – 2013), only single-vehicle crashes



 $V_i = \beta_0 + \sum_{i=1}^n (\beta_i \cdot \mathbf{x}_i)$ 

V... speed

beta ... regression coefficients x ... environment variables, CCR, preceding tangent length

(separately for tangents and curves)

 $P_i = \exp(\beta_0) \cdot AADT_i^{\beta_1} \cdot L_i^{\beta_2} \cdot \exp(\beta_3 \cdot |dV_i|)$  (one model for both tangents and curves)

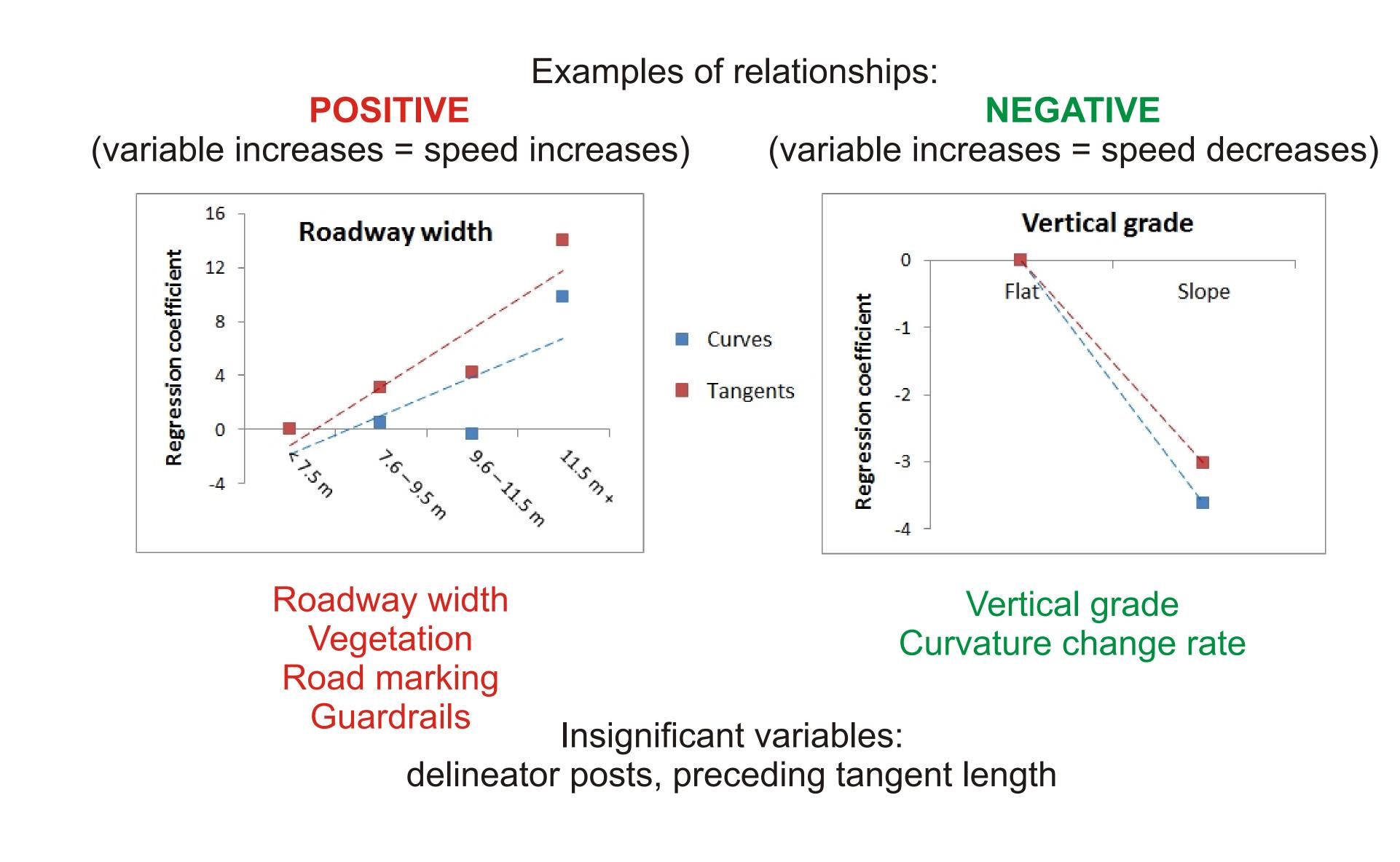
P ... predicted crash frequency
beta ... regression coefficients
AADT ... traffic volume
L ... segment length
|dV| ... speed consistency = absolute difference
between predicted tangent and curve speeds

#### RESULTS

Safety model:

(3 variables)

Speed model: (6 variables)



- All variables (AADT, length, speed consistency) significant (although speed consistency only on 13% level), with positive relationship to crashes.
- Magnitude of regression coefficients is comparable to the results of other studies.
  Adding speed consistency to the model increases explanatory power only by 0.65%.
  This is comparable to 0.66% in Anderson et al. (3).

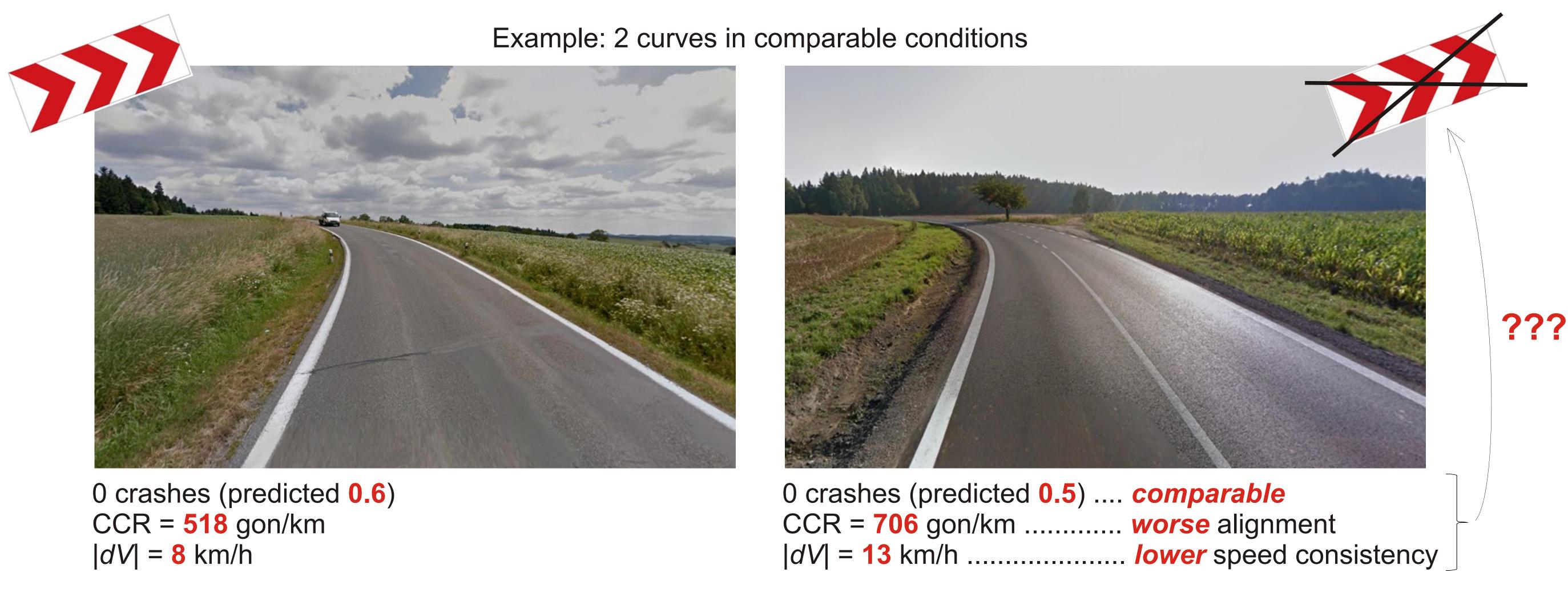
## DISCUSSION AND CONCLUSIONS

Possible biases: omitted variables (pavement, superelevation, etc.), speed based on one drive only, segment-level aggregation of speed, small crash sample...

The limitations are addressed in further stages of the project:

- sample enlargement in time and space, using vehicle fleet data from repeated drives (4)
- improvement of evaluation methodology (more data collection spots in curves)

In future the concept may be applied in **proactive network screening** (identification of hazardous curves) instead of 'waiting for crashes'.



In the identified curves potential countermeasures (such as **chevrons**) may be applied – **consistently**, for example **based on speed or safety predictions** from the presented models.



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