2-BE-SAFE
2-WHEELER BEHAVIOUR AND SAFETY
Grant Agreement number: 218703
Funding Scheme: Collaborative project small scale
Start date of the contract: 01/01/2009
Project website address: ***www.2besafe.eu***

Interaction between Weather Conditions and Powered Two Wheeler Accidents

Confidentiality level: public

Deliverable 1.3

Status: final

Date: 20100301

Editor: Martin Winkelbauer, Kuratorium für Verkehrssicherheit

Project Coordinator:
Stephane Laporte
Europe Recherche Transport
c/o INRETS
stephane.laporte@ert-sas.fr
Téléphone : 04.78.65.68.16

Authors

Name	Company
Martin Winkelbauer	KfV
Christian Brandstätter	KfV
Sebastian Riegler	KfV
O.Univ.-Prof. Dr. Reinhold Steinacker	UNIVIE
Michael Tiefgraber	UNIVIE
Eleni I. Vlahogianni, Ph.D.	NTUA
John Golias, Ph.D.	NTUA
George Yannis, Ph.D	NTUA
Panagiotis Papantoniou	NTUA
Niccolò Baldanzini, Ph.D.	UNIFI
David Grassi	UNIFI

Amendments

Date of Issue	Description
29/10/2009	Martin Winkelbauer: new introduction, some comments on the rest of the document
02/11/2009	Sebastian Riegler: microscopic analysis
05/11/2009	Sebastian Riegler: amendment of Italian data
11/11/2009	Martin Winkelbauer: completed and sent for WP internal review
30/11/2009	Sebastian Riegler: macroscopic analysis with respect to precipitation
03/12/2009	Michael Tiefgraber: additions in chapter 5
04/12/2009	Reinhold Steinacker, WP-internal review
11/12/2009	Martin Winkelbauer: synthesis of comments
24/01/2010	Official review by José Miguel Perandones
11/01/2010	Official review by Lars Leden and Per Gader
26/02/2010	Final Version by Martin Winkelbauer

Applicable Documents

Description
none

Acknowledgements

Description
Special thanks to Lards Leden, Per Garder and José Miguel Perandones for their constructive comments within the review procedure as well as Rainer Krautscheid and Andreas Hegewald for their input.

Abstract

This volume describes motivation, methodology and results of an analysis of the correlation between weather and PTW accidents. It is a matter of common sense that PTW (powered two-wheelers, i.e. moped, motorcycles) accidents strongly depend on the actual weather. This impact can derive from the difference of intrinsic risk of riding under different weather conditions, from differences in risk taking behaviour of riders under different weather conditions as well as the impact of weather on exposure. However, such relations have not been researched so far.

For this purpose, a weather database prepared by the Institute for Meteorology and Geodynamics at the Vienna University was used. This database gives information on temperature, wind and cloudiness at each corner point of a grid with a cell size of 20 km x 20 km, 16 km x 16 km and 10 km x 10 km, depending on the variable. A parameter for precipitation with 16 km x 16 km was added to this database in the course of this study.

The Austrian (police recorded) accident database was adapted, all accident received geo-reference using the geometrical centre of the municipality in which the accident occurred. This database also contains information on the weather at the scene. This data was used to validate the weather information from the two databases against each other.

The macroscopic analysis comparing the official accident databases of Austria, Greece and Italy did not bring about much additional knowledge, since exposure cannot be controlled for.

Comparison between weather data as recorded in police reports on road crashes and the weather database created for this study proved the latter to be valid, in particular for further analysis within this study.

It was found that:

- On sunny weekend days, eight times more motorcycle accidents happen than on rainy weekend days.
- On sunny workdays, five times more motorcycle accidents happen than on rainy workdays.
- On sunny days, six times more motorcycle accidents happen than on rainy days.

It was also found that there are different characteristics in terms of accident types and crash severity depending on rain likeability.

Finally, it was approved that controlling for precipitation as a moderating factor of annual crash records is reliably possible. About 70% of the variation of motorcycle rider injuries and about 40% of the variation of fatalities can be attributed to variation of weather conditions. In total, predicting the number of motorcycle rider injuries based on the weather characteristics of this particular year, average weather conditions and the relation between weather and accidents is possible with an error less than 3%.

Research in this issue should be continued by including more data to be able to consider additional factors. Mobility data is needed to separate impact of exposure, intrinsic risk and compensatory behaviour of riders.

Table of contents

Tables

Figures

1. Executive Summary

Introductory remark

It is a matter of common sense that PTW (powered two-wheelers, i.e. moped, motorcycles) accidents strongly depend on the actual weather. Precipitation is considered to - among all parameters of weather - have the strongest impact on PTW rider safety. Therefore, for this pilots study, it was decided to focus in precipitation.

The relation between weather and PTW accidents may de described by three functions:

- the difference of intrinsic risk of riding under different weather conditions
- differences in risk taking behaviour of riders under different weather conditions, maybe as a compensation for higher subjective risk on wet roads
- the impact of weather on exposure

State of the art

However, such relations have not been researched so far. A comprehensive literature survey carried out on this issue discovered al lot of research done on meteorosensitivity. This might also be an issue in the relation between weather and PTW accidents; however, the impact may be rather small compared to the hard and soft facts mentioned in the bullet points above. Further, meteorosensitivity impacts to road user behaviour normally hours or days in advance of a change of weather. Hence, this is out of the scope of this research. Other studies have mainly been carried out based on police reports. Such studies suffer from major shortcomings, hence, weather is only considered at the very place and time of an accident, but do not include weather conditions on the remaining 364 days, 23 hours and 59 minutes of the year. In terms of PTW, such an analysis would measure exposure instead of accidents risk. Some studies were also done on the basis of representative weather data, but none of these studies addresses PTW accidents separately. Generally speaking, these studies discover that accident risk increases proportionately to rain intensity, especially on old pavements. Further, accident risk increases with the length of a dry period in advance. In case of longer rainy periods, the accident risk is highest at the beginning of these periods, in particular in the very first minutes. During this short period, dust on the road mixes up with water and creates a slippery film on the road, which is washed away very soon.

Motivation

For almost 20 years, the number of motorcycle fatalities in Austria faces no trend; fatalities fluctuate between 80 and 120 without any clear reason, although the number of registered vehicles quadrupled within this period and a major change in the population took place. It is generally supposed that weather conditions are the strongest moderating factor in this, but this hypothesis was never proved. When daytime running light was implemented in Austria, some lobbies complained about the tremendously increasing accident numbers of PTW although any study done before on this issue proved that there is hardly any impact of daytime running lights on PTW accidents. It was not mentioned, that the period these lobbies were talking about included the warmest January since weather records are available in Austria. This gave the last impulse to assess the impact of weather on PTW accidents; since information, that was supposed to be strongly biased, was used to lobby for abolishment of a very useful road safety measure.

Hypotheses

1. PTW accidents correlate with weather conditions. This correlation can be described in mathematical terms.

2. The accident record of a year can be normalised using a correlation between accidents and weather conditions.
3. The correlations between weather and accident numbers differ for weekends and workdays.

The term "normalised" as used above shall mean: A given accident record of a certain period - typically one year - is corrected for the expected impact of weather. In other words: If one year includes more sunny day than the average and accidents are more frequent on sunny days, this will result in a higher number of accidents in this year compared to the average. But this fact does not necessarily mean that the risk of riding PTW is different in this year compared to other ones. There may be a random input, there may be influence from other parameters, which could - using other information - also be controlled for, e.g. change in the vehicle fleet, rider behaviour of change of pavement condition. However, this study is done to settle the empiric basis to control for the impact of weather conditions.

Methodology

Although it was already mentioned before, a macroscopic analysis of PTW crashes with respect to weather was carried out using data from the official road accident databases in Austria, Greece and Italy (for 2007) and the CARE database (2006). It was found that a vast majority of PTW accidents (more than 90%) occur on dry roads, but no particular differences could be found between countries based on this data, although the countries strongly differ in typical weather conditions and typical use of PTW. However, this kind of assessment did not discover any other striking results compared to studies executed before. E.g., an analysis of all fatal PTW crashes in the United States carried out by Garder shows that there were 5034 fatal crashes in 2008 involving MC or moped. The roadway was dry in 4832 cases (96%). The atmospheric conditions were as follows: No adverse conditions (clear or cloudy) 4902 (97.4%), rain 76 (1.5%), sleet/hail 0, snow 0, fog/smog 20 (0.4%), severe crosswinds 7 (0.1%), blowing sand 1 (0.0.02%), and other or unknown 28 (0.6%).

To assess the real impact of weather on PTW collisions, it is necessary to have information on weather at any place of the area at any time of a given period included in this assessment. For this purpose, the Institute for Meteorology and Geophysics at the University of Vienna (UNIVIE) extended its existing database. On a grid of 20 km x 20 km, 16 km x 16 km or 10 km x10 km, depending on the parameter, weather information on temperature, humidity, wind and air pressure was already available. This database included weather information from various sources including the approximately 150 weather recording stations all over Austria and slightly beyond its borders. This gives an average of about 500 km² per weather station. These weather stations record the weather with an interval of 3 hours. Other sources could have been used, but neither radar nor automatic recording stations provide weather data of reasonable accuracy for the purpose.

The existing weather database mentioned above was extended by data about precipitation, which most experts on the field of PTW safety consider to be the most important variable of influence on PTW crashes. Finally, UNIVIE provided a database including information on precipitation for 2002 and 2003 based on a grid of 16 x 16 km with a resolution of 3 hours. Precipitation was ranked into six categories from 0 (no rain) to 5 (hard rain).

The Austrian road accident database needed preparation as well. Since this database does not contain geo-referenced accident location, this information had to be created. This was done on the basis of the municipality, where the accident occurred. The geometric centre of the respective municipality was considered as the location of the accident.

Validation of weather database

A weighted mean of precipitation intensity at the four grid points surrounding the accident location was calculated. This was done twice, for the last measurement before and the first measurement after the accident and added to each accident dataset as two additional parameters. It was found, that "rain before accident" matches in 94% of all accident with the weather information collected by police ("rain after accident" in 93%). It may be assumed that a police officer arriving at the scene shortly after the event is reliably able to judge and document the weather conditions at the time and moment of the event. It cannot be presumed that police recorded weather data does not include any mistakes; however, it is known from other validation that this data may be considered very reliable. Validation of the VERA data has not been carried out so far. Hence, these results proved the VERA database to be a sound basis for further analysis. Further police data only contains yes/no information about precipitation. Five different levels of rain may be considered an additional benefit of using VERA data.

<u>Correlation of weather and motorcycle accidents</u>

As a starting point for this study, it was assumed, that decision making on choice of mobility by PTW riders (i.e. whether to take a PTW, a car, public transport or to stay at home) is different on workdays and weekends. On workdays, commuting rides might be the dominating events, while on weekends, there could be more rides for recreational purposes. Hence, these periods were analyses separately and together as well.

Further, it was presupposed that this effect is stronger for motorcycles than for mopeds. Hence, the sample for this analysis was restricted to motorcycle accidents.

In addition, it was assumed that local weather would not be the suitable for the purpose of this analysis. Decisions on whether to ride or not might frequently not be made by a single observation. A series of observations and the weather report might influence these decisions as well. Hence, a general parameter for weather was formed, which should represent weather status more generally. Further, yes/no decisions were considered to vary greatly with type of trip. If it is for a recreational 30 minute ride, or going to the local store, current weather would typically be a good indicator of ride weather. If it is a commute to work, then the weather forecast would frequently be used to predict what the weather will be like some 8 hours later. Nevertheless, as a first approach which could be further developed later, "rain likeability" was calculated as a national average of all included weather stations over one day expressed in values between 0% and 100%. 0% to 15% would be a sunny day in Austria. 75% to 100% would be a rainy day with rain (almost) all day long all over Austria. It would have been possible to define regional weather parameters as well, however, the total number of accidents would have been too low to achieve sound and significant results.

It was found that rain likeability and accident number correlate very well. The relation can be expressed in an exponential function. Further, it was found that workdays differ from weekend days. In other words:

- On sunny weekend days, eight times more motorcycle accidents happen than on rainy weekend days.
- On sunny workdays, five times more motorcycle accidents happen than on rainy workdays.
- On sunny days, six times more motorcycle accidents happen than on rainy days.

It has to be noted, that these values include all three impacting functions as mentioned at the very beginning of this summary.

Hence, another analysis was done comparing accident types under different values of precipitation. Such an analysis would minimise the impact of exposure, but still describe intrinsic risk and risk taking behaviour together. It was found that at high rain likeability, run-off-the-road accidents decrease. This would be an indication that motorcycle riders over-compensate the additional intrinsic risk by careful riding. On the other hand, crashes at intersections increase at high rain likeability. This could be an indication for the importance of conspicuity and appropriate braking skills or installation of ABS or other advance braking systems.

All three hypotheses of this research activity could be positively verified.

Beyond that, some more principles concerning the relation between precipitation and PTW crashes could be found.

There are differences in distribution of collision types. Single vehicle accidents (run-off-the-road) are most frequent with moderate rain likeability, but fewest on rainy days. Sideswipe and rear-end collisions decrease with increasing rain likeability. The share of head-on collisions does not change with rain likeability. Collisions at angle, i.e. mainly crashes at intersections are much more frequent on days with high rain likeability than on days with low and moderate rain likeability.

It was also found that severity of injuries decreases as rain likeability increases.

Outlook

This study can be considered as a pilot study about correlation between weather and road accidents. Since the impact of weather on PTW and especially on motorcycle accidents might be higher than for other vehicle categories, this research on motorcyclists should be continued first, by assessing more years of weather and accident data, by including temperature and maybe other weather parameters as well.

Furthermore, additional research should be undertaken to separate the three functions mentioned at the very beginning of this summary. The present results only give evidence about all three functions together. As a priority, the relation between weather and mileage (or generally, exposure) should be matter of a sound study on mobility of PTW riders. From the view of behavioural research, it might be most interesting to which extent PTW riders compensate for particular dangers of riding in rain.

With a broader database, more parameters could be included, such as urban vs. rural areas and mopeds vs. motorcycles. This additional information could be used to optimise comparability of data. On the long run, neither time series nor international comparison of accident numbers should be done without correcting the data for weather conditions before, at least for PTW accidents.

Research on mobility behaviour with respect to weather (in particular precipitation and temperature) is urgently needed to separate the effect of risk taking behaviour and intrinsic risk within certain weather conditions from the exposure effect.

Once this is done, further research is needed to separate the effect of risk taking behaviour from intrinsic risk within certain weather conditions.

Knowledge about how to control for impact of weather should be extended to other vehicles categories, even if there is more information available about exposure and the impact might be much lower. Still, the methodology may provide insight to compensatory behaviour of road users for additional risk due to bad weather conditions.

2. Introduction

2.1. Editorial remark

While this volume passed the process of internal review, additional weather data became available for analysis. This analysis was done, extending the data base from 200 and 2003 to 2004. Respective results have been summarised and - without having been reviewed - added to this report in Annex VI. These results fully support previous conclusions.

2.2. General

The objective of this activity is to determine the relationship between weather conditions and motorcycle accident occurrence and to establish a framework of procedures to measure the influence of the variable “weather” on motorcycle accident records. These records still suffer (besides other influences which are known but not quantified, and for sure, also a random fluctuation) from the influence of this uncontrolled variable with strong but unknown and not quantified impact. So far, it is unknown if a year with low motorcycle accident number is a good year in terms of safety performance (e.g. with regards to PTW safety measure that have been implemented) or a bad year in terms of motorcycle weather.

Undoubtedly, the occurrence of PTW and in particular of motorcycle accidents is related to the prevailing weather conditions. From several databases, it is possible to describe a function between motorcycle accidents and the weather conditions at the particular time and place of the accident - but it is not possible to determine the actual contributory role of weather, since time series of weather conditions at the same site are not known.

This activity aims at quantifying the impact of weather as a moderating factor on motorcycle accidents. This impact can be modelled by a grid of dependencies - i.e. exposure and actual driving risk as a function of weather conditions. These functions shall then allow an estimate of the total weather-dependant crash risk.

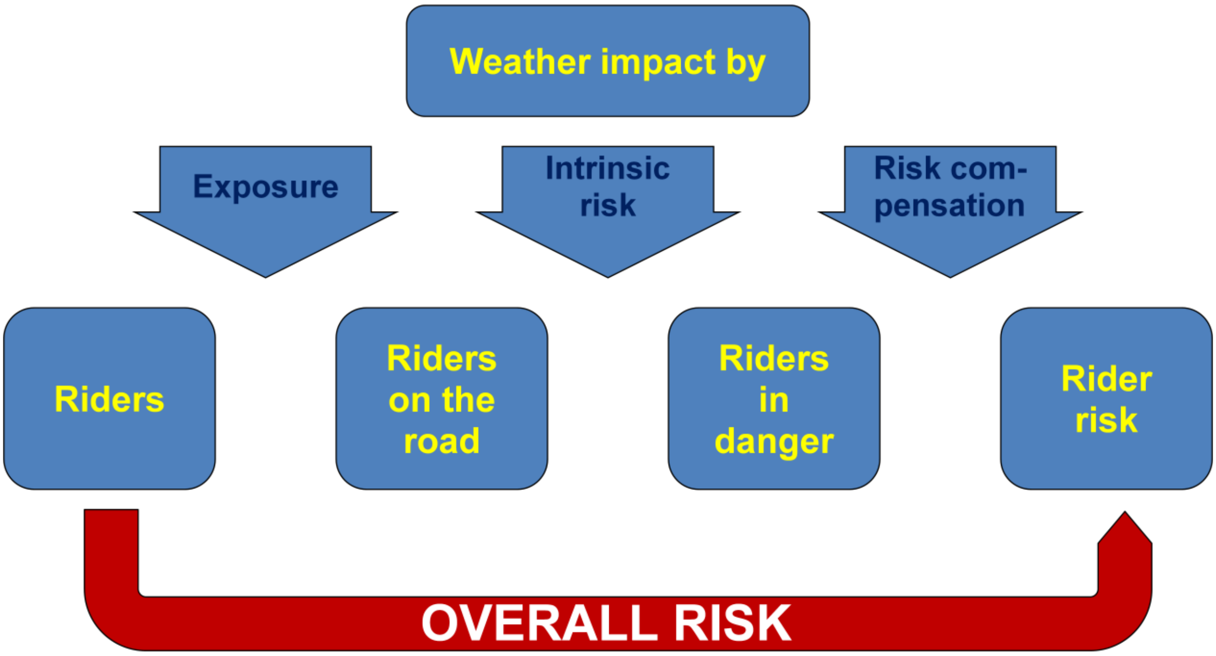


Figure 1: Model of impact of weather on PTW rider risk

Within this study, the overall risk shall be analysed. There is no exposure data available, neither is there anything known about the other two functions. However, for the purpose of this study it is not necessary to separate the effects.

It is supposed by many experts in the field, that PTW accident counts are strongly linked to exposure. Such evidence can be found in 2 BE SAFE Deliverable D2 (Saleh et al, 2009). However, this may give an indication that most of the effect of weather is on exposure rather than on intrinsic risk and risk compensatory behaviour, but there is no information in that, how weather impacts on exposure.

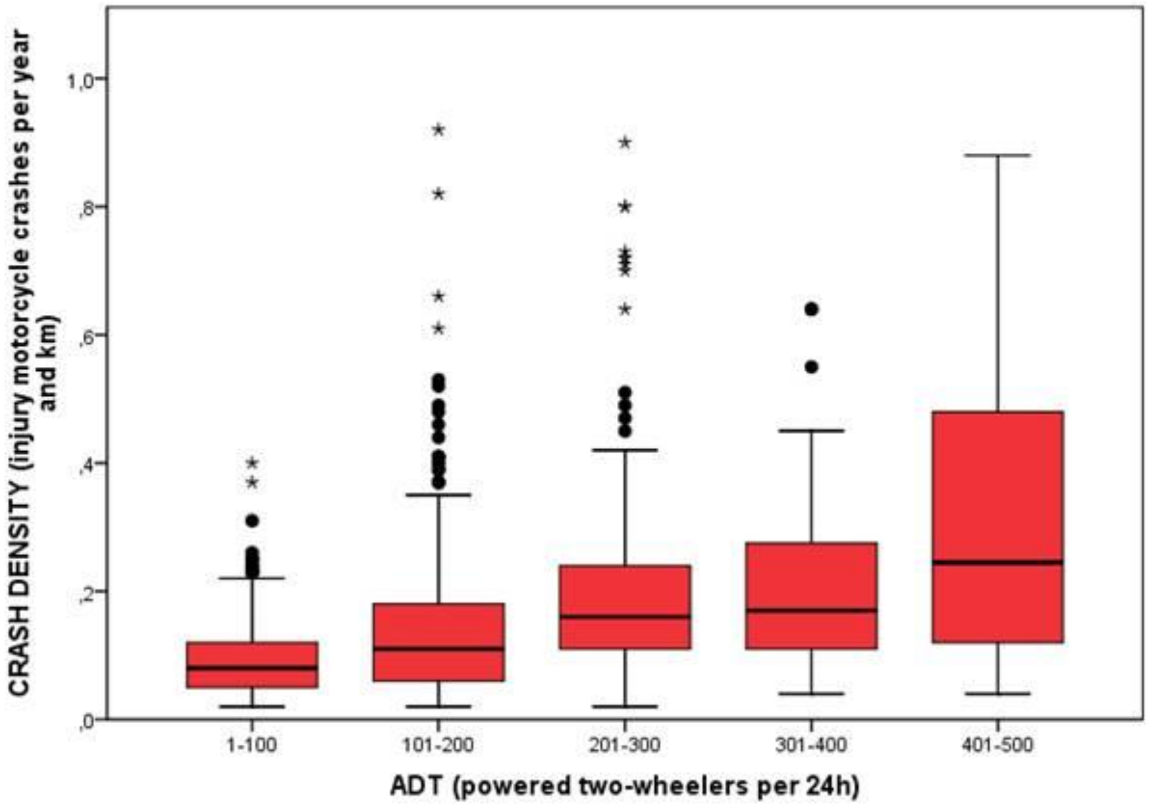


Figure 2: Correlation between PTW crash density and average daily traffic

For each microscopic accident analysis, just the available data about motorcycle accidents was used. It was assumed that moped riding is less weather-dependent than motorcycle riding because mopeds are often used as a means of transport by riders, who are not allowed to drive a car (yet). Thus if they were included in the analyses, they would have distorted the results as mopeds are hardly used for recreational purposes but for commuting in Austria. It might have been the most natural procedure to first analyse moped and motorcycle accidents separately and then decide whether to combine data or not. But since this is a pilot study, it was decided to start off with the category of vehicles, where the strongest impact was expected, and eventually later extend the analysis to mopeds within another study.

2.3. Method

The first task is looking at national accident data at a macro-level in relation to weather conditions. The main task involves setting up a database of weather conditions for a certain geographical area and a certain period of time. A lot of work on this field has already been done by the Department for Meteorology and Geophysics at Vienna University (in the following: UNIVIE). However, their database needs improvement in terms of precipitation (rain and snowfall) to be suitable for the purpose of this project. This data will be matched with motorcycle accident records over the same time period and area.

2.4. Motivation

The starting point as to work on this issue can be found in Austrian PTW accident data. In Austria, for 20 years, on an average about 100 motorcycle riders sustain fatal injuries every year. However, these numbers fluctuate between 80 and 120 without any recognisable reason. All competent stakeholders supposed weather conditions, in particular on the typical PTW weekend trip weekends in spring and fall, to be the main reason. But nobody ever did any research on this issue before.

There were a lot of queries performed using the official accident database and the information on weather included there. Unfortunately, such an analysis is bound to fail in providing the true figures. The official accident records give good information about the weather conditions at the location of the accident and exact time. But this information does not tell how the weather was for the rest of the day, the day before and for the rest of the year.

Hence, doing such an analysis based on weather at the place and time of the accident does not measure risk, it measures exposure. Nevertheless, such an analysis will be done in the course of this activity in order to highlight the difference to the detailed analysis based on the link between accident record and weather database.

2.5. Goals, Methods and Hypotheses

The main goal of this activity is to give figures about the relation between weather conditions and motorcycle rider risk. Primarily, it is intended to set up a function to estimate correction factors to eliminate the impact of weather from the police reported accident records.

Hypothesis 1: Police reported motorcycle accident counts correlate with weather conditions. This correlation can be described in mathematical terms.

In other words: Once a year has passed by, using this function, the weather data can be processed together with a long term statistical trend for motorcycle accidents. The result of this calculation is a set of expected values for police reported motorcycle accident counts, which can be compared with the actual values. The difference may be considered a real change compared to a long term trend.

Hypothesis 2: The accident record of a year can be normalised using a correlation between accidents and weather conditions.

PTW are used for different purposes. Some riders use their moped or motorcycle as a means of transport in order to have the shortest duration of a trip from A to B and back, without having to look for a place to park at B (maybe also, when they are back at A). Some riders may choose a moped or motorcycle as a means of transport, since they cannot afford a car or are not (yet) allowed to drive cars. Other riders buy a motorcycle or moped to use it for recreational purposes, e.g. to go out for the weekend or on holidays.

Leisure time riders might stay at home, if they expect rain, since riding in rain is not as funny or comfortable as it is under sunny weather conditions. Commuters might care less about the weather.

It is not excluded, that riders use their motorcycle for one of these reasons, nevertheless:

Hypothesis 3: The correlations between weather and police reported accident counts differ for weekends and workdays.

In addition, there are other goals:

- determine the behaviour of motorcycle riders encountering the typical risks of bad weather conditions
- validate accuracy of the weather information of the police reports and the weather data base against each other
- provide recommendations for further development of the measure and application at the European level

2.6. Limitations

This analysis is done based on the weather data of two years within the national territory of Austria. Due to limitations of the budget, it was not possible to set up a weather data base particularly for the purpose. Practically, this was not necessary since the weather database as provided by UNIVIE was considered a promising instrument for the purpose and turned out to be very useful. Budget limitations also impeded including more years. Hence, this activity can be considered a pilot project. Cross-analysis of weather data and accident data as it is done in this activity could not be found anywhere in the literature.

Long term trends of accident records might also be due to a change of behaviour of PTW or especially motorcycle riders in relation to weather conditions accepted for riding and other factors as changes in vehicle fleet, behaviour etc. Climate change could influence these long term trends as well. Hence, these long term trends could be influenced by parameters, which also feed into the function between weather parameters and accident numbers. In other words, basic data (i.e. the official accident records) could be biased by parameters, which are also included in the function between weather and accidents. These parameters would then be considered twice.

The true mean value of safety has to be estimated first to be able to estimate the true trend. Statistics are biased by systematic errors and random input. Random input can be dealt with by chosing suitable sample sizes to eliminate their impact. Systematic errors can be either quantified or not. Not quantified systematic errors are the ones, which are worst for statistical analysis. Impact of weather representy such an unknown systematic error. The aim of this study is to turn it into a quantified systematic error in order to improve the possibilities for detecting trends in the true value of safety.

These implications could be solved by an extensive study on mobility issues. Hence, such a study in mobility behaviour of PTW riders including the issue of weather would be the next step towards exact determination of the relation between weather and accidents.

Finally, this choice of mobility could not only be based on the actual weather but also on weather forecast, in particular in case of weekend spare time trips.

2.7. Definitions

Definitions of motorcycles and mopeds were used as according to the European Directive 2002/24:

(a) mopeds, i.e. two-wheel vehicles (category L1e) or three-wheel vehicles (category L2e) with a maximum design speed of not more than 45 km/h and characterised by:

(i) in the case of the two-wheel type, an engine whose:

- cylinder capacity does not exceed 50 cm3 in the case of the internal combustion type, or

- maximum continuous rated power is no more than 4 kW in the case of an electric motor;

(ii) in the case of the three-wheel type, an engine whose:

- cylinder capacity does not exceed 50 cm3 if of the spark (positive) ignition type, or

- maximum net power output does not exceed 4 kW in the case of other internal combustion engines, or

- maximum continuous rated power does not exceed 4 kW in the case of an electric motor;

(b) motorcycles, i.e. two-wheel vehicles without a sidecar (category L3e) or with a sidecar (category L4e), fitted with an engine having a cylinder capacity of more than 50 cm3 if of the internal combustion type and/or having a maximum design speed of more than 45 km/h

Only two-wheel vehicles were considered.

3. State of the Art

It is very easy to analyse the relation between weather and PTW accidents. Most of the national as well as international crash data bases give the opportunity to select accidents with participation of PTWs and prepare tabs about the weather and road surface conditions that can be found in the various data sets about accidents. Practically, this can be done in a couple of minutes. Unfortunately, such a result does not tell us anything about the risk of PTW riding under "bad" weather conditions.

It is a generally accepted hypothesis that PTW-riding is heavily influenced by weather conditions. Many PTW riders, in particular those who ride their PTW as a spare time activity, choose not to go out with the bike in case the weather is bad - or the weather report forecasts bad weather. Weather has been reported to be a less influential factor in 98% of motorcycle accidents in a research conducted in California (Hurt et al. 1981). In MAIDS report, weather made no contribution to accident causation in 92.7% of MAIDS cases (854 cases) and was the precipitating event in 7 cases (0.8% of all cases); weather conditions at the time of the accident were most frequently dry (90%). Rain at the time of the accident was noted in 8% of all cases, whereas dry and free of contamination in 85% of all accidents. More than 80% of crashes entailing the death of a motorcyclist between 1999 and 2003, in Australian roads were reported under fine weather conditions (Johnston et al. 2008). Riding under fine weather also appears to result in more severe injuries regardless of what control measure was employed (Pai and Saleh 2007).

Even PTW users, who use the vehicle as a means of transport on a daily basis, change to other modes (e.g. car, public transport) when they expect bad weather conditions. From December to March, the Austrian crash database normally contains no or almost no fatal and very few injury accidents. Therefore, traditional analysis of crash data basis provides more information about the weather than about PTW risk.

There is also the question, how to define "bad weather". Temperatures too low to ride comfortably or atmospheric fallout are generally accepted as "bad weather" in terms of PTW-riding. But it might also be too hot for a comfortable or safe ride, i.e. too hot to wear a helmet and protective gear.

The hypotheses, which shall be studied within activity 1.3 of 2 BE SAFE, read as follows: The relation between weather can be described by two functions:

- On the one hand, the weather or the weather forecast has an impact on exposure.
- On the other, the risk of using a motorcycle, among many other factors, depends on weather and road surface conditions.
  This effect may be divided into two subordinated issues: One the one hand, there is intrinsic risk of PTW riding in rain, respectively on wet surfaces. On the other hand, there is the question, how PTW riders cope with adverse conditions, i.e. how they change their behaviour in order to compensate for these conditions.

A third issue has to be considered: There is not only a direct impact of weather on exposure and risk. The weather conditions also influence the general condition of the rider, at least of a group of riders, i.e. the group that is meteorosensitive.

3.1. Meteorosensitivity

Runge (1991) investigated 18.000 traffic accidents in the City of Hamburg, Germany. He found that accidents were 30% more frequent on days, which were critical for meteorosensitive people. Beine (1976) supposed a modulated electrostatic field of direct current to be one of the phenomena typically appearing when the weather is warm and sunny. He tested the physical fitness of 110 probands of which 70 were exposed to such field in a laboratory. The test results for those tested under such "nice weather conditions" were significantly better than the results of test persons not exposed to the electrostatic field (i.e. bad weather).

A study by Mercedes Benz analysed 54,000 accidents. It was found that anticyclones in summer linked with extraordinary high temperatures indicate high traffic risk. This appears particularly in early summer, when human physiology has not yet acclimatised to hot weather. Harlfinger from an Austrian automobilist club found a 40% increase of road crashes on days with both hot and humid weather.

For a while, in German court cases it was - based on some of the studies and results mentioned before - popular to bring forward weather-induced physical state of a person as an excuse for an accident. Since the judges normally asked for a proof of meteorosensitivity of the respective person, this strategy was soon abolished again.

A phenomenon, which was investigated closely, is foehn. Foehn is today considered a warm falling wind that is indicated by an anticyclone on the one and a cyclone on the other side of range of mountains. The air goes over the mountains, is cooled down and as soon as it enters a valley on the other side of the mountain is warmed up and dry. This phenomenon is frequently observed in the Austrian Alps. In addition, the warm winds sometimes even come from Africa carrying along dessert sand. Anderle & Urban (1993) investigated the Austrian accident records for influence coming from foehn. They could not find any direct impact on accident numbers. But they found that the variation of accident numbers is significantly higher on days, on which foehn blows. They concluded that the positive impact of foehn on the driving conditions (no fog, no rain, no black ice, etc.) strikes out the negative impact on human physiology.

None of the papers that were analysed particularly refers to PTW. Nevertheless, as long as there is no proof that sensitivity of PTW riders is different from other road users, this has to be considered.

3.2. Pavement

Type and quality of pavement are for sure a major issue in terms of motorcycle safety. A major research project on “Traffic safety and the properties of road surfaces (TOVE)” consists of a literature survey and four sub-studies in four Nordic countries. The first sub-study dealt with the effect of pavement age on traffic safety. The research design was so that the age of the pavement was divided into two equally long periods. The first period represent “new” pavement and the “second” old. On average the accident risk increased slightly with ageing pavement from 14.9 to 15.3 police reported injury accidents per 100 million vehicle mileage. The injury accident rate (per 100 million vehicle mileage) was clearly higher on old pavements (21.8) than on new (16.8) during very rainy days when the daily rainfall exceeded 10 mm. (Leden and Salusjärvi, 1989)

The safety effects of the condition of the pavement were investigated in the second sub-study. In all four countries, the accident risk on inferior road pavements were about 7% lower than on good pavements However on very rainy days, accident risks on inferior road surfaces were higher (14.4) than on good surfaces (10.9). The third and fourth sub-study did not consider weather conditions. (Hemdorff, Leden, Sakshaug, Salusjärvi and Schandersson, 1989)

We found only one paper that exclusively compares two types of road pavement (i.e. asphalt concrete and surface dressing) under different weather conditions using accident numbers. Björketun (1985) found that the relationship between accidents under good weather conditions and accidents under poor weather conditions is considerably higher on asphalt concrete than on surface dressed pavement, in particular in winter and in southern and central Sweden. However, he also confesses that his results are somewhat uncertain due to a lot of uncontrolled variables and large variations in statistical material.

There is no doubt that bad weather, i.e. cold and wet road surfaces, worsens the conditions for safe PTW riding. This study does not refer to PTW accidents in particular. By this study cannot be determined, to which extent PTW riders change their riding style to compensate for worse conditions.

3.3. Influence of weather conditions on accident numbers

There are several studies dealing with the impact of weather conditions on accident occurrence and traffic volume. Most of the studies identify clear influences of weather conditions on accident counts. None of the studies analyses these relationships for different road user types hence there are no results on the relationship between weather variables and crash rates of motorcyclists respectively powered two wheelers.

Fridstrom et al. (1995) analysed the contributions of various factors, including weather, to monthly crash rates by country or province. Data from the Nordic countries Denmark, Sweden, Norway and Finland was analysed. As a conclusion they state “weather conditions appear to play a fairly important role in the accident-generating process, although in the Nordic countries the direction of impact is somewhat counterintuitive” (Fridstrom et al. 1995).

According to the results of this study, rainfall increases the fatal crash rate in Denmark, the impact is insignificant in Norway and Sweden and is not recorded for Finland. Snowfall decreases the fatal crash rate in Denmark, Norway and Sweden. Snow depth decreases fatal crash rates for the countries Finland, Sweden and Denmark.

The authors also found a positive relationship between rainfall and injury crash rates and a negative relationship between snowfall and injury crash rates. The variable "snow depth" also shows a significantly negative effect on injury accidents in Finland and Sweden.

The authors conclude that weather conditions play an important role for crash rates, nevertheless the category traffic volume remains the most important systematic determinant.

Using a negative binomial model along with models of the frequency of specific accident types Shankar et al. explore the frequency of the occurrence of highway accidents. The authors focus on the interactions between weather and geometric variables.

The main insights concerning weather and accident rate are as follows: Maximum rainfall on a given day increases sideswipe, parked-vehicle, fixed object and overturn collisions and decreases rear end collisions. The average daily rainfall affects the rate of rear end collisions. An increase in the average daily rainfall results in an increase of the accident rate as it is an indicator of a more prolonged wet-month weather effect. The number of rainy days in the month has the effect to decrease sideswipe and rear-end collisions and to increase collisions with fixed objects. Maximum snowfall on a given day of the month results in increased rates of rear-end collisions, collisions of vehicles moving in the same direction, collisions with parked vehicle and fixed objects. The number of snowy days in the month has the effect to increase sideswipe collisions, collisions with fixed objects and rollovers.

The authors state that the snowfall-grade interaction tends to decrease sideswipe, rear end, parked-vehicle and same direction collisions. The snowfall-curve interaction increases rear end, rollover and other collisions in the same direction as the rainfall-curve interaction.

According to the authors, the insights of their work have significant implications for highway design standards. Whilst conventional standards refer to pavement-tire interactions on wet pavements, the results of this study show that design criteria should be expanded beyond wet pavements.

Arminger et al. (1996) investigated the impact of weather on accident numbers in the former Federal Republic of Germany for the years 1985, 1991, 1992, and 1993. In doing so, they used a micro analytical approach for analysing the relationship between accident numbers and weather conditions in small local regions with homogeneous weather conditions and short time periods.

The analysis reveal that 6% of the variation in road accidents can be explained through the variables 'range of sight', 'long time change from good to bad weather', 'dry or wet road condition' and 'thermal stress'. Thereby the variables 'dry or wet road condition' and 'thermal stress' tend to have the strongest impact on crash rates.

According to authors of that study, a huge part of variation (50% to 70%) in accident numbers can be explained by mileage.

Injury accidents inside city limits are influenced by 'rain', 'dry or wet road condition' and 'thermal stress'. The numbers of accidents increase by 6% in case of rainfall compared to no or low rainfall.

The number of injury accidents also increases by 5% in case of a long time change from good to bad weather. In case of dry road surfaces accident rates decrease by 20% compared to wet conditions. Thermal stress leads to an increase of 22% of injury accidents inside city limits.

Injury accidents outside city limits are influenced by dry or wet road condition and thermal stress. In case of dry road surfaces accident frequency decreases by 18% compared to wet conditions. Thermal stress leads to an increase of 13% of injury accidents outside city limits.

Aminger et al. (1996) found a relationship between accidents with personal injury and/or major property damage inside city limits and rainfall, thermal stress and dry and wet road condition. The number of accidents increases by 8.3% in case of heavy rainfall compared to no or low rainfall and decreases by 26.4% in case of dry road conditions. When thermal stress is high accident numbers are by 12% higher than normal.

Accidents with personal injury and or major property damage outside city limits are influenced by dry or wet road condition and thermal stress. The relationship between the variables is not as strong as for the other three dependent variables. In case of dry road surfaces accident rates decrease by 25,4% compared to wet conditions.

The article closes with the recommendation of a collection of data on local weather conditions directly when recording the accident data and an enhancement of the data on mileage.

Eisenberg (2004) analysed the relationship between crash rates and weather conditions in all contiguous states of the USA using a negative binomial regression. He finds a negative and significant relationship between monthly precipitation and monthly fatal crashes. 100 mm of rain result in a 3.7% decrease in the fatal crash rate. The results on a daily level show a positive relationship. Eisenberg explains these results by the effect that precipitation clears the road of oil and by conditioning of drivers.
Another interesting result of Eisenberg’s analysis is the fact that the risk imposed by precipitation increases dramatically as the time since last precipitation increases. The more days that have passed since the last precipitation the higher the fatal crash rate as well as the non-fatal crash rate get.

Quellet et al. (2003) conducted on-scene, in-depth accident investigations of 1082 motorcycle crashes in Thailand in 1999 and 2000 to examine the contribution of environmental effects on motorcycle accidents. View obstructions contribute to the accidents in 13% of all cases and roadway design defects were a contributing factor in 6.5% of all cases. The authors report weather factors to be rarely a contributing factor. The category weather is stated as primary accident cause in none of all accidents. It is stated as secondary cause in 11 out of 693 records and as tertiary cause in 5 out of 148 records. An explanation for this result is, according to the authors, that motorcyclists tend to stay off the road when it rains.

Keay and Simmonds (2005, 2006) analysed various effects of weather conditions in Melbourne, Australia. First they studied how weather influences the traffic volume (Keay/Simmonds 2005) and then they examined the relationship between rainfall and road accidents (Keay and Simmonds 2006).

In their 2005 study the authors used data from the years 1989 to 1996 for analysing the influence of weather variables on the traffic volume in Melbourne. Daytime and night-time periods were investigated separately. The results of the study show that rainfall has the greatest impact on traffic volume in winter and spring. There is a negative relationship between traffic volume and the amount of rainfall. There are significant decreases of 1.35% and 2.11% in traffic volume on wet days in winter and spring. Keay and Simmonds also found a reduction of 1.86% in winter and 2.16% in spring during daytime rainfall. The reduction of traffic volume during night-time is according to the authors significant over all seasons.

Furthermore Keay and Simmonds (Keay and Simmonds 2006) normalised the road accident count with traffic volume and found a positive relationship between rainfall and accident counts. Rainfall increases accident rates by 2.4% compared to the daily dry mean accident count. Split into daytime and night time, the authors of the study were able to show an increase of 1.9% and 5.2% in accident counts compared to estimated mean accident counts for dry weather conditions.

In a study which was published one year later, Keay and Simmonds investigated the impact of rainfall on daily road accidents in Melbourne, Australia (Keay and Simmonds 2006). The investigation refers to the years 1987-2002 which the authors divided into three epochs (1987-1991, 1992-1996, and 1997-2002) due to a large, non linear effect in the data. In general, there is an association of more accidents with rainfall for all epochs and subdivisions of a day. Furthermore Keay and Simmonds describe larger values in spring and lower values in autumn.

The authors also revealed a 40% decrease in accidents from the first to the second epoch. The reason for this effect has to be seen in non-weather aspects, because the second time period is wetter than the first one.

As most other studies Keay and Simmonds (2006) found that the presence of rainfall constantly represents a driving hazard. They investigated the relative risk of an accident in wet conditions and the impact of rain after dry spells.

Keay and Simmonds (2006) quantified a strong impact of rain after dry spells. Rainy days after spells show an increase of the crash rates of about 9% when the spell had duration of 1-5 days. When the spell lasted more than five days the crash rate increases by approximately 18%.

Brijs et al. (2008) analysed the impact of weather conditions on crash rates on the basis of daily crash counts and found out that the variables precipitation, temperature and sunshine have significant effects on crash rates.

The authors found a positive relationship between the intensity of rain, being the ratio between daily precipitation amount and daily precipitation duration. They also found a positive relationship between crash rates and the number of hours of rainfall per day. This means that the higher the counts for those variables get, the more accidents will occur.

The relationship between temperature and crashes is somewhat finical. Lower temperatures lead to more accidents with temperatures below zero being the most significant. The authors also found out that the deviation from monthly meant temperature has an effect on the crash rate. This means that "although on average a daily temperature of say 10°C leads to a higher number of crashes compared to temperatures above 20°C, the deviation from the monthly mean temperature may indicate the reverse" (Brijs et al. 2008). So 10°C can lead to more crashes as well as to fewer crashes depending on the average temperature.

Concerning the variable sunshine the authors found a positive relationship between the relative amount of sunshine, which is the percentage of maximum possible sunshine duration, and the number of crashes.

3.4. Summary

A literature review has shown that there are several papers which examine the relationship between accident rates and weather conditions. Most studies demonstrate effects of weather conditions on the numbers of accidents. The parameters that were shown to have an impact on accident counts are:

- amount of daily rainfall and snowfall
- daily hours of rainfall and snowfall
- intensity of rainfall
- duration of previous dry periods
- temperature
- gradient of chance of some of these variables

There is also clear indication that other variables like grade and curvature as well as time of the day and season have an impact in accident numbers in combination with some of the variables of weather.

Some of the studies conclude that the impact in accident number is a secondary effect resulting from an impact of weather on exposure.

None of the studies has investigated the influence of weather variables on the accident risk of motorcycle riders.

4. Macroscopic analysis of police reported accidents

In a first step of this activity, the traditional method of analysing PTW rider accidents with reference to weather conditions was applied, using accident data from Greece, Italy and Austria as well as data from the CARE database. The main purpose of this activity was to look for remarkable results of correlation between weather and accident occurrence. To compare the general figures of PTW accidents of these countries was not a focus of this chapter, but will nevertheless be done in 0. At least, this comparison involves two countries where PTW riding typically is a full year mode of mobility and one country where riding in winter is very uncommon.

Since data on injuries is known not to be comparable between countries, this analysis was done for fatalities only.

The available data in the three countries and the CARE data base were compared and a common approach was defined in terms of queries to be run and displayed.

4.1. Austria

For this analysis, datasets from the Austrian Road Accident Database were used. This data is collected by the police. Police records mainly injury accidents. Property-damage-only-accidents are not recorded, except in some Austrian regions. In these cases, the sample is highly biased since police includes only accidents they are notified about. There is a legal obligation to notify the chaser's authorities or the police in case of crashes with animals. Hence, 70% of the property-damage-only-accidents in the police records are accidents with animals.

To overview the Austrian data availability, the Austrian Accident Data Form, which has to be filled in by them, is attached to this paper (Annex II).

Subsequently, after having recorded the required data, these Accident Data Forms are sent to “Statistics Austria” (independent and non-profit federal institution under public law). The accident data forms are digitised and fed into the official accident database. Today, this database contains all the road traffic accidents resulting in personal injury from 1961 up to now.

KfV purchases the data set each year. For each single case, plausibility is assessed and corrections are made (a rather small proportion of the cases is corrected, in most cases, location data in implausible).

In this research, the datasets included all powered two wheeler and passenger car accidents, which were recorded in Austria in 2007 and where at least one of the occupants. The cross-analysis of accident cases was done by age, sex, occupant category, area of accident, drunk driving, collision type and precipitation.

In terms of vehicles, the term "motorcycle" describes powered two-wheelers with an engine capacity above 50 cm^3. Until 1992, there was a category of PTW in Austria called "Kleinmotorrad" (i.e. "small motorcycle" in direct translation). These are PTW with a capacity up to 50 cm^3, but without a speed limit. Traditionally, these vehicles used to be counted together with mopeds in accident statistics. Meanwhile, hardly any vehicles of this kind are used on the road; hence, they were not included in this analysis.

A final remark addresses the size of the sample: Executing an analysis of only one year of accident data is reasonable for sample sizes given in Greece and Italy and within the CARE data. In Austria, the total number of 96 people being killed within one year does not offer the opportunity of statistically significant conclusions. All of the following remarks have to be considered taking this into account.

Detailed data on the analysis of the Austrian accident database can be found attached to this document within Annex V.

4.2. Greece

Data from the Greek National database with disaggregate road accident data are used in this research. Information for each accident is collected by the Police and coded by the National Statistical Service of Greece. The System for ANalysis of TRaffic Accidents (SANTRA) developed by NTUA uses this national data file (DTPE 2002). This database contains all injury accidents, the related casualties, and the drivers involved for the period 1985 – 2007. The dataset used in this research includes all mopeds, motorcycle and passenger cars (PC) accidents that included fatalities reported for 2007, cross-classified by driver's nationality, inside and outside urban areas, at or not at junctions and other variables (SANTRA, 2007). All variables contained in SANTRA are presented in the Annex III: Greek accident data form.

Detailed data on the analysis of the Greek accident database can be found attached to this document within Annex V.

4.3. Italy

In this research, data from the Italian National Database (ISTAT database) are used. The dataset is comprised of accidents, which involve all road vehicles and at least one injured person, and which have occurred on a public roadway. Accident information is documented by public authorities. However, since they are not systematically informed of all the accidents, their presence is guaranteed only whenever medical assistance is required. This collection method leads to an underestimation of uninjured people but to a correct count of accidents with fatalities. This analysis is based on data of 2007.

The analysis separately takes into consideration the weather conditions (clear / rain / other) reported at the accident and the road conditions (dry / other), in order to evaluate a potential influence on the number of fatalities. The term “other” stands for accidents, which happened on wet, sandy etc. pavement. Of 567 accidents, which belong to this category, 497 occurred on wet pavement.

Detailed data on the analysis of the Italian accident database can be found attached to this document within Annex V.

4.4. Comparison of the Austrian, Greek and Italian data

This section compares the data displayed in sections 12, 12.2 and 12.3.

There is no information about the fatalities linked to drink-driving from Greece and Italy as well as no information about the traffic control in Austria. Besides, the terms used for Austrian and Greek collision types respectively for the Greek and Italian "traffic control" differ. Hence, the fatal casualties were just observed by age and gender.

In general, the number of accidents recorded under rainy conditions is rather low. In particular for Greek data, even including 10 years instead of one would not give absolute numbers useful for preparing statistically meaningful results.

This also indicates that there are countries, where the impact of weather would have to be measured in another way, if there should be any impact.

4.4.1. Transnational comparison of PTW fatalities by age

In all three countries, at least 90% of the PTW fatalities were recorded under dry weather conditions. Especially in Greece, just 18 of 445 took place when it was not dry. On the contrary, the highest percentage of fatal PTW accidents under rainy conditions was reported in Austria in 2007.

Concerning the age of the fatally injured PTW rider, there are hardly any national shifts anent the weather condition. But it is visible that in Austria and in Italy, proportionally more 15 to 17 year old PTW riders died than in Greece. In the age category from 18 to 24 years, more fatalities happened in Greece than in the other two EU countries. In comparison with Austria and Italy, the total as well as the proportional number of fatally injured elderly persons (65+) is the highest in Greece, too. And in all three countries, under each weather condition, the percentage of killed 25 to 49 year old PTW riders is always at least 50%, whereas the maximum is 75%.

Table 1: PTW fatalities with respect to age and weather, EU comparison 2007

Age	Austria				Greece						Italy					
	Dry		Rain		Dry		Other		Rain		Dry		Other		Rain/Hail	
00-14	0	0,0%	0	0,0%	2	0,4%	0	0,0%	0	0,0%	19	1,4%	4	3,6%	0	0,0%
15-17	12	11,0%	0	0,0%	22	4,9%	0	0,0%	1	8,3%	97	7,2%	7	6,4%	5	10,4%
18-24	12	11,0%	1	13,0%	111	24,9%	2	33,3%	3	25,0%	216	15,9%	21	19,1%	8	16,7%
25-49	61	54,0%	6	75,0%	232	52,1%	3	50,0%	6	50,0%	800	59,0%	58	52,7%	26	54,2%
50-64	20	18,0%	1	13,0%	37	8,3%	0	0,0%	1	8,3%	124	9,2%	9	8,2%	7	14,6%
65+	7	6,0%	0	0,0%	41	9,2%	1	16,7%	1	8,3%	83	6,1%	9	8,2%	2	4,2%
Unknown	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	16	1,2%	2	1,8%	0	0,0%
Total	**112**		**8**		**445**		**6**		**12**		**1355**		**110**		**48**	
	93%		7%		96%		1%		3%		90%		7%		3%	

4.4.2. EU comparison of PTW fatalities by sex

Table 2 displays the EU comparison of PTW fatalities by sex. In every analysed country, the number of male PTW fatalities is much higher than the respective one for female killed persons. Besides, there are hardly any sex shifts concerning the weather condition because the percentage indicating male fatalities is for each country and weather type approximately 90%.

Table 2: PTW fatalities with respect to sex and weather, EU comparison 2007

Sex	Austria				Greece						Italy					
	Dry		Rain		Dry		Other		Rain		Dry		Other		Rain/Hail	
Male	100	89,3%	8	100,0%	416	93%	6	100,0%	11	91,7%	1271	93,8%	98	89,1%	44	91,7%
Female	12	10,7%	0	0,0%	29	7%	0	0,0%	1	8,3%	84	6,2%	12	10,9%	4	8,3%
Total	**112**		**8**		**445**		**6**		**12**		**1355**		**110**		**48**	
	93%		7%		96%		1%		3%		90%		7%		3%	

4.5. PTW fatalities and weather conditions all over Europe

Table 3 summarizes the number of fatalities in accidents involving PTW (mopeds and motorcycles) by the different weather conditions for the year 2006 using the CARE database. The majority of accidents (more than 80% in all European countries) occur under fine weather conditions

Table 3: Fatalities across European countries by weather conditions and PTW type

Country	Mopeds				Motorcycles			
	Dry	Rain	Other	Total	Dry	Rain	Other	Total
AT	37	2	0	39	92	3	0	95
BE	34	1	1	36	116	4	10	130
CZ	3	0	0	3	107	4	2	113
DK	20	3	1	24	19	1	1	21
EE	2	0	0	2	4	0	1	5
ES	286	12	4	303	471	8	10	488
FI	12	0	1	13	24	0	2	26
FR	274	31	12	317	727	39	23	789
GB	26	3	0	29	530	26	13	569
GR	54	1	2	57	423	12	5	440
HU	38	1	3	42	87	2	0	89
IT	300	18	28	346	1009	32	86	1127
LU	-	-	-	-	-	-	-	-
LV	6	0	0	6	10	0	0	10
MT	-	-	-	-	2	0	0	2
NI	0	0	0	0	12	2	0	14
NL	58	3	2	63	53	4	0	57
PT	86	9	2	97	129	6	2	137
SE	13	1	1	15	52	1	2	55
Total	**1249**	**86**	**57**	**1392**	**3867**	**143**	**157**	**4167**

Source: CARE Database / EC
Date of query: August 2008

5. Microscopic analysis of police recorded accidents with respect to precipitation

5.1. Weather data provided by UNIVIE

As part of the University of Vienna, the Institute for Meteorology and Geophysics participates in 2 BE SAFE by the contribution of timely and regionally highly detailed weather information with respect to precipitation. With these data, KfV will draw the connection between weather conditions and PTW accidents in Austria.

5.1.1. Selection of an appropriate data source

To determine an appropriate data basis for precipitation analyses, following data sources were under consideration:

- RADAR: The usage of radar data would make sense, because it provides a high time and spatial resolution of precipitation (time resolution: 5min, spatial resolution: 1km). But it has to be considered that the precipitation amount, which is deducted from the radar, is seriously erroneous, especially in mountainous regions. Thus the negative influence of the very complex Austrian topography on the quality of the contemporary radar data was too big for this project. In the near future, this data source will be improved immensely due to the planned construction of a new radar meteorological network. Besides, another disadvantage of radar data are their extremely high costs in Austria.
- Satellite: Although satellite data offer a time and spatial resolution (geostationary: time resolution: 15min, spatial resolution: 5km; polar orbit: time resolution: 6h, spatial resolution: 1km), their data quality is even worse compared to radar data. Especially in summer, often occurring convective rain events cause big problems.
- Automatic Stations: These stations provide precipitation amounts in a high time resolution (time resolution: 10min, spatial resolution: app. 25 km). Considering the spatial-time scale of weather events, the distance between neighbouring stations should be in the range of a few kilometres for an expediently spatial link to the 10 minute data. This requirement cannot be fulfilled anywhere nowadays.
  In addition, this method of measurement is quite inertial: The automatic stations just react when the rain is more than just a drizzle. Hence, it is possible that short drizzle is completely missed by the stations.
- Human Observation: To find the best balance between spatial and time resolution concerning weather data, human observations have to be carried out (time resolution: 3h, spatial resolution: ca. 35km). Next to one hundred different weather conditions and weather courses, statements about the cloudiness respectively the visibility are reported. The observation is reported about what the weather is like at the very moment of observation. In terms of precipitation, the value does not add up millimetres of rain within the recent three hours (as it is usually done), it is the experienced impression of the observer at the particular moment. Finally, this data source was chosen for the precipitation analyses in the 2 BE SAFE project.

5.1.2. Functional description of VERA (Vienna Enhanced Resolution Analysis)

The interpolation method VERA, which was used for 2 BE SAFE, was developed at the University of Vienna at the Institute for Meteorology and Geophysics. It was especially designed for regions, which are characterised by a complex terrain (e.g. Austria), and it is being improved steadily.

In general, VERA is made up of a variation algorithm, which can be traced back to the “thin plate spline” method. The squares of the spatial first and/or second derivate of the measuring field are minimised. Thereby, it is assumed that many field distributions of meteorological parameters behave in such a way, that their curvature is minimal. This approach is based on the “principle of least effort”, which can often be seen in the nature (e.g. the surface of a soap bubble).

This method can also be shown with the help of an example: At first, a 1-D grid point field with constant distances (e.g. 16km), which is filled with 5 in any order distributed data, is created. These data come from measurements at measuring points. At the unknown grid points, the measuring field has to be interpolated. The interpolated values between the data points can principally be described with any function, which links all the given points (“nodes”). Now, if e.g. an elastic ruler or a spline is spanned to the nodes, the form will approximately be in line with the function of the interpolation. This specific function is defined as the very function, whose entire curvature is minimal between 1 and 5 (“cubic spline”). For it, the mathematic formulation is:

$$J = \int_1^5 \left(\frac{\partial^2 \Psi}{\partial x^2} \right)^2 dx \rightarrow Min$$

For the practical usage in VERA, this principle is extended to 2, 3 and 4 dimensions.

5.1.3. Data processing for motorcycle studies

For 2 BE SAFE, the extensive synoptic data set, which contains Europe-wide three hour weather information from 1971 to 2005, was used. At the University of Vienna, this specific data set was developed by the Institute of Meteorology and Geophysics in the course of the project “MESOCLIM” and bases upon ERA-40 raw data.

The main task for the Institute of Meteorology and Geophysics was to make a statement about the weather condition before, while and after the accident. Therefore, the available three hour measurements were classified according to an intensity scale, beginning with 0 (“no rain”) up to 5 (“very heavy rain”). Subsequently, with the help of the analysis method VERA, these values were interpolated on a 16x16km grid.

With this method, a rectangle, which consisted of 740 grid points, was drawn around Austria. Afterwards, three hour grid point time series, resulting in 5840 measurements per grid point, were calculated for 2002 and 2003. This can be seen in Figure 3.

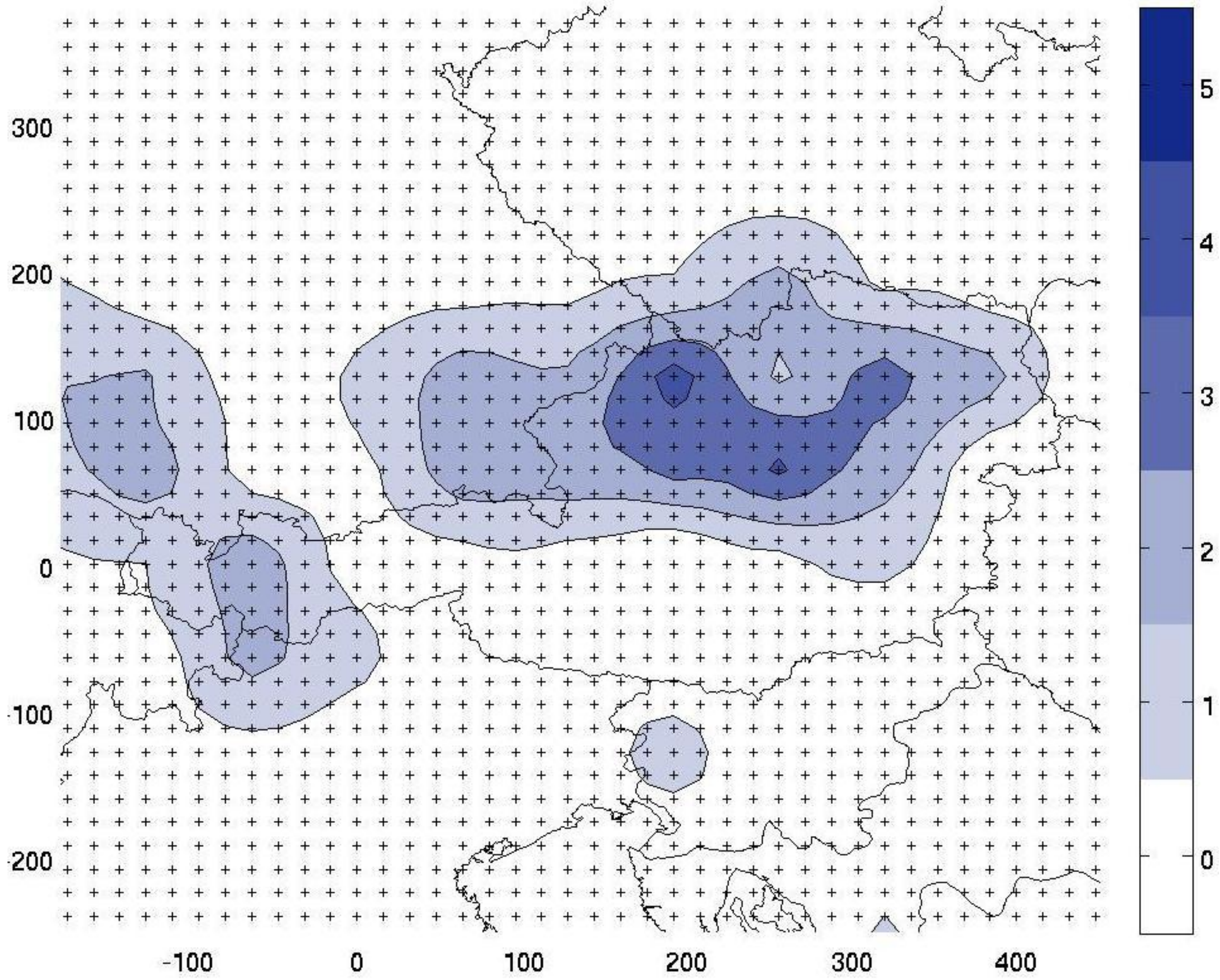


Figure 3: Example of weather data provided by UNIVIE

5.2. Description of the preparation for the microscopic analysis

The meteorological data as described above is linked to the accident database in two ways:

For the comparison of the police recorded weather conditions with the precipitation data from the university Vienna, GPS coordinates were generated for each accident based on the municipality in which the accident occurred. There are about 2200 municipalities all over Austria. The representative point of one municipality is the geometrical mean of its borders, i.e. in other terms, the centre of gravity of its shape.

Respectively, the weather data for each of the municipalities and for each time frame was generated by calculating a weighted mean of the four nearest measurement points of the meteorological data for the time before and after the accident time.

For computing daily weather conditions over a broader area, a percentage of measurements with precipitation relative to all measurements on each day in one region in Austria (Austria is divided in 9 federal states) is calculated for the years 2002 and 2003 (see a more detailed description in chapter 5.4 and Table 4).

5.3. Limitations

Although 2608 nationwide measurements are taken daily, the merge of the data provided by UNIVIE with the police recorded motorcycle accidents is subject to several limitations concerning the time frame and the regional raster. On the one hand, the measurements are performed every three hours, resulting in 8 daily measurements per measuring point. On the other hand, as displayed in Table 4, the number of measuring points per federal state varies from 2 to 71. Thus the average area, which should theoretically be covered by one measuring point, is approximately 208km².

For these reasons, microscopic weather changes as well as the actual weather condition of an accident can just be recorded when an accident happens near a measuring point at the moment, when the precipitation is measured. Since this is rather unlikely, these limitations have to be considered when comparing the data provided by UNIVIE with the police records in 5.5.

Table 4: Precipitation measuring points and daily measurements per federal state

Federal State	Federal State's Area [km²]	Measuring Points	Measurements/ Day	Area/Measuring Point [km²]
Burgenland	3965	18	144	220
Carinthia	9536	33	264	289
Lower Austria	19178	71	568	270
Upper Austria	11982	50	400	240
Salzburg	7154	29	232	247
Styria	16392	63	504	260
Tyrol	12648	49	392	258
Vorarlberg	2601	11	88	236
Vienna	415	2	16	208
Total	**83871**	**326**	**2608**	**208**

5.4. Preparation of the database

As part of the Austrian accident data form (Annex II: Austrian accident data Form), the actual weather condition at the accident location has to be recorded by the police. Information is collected exactly at the site of the accident. Police normally arrive only a couple of minutes after the accident occurred and then, the victims are interviewed. Below, it has been assumed that weather information by the police is very accurate. However, mistakes could be made when filling the accident reporting form. As no empirical data of the magnitude of the mistakes has to been found results below has to be interpreted within this limitation.

Although 2608 measurements daily feed into the weather database provided by UNIVIE, such a database cannot cover microclimate at a particular place nor seasonal swift weather changes. On the other hand, police reported weather is not suitable for analysis as it is done in the following, because weather data from police reports is only know for the very time and place of an accident, but not for the remaining time of the year as the same spot. Hence, it is of high interest to validate the two databases against each other, in particular, whether the all-year database is suitable to accurately determine weather conditions for a single place and time (i.e. locations and time of an accident known from the accident database).

Data provided by UNIVIE was categorized in 6 categories, beginning with "0", which stood for “no rain”, up to "5", which meant “heavy rain”.

From the official Austrian accident database, all accidents involving at least one motorcyclist were selected for the relevant years (2002 and 2003). Each of these 6,857 accident forms one data set. One data set contains information about the accident itself (e.g. location, particular circumstances, road type, accident type, light conditions, road conditions and weather), about involved parties (e.g. age, sex, licensing year, categories of licenses, place of living, type of involvement, degree in injuries) and about the vehicles involved (e.g. category of vehicle, make & type, engine power). Each of these accident data sets was extended by adding two more integer variables for precipitation: “rain before accident”, which is the regionally and timely closest weather status before the accident, and “rain after accident”, representing the regionally and timely closest precipitation after the accident. On the basis of these fundamentals, different analyses concerning the conformity of UNIVIE’s data with the police records were carried out.

The official Austrian accident database contains information on condition of the road and weather condition, as describe in Table 5.

Table 5: Road, weather and light conditions in Austrian accident database

road condition		weather condition		light conditions	
1	dry	1	rain (drizzle)	1	blinding sun
2	wet	2	hail	2	daylight
3	sand, grit	3	freezing rain	3	dawn, dusk
4	snow, mud	4	snow	4	darkness
5	wintry slippery road gritted			5	artificial road lighting
6	wintry slippery road no gritted				
7	other (e.g. oil, soil)				

From these values, only "weather condition" was used, since it is the most suitable variable, although road conditions might be more relevant to an accident. But road conditions are hard to determine by actual weather data. In case they could be calculated using time series of weather data, and then be compared to the values given by the accident reports. This could be done in another study. Light conditions are not under investigation in this report, however, they could be cross-checked with weather conditions to eliminate database errors. Such cross-checks have been discussed many times, but were considered not to be useful. There is hardly any combination of conditions, which is not possible. E.g. "rainfall" and "blinding sun" do not exclude each other, this exactly the conditions, where rainbows appear. When is it is just beginning to rain, dry road is not excluded. There are many more examples of this kind. In addition, other validation of the police recorded accident database has found that this data is very reliable (except for the detailed information on location of the accident, which is not relevant in this study). Hence, it does not matter, that no value for the variable "weather condition" could mean that there was no precipitation or the policeman forgot fill this item on the form. Experience says that the latter hardly ever happens.

All kinds of precipitation were summarized to a Boolean variable precipitation yes/no. Inconsequently, this variable sometimes is called "rain", in real it is all kinds of atmospheric fallout.

5.5. Comparison between police data and information provided by UNIVIE

5.5.1. Preparation of additional variables

As a first step, the conformity between weather information as described above and the police records was evaluated. To get representative values, this was done on the level of federal states (see Table 4). A more detailed analysis could not be not carried out because the total numbers of accidents in single items would have dropped below the limit for proper statistical analysis.

As the next step, the two weather variables had to be compared for all accidents. One of these variables is Boolean, the other an integer variable with six values. Hence, it had to be determined, which of the six values refers to the two values of the other variable.

Therefore, another Boolean variable was added. The six categories were divided into two main precipitation classes, whereas the first one contained the accidents under dry weather conditions and the second one all the other crashes. But before this classification was finalised, the precipitation category number 1, "very slight rain", was examined, whether it better fits into "rain" or "no rain". For that purpose, the relative conformity with the police records per federal state was evaluated twice: Firstly, it was assumed that category 1 meant that it was raining (Figure 4**Fehler! Verweisquelle konnte nicht gefunden werden.**). Secondly, the same evaluation was done, but this time, category 1 stood for "no rain" (Figure 5). In both of these cases, the data of UNIVIE was rated as wrong if neither the value "Rain before accident" nor "Rain after accident" matched the weather conditions reported by the police. In addition, due to that fact that motorcycle riding is bound to seasonal conditions, just the appropriate period was observed: Over 95% of the accidents in 2002 and 2003 happened from March to October (6612 out of 6857).

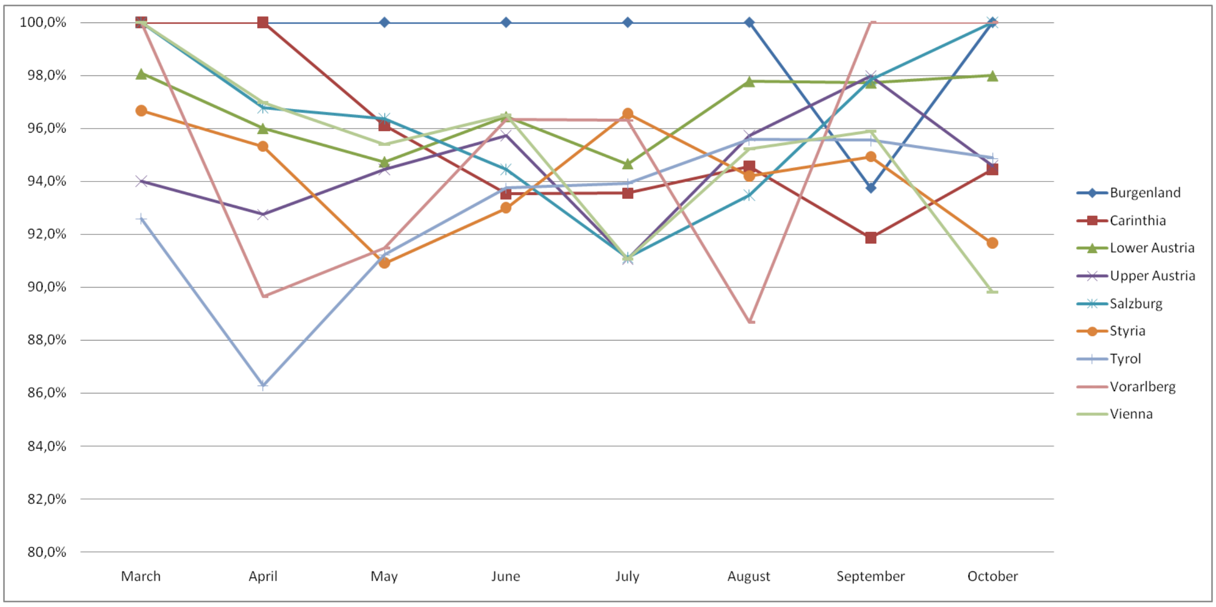


Figure 4: Relative conformity of UNIVIE's data with the police records per federal state and month, category 1 = rain, Austria 2002 & 2003

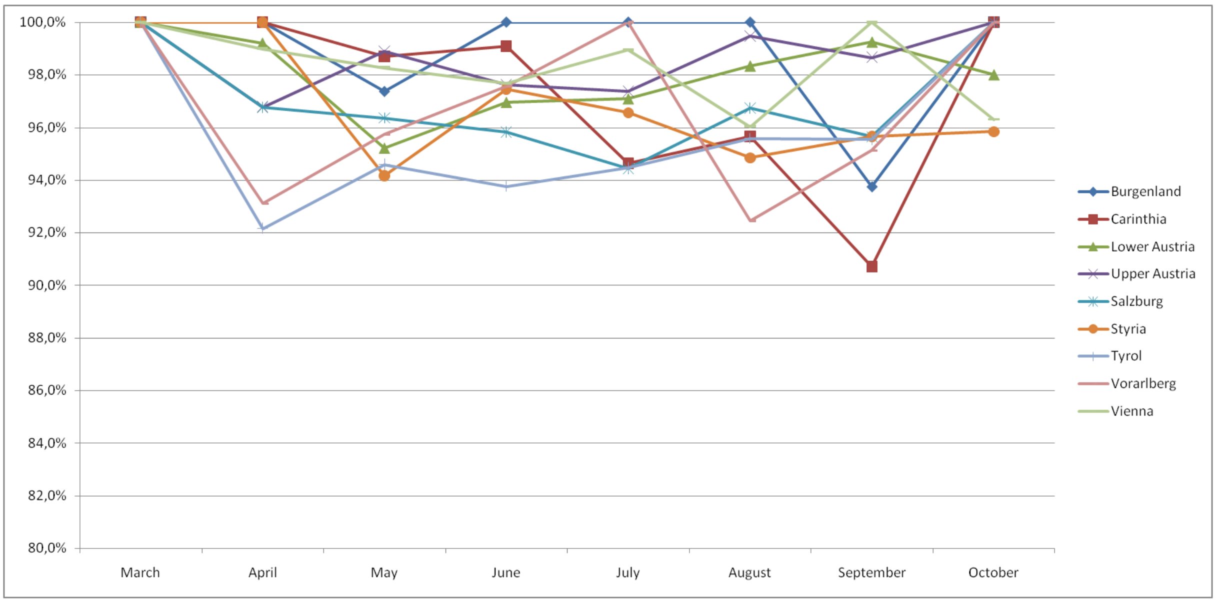


Figure 5: Relative conformity of UNIVIE's data with the police records per federal state and month, category 1 = no rain, Austria 2002 & 2003

Although these evaluations hardly differ, it is visible that the second one, where category 1 belongs to the class “no rain”, is slightly better than the first one. These results are also shown in detail in Table 6.

Table 6: Relative conformity of UNIVIE's data with the police records per federal state, Austria 2002 & 2003

Federal State	category 1 = rain		category 1 = no rain	
	Average	Minimum	Average	Minimum
Burgenland	99,4%	93,8%	98,9%	93,8%
Carinthia	94,5%	91,9%	97,3%	90,7%
Lower Austria	96,6%	94,7%	98,0%	95,2%
Upper Austria	95,6%	91,1%	98,6%	96,8%
Salzburg	97,0%	91,1%	97,0%	94,4%
Styria	95,3%	90,9%	96,8%	94,2%
Tyrol	94,0%	86,3%	95,8%	92,2%
Vorarlberg	96,2%	88,7%	96,7%	92,5%
Vienna	95,9%	89,8%	98,3%	96,0%
Average	**96,1%**		**97,5%**	

As a result from these findings, the precipitation classes, which were used in the further calculations, were made up as followed: class 1 contained the rain categories 0 (“no rain”) and 1 (“very slight rain”) and class 2 included the categories 2 to 5.

5.5.2. Comparison of weather variables

The last step in this validation is to compare the two Boolean variables (“rain before accident” and “rain after accident”) from the weather database with the weather information from the accident database. This comparison distinguishes between the two different types of evaluation carried out above as well. Since there are values for intensity of rain every three hours (3:00, 6:00, ..., 24:00), determining the weather at specific point in time could be done either by selecting the value measured before or the next one after this point in time. This is to judge whether the previous or the next value suits better for the purposes of this study.

At first, the validation, where the category “very slight rain” belongs to the class “rain”, was conducted. If the conformity of the data provided by UNIVIE with the police records is evaluated in detail, it can be observed that both measurements "rain before accident" as well as "rain after accident", were in line with the police report in 83% of the accidents (Figure 6). Among the remaining 17%, 12% of those were covered by measurements, where at least one of them went conform to the police recorded weather condition.

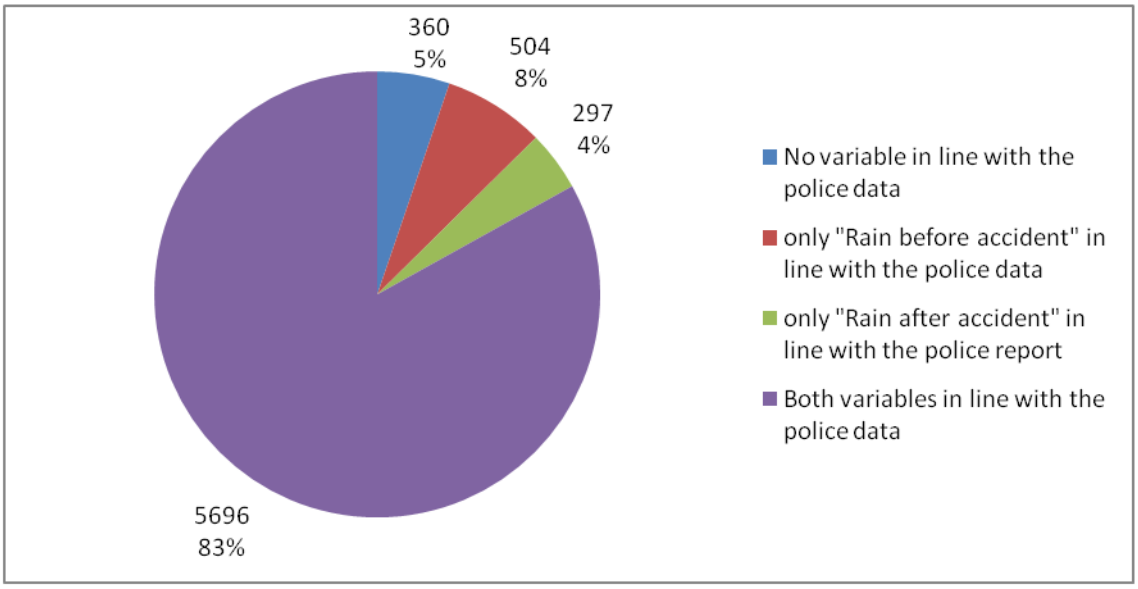


Figure 6: Detailed conformity of UNIVIE’s data with the police records, category 1 = rain, Austria 2002 & 2003

Afterwards, the accidents, which happened under “very slight rain”, were included in the category “no rain” and then, the same procedure was executed. This time, 90% of both measurements were in line with the police report. Of the remaining 10%, 7% were covered by measurements, where at least one of them suited to Figure 8).

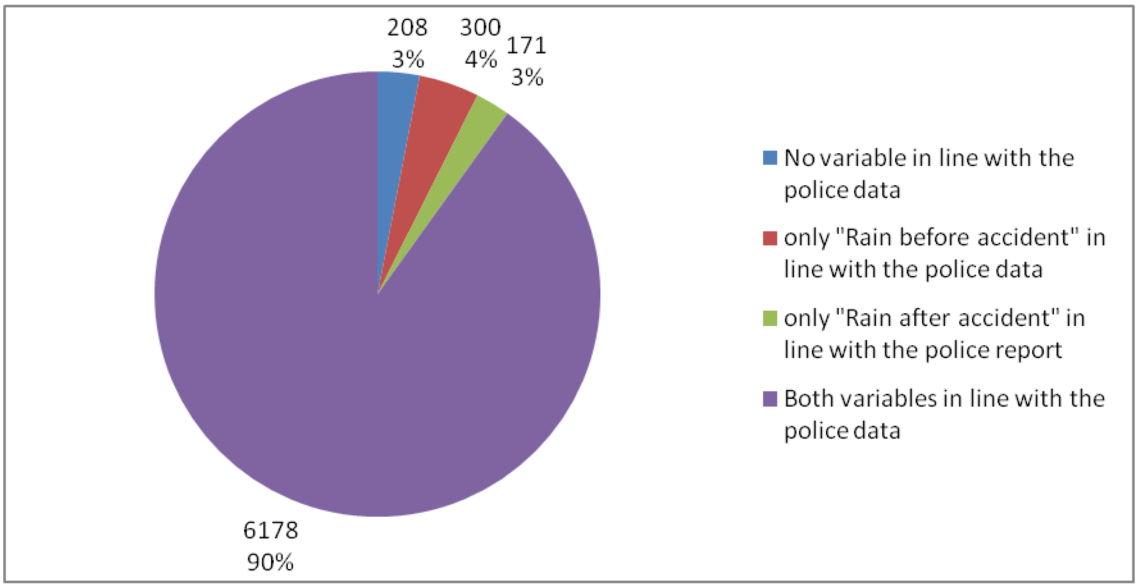


Figure 7: Detailed conformity of UNIVIE’s data with the police records, category 1 = no rain, Austria 2002 & 2003

As an additional step, the sample was limited to accidents, where the police record reports rain (Figure 9) and compared to the weather information from the weather database.

If category 1 "very slight rain" was attributed to "rain", 57% of the accidents, which happened under rainy conditions, were covered by both measurements. Among the remaining 43%, one of two measurements went in line with the police recorded accidents in 27% and just 16% were not covered neither by the measurement “rain before accident” nor by “rain after accident”.

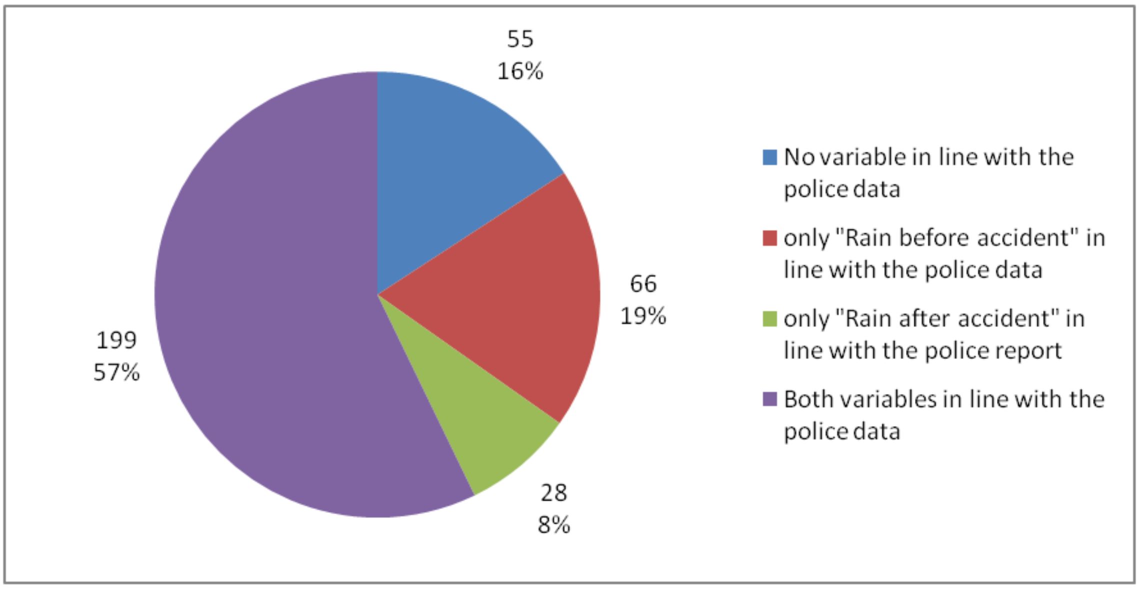


Figure 8: Conformity of UNIVIE’s data with accidents, which happened under rainy conditions, category 1 = rain, Austria 2002 & 2003

In the case, where “very slight rain” was assumed to be no rain, compliance between the weather information in the two databases is lower by far. For 24% of these cases, all weather values match. In 41% of the cases where police reports rain, neither "rain before accident" nor "rain after accident" have the respective values (Figure 9).

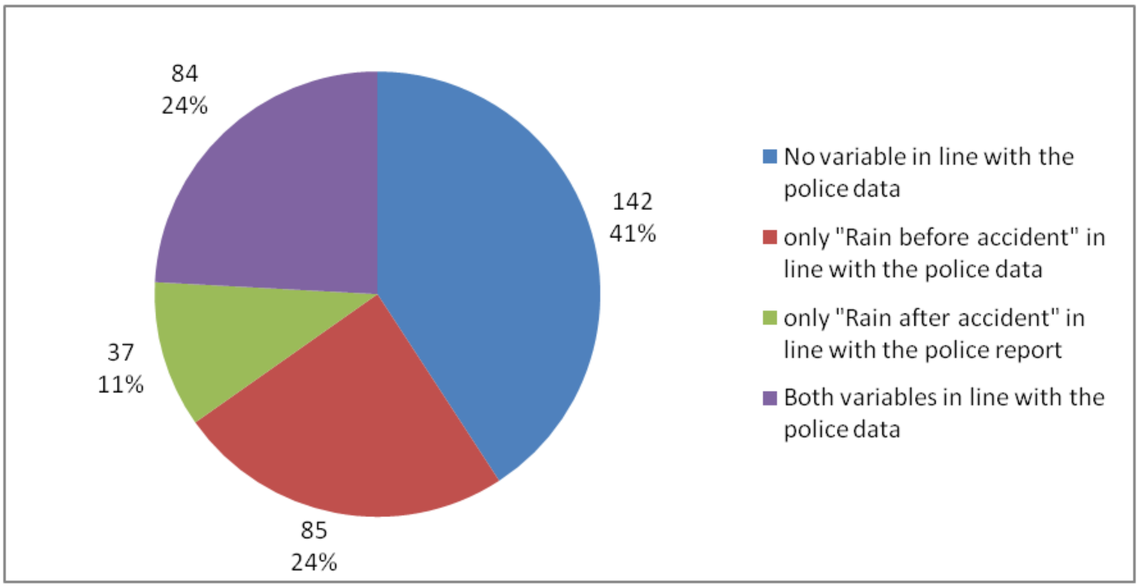


Figure 9: Conformity of UNIVIE’s data with accidents, which happened under rainy conditions, category 1 = no rain, Austria 2002 & 2003

5.5.3. Summary and Conclusions

In general, weather information from UNIVIE's database and the algorithm, that was used for linking it to police reports about road accidents and the weather information included in these reports, show acceptable compliance.

If UNIVIE’s category 1 is attributed to “no rain”, the variable "rain before accident" calculated from UNIVIE's database show compliance in 91% (see Figure 6: 83%+8%) of the 6,857 cases, "rain after accident" in 87% (see Figure 6: 83%+4%). Both variables at a time match with the police weather information in 83% of the cases. If "very slight rain" is considered “no rain”, the variable “rain before accident” is in line with the police data in 94%, “rain after accident” in 93%. In this case, both variables conform to the weather information provided by the police in 90%. Hence, for this more general analysis, it seem that considering "very slight rain" to be "nor rain" is more suitable.

If the analysis is limited to accidents where the police reports rain, compliance is much lower. If category 1 "very slight rain" is assumed to be rather “no rain”, none of two variables matches with police information in 41% of these cases. Again, "rain before accident" shows better compliance (48%, i.e. 24%+24%, see Figure 9) than "rain after accident" (35%, i.e. 24%+11%). This time, the alternative, where category 1 is attributed to “rain”, shows more conformity with the actual data: at least one variable is in line with the police recorded data in 84% (Figure 8: 57%+19%+8%). Furthermore, “rain before accident” matches more often (76%, i.e. 57%+19%) with the police information than “rain after accident” does (65%).

Therefore, considering "very slight rain" as "no rain" and preferring "rain before accident" provides the most suitable prediction.

Hence, UNIVIE's database and the algorithm would not be suitable to reconstruct the weather conditions on a particular accident. This derives from the limited number of weather stations, the limitations concerning frequency of measurements and the fact, that precipitation sometimes is a very local phenomenon with rapid changes. Thus if it is raining over a large area, the conformity of UNIVIE’s data with the police reports is very probable, whereas it is difficult to measure a local rain shower.

However, to reconstruct weather at a certain place and time was not the purpose of this activity. Decisions made by PTW riders whether to take the PTW or chose the car or stay at home, are not done by weather information at a single moment at a single place. Such decisions are made by impressions collected over a certain period. This validation provides sufficient proof, that UNIVIE's weather database is suitable to fulfil the purpose of providing values, which reflect such impressions.

This validation also shows that UNIVIE's weather database and the algorithm of linking it to the accident database will be fully suitable for the other tasks of this study.

5.6. Accident occurrence concerning precipitation

5.6.1. Introductory remark

The main task of WP 1.3 is to determine the influence of different weather conditions on the occurrence of powered two wheeler accidents. Additionally, a function, which describes the relation between annual motorcycle crashes and weather data, should be found.

It is generally assumed that motorcyclists include the aspect of weather when they make decisions about whether to use their motorcycle, to take a car instead, to use public transport or to stay at home. Such decisions will be different for people who use their motorcycle as a means of transport to work or to school and for people who take a leisure time trip on the weekend. Hence, workdays and weekends were analysed separately in the following.

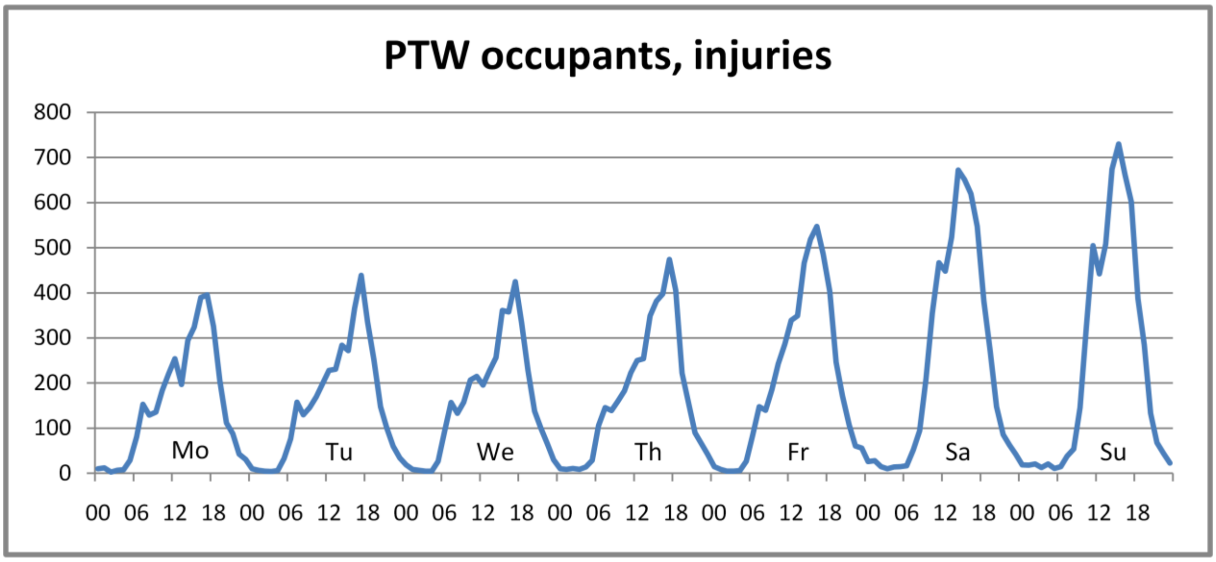


Figure 10: Injured Motorcycle Occupants by day of week and hour, Austria, 2000 to 2008

Although many people in Austria (e.g. in shops) are working in Saturdays, it seems that Friday is more of a marginal case than Saturday. Figure 10 indicates, that there is a rather clear districting, at least clear enough for the purpose of this study, to consider Monday to Friday being one category ("workdays") and Saturday and Sunday within the other ("weekend").

Motorcyclists' decision about mode of mobility will not (only) depend on the weather as observed looking out of the window before putting on helmet and gloves. Some riders may rely on the weather report; others may observe the weather a couple of times before they go out. Hence, it will hardly be useful to go too much detail - neither locally nor in time - even if such data would be available. Based on these facts, it was decided to choose a model of a "rainy day" for the evaluation, which includes a broad view on the weather. Given the weather forecast tells the truth, such "rainy days" would be forecasted and this forecast would impact on exposure as expected.

5.6.2. Preparation and execution of analysis

At first, all the days of 2002 and 2003 were aggregated: For each day, the nationwide sum of the daily measured values, which indicated rain occurrence, was calculated. On this basis, the percentage of the precipitation per day was determined (this could be called "Austrian average rain likeability"). Subsequently, a classification was done in 15% increments except for the last category, which consists of the days, where 75% to 100% of the measurements indicated rain.

In the next step, the reported accidents of 2002 and 2003 were merged with these rain classes. This way, the average accident occurrence per workday and weekend with respect to precipitation could be determined (Table 7). The results as well as the exponential regression curves are displayed in Figure 11.

Table 7 shows that on average, 35% more accidents happen on average weekend days than on average workdays. Besides, there is an even bigger difference (55%) between average workday and average weekend accidents under dry weather conditions (category 0%-15%) according to the estimate "Austrian average rain likeability". But as the precipitation rate rises, the occurrence of motorcycle accidents on weekends decreases more rapidly than on workdays.

Accordingly it may be assumed that there are two different types of motorcycle usage: On workdays, motorcycles are predominantly used as a means of transport and as a consequence, this usage is less weather-dependent. Austrians have, depending on their age, a legal minimum of 25 to 30 of vacation a year. It is quite likely, that some of these days are also used for leisure riding. Nevertheless, it would be impossible to separate days of vacation. Hence, this possible error within the assessment is neglected. On weekends, riding seems to be a leisure activity predominantly. We assume that most of the riders do not like riding in rain very much. This results in higher elasticity of accidents with respect to weather conditions.

Table 7: Accident occurrence with respect to precipitation percentage, Austria 2002 & 2003

Percentage	Workday			Weekend			Workday & Weekend		
	Accidents	Days	Average	Accidents	Days	Average	Accidents	Days	Average
0%-15%	2943	272	10,82	1727	103	16,77	4670	375	12,45
15%-30%	879	98	8,97	338	36	9,39	1217	134	9,08
30%-45%	296	57	5,19	201	34	5,91	497	91	5,46
45%-60%	248	59	4,20	111	19	5,84	359	78	4,60
60%-75%	65	26	2,50	17	11	1,55	82	37	2,22
75%-100%	23	10	2,30	9	5	1,80	32	15	2,13
Total	**4454**	**522**	**8,53**	**2403**	**208**	**11,55**	**6857**	**730**	**9,39**

Please note, that this is still a combined phenomenon, which includes exposure effects, the intrinsic risk of riding in rain and risk taking of riders under different conditions.

As can be seen in Figure 11, all three curves decrease nearly exponentially as the rain gets stronger. The difference between workdays and weekend day is visible by the different gradient of the respective curves. The steeper decrease of the weekend curve shows higher elasticity for weather impact.

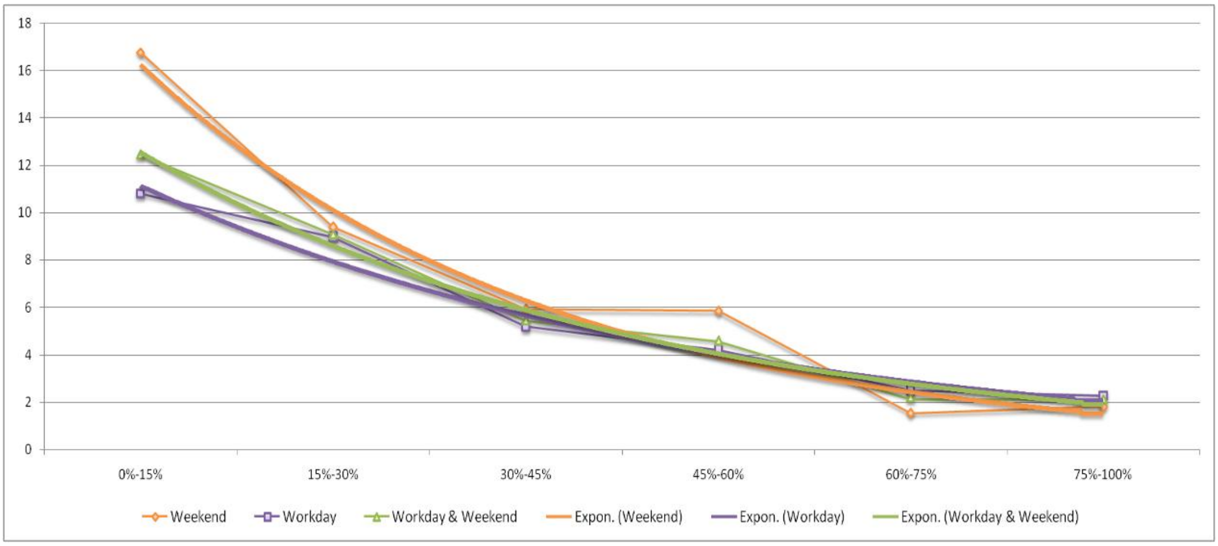


Figure 11: Average accidents per day with respect to precipitation, Austria 2002 & 2003

Table 8 shows the exponential regression functions for the occurrence of accidents per day concerning weather conditions in Austria in 2002 and 2003. Especially the exponents, which describe the rate of the curve's decrease, and the high coefficients of determination are of interest.

Table 8: Regression curves for average accidents of 2002 & 2003 per day with respect to precipitation, Austria

Regression Curve	Function	R^2
Weekend	$y= 26{,}109e^{-0{,}474x}$	0,9061
Workday	$y= 18{,}298e^{-0{,}378x}$	0,9656
Workday & Weekend	$y= 15{,}589e^{-0{,}337x}$	0,9718

5.6.3. Conclusions

There is a clear relation between parameters describing the weather and the number of motorcycle accidents.

Hypothesis 1 of this study is confirmed, meaning that police reported motorcycle accident counts correlate with weather conditions and this correlation can be described in mathematical terms.

It is not necessary to go into much detail concerning the description of weather by time and locations. At least in a country as small as Austria, defining a national rain likeability is adequate to prove relations of this variable to accident likeability. Weather information collected by one weather station per about 200 km² with an interval of 3 hours is sufficient for this purpose.

If a "sunny day" is considered a day with rain likeability up to 15% and a "rainy day" is a day with rain likeability above 75%:

- On sunny weekends, 8 times more motorcycle accidents happen than on rainy weekend days.
- On sunny workdays, 5 times more motorcycle accidents happen than on rainy workdays.
- On sunny days, 6 times more motorcycle accidents happen than on rainy days.

5.7. Validation of safety trends by eliminating weather-dependent distortions

5.7.1. Introduction

If the statistical occurrence of accidents like in 5.6 is done separately for each year over a longer period of time, conclusions about safety trends, which are not distorted by weather conditions, can be drawn. Although UNIVIE provided KfV just with the precipitation measurements of 2002 and 2003, the potential of such an evaluation can be shown.

5.7.2. Execution of analysis

In 2003, altogether 379 more motorcycle accidents happened than in 2002, whereas 141 of them occurred on weekends and 238 on workdays (Table 9). In general, statistics say that per day, 9.91 motorcycle accidents took place in 2003, whereas just 8.87 daily accidents occurred in 2002. Consequentially, without knowing relevant weather data, someone could assume that motorcycle riding became more dangerous in 2003 compared to 2002.

Table 9: Separate accident occurrence for 2002 & 2003 with respect to precipitation, Austria

Precipitation	2002									2003								
	Workday			Weekend			Total			Workday			Weekend			Total		
	Accidents	Days	Average	Accidents	Days	Average	Accidents	Days	Average	Accidents	Days	Average	Accidents	Days	Average	Accidents	Days	Average
0%-15%	1409	128	11,01	703	42	16,74	2112	170	12,42	1534	144	10,65	1024	61	16,79	2558	205	12,48
15%-30%	337	52	6,48	200	18	11,11	537	70	7,67	542	46	11,78	138	18	7,67	680	64	10,63
30%-45%	134	25	5,36	124	20	6,20	258	45	5,73	162	32	5,06	77	14	5,50	239	46	5,20
45%-60%	154	35	4,40	85	14	6,07	239	49	4,88	94	24	3,92	26	5	5,20	120	29	4,14
60%-75%	52	14	3,71	12	6	2,00	64	20	3,20	13	12	1,08	5	5	1,00	18	17	1,06
75%-100%	22	7	3,14	7	4	1,75	29	11	2,64	1	3	0,33	2	1	2,00	3	4	0,75
Total	**2108**	**261**	**8,08**	**1131**	**104**	**10,88**	**3239**	**365**	**8,87**	**2346**	**261**	**8,99**	**1272**	**104**	**12,23**	**3618**	**365**	**9,91**

As already pointed out in 5.6, a disproportionately high share of PTW accidents happens on weekends and in many cases, inexperienced riders are involved (see 12.1.1 and 12.1.5). On weekends, there is a difference of 321 accidents concerning the precipitation class from 0% to 15%. Normally, this would mean that in 2003, on weekends motorcycle riding in sunny weekend days would have been more risky than in 2002. But with respect to the different number of sunny weekend days, it can be verified that the opposite is the case (assuming there is no difference in mileage per sunny day, no change to the intrinsic risk of riding on a sunny day and no change of riders' risk taking behaviour on sunny days): Statistically, especially in this rain class, fewer accidents happened per weekend in 2003 than in 2002 (Figure 12).

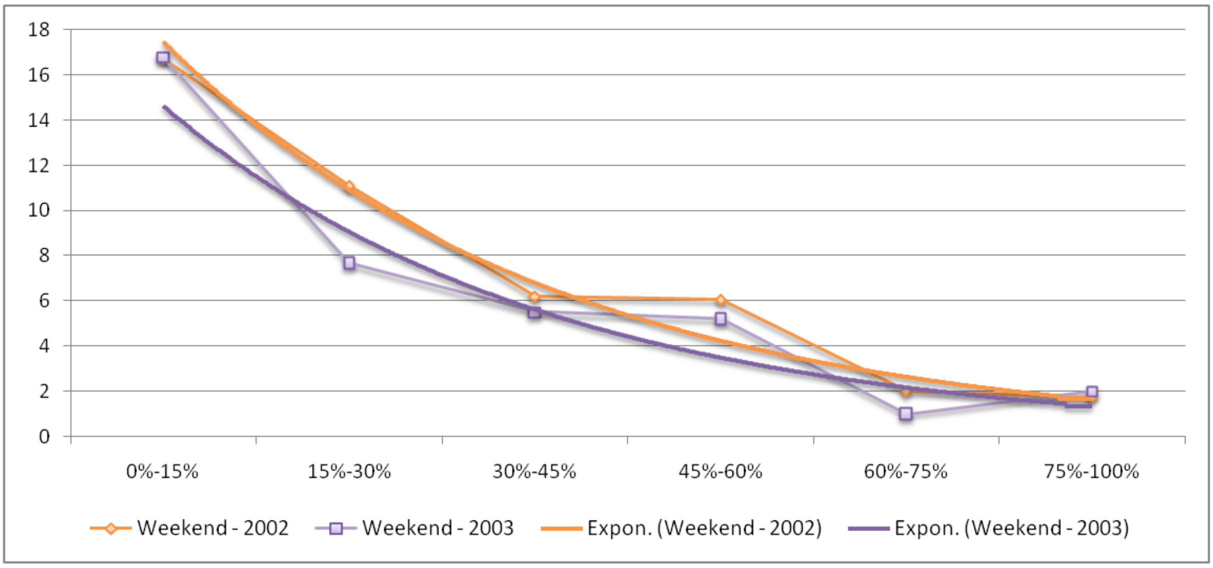


Figure 12: Separate average accidents per weekend for 2002 and 2003 with respect to precipitation

Figure 13 displays the average accident counts per workday for 2002 and 2003 by rain likeability. Although in 2003, 238 more motorcycle accidents happened than in 2002, the average number of accidents per workday is just once higher in the category from 15% to 30% precipitation. This is also visible with regard to the exponential regression curves, where the curve of 2003 decreases much more rapidly than the one of 2002.

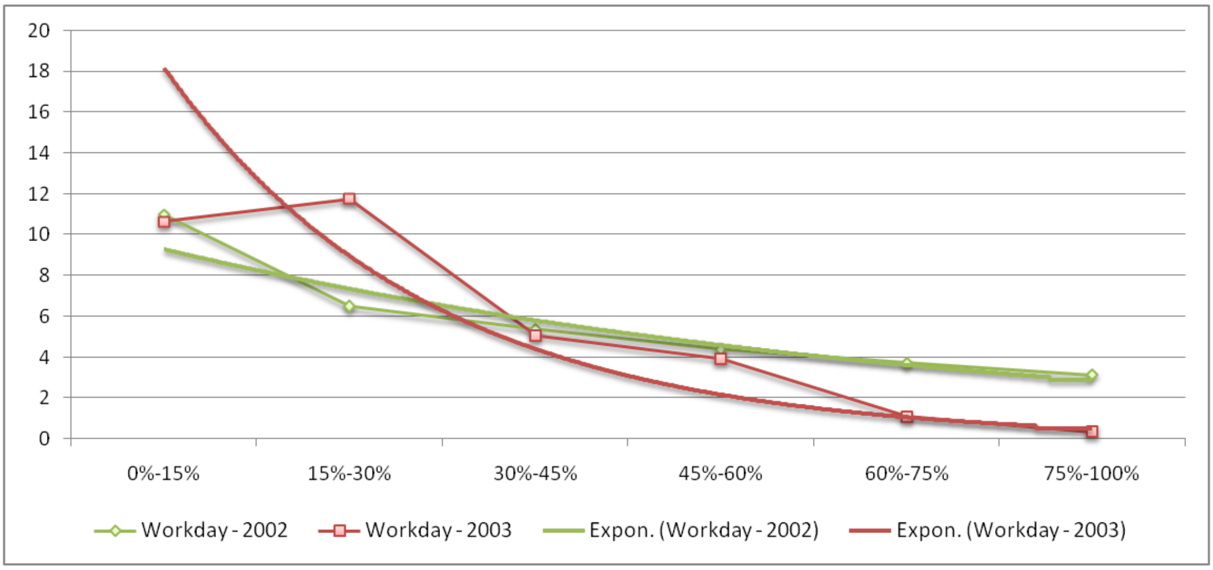


Figure 13: Separate average accidents per weekend for 2002 and 2003 with respect to precipitation

The following figure (Figure 14) displays the average number of accidents per day, which is the combination of the two figures above (Figure 12 and Figure 13,). Due to the fact that accidents on workdays make up a larger number of accidents, they influence the daily average of motorcycle accidents more than accidents on weekends (5 workdays, only 2 days of weekend). Again, the number of accidents per day is greater in 2003 than in 2002.

Figure 14: Separate average accidents per day for 2002 and 2003 with respect to precipitation

In the table below, the coefficient of determination and the regression curves, describing the average number of accidents for 2002 and 2003, are listed (Table 10). In three of the cases, the exponent of the regression curve's representing the average number of accidents on weekends is higher than the other one of the accidents on workdays. And for both years, the coefficient of determination is very high, whereas five of six are even over 0.9.

Table 10: Separate regression curves for average accidents of 2002 & 2003 per day with respect to precipitation, Austria

Regression Curve	2002		2003	
	Function	R^2	Function	R^2
Weekend	$y= 27,938e^{-0,47x}$	0,946	$y= 23,675e^{-0,48x}$	0,8075
Workday	$y= 11,717e^{-0,232x}$	0,9393	$y= 36,868e^{-0,707x}$	0,9032
Workday & Weekend	$y= 15,236e^{-0,301x}$	0,9802	$y= 30,2e^{-0,606x}$	0,9406

5.7.3. Conclusions

This example illustrates the diverse impact of weather on motorcycle accident numbers.

The years 2002 and 2003 significantly differ in number of "sunny" and "rainy" days. These two years also differ in number on accidents respectively. For weekends, the figures are very similar. That means, if motorcyclists have the choice of taking a ride or not, this decision is strongly influenced by weather conditions. This is also the case for workday trips, but not to the same extent.

Commuters care less about the weather than leisure time riders do. To be more precise, commuting is less depending on weather than riding for recreational purposes, hence, accidents on weekday depend less on weather than accidents on weekends.

Herewith, hypothesis 2 is confirmed, i.e. that the accident record of a year can be normalised using a correlation between accidents and weather conditions.

In connection with results from chapter 5.6,

Hypothesis 3 is confirmed as well, i.e. that correlations between weather and police reported accident counts differ for weekends and workdays.

5.8. Collision types with respect to weather conditions

5.8.1. Introduction

This part of the microscopic analysis deals with collision types under different precipitation levels. Therefore, all the motorcycle accidents from 2002 and 2003, consisting of 104 different collisions defined by “Statistics Austria”, were classified according to the CARE dataset. Subsequently, these classified accidents were analyzed with respect to different precipitation classes.

In order to make the results more visible, another classification of rain likeability was used for this purpose including only three classes.

This kind of calculation eliminates the impact of exposure. Hence, the results show a combination of intrinsic risk of riding under the different weather conditions and the risk taking behaviour of riders with respect to these conditions.

5.8.2. Analysis

Table 11 displays the results of this calculation. Compared to Table 33, there are minor changes concerning the percentage of the listed collision types. The difference results from including all motorcycle accidents instead of just the fatal ones.

Table 11: Collision types with respect to precipitation, Austria 2002 & 2003

Collision Type	Precipitation							
	0-33%		33%-66%		66%-100%		**Total**	
Avoiding animal	111	1,8%	13	2,0%	0	0,0%	**124**	**1,8%**
Avoiding pedestrian	112	1,8%	18	2,7%	3	2,1%	**133**	**1,9%**
Between moving vehicles, at angle	1078	17,8%	128	19,4%	43	30,7%	**1249**	**18,2%**
Between moving vehicles, head on	1093	18,0%	120	18,2%	27	19,3%	**1240**	**18,1%**
Between moving vehicles, lateral	988	16,3%	86	13,0%	18	12,9%	**1092**	**15,9%**
Between moving vehicles, rear end	674	11,1%	68	10,3%	10	7,1%	**752**	**11,0%**
Run off the road	1877	31,0%	209	31,6%	39	27,9%	**2125**	**31,0%**
Single vehicle collision with parked car	8	0,1%	2	0,3%	0	0,0%	**10**	**0,1%**
Single vehicle collision with stable/immov. object	46	0,8%	8	1,2%	0	0,0%	**54**	**0,8%**
Other	69	1,1%	9	1,4%	0	0,0%	**78**	**1,1%**
Total	**6056**		**661**		**140**		**6857**	**100,0%**

Nevertheless, like in Table 33, five categories, which are shown separately in Figure 15 make up the major part of road crashes in Austria. As can be seen in the figure, there are several shifts and behavioural changes due to the weather conditions.

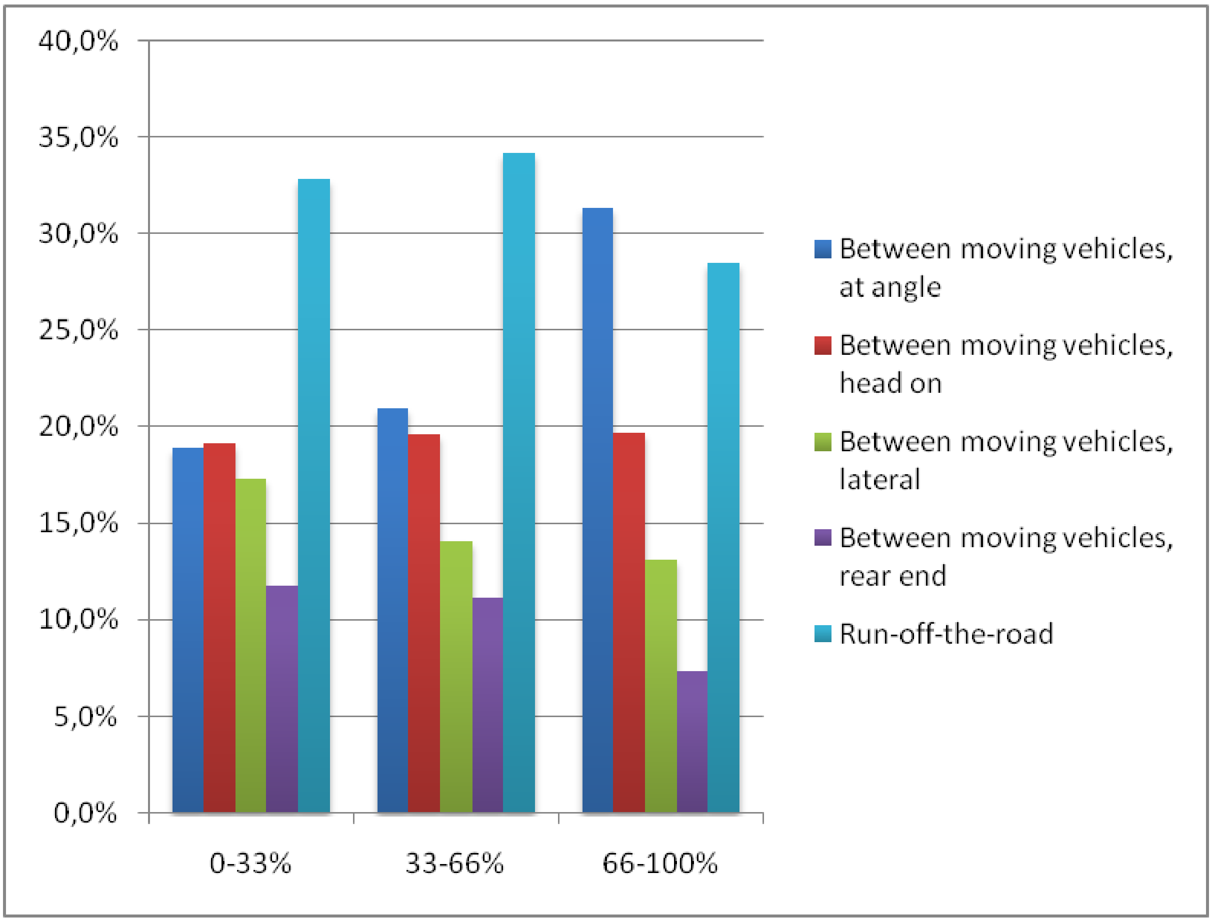


Figure 15: Collision types with respect to precipitation, Austria 2002 & 2003

In the following, these changes as described and possible explanations for the respective phenomenon are developed. The facts and assumption mentioned may be relevant for other collision types as well, however, they are considered of particular importance for the respective collision type.

a) Collisions at angle, i.e. mainly crashes at intersections are much more frequent on days with high rain likeability than on days with low and moderate rain likeability.
Conspicuity has a major impact on collisions at intersections. About three quarters of these collisions are to be blamed on the other vehicle driver (not the motorcyclist). It could be assumed that rain has a negative impact on conspicuity of PTW riders and/or worsen conditions of sight out of the vehicle.
Further, collisions at intersections are influenced by the ability of motorcycle riders to decelerate before the collision properly. The severity of injuries increases, if motorcyclists fall off their vehicles before the collision. As a matter of fact, the possibilities of decelerating the motorcycle before the collision are impaired by reduced friction resulting in two possible outcomes:
- less friction means less deceleration leading to higher collision speed
- less friction means locking of wheels by braking more likely means more motorcyclists falling off before the collision and being trapped between the car and their own vehicle.
Hence, these conclusions clearly indicate that use of advanced braking system, in this case, particularly ABS would solve at least a part of the problem.

b) The share of head-on collisions does not change with rain likeability.
This means that the three moderating parameters (intrinsic risk of driving in rain, risk taking and exposure) are all equal or their changes strike each other out.

c) Lateral collisions of vehicles moving in the same direction decrease when rain intensity increases.
It might be assumed that many lateral collisions are caused by motorcycle riders coming from behind, maybe overtaking between queues, and passenger cars' drivers failing to recognise them when changing lanes. If motorcyclists drive slower in rain, the number of such conflicts decreases, which results in fewer collisions.

d) A similar situation can be observed for rear end collisions.
For motorcycle riders, it is uncomfortable to ride closely behind a car in rain. The spray of water impairs visibility and riders get wet much quicker. It could be assumed, that motorcyclists keep longer time headway behind cars to avoid these impacts. However, this is in contradiction to impaired ability of deceleration.
On the other hand, passenger cars behind motorcycles: For this case, it may be assumed that ability of braking is less impaired for car drivers than for motorcyclists. It may be concluded that from this reason, cars crash into motorcycles in front of them less frequently.

e) Finally, run-off-the-road accidents are highest with moderate rain likeability, are slightly lower with low rain likeability and lowest with high rain likeability.
It may be assumed that the intrinsic risk of riding is higher on wet roads. Hence, this gives an indication that - at least for riding situations, where run-off-the-road accidents are typical (rural roads, bends), motorcyclists overcompensate the intrinsic risk by adopting their driving style.
Nevertheless, an impact of exposure cannot be excluded. It might also be assumed that situations, which are typical for run-off-the-road accident, occur less frequent on rainy days.
This hypothesis would be supported, if we suppose that commuters are more frequently using urban or semi-urban roads than winding rural roads (which are considered to be the favourite ones for spare time rides).

5.9. Injury severity with respect to precipitation

5.9.1. Introduction

After having analysed different collision types with respect to precipitation classes, the same procedure was done for the severity of injuries. Thus all the injured motorcyclists, who were involved in an accident in 2002 and 2003, were grouped according to their injury degree. With reference to the Austrian accident data form (Annex II), there is a differentiation between nine different types of injury severity, which is listed in Table 12:

Table 12: Categories of injury severity

lass	Severity of Injury
0	not injured
1	deceased at accident location
2	deceased within 24 hours
3	deceased within 24 to 48 hours
4	deceased within 48 to 72 hours
5	deceased within 72 hours and 30 days
6	seriously injured
7	slightly injured
8	degree of injury not identifiable

In Austria, road users, who die either immediately after the accident or within 30 days, are classified as “fatally injured”. Hence, for the project’s purpose, the injury severity classes 1 to 5 were merged as they all represent fatal injuries. Besides, the Austrian law defines the difference between slight and serious injuries after an accident as follows: If a physical impairment lasts longer than for 24 days, the injury is considered as “serious”; otherwise it is called a “slight” injury. And if the doctor or the police officer, who fills in the Austrian accident data form, is not able to determine the severity of injury, it is recorded as class 8, which stands for “degree of injury not identifiable”. For 2 BE SAFE, according to Risser A., this category was split up as follows:

- 60% of the motorcyclists of this category were distributed to the class “slightly injured”
- 40% of the motorcyclists of category 8 were distributed to the class “seriously injured”

5.9.2. Execution of analysis

At first, the different types of the degree concerning the physical impairment resulting from an accident, beginning with “uninjured”, “slightly injured”, “seriously injured” up to “fatally injured”, were analysed with respect to three different precipitation classes. The outcome of the evaluation is shown in **Fehler! Ungültiger Eigenverweis auf Textmarke.**.

As can be seen in **Fehler! Ungültiger Eigenverweis auf Textmarke.**, more than half of the motorcyclists, who were involved in a traffic accident, were slightly and about one third seriously injured. Thus in the period from January 2002 to December 2003, motorcycle riders with non-fatal injuries made up over 90% of all motorcyclists involved in an accident. Furthermore, it is also visible that in each injury category, at least 56% up to 67% of the injuries were reported in the precipitation class from 0% to 33%. For each injury category, the percentage describing the injured motorcyclists per day was steadily decreasing as the rain got stronger. In general, the number of motorcyclists per precipitation class nearly corresponds with the half of the previous one. As a rule of thumb, it can be concluded: "the stronger the rain, the lower severity of injuries".

Table 13: Number of injured motorcyclists per day with respect to precipitation and injury severity, Austria 2002 & 2003

Precipitation	Days	Uninjured			Slightly injured			Seriously injured			Fatally injured		
		Uninjured	Uninjured/Day		Injured	Injured/Day		Injured	Injured/Day		Killed	Killed/Day	
0%-33%	532	421	0,79	58%	3735	7,02	56%	2368	4,45	63%	175	0,33	67%
33%-66%	171	67	0,39	29%	582	3,41	27%	328	1,92	27%	22	0,13	26%
66%-100%	27	5	0,19	14%	60	2,21	17%	19	0,72	10%	1	0,04	7%
Total	**730**	**493**	**0,68**	**100%**	**4377**	**6,00**	**100%**	**2715**	**3,72**	**100%**	**198**	**0,27**	**100%**
			6%			56%			35%			3%	

For further evaluations and to be able to compare the different types of injury, they have to be multiplied with their respective economic costs on the available basis of 2004. These costs include the consequences of an accident as well as the human balefulness. Obviously, the costs per fatally injured road user are the highest (EUR 2,461,345 in the year 2004): They are about nine times higher than the costs per seriously injured (EUR 291,275) and approximately 100 times higher than the respective ones per slightly injured road user (EUR 20,896).

In Table 14, the average number of injured motorcyclists and costs per day with respect to precipitation are listed. In the precipitation category from 0% to 33%, statistically 12 motorcycle riders were injured daily, which caused about EUR 2.5 Mio economic costs per day. And although over 50% of the motorcyclists, who were involved in an accident in 2002 and 2003, were slightly injured, this injury category incurred the lowest costs, followed by fatal injuries.

Table 14: Costs per day with respect to precipitation and injury severity, Austria 2002 & 2003

Injury Severity	Costs/ Injured [€]	0%-33%		33%-66%		66-100%	
		Injured/Day	Costs/Day [€]	Injured/Day	Costs/Day [€]	Injured/Day	Costs/Day [€]
Slightly injured	20.896	7,02	146712	3,41	71169	2,21	46126
Seriously injured	291.275	4,45	1296393	1,92	558022	0,72	209286
Fatally injured	2.461.345	0,33	809653	0,13	316664	0,04	91161
Total		**12**	**2252758**	**5**	**945854**	**3**	**346573**

Figure 16 illustrates the results of Table 14 graphically. In 2002 and 2003, the economic costs for serious and fatal injuries were decreasing rapidly as the rain got stronger, whereas the respective figures for slight injuries hardly influenced the total daily costs. Thus due to the fact that the consequences respectively costs of severe accidents are significantly high, they have a large effect on the economic costs caused by accidents.

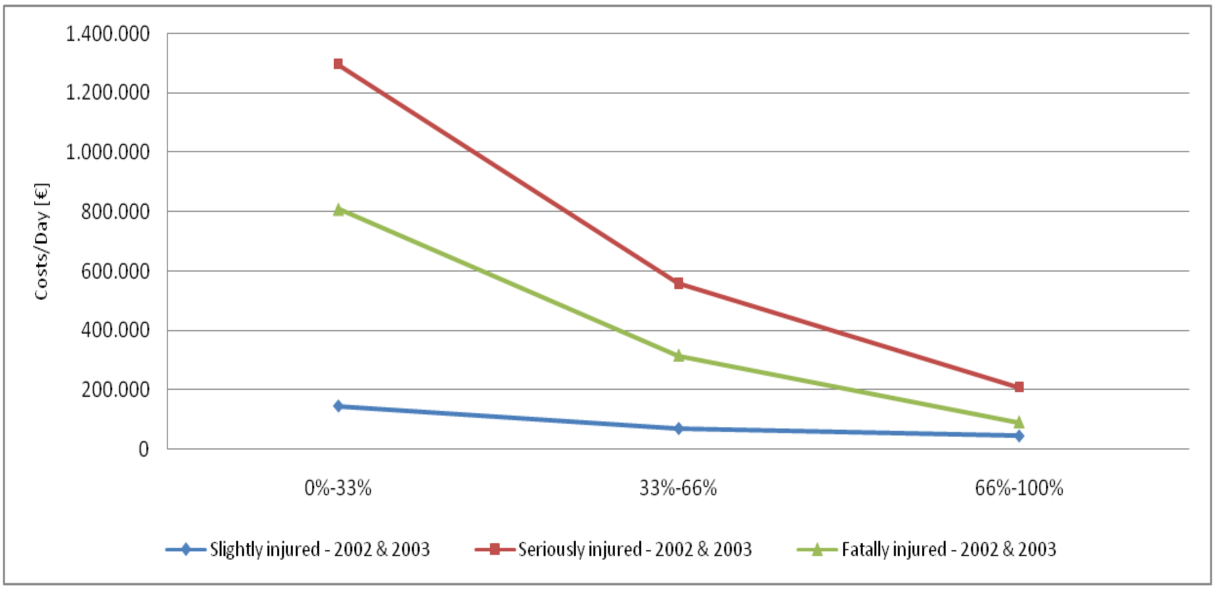


Figure 16: Costs per day with respect to precipitation and injury severity, Austria 2002 & 2003

5.10. Macroscopic prediction models with respect to precipitation and degree of injury

5.10.1. Introduction

In chapter 4, a macroscopic analysis was carried out dealing with the motorcycle fatalities, which happened in Austria in 2007. The same procedure can also be done for the years 2002 and 2003, but this time with respect to precipitation. For that purpose, like in the previous chapter 5.9, the injured motorcyclists were classified according to their degree of injury as well as to five different precipitation categories.

Subsequently, the injured motorcyclists were observed separately for 2002 and 2003 and the proportional difference per precipitation class between these two years was calculated. The results, which were found, are shown in Table 15.

Table 15: Comparison of the injury severity between 2002 and 2003 with respect to precipitation

Precipitation	Uninjured			Slightly injured			Seriously injured			Fatally injured			Total		
	2002	2003	Difference	2002	2003	Difference	2002	2003	Difference	2002	2003	Difference	2002	2003	Difference
0%-15%	135	201	48,9%	1329	1647	23,9%	873	1020	16,8%	62	69	11,3%	2399	2937	22,4%
15%-30%	37	48	29,7%	331	428	29,3%	212	263	24,1%	16	28	75,0%	596	767	28,7%
30%-45%	20	13	-35,0%	160	158	-1,4%	105	93	-11,3%	3	6	100,0%	288	270	-6,3%
45%-60%	11	18	63,6%	169	73	-56,7%	76	42	-45,0%	7	6	-14,3%	263	139	-47,1%
60%-75%	7	1	-85,7%	44	15	-65,6%	19	3	-84,5%	0	0	0,0%	70	19	-72,9%
75%-100%	1	1	0,0%	24	0	-100,0%	6	2	-68,8%	1	0	-100,0%	32	3	-90,6%
Total	**211**	**282**	**34%**	**2056**	**2321**	**13%**	**1292**	**1423**	**10%**	**89**	**109**	**22%**	**3648**	**4135**	**13%**

As displayed in Table 15, in 2003 the number of injured motorcyclists was significantly higher than the respective figures of 2002 in each injury category. Hence, compared to 2002, 2003 was a “risky” year for motorcyclists with a high number of motorcycle accidents. Without having any additional pieces of information about the weather conditions, this statement would be the outcome of the "common" macroscopic analysis.

But to determine if 2003 was either a "bad" year in terms of safety performance or a "good" year in terms of motorcycle weather, further steps have to be taken. In general, there are two possibilities of analysis:

(1) Comparison of the injury severity between 2002 and 2003 with respect to the number of **days** per category of precipitation

(2) Comparison of the injury severity between 2002 and 2003 with respect to the number of **accidents** per category of precipitation

The following section is dedicated to estimating the accuracy of these two possibilities. For both analyses, the proportional comparison of the number of injured as well as fatally injured motorcyclists between 2002 and 2003 with respect to precipitation provided the basis (Table 15). This relative difference of the injury degree was compared to the proportional change of (1) the number of days and (2) the number of accidents per category of precipitation.

Besides, another calculation method was carried out for each of these possibilities of analysis: On the basis of the data of 2002, the quantity of injured and fatally injured motorcyclists was estimated and compared to the given figures of 2003.

5.10.2. Execution of analysis

(1) Comparison of the injury severity between 2002 and 2003 with respect to days per category of precipitation

The first analytical method deals with the daily number of motorcyclists per injury degree and category of precipitation. To compare the data of 2002 to the respective one of 2003 in a significant way, the number of categories of precipitation was reduced from five to three. On this basis, the days per category of precipitation were evaluated separately for 2002 and 2003. Then, the relative differences of the amount of days per category between these two years were calculated. Subsequently, each percentage was compared to the proportional change of the numbers of injured motorcyclists per category of precipitation and category of injuries (see Table 15). Thus it was examined if the number of casualties changed less, equally or more compared to the number of days.

The results of the undertaken analysis are shown in Table 16. There, the differences between the days and number of injuries per category of precipitation, which are larger than 5%, are highlighted in red and the ones, which are smaller than -5%, are highlighted in green. The deviations within the interval from -5% to 5% are considered negligible. The total proportional difference relates to the total of the daily number of injured motorcyclists per category of rain.

Table 16: Proportional difference of the injury severity between 2002 and 2003 with respect to the number of days per category of precipitation

Precipitation	Days			Difference				
	2002	2003	Difference	Uninjured	Slightly injured	Seriously injured	Fatally injured	**Total**
0%-33%	254	278	9,4%	35,3%	15,6%	8,8%	14,9%	14,2%
33%-66%	94	77	-18,1%	4,2%	-12,8%	-10,0%	38,1%	-10,0%
66%-100%	17	10	-41,2%	7,8%	-43,3%	-40,5%	-58,8%	-40,8%
Total	**365**	**365**	**-**	**21%**	**-14%**	**-8%**	**6%**	**-10%**

On the one hand, in the category of precipitation from 0% to 33%, more casualties per day were observed in 2003 than in 2002. On the other hand, less injured motorcyclists were reported in most of the other two categories. And in three out of five categories of severity of injuries, the percentage of the comparison of the total of the daily casualties was less in 2003 than in 2002. It is also seen that the number of the daily uninjured motorcyclists is about one fifth higher in 2003 than in the previous year.

Next to this analysis, a similar one has to be carried out to determine if a year with a high number of motorcycle accidents was either a “bad” year in terms of safety performance or a “good” year in terms of motorcycle weather. In general, Austrian statistics tell us that 89 motorcyclists died in 2002 and 109 deceased in 2003. Hence there is a difference of 20 fatalities between 2002 and 2003. Thus the macroscopic analysis, dealing with the fatalities, has to be undertaken once again, but this time with respect to precipitation.

Regarding the number of days per category of precipitation, other conclusion can be drawn: Assuming that the number of injuries per day and category of rain is constant, the number of accidents as well as the number of physically impaired motorcyclists in 2003 can be estimated on the basis of the data of 2002. At first, the proportional changes concerning the days per category of precipitation between 2002 and 2003 have to be calculated. Subsequently, each percentage is multiplied by the corresponding number of accidents respectively injured motorcyclists reported in 2002.

The estimated motorcycle accidents in 2003 on the basis of the days per category of precipitation of 2002 are listed in Table 17.

Table 17: Estimated motorcycle accidents in 2003 on the basis of days per precipitation class

Precipitation	Days			Accidents				
	2002	2003	Difference [%]	2002	Estimated in 2003	Recorded in 2003	Difference	Difference [%]
0%-15%	170	205	20,6%	2112	2547	2558	11	0%
15%-30%	70	64	-8,6%	537	491	680	189	28%
30%-45%	45	46	2,2%	258	264	239	-25	-10%
45%-60%	49	29	-40,8%	239	141	120	-21	-18%
60%-75%	20	17	-15,0%	64	54	18	-36	-202%
75%-100%	11	4	-63,6%	29	11	3	-8	-252%
Total	**365**	**365**	**-**	**3239**	**3508**	**3618**	**110**	**3,0%**

The table displays that is an error of 189 accidents in the estimate for the category of precipitation from 15% to 30% (i.e. 28% of actual counts for 2003). There are two possibilities to explain this discrepancy: Either 2002 or 2003 was a year, where abnormally few respectively many accidents happened in this category; hence, it is not linear. If this was the case, a larger statistic basis about the accident occurrence of the last few years with respect to precipitation would possibly provide more clarity.

But it is also quite possible that this category of precipitation includes the regional “microscopic threshold” between dry and rainy weather. As the national rain likeability is between 15% and 30%, it is possible that it is raining in one federal state and that it is dry in another. Thus, if this is the case it can be assumed that it is very probably nationwide “sunny” if the national rain likeability is lower than 15% and nearly throughout Austria “rainy” if it is higher than 30%.

Nevertheless, most of the accidents, which were recorded in 2003, could have been estimated with the help of the data of 2002. Thus, according to this table, following conclusion can be drawn:

In 2003, there were 379 more accidents than in 2002. Based on the different counts for all categories of precipitation and the numeric relation between precipitation and accident occurrence, 269 would have been estimated. Hence, 71% of the change in accident counts between 2002 and 2003 can be explained by different weather conditions.

As already mentioned above, the same procedure was conducted to estimate the quantity of slight, severe and fatal injuries motorcyclists per category of precipitation. The results of this analytic method are displayed in Table 18. In this context, the term "injured" includes all motorcyclists, who were involved in a traffic accident and sustained either slight, serious or fatal injuries.

Table 18: Estimated injured and fatally injured motorcyclists in 2003 on the basis of days per precipitation class

Precipitation	Days			Injured					Fatally Injured				
	2002	2003	Difference [%]	2002	Estimated in 2003	Recorded in 2003	Difference	Difference [%]	2002	Estimated in 2003	Recorded in 2003	Difference	Difference [%]
0%-15%	170	205	20,6%	2264	2730	2736	6	0%	62	75	69	-6	-8%
15%-30%	70	64	-8,6%	559	511	719	208	29%	16	15	28	13	48%
30%-45%	45	46	2,2%	268	274	257	-17	-7%	3	3	6	3	49%
45%-60%	49	29	-40,8%	252	149	121	-28	-23%	7	4	6	2	31%
60%-75%	20	17	-15,0%	63	54	18	-36	-198%	0	0	0	0	0%
75%-100%	11	4	-63,6%	31	11	2	-9	-464%	1	0	0	0	0%
Total	**365**	**365**	**-**	**3437**	**3729**	**3853**	**124**	**3,2%**	**89**	**97**	**109**	**12**	**11,0%**

Within the categories with higher likeability of rain, the estimations deviate much more from the actual recorded data in 2003 than for sunny days. In particular in the last two precipitation categories, there is a proportional difference by -198% respectively by -464% for injured motorcyclists. It may be assumed that either the exponential correlation does not work perfect within these categories, or, considering very low total values, random input is predominant.

Nevertheless, according to this table, following results can be shown:

In 2003, there were 416 more injured motorcyclists than in 2002, but 292 (70%) of them can be explained by differences in weather conditions.

In 2003, there were 20 more motorcycle fatalities than in 2002, but 8 (40%) of them can be explained by differences in weather conditions.

With respect to total values of injuries and fatalities, the impression of accuracy of this methodology is different: The estimate for the total number of injuries sustained by motorcycle occupants for 2003 based on 2002 accident and weather data using the correlation found within this study, differs from the actual values by only 3%. The respective error for fatalities is 11%.

(2) Comparison of the injury severity between 2002 and 2003 with respect to accidents per category of precipitation

The second analytical method evaluates the average number of motorcyclists per accident, injury degree and category of precipitation. Once again, three different categories of rain as well as the corresponding accident counts provided the basis of analysis. With reference to these data sets, the accidents per category of rain were calculated separately for 2002 and 2003. In an analogous way to the approach above, the relative differences in the number of accidents per category between these two years was calculated. By comparing each percentage to the proportional change of the numbers of injured motorcyclists per precipitation and category of injuries (see Table 15), the linearity between the number of casualties and accidents was examined.

Table 19 shows the outcome of the examination. The way, in which the cells are highlighted, is the same as above in subchapter (1). This time, the total proportional difference relates to the sum of the average number of injured motorcyclists per accident and rain category.

Table 19: Proportional difference of the injury severity between 2002 and 2003 with respect to the number of accidents per precipitation class

Precipitation	Accidents			Difference				
	2002	2003	Difference	Uninjured	Slightly injured	Seriously injured	Fatally injured	**Total**
0%-33%	2719	3304	21,5%	23,3%	3,5%	-3,3%	2,8%	2,2%
33%-66%	460	302	-34,3%	20,5%	3,5%	6,2%	54,3%	6,3%
66%-100%	60	12	-80,0%	46,7%	-4,5%	-1,7%	-20,0%	-1,9%
Total	**3239**	**3618**	**12%**	**80%**	**-6%**	**0%**	**3%**	**1%**

Compared to Table 16, the result is totally different. Particularly in the category of precipitation from 0% to 33%, the deviations are – except the one for uninjured motorcyclists – within an interval from -5% to 5%. Besides, the total proportional difference of the sum of injured motorcyclists per accident hardly differs from 0%. Hence it can be inferred that the approach for this analytic method is more likely than the one in section (1).

To undertake the same macroscopic analysis for the injured and fatally injured motorcyclists, the accidents have to be analysed with respect to precipitation. Therefore, it has to be assumed that the number of injuries per accident and rain class is constant. Then, the further procedure is analogous to the one in (1): First of all, the relative differences anent the accidents per rain category between 2002 and 2003 have to be computed. Next, each percentage is multiplied by the corresponding number of injured motorcyclists reported in 2002.

The finding of this approach of the analytic method is listed in Table 20, where the term “injured” is in line with the definition used above in (1). Thus, like in Table 18, this statistics does not contain any uninjured motorcyclists, who were involved in a traffic accident, but just physically impaired ones.

Table 20: Estimated injured and fatally injured motorcyclists in 2003 on the basis of accidents per precipitation class

Precipitation	Accidents			Injured					Fatally Injured				
	2002	2003	Difference [%]	2002	Estimated in 2003	Recorded in 2003	Difference	Difference [%]	2002	Estimated in 2003	Recorded in 2003	Difference	Difference [%]
0%-15%	2112	2558	21,1%	2264	2742	2736	-6	0%	62	75	69	-6	-9%
15%-30%	537	680	26,6%	559	708	719	11	2%	16	20	28	8	28%
30%-45%	258	239	-7,4%	268	248	257	9	3%	3	3	6	3	54%
45%-60%	239	120	-49,8%	252	127	121	-6	-5%	7	4	6	2	41%
60%-75%	64	18	-71,9%	63	18	18	0	2%	0	0	0	0	0%
75%-100%	29	3	-89,7%	31	3	2	-1	-60%	1	0	0	0	0%
Total	**3239**	**3618**	**11,7%**	**3437**	**3846**	**3853**	**7**	**0,2%**	**89**	**102**	**109**	**7**	**6,7%**

Table 20 shows that this approach, which is based on the accidents per rain class, is highly accurate: In the category from 0% to 15% rain, there is a deviation of 0% for injured and -9% for fatally injured casualties. The total conformity is very high. All in all, there is an error of only 0.2% in the estimate for the number of injuries and 6.7% for fatalities.

According to this table, most of the differences concerning the injured as well as fatally injured motorcyclists between 2002 and 2003 can be explained:

In 2003, there were 416 more injured motorcyclists than in 2002, but 409 of them (98.3%) can be explained by differences in weather conditions.

In 2003, there were 20 more motorcycle fatalities than in 2002, but 13 (65%) of them can be explained by differences in weather conditions.

There are two strong weaknesses within this approach:

- It is based on the assumption that the number of injuries by accident and category of precipitation is constant.
- On the other hand, the average number of daily accidents per precipitation category is not considered.

5.10.3. Summary and Conclusions

There are two methods to "forecast" accident numbers and/or number of fatalities for a particular year. Weather data for this year serves as input; in case of method two an actual value of the number of accidents is favourable. A calculation using the relations between weather and accidents, injuries and fatalities (as found by this study) has to be applied using accident and weather data from other years as a baseline. These methods are:

1. Comparison of the injury severity between 2002 and 2003 with respect to the number of **days** per category of precipitation
2. Comparison of the injury severity between 2002 and 2003 with respect to the number of **accidents** per category of precipitation

With the help of these approaches, a weather-independent macroscopic analysis can be executed. But both approaches involve weaknesses, which have to be kept in mind:

- Approach (1) assumes that numbers of accidents, injuries and fatalities per day within all categories of precipitation are constant.
- Approach (2) assumes that the number of injuries by accident and category of precipitation is constant. Further, the average number of daily accidents per precipitation category is not considered.

Method 1 allows for calculating an estimate of absolute numbers of accidents, injuries and fatalities. This estimate represents the accident number as they should have been, if the only moderating factor for accident occurrence would be the impact of weather (respectively precipitation). This method was tested for the weather and accident records of 2003 compared to 2002. There is a strong difference in number of accidents and fatalities between these two year, 70% of the difference in accident numbers and 40% of the difference in fatalities could be explained by different weather conditions.

Method 2 is not suitable to predict the absolute counts of accidents. On the contrary, an actual value for accident counts in the respective year is needed. The method could also be applied using the predicted value for accidents calculated by method 1, in that case, the errors of both methods would add up. This method was also tested for the weather records and total number of motorcycle accidents of 2003 compared to 2002. 98% of the difference in numbers of injuries and 65% of the difference in numbers of fatalities could be explained by different weather conditions.

But there is a particular advantage in this method as well. As found for method 1, the prediction of fatalities is not very precise. Both methods, by nature, are applied at a stage, where actual time series of weather and actual accident records are know. Hence, this method can be used particularly in terms of fatalities.

Hence, to get a detailed knowledge if a year with a high number of motorcycle accidents was either a “bad” year in terms of safety performance or a “good” year in terms of motorcycle weather (or vice versa for years with low numbers of accidents), both methods should be applied out and the results should combined.

In terms of total numbers (instead of differences between years), both methods create reasonable results. If the number of motorcycle rider injuries / fatalities is estimated using accident record from other years and a mathematical model for correlation between injuries / fatalities and precipitation, the error made by applying method 1 is 3% / 11%. Method 2 results in a difference between calculation and actual values of 0.2% / 6.6% for injuries / fatalities.

It may be considered, that using both method 1 and 2 would bring about more clarity about the actual development of motorcycle accidents, controlling for the systematic - and now known - impact of weather on PTW may be considered possible. It would be beneficial to use accident counts corrected by this method for a more accurate comparison of PTW accidents, either in time series or comparing different locations.

6. Conclusions and Recommendations

As a matter of common sense, PTW and in particular motorcycle accidents depend on the weather. Nevertheless, this effect was currently neither fully verified nor quantified. This work aimed at studying relations between weather and accident numbers.

6.1. Conclusions

1. Comparison of accident numbers between different countries can normally be done only on the basis of fatalities. Methods of data collection, processing and categorisation are too different to allow a useful comparison on the basis of accident counts or number of injuries.
2. Comparison of PTW accidents between different countries is difficult, since the numbers are too small for this purpose; even if several years are included (given, only fatalities are compared - as explained right above).
3. Comparison of PTW accidents based on fatalities is hardly possible between countries of different predominant mode of PTW use. There are countries, where PTW are predominantly used as a means of transport (either to avoid getting jammed in traffic, to avoid searching for a place to park or selecting a PTW as a cheap alternative to a car). In other countries, PTW are - besides being a mode of transport - widely used for recreational activities (e.g. leisure rides on the weekend).
4. Comparing accident records from Austria, Greece and Italy: In all countries, more than 90% of both moped and motorcycle accidents occur on dry roads (except moped in Austria: 88%).
5. Comparison of several parameters (age, sex, accident type, occupant category, etc) is not possible on the basis of one year, since the numbers of accidents in rain are too small for statistical analysis.
6. A weather parameter for precipitation based on weather data, collected by one weather station per 500 km² with an interval of three hours does not allow for reconstruction of the exact weather conditions at a certain place and time (as a result of comparing this weather parameter with weather information from police reports on accidents). This in particular derives from the fact, that precipitation sometimes is a very local phenomenon with rapid changes.
7. However, such a method is fully suitable to analyse correlation between parameters of weather with overall (annual, national) accident records. A variable "rain before accident", calculated from the most recent measurement of precipitation at the weather stations closest to the location of an accident, matches the weather information from the police recorded accident database in more than 94% of the cases, which is slightly better than "rain after accident (match in 93% of the cases).
8. Motorcycle accidents correlate with weather conditions. This correlation can be described in mathematical terms and follows an exponential pattern. A simplifies expression of these relations reads as follows:
9. On sunny weekends, 8 times more motorcycle accidents happen than on rainy weekend days.
10. On sunny workdays, 5 times more motorcycle accidents happen than on rainy workdays.
11. On sunny days, 6 times more motorcycle accidents happen than on rainy days.

12. The correlations between weather and accident numbers differ for weekends and workdays. This may be due to the fact that decisions about leisure time trips are more depending on the weather than commuting.
13. The dependencies developed within this study can be used to "normalise" an accident record of a single year with respect to weather conditions in order to eliminate the impact of weather in time series. 70 to 98 % of the difference in injuries and 40 to 65% of the difference in fatalities between different years of accident records can be explained by different weather conditions.
14. Extrapolation of the number of injuries / fatalities using accident record from other years and a mathematical model for correlation between injuries / fatalities and precipitation, the error made is less than 3% for injuries and less than 11% for fatalities.
15. Motorcyclists are not able to compensate for the additional risk of driving in rain at intersections. Other vehicle drivers do not compensate for this additional risk either, although this might be predominantly their task. Advanced braking systems (ABS, CBS) and improvement of conspicuity could contribute to solving this problem.
16. For all other kinds of crashes, motorcycle riders are able to compensate for additional risk of riding in rain compared to riding on dry surface by adopting their riding style, if it is assumed that riding in rain has a higher intrinsic risk than riding on wet roads.

6.2. Recommendations

In the long run, the information produced in this study should be used to eliminate the impact of weather when analyzing motorcycle accidents all over Europe. Time series of accidents should not be done without eliminating the impact of weather. This could also be used to improve comparison of accident records of different countries among each other. Currently, countries like Greece are compared with countries like Finland without any compensation for different climate.

However, before doing this, further research and other activities are needed:

1. The results of this pilot study should be validated by using more years of accidents and weather data. This data could then be used to set up a more detailed matrix of parameter values, e.g. separated by moped and motorcycles as well as by accidents inside and outside urban areas.
2. At least temperature should be investigated with respect to its impact on accidents involving motorcyclists. It may be assumed that there is a lower limit of temperature, below which almost no accidents occur. At higher temperature, some motorcyclists may waive riding (since it is uncomfortable underneath a full gear of protective clothing); other riders might waive using protective clothing and hence, accident severity might increase.
3. Research on mobility exposure in general, with respect to weather in particular (with a focus on precipitation and temperature) is urgently needed to separate the effect of risk taking behaviour and intrinsic risk within certain weather conditions from the exposure effect.
4. Once this is done, further research is needed to separate the effect of risk taking behaviour from intrinsic risk within certain weather conditions.
5. Using the knowledge acquired for motorcycles, this should be done for bicycling and passenger car travel as well.
6. The methodology developed within this study can also be used for very different purposes, e.g. analysis of workplace accidents, evaluating growth of any kind of plant, etc, etc.

7. Literature

ANDERLE, F.G., URBAN, S.: Die möglichen Einflüsse von Föhn auf die Anzahl und den Verlauf von Verkehrsunfällen.; Kuratorium für Verkehrssicherheit, Landesstelle Kärnten, Klagenfurt 1993, 41 S. + Anhang.; 1993.

AREND, H.; SCHWENCKE, K.R.; ZMECK, D.: Witterungsbedingte Veränderungen der Verkehrssicherheit auf innerstädtischen Autobahnen und Hauptverkehrsstraßen.; Straßenverkehrstechnik Jg 24, H 4, Juli/August, S 113-117.; 1980.

ARMINGER, G.; BOMMERT, K.; BONNE, T.: Einfluß der Witterung auf das Unfallgeschehen im Straßenverkehr.; Allgemeines statistisches Archiv. Organ der deutschen statistischen Gesellschaft.; Bd. 80 Nr.2, April/Juni 1996, S. 181-206.; 1996.

AUTOMOBIL REVUE: Wetterlagen und Unfallgefahr.; Automobil Revue Nr. 34, 15. 8. 1991, 1 S.; 1991.

BALD, S.: Untersuchungen zu Determinanten der Geschwindigkeitswahl.; Bericht zum FP 8525/3 der BAST, Bereich Unfallforschung, Nr. 158, Bergisch Gladbach, April 1987, 119 S.; 1987.

BAUMGÄRTNER, H.: Wetter und Verkehrswesen.; Zeitschrift für Verkehrssicherheit Jg 7, H 1/2, 1./2. Quartal, S 50-67.; 1958.

BECKER, F.: Der Einfluß des Wetters auf Verkehrsunfälle.; Unfall- und Sicherheitsforschung Straßenverkehr Heft 16, 1978, S. 90-95.; 1978.

BEHR, L.: Mehr Risiko für Wetterempfindliche?; Automobil-Revue Nr. 22 vom 24. Mai 1984, S. 41.; 1984.

BEINE, W.: Wetterfühligkeit. Gute Fahrt im Gleichstromfeld.; Auszug aus: Einfluß der Wetterempflindlichkeit auf die Kraftfahreignung. Dissertation, Univ. Graz 1975. KVDB sicher aktuell Nr. 245, S 3, 7. September 1976.

BIEHL, B.: Zeitvariable Bedingungen der Unfallgefährdung.; Übung: Psychologische Unfallforschung, Universität Mannheim Psychologisches Institut, Manuskript, Mannheim, ohne Jahresangabe, 8 S.; -.

BJÖRKETUN, U.: Relationships between Pavement Types and Traffic Accidents in Different Weather Conditions.; VTI Topics Vol.4 No.3, May 1985, S. 3-4.; 1985.

BRIJS, T.; KARLIS, D.; WETS, G.: Studying the effect of weather conditions on daily crash counts using a discrete time series model.; Accident Analysis & Prevention Vol.40, 2008, S. 1180-1190.; 2008.

BRODSKY, H.; HAKKERT, A.S.: Risk of a Road Accident in Rainy Weather.; Accident Analysis & Prevention Vol.20 No.3, June 1988, S. 161-176.; 1988.

CODLING, P.J.: Weather and Road Accidents.; Climatic Resources and Economic Activity, Newton, Abbot, S 205-222.; 1974.

CROSS, K.D.; FISHER, G.: A Study of Bicycle/Motor-Vehicle Accidents: Indentification of Problem Types and Countermeasure Approaches.; Vol. I, Final Report September.; 1977.

EISENBERG, D.: The mixed effects of precipitation on traffic crashes.; Accident Analysis & Prevention Vol.36, 2004, S. 637-647.; 2004.

FRIDSTROM, L.; IFVER, J.; INGEBRIGTSEN, S.; KULMALA, R.; KROGSGARD THOMASEN, L.: Measuring the contribution of Randomness, Exposure, Weather, and Daylaght to the variation in Road Accident Counts.; Accident Analysis & Prevention Vol.27 No.1, 1995, S. 1-20.; 1995.

GALVAGNINI, S.: Die Verkehrssicherheit der motorisierten Zweiräder.; Diplomarbeit am Institut für Straßenbau und Verkehrswesen der TU Wien, Abteilung für Verkehrsplanung und Verkehrstechnik, Wien, 29. Oktober 1985, 205 S.; 1985.

HEMDORFF, S., LEDEN, L., SAKSHAUG, K., SALUSJÄRVI, M. AND SCHANDERSSON, R.: Trafiksäkerhet och vägytans egenskaper (TOVE) (Traffic Safety and the properties of road safety). Technical Research Centre of Finland. Research Notes 1075, 1989.

KEAY, K.; SIMMONDS, I.: Road accidents and rainfall in a large Australian city.; Accident Analysis & Prevention Vol.38, 2006, S. 445-454.; 2006.

KEAY, K.; SIMMONDS, I.: The association of rainfall and other weather variables with road traffic volume in Melbourne, Australia.; Accident Analysis & Prevention Vol.37, 2005, S. 109-124.; 2005.

LEDEN, L., SALUSJÄRVI, M.: Trafiksäkerhet och vägytans egenskaper (TOVE). Samband mellan beläggningens ålder och trafiksäkerheten (Traffic Safety and the properties of road safety. The relationship between pavement age and traffic safety). Technical Research Centre of Finland. Research Notes 1076, 1989.

OUELLET, J.V.; SMITH, T.A.; THOM, D.R.; KASANTIKUL, V.: Environmental Contributing Factors in Thailand Motorcycle Crashes.; INSTITUT FÜR ZWEIRADSICHERHEIT (Hrsg.): Sicherheit Umwelt Zukunft IV.; 2002.

RISSER, A.: Sicherheit der Arbeitswege in Wien, Kuratorium für Verkehrssicherheit; 2000

SALEH P. et al: Road Infrastructure and road safety for PTW, 2 BE SAFE Deliverable D2, Vienna, 2009

SEXTON, B.; BAUGHAN, C.; ELLIOTT, M.; MAYCOCK, G.: The accident risk of motorcyclists.; TRL Report 607, Crowthorne, Berkshire 2004, 57 S.; 2004.

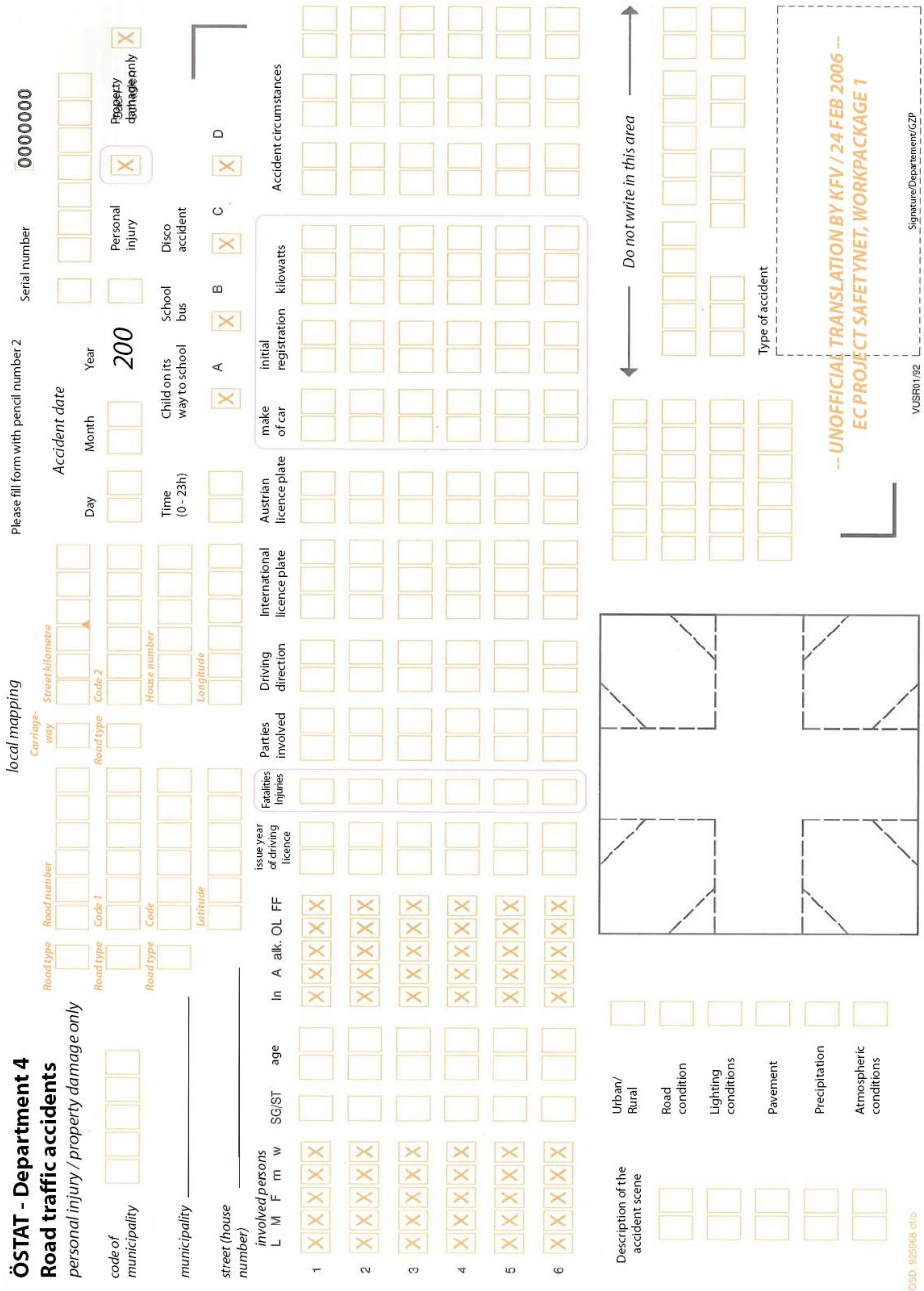
SHANKAR, V.; MANNERING, F.; BARFIELD, W.: Effect of roadway geometrics and environmental factors on rural freeway accident frequencies. Accident Analysis & Prevention Vol.27, 1995, S. 371-389.; 1995.

8. Annex I: PTW fatalities with respect to age and issue year of driving licence

Table 21: PTW fatalities with respect to age and issue year of driving licence, Austria 2004-2008

Issue year of driving licence	18-24	25-49	50-64	65+	Total	
01-05	61	75	28	4	**168**	**32%**
06-10	21	63	12	2	**98**	**18%**
11-15	0	43	6	0	**49**	**9%**
16-20	0	47	8	0	**55**	**10%**
21-25	0	37	5	0	**42**	**8%**
26-30	0	30	5	1	**36**	**7%**
31-35	0	5	20	1	**26**	**5%**
36-40	0	0	12	2	**14**	**3%**
41-45	0	0	5	0	**5**	**1%**
46-50	0	0	1	7	**8**	**2%**
51-55	0	0	0	1	**1**	**0%**
55-60	0	0	0	1	**1**	**0%**
unknown	7	14	4	3	**28**	**5%**
Total	**89**	**314**	**106**	**22**	**531**	
	17%	59%	20%	4%		

9. Annex II: Austrian accident data Form


ÖSTAT - Department 4
Road traffic accidents
personal injury / property damage only
Please fill form with pencil number 2
Serial number
0000000
local mapping
code of municipality
Road type | Road number | Carriage-way | Street kilometre
Road type | Code 1 | Road type | Code 2
Road type | Code | House number
Latitude | Longitude
municipality
street (house number)
Accident date
Day | Month | Year 200
Personal injury | Property damage only
Time (0 - 23h)
Child on its way to school | School bus | Disco accident
A | B | C | D
involved persons L M F m w
SG/ST | age | In | A | alk. | OL | FF | issue year of driving licence | Fatalities Injuries | Parties involved | Driving direction | International licence plate | Austrian licence plate | make of car | initial registration | kilowatts | Accident circumstances
1
2
3
4
5
6
Description of the accident scene
Urban/ Rural
Road condition
Lighting conditions
Pavement
Precipitation
Atmospheric conditions
Do not write in this area
Type of accident
-- UNOFFICIAL TRANSLATION BY KFV / 24 FEB 2006 --
EC PROJECT SAFETYNET, WORKPACKAGE 1
VUSR01/92
Signature/Departement/GZP
ÖSD 925868 d/o

STAT Österreichisches Statistisches Zentralamt

DEPARTMENT 4
FOREIGN TRADE AND PAYMENTS, TRANSPORT
(road accidents)
Hintere Zollamtsstraße 2b, 1033 Wien, Postfach 4000
Tel. 711 28-0*

Please write as indicated below or tick appropriate box X

0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J
K L M N Ø P Q R S T U V W X Y Z

INSTRUCTIONS FOR COMPLETION OF THE ACCIDENT DATA FORM
(to fill out only in connection with the corresponding order)

Road type
1 motorway
2 express road
3 national road
4 ordinary road
5 other road
6 motorway entrance or exit slip road

Carriageway
1 increasing km
2 decreasing km

Legend
L driver
M passenger
F pedestrian

m male
f female

In Austrian national
A Foreigner

alk drunk
OL driving without licence
FF hit-and-run driving

SG/ST
1 seat belt
2 crash helmet
3 airbag
4 seat belt and airbag
5 child restraint

Fatalities/Injuries
1 deceased at accident location
2 deceased within 24 hours
3 deceased within 24 to 48 hours
4 deceased within 48 to 72 hours
5 deceased within 72 hours and 30 days
6 seriously injured
7 slightly injured
8 degree of injury not identifiable

Parties involved
1 moped
2 motorcycle
3 passenger car (incl. station wagon, taxi)
4 bus
5 omnibus
6 lorry < 3.5t without trailer
7 lorry < 3.5t with trailer
8 lorry > 3.5t without trailer
9 lorry > 3.5t with trailer
10 truck with semitrailer
11 tanker without trailer
12 tanker with trailer or semitrailer
13 construction- or agricultural machine without trailer
14 construction- or agricultural machine with trailer
15 passenger car with trailer
16 emergency vehicle
17 tramway
18 railway
19 bicycle
20 motorcycle (under 50cc)
21 play and sports equipment
22 pedestrian
23 game animal
24 light motorcycle
29 others (incl. domestic animals)

Accident circumstances
1 disregard of priority rules
2 disregard of driver traffic rules
3 cutting curves
4 insufficient driving on the right side of lane / carriageway
5 driving on wrong side of road
6 lane change
7 getting into lane
8 no indicator (direction lights)
9 left turn
10 right turn
11 heading towards left lane boundary
12 turning around
13 backing up
14 wrong direction
15 collision with guard rail
16 driving without lights
17 collision with parked vehicle or object
18 jumping the queue
19 driving past (passing)
20 traffic-obstructing stoppage and parking
21 abrupt braking
22 skidding
23 door opening
24 falling from vehicle
25 disregard of pedestrian traffic rules
26 other pedestrian behaviour
27 collision with pedestrians
28 children on road
29 technical deficiencies
30 overtaking
31 head-on collision
32 perpendicular collision
33 losing track (left)
34 losing track (right)
35 rear-end collision with moving vehicle
36 rear-end collision with stopped vehicle
37 lateral collision
38 other circumstances

Urban / Rural
1 Urban area
2 Rural area

Road condition
1 dry road
2 wet road
3 sand, gritting material
4 snow, slush
5 winter slickness (gravel)
6 winter slickness (road untreated)
7 others (e.g. oil, dirt,...)

Lighting conditions
1 dazzling sun
2 daylight, not dazzling
3 twilight
4 darkness
5 darkness, street lights lit

Lane pavement
1 tarmac
2 concrete
3 pavement
4 gravel, sand
5 other paving

Precipitation
1 rain (drizzle)
2 hail
3 freezing rain
4 snowfall

Atmospheric conditions
1 clear / fine
2 cloudy
3 fog
4 strong wind / gale

Description of the accident scene
5 traffic calming zone
6 pedestrian zone
7 bicycle lane
8 pavement / sidewalk
9 shoulder
10 crosswalk
11 intersection with traffic lights
12 crossroads with priority
13 other crossroads
14 crossroad +
15 T-junction ⊥
16 intersection with more than 4 roads *
17 staggered junction
18 roundabout
19 level crossing with full length barrier
20 level crossing with half size barrier
21 level crossing with traffic light
22 other level crossing
23 carriageway with rails
24 one-way street
25 dual carriageway
26 frontage road
27 bridge
28 curve
29 knoll
30 underpass / tunnel
31 bottleneck
32 roadwork zone
33 visual obstruction
34 slip road to house or site
35 tramway or bus stop
36 other specific characteristics

-- UNOFFICIAL TRANSLATION BY KFV / 22 FEB 2006 --
EC PROJECT SAFETYNET, WORKPACKAGE 1

10. Annex III: Greek accident data form

ROAD ACCIDENT

A2	Period: Year	
A3	Month	January
		February
		March
		April
		May
		June
		July
		August
		September
		October
		November
		December
		Unknown
A4	Serial number of accident	
A5	Packet Number	
A6	Accident ID	
A7	Accident No. in Department	
A8	Police authority	
A9	Geographical code	
A9_2	Department code	
A10	Area type	Inside built-up area
		Outside built-up area
A11	Street or square	
A12	Road km	
A13	Direction	Increasing kilometre counting
		Decreasing kilometre counting
A14	Road type	New national road
		Old national road
		County road
		Municipal
		Communal
		Other
A15	Road code	
A16	Road code (when junction)	
A15_2	Department Road Code	
A17	Motorway	Yes
		No
A18	Accident week	
A19	Day of week	Sunday
		Monday
		Tuesday
		Wednesday
		Thursday

		Friday
		Saturday
		Unknown
A20	Hour	
A20_2	Lighting conditions	Daylight
		Dusk
		Night
A21	Day of month	
A22	Number of persons killed	
A23	Number of persons seriously injured	
A24	Number of persons slightly injured	
A25	Number of vehicles	
A26	Pavement type	Tarmac
		Concrete
		Gravel
		Paving-stone
		Ground
		Other
A27	Weather	Clear sky
		Strong wind
		Frost
		Fog or mist
		Drizzle
		Rain
		Tempest
		Storm
		Hail
		Snow or sleet
		Smoke
		Dust
		Other
A28	Pavement condition	Normal
		Wet
		Dirty, greasy, oily
		Frozen
		Snowbound
		Other
A29	Pavement state	Sand, stones on the pavement
		Uneven surface
		Works on the road
		Other
		Normal
A30	Night lighting	Good street lighting
		Poor street lighting
		Street lights unlit
		No street lighting
A31	Number of directions	One
		Two

A32	Number of lanes per direction	
A33	Direction markings	Clear
		Not clear
		No
A34	Lane markings	Clear
		Not clear
		No
A35	Left edgeline markings	Clear
		Not clear
		No
A36	Right edgeline markings	Clear
		Not clear
		No
A37	Median	Yes
		No
A38	Central barrier	Yes
		No
A39	Left side barrier	Yes
		No
A40	Right side barrier	Yes
		No
A41	Left side shoulder	Yes
		No
A42	Right side shoulder	Yes
		No
A43	Pavement width	
A44	Straight	Yes
		No
A45	Narrowing	Yes
		No
A46	Level crossing	Yes
		No
A47	Right turn	Normal bend
		Sharp bend
A48	Left turn	Normal bend
		Sharp bend
A49	Turn alternation	Yes
		No
A50	Ascent	Normal inclination
		High inclination
A51	Descent	Normal inclination
		High inclination
A52	Ascent descent sharp alternation	Yes
		No
A53	Accident type	Head on collision between moving vehicles
		At angle collision between moving vehicles
		Side impact collision between moving vehicles
		Rear end collision between moving vehicles

		Collision with train
		Vehicle collision with parked vehicle
		Vehicle collision with vehicle parking
		Vehicle collision with vehicle stopping
		Vehicle collision with post or tree
		Vehicle collision with building or other stable object
		Pedestrian involvement
		Animal involvement
		Came off in the opposite direction
		Came off the road to the right
		Came off the road to the left
		Overturned on carriageway
		Overturned outside the carriageway
		Fire
		Other
A54	Vehicle manoeuvre	Going ahead normally
		Entering into the traffic
		Entering into the traffic from junction with left turn
		Entering into the opposite traffic lane from junction with right turn
		Entering into the opposite traffic lane
		Exiting from the traffic
		Overtaking from the left
		Overtaking from the right
		Not respecting right priority of other vehicles
		Not respecting pedestrian priority on pedestrian crossing
		Turning left
		Turning right
		U turn
		Starting
		Parking manoeuvre
		Reversing
		Stopping
		Slowing down
		Sudden braking
		Changing lane
		Exceeding speed limit
		Stopping before traffic lights
		Not stopping before traffic lights
		Not stopping before stop sign
		Not stopping before give way sign
		Not stopping on policeman sign
		Not informing for changing lane or direction
		Other
A55	Pedestrian D141	Walking normally
		Crossing pedestrian crossing with red light on
		Not walking on the sidewalk
		Not walking on the pedestrian crossing
		Crossing without controlling a road without pedestrian crossing

		Other
A56	Traffic control 1	Traffic policeman
		Traffic lights in operation visible
		Traffic lights in operation hidden
		Traffic lights not in operation
		Stop or give way sign visible
		Stop or give way sign hidden
		Sign of dangerous turn
		Sign of dangerous upward or downward slope
		Other warning sign
		Automatic control of level crossing
		Manual control of level crossing
		Level crossing without control
		Other
		No control

VEHICLE

V2	Year	Same as A2
V3	Month	Same as A3
V4	Serial number of accident	Same as A4
V5	Serial number of vehicle	
V6	Vehicle type	Passenger car, private use
		Passenger car, public use
		Passenger car of state services, diplomatic corps, foreign mission, etc.
		Jeep for professional use
		Special vehicles for works (excavators, etc.)
		Lorry, up to 3.5 tons
		Lorry, over 3.5 tons
		Caravan
		Tractor
		Bus, private use
		Urban bus, public use
		Interurban bus, public use
		School bus
		Tourist bus
		Bus of state services, diplomatic corps, foreign mission, etc.
		Ambulance with patient
		Ambulance without patient
		Fire brigade vehicle
		Trolley bus
		Tanker
		Pedal cycle
		Two-wheel, up to 49 cc
		Two-wheel, 50-115 cc
		Two-wheel, 116-269 cc
		Two-wheel, 270-730 cc
		Two-wheel, of 730 cc or over
		Tricycle

		Tractor motor-vehicle for agricultural use
		Other motor vehicles for agricultural use
		Train
		Other vehicles (horse and coach, etc.)
		Unknown
V7	Vehicle nationality	
V8	With trailer	Yes
		No
		Unknown
V9	Vehicle make	
V10	Vehicle cc	
V11	First registration year	
V11_2	Vehicle age	Less than 1 year
		1-2 years
		3-5 years
		6-10 years
		More than 10 years
		Unknown
V12	Technical inspection	Inspection carried out
		Inspected had to be done
		Inspected had not to be done
		Unknown
V13	Number of drivers and passengers	
V14	Alcotest type	Alcotest not carried out
		Blood alcotest
		Breath alcotest
V15	Alcotest results	Negative (0 gr/lt)
		0,1 - 0,5 gr/lt
		0,5 - 0,8 gr/lt
		0,8 - 1,0 gr/lt
		1,0 - 1,5 gr/lt
		Over 1,5 gr/lt
		Results not yet available
V16	Alcotest hour	
V17	Alcotest place	On the spot
		Hospital
		Elsewhere
V18	Driving license nationality	Driving license from a foreign country
		Without driving licence
		Unknown
V19	Driving license category	Category A
		Category B
		Category C
		Category D
		Category E
		Category Z
V20	Driving license first year	

PERSON

P2	Year	Same as A2
P3	Month	Same as A3
P4	Serial number of accident	Same as A4
P5	Serial number of vehicle	
P6	Serial number of casualty	
P7	Road user type	Driver
		Passenger
		Pedestrian
P8	Sex	Male
		Female
		Unknown
P9	Age	
		Less than 1 year
		Unknown
P10	Nationality	
P11	Use of safety equipment	Seat belt
		Helmet
		Special baby/child seat
		Seat belt not used
		Helmet not used
		Special baby/child seat not used
		Unknown
P12	Casualty severity	Killed
		Seriously injured
		Slightly injured
		Intact driver
P13	Position in the vehicle	Co-driver
		Other seat, window
		Other seat, corridor
		Elsewhere
		Unknown
P14	Trip purpose	Home-work trip
		Business trip
		Home-school trip
		Home-sports area trip
		Tourism, recreation
		Trip for health reasons
		Other purposes
		Unknown
P15	Accident place for young pedestrians	Close to school, <150m
		Close to school, >150m
		At the bus station
		Close to a children's playground
		On the street during the game
		Arriving or leaving sports areas
		Elsewhere
		Unknown

P16	Child pedestrian accompanied	Accompanied by parents
		Accompanied by other adults
		Not accompanied
		Unknown

SAFETY EQUIPMENT

F2	Year	Same as A2
F3	Month	Same as A3
F4	Serial number of accident	Same as A4
F5	Serial number of vehicle	
F6	Safety equipment	Seat belt in front
		Seat belt behind
		Head rest in front
		Head rest behind
		Special baby/child seat
		ABS
		Speed limiter
		Airbag
		Additional bumpers
		None of the above
		Unknown

11. Annex IV: Italian accident data form

ISTAT
ROAD ACCIDENTS REPORT

ROAD ACCIDENT DATE AND LOCATION

Year ☐☐ Month ________ ☐☐

Province ________ ☐☐☐

Commune ________ ☐☐☐

Road accident date ☐☐ Road accident time (round it by the hour) ☐☐

ROAD ACCIDENT REPORT MADE BY:

Road police officer 1 ☐
Carabiniere 2 ☐
Policeman 3 ☐
Communal police officer 4 ☐
Others 5 ☐

Progressive number of model within the year ☐☐☐☐☐

COORDINATING ORGAN

Road police station 1 ☐
Carabinieri's Group 2 ☐
Statistical communal office in chief towns:
Communes with over 250,000 inhabitants 3 ☐
Other chief towns 4 ☐

1. Localization of the accident
(name of the street, street number)

BUILT-UP AREAS

Urban road 1 ☐ ________
Provincial road (within built-up areas) 2 ☐ ________
National road (within built-up areas) 3 ☐ SS N° ☐☐☐ ________

OUTSIDE BUILT-UP AREAS

Communal extra-urban road 4 ☐ ________
Provincial road 5 ☐ ________
National road 6 ☐ SS N° ☐☐☐ ________
Motorway 7 ☐ N° ☐☐☐ ________
Other roads 8 ☐ ________

At which kilometer of the road? (round it by the km) ☐☐☐

NATIONAL ROAD OR MOTORWAY SECTION
(road identification additional codes)

National road – branch – junction – dir. A 1 ☐
National road – dir. B; slip-road 2 ☐
National road bis: dir C 3 ☐
National road ter: bis dir. 4 ☐
National road quarter: slip-road: bis slip-road 5 ☐
Motorway left carriageway 6 ☐
Motorway right carriageway 7 ☐
Motorway slip-road entrance 8 ☐
Motorway slip-road exit 9 ☐
Motorway slip-road section two way carriageway 10 ☐
Motorway toll-gate 11 ☐
Others etc. 12 ☐

2. Location of the accident

TYPE OF ROAD	PAVEMENT	JUNCTION	NON-JUNCTION	ROAD-BED	TRAFFIC SIGNS	WEATHER
One-way carriageway 1 ☐	Paved road 1 ☐	Cross road 1 ☐	Straight road 7 ☐	Dry 1 ☐	Not present 1 ☐	Clear 1 ☐
Two-way carriageway 2 ☐	Uneven paved road 2 ☐	Roundabout 2 ☐	Bend 8 ☐	Wet 2 ☐	Vertical 2 ☐	Fog 2 ☐
Two carriageways 3 ☐	Unpaved road 3 ☐	Junction indicated by 3 ☐	Hump, 9 ☐	Slippery 3 ☐	Horizontal 3 ☐	Rain 3 ☐
More than two carriageways 4 ☐		- traffic lights or traffic warden 4 ☐	narrow passage	Icy 4 ☐	Vertical and horizontal 4 ☐	Hail 4 ☐
		- non indicated 5 ☐	Slope 10 ☐	Snow-clad 5 ☐		Snow 5 ☐
		Level crossing 6 ☐	Lit up tunnel 11 ☐			Severe wind 6 ☐
			Unlit tunnel 12 ☐			Other 7 ☐

3. Road accident type

A) BETWEEN MOVING VEHICLES

Head-on crash 1 ☐
Head-on side crash 2 ☐
Side crash 3 ☐
Nose to tail crash 4 ☐

B) BETWEEN A MOVING VEHICLE AND PEDESTRIANS

Running down pedestrians 5 ☐

C) BETWEEN A MOVING VEHICLE AND A STATIONARY ONE OR OTHER

Collision with a vehicle slowing/stopping or stationary 6 ☐
Collision with a parked vehicle 7 ☐
Collision with an obstacle 8 ☐
Collision with a train 9 ☐

D) MOVING VEHICLE WITHOUT COLLISION

Running off road (skidding) 10 ☐
Injury following a sudden braking 11 ☐
Injury resulting from falling out of the vehicle 12 ☐

4. Type of vehicles involved

Vehicle:	A	B	C
Private vehicle	1 ☐	1 ☐	1 ☐
Private vehicle with a trailer	2 ☐	2 ☐	2 ☐
Public vehicle	3 ☐	3 ☐	3 ☐
Police or rescue vehicle	4 ☐	4 ☐	4 ☐
Urban bus or trolley-bus	5 ☐	5 ☐	5 ☐
Extra-urban bus or coach	6 ☐	6 ☐	6 ☐
Tram	7 ☐	7 ☐	7 ☐
Truck	8 ☐	8 ☐	8 ☐
Trailer truck	9 ☐	9 ☐	9 ☐
Articulated vehicle or semi-trailer	10 ☐	10 ☐	10 ☐
Special vehicles	11 ☐	11 ☐	11 ☐
Road tractor or motor	12 ☐	12 ☐	12 ☐
Farm tractor	13 ☐	13 ☐	13 ☐
Bicycle	14 ☐	14 ☐	14 ☐
Moped	15 ☐	15 ☐	15 ☐
Motor-cycle (allowed to transport the driver only)	16 ☐	16 ☐	16 ☐
Motor-cycle carrying a passenger	17 ☐	17 ☐	17 ☐
Three-wheeler or motor-van	18 ☐	18 ☐	18 ☐
Animal traction or hand pushed vehicle	19 ☐	19 ☐	19 ☐
Vehicle unknown (escaped)	20 ☐	20 ☐	20 ☐

5. Accident circumstances
(to be filled in by the organ making the crash report)

	Traffic Inconveniences	Vehicle defects or damages	Psycho - physical condition of the driver
Vehicle A	☐☐	☐☐	☐☐
Vehicle B, Pedestrian or obstacle	☐☐	☐☐	☐☐

Report code number

CYLINDER CAPACITY (cubic centimeters)

Vehicle A ☐☐☐☐ Vehicle B ☐☐☐☐ Vehicle C ☐☐☐☐

TOTAL WEIGHT (FULL LOADED VEHICLE) – QUINTALS (GOODS FREIGHTING VEHICLES ONLY)

Vehicle A ☐☐☐☐ Vehicle B ☐☐☐☐ Vehicle C ☐☐☐☐

6. Vehicles involved

License plate (national vehicle)	Initials (foreign vehicle)	Year of first registration (last two figures)	Year of last technical inspection (last two figures)	Km covered (in thousands)
Vehicle A ☐☐☐☐☐☐	☐☐☐	Vehicle A ☐☐	Vehicle A ☐☐	Vehicle A ☐☐
Vehicle B ☐☐☐☐☐☐	☐☐☐	Vehicle B ☐☐	Vehicle B ☐☐	Vehicle B ☐☐
Vehicle C ☐☐☐☐☐☐	☐☐☐	Vehicle C ☐☐	Vehicle C ☐☐	Vehicle C ☐☐

7. Consequences of road accident on persons

DRIVERS INVOLVED | INJURED PASSENGERS

VEHICLE A

Age of driver	Driving License Type:	Year of issue of driving license (last two figures)			Dead / Injured / Age / Sex
Sex: M 1 / F 2	A 1		Yes	No	Front seat 1 (M) / Front seat 2 (F)
Uninjured 1	B 2	Professional driver	1	2	Front seat: 1 / 2 / Age / 3 / 4
Injured 2	C 3	Compulsory (seat belts, crash helmet)	1	2	Back seat: 1 / 2 / Age / 3 / 4
Dead (within 24 hours) 3	D 4	Helmet worn by: Driver	1	2	Back seat: 1 / 2 / Age / 3 / 4
(within 30 days) 4	E 5	Passenger	3	4	Back seat: 1 / 2 / Age / 3 / 4
	ABC special 6	Seat belt worn by: Driver	5	6	Other passengers injured in vehicle A
	Not required 7	Front seat passenger	7	8	Male / Female: Dead, Injured
	Provisional permit 8				
	Without license 9				

VEHICLE B

Age of driver	Driving License Type:	Year of issue of driving license (last two figures)			Dead / Injured / Age / Sex
Sex: M 1 / F 2	A 1		Yes	No	Front seat 1 (M) / Front seat 2 (F)
Uninjured 1	B 2	Professional driver	1	2	Front seat: 1 / 2 / Age / 3 / 4
Injured 2	C 3	Compulsory(seat belts, crash helmet)	1	2	Back seat: 1 / 2 / Age / 3 / 4
Dead (within 24 hours) 3	D 4	Helmet worn by: Driver	1	2	Back seat: 1 / 2 / Age / 3 / 4
(within 30 days) 4	E 5	Passenger	3	4	Back seat: 1 / 2 / Age / 3 / 4
	ABC special 6	Seat belt worn by: Driver	5	6	Other passengers injured in vehicle B
	Not required 7	Front seat passenger	7	8	Male / Female: Dead, Injured
	Provisional permit 8				
	Without license 9				

VEHICLE C

Age of driver	Driving License Type:	Year of issue of driving license (last two figures)			Dead / Injured / Age / Sex
Sex: M 1 / F 2	A 1		Yes	No	Front seat / Front seat / Front seat
Uninjured 1	B 2	Professional driver	1	2	Front seat: 1 / 2 / Age / 3 / 4
Injured 2	C 3	Compulsory(seat belts, crash helmet)	1	2	Back seat: 1 / 2 / Age / 3 / 4
Dead (within 24 hours) 3	D 4	Helmet worn by: Driver	1	2	Back seat: 1 / 2 / Age / 3 / 4
(within 30 days) 4	E 5	Passenger	3	4	Back seat: 1 / 2 / Age / 3 / 4
	ABC special 6	Seat belt worn by: Driver	5	6	Other passengers injured in vehicle A/B/C
	Not required 7	Front seat passenger	7	8	Male / Female: Dead, Injured
	Provisional permit 8				
	Without license 9				

PEDESTRIANS INVOLVED	NUMBER OF VEHICLES INVOLVED IN ADDITION TO VEHICLES A,B,C	SUMMARIZATION OF INJURED PERSONS
Dead: M 1 / F 2 / Age	PERSONS INVOLVED ON OTHER VEHICLES IN ADDITION TO VEHICLES A,B,C	Dead within 24 hours
Injured: M 3 / F 4 / Age	M / F: Dead, Injured	Dead within the 30th day
		Injured

12. Annex V: Detailed results of macroscopic analysis

12.1. Austria

12.1.1. Motorcycle accidents by weather, age and sex

In 2007, 95% of all motorcycle fatalities occurred under dry weather conditions (Table 22). Furthermore, three quarters of the fatal accidents under these conditions were reported outside urban areas. More than 85% of the victims were male. More than half of the fatalities were recorded for the age group 25 to 49. Within the generation 50+, the number of motorcycle fatalities is steadily decreasing.

Beyond that, Austrian statistics prove that especially inexperienced bikers, no matter how old they are, run the risk of getting killed in a motorcycle accident: Within the period from 2004 to 2008, approximately one third of the reported motorcycle fatalities involved motorcycle riders, who were holding their motorcycle license for less than five years (see Table 21).

Table 22: Motorcycle fatalities with respect to weather and age/sex, Austria 2007

Age	Sex	Inside urban areas		Outside urban areas		Total absolute		Total relative	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
18 - 24	Male	3	0	8	1	**11**	**1**	**13,2%**	**20,0%**
	Female	0	0	1	0	**1**	**0**		
25 - 49	Male	8	1	43	2	**51**	**3**	**62,6%**	**60,0%**
	Female	0	0	6	0	**6**	**0**		
50 - 64	Male	3	0	12	1	**15**	**1**	**19,8%**	**20,0%**
	Female	0	0	3	0	**3**	**0**		
65+	Male	1	0	3	0	**4**	**0**	**4,4%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**15**	**1**	**76**	**4**	**91**	**5**	**100,0%**	**100,0%**
		94%	6%	95%	5%	95%	5%		

12.1.2. Motorcycle accidents by weather and influence of alcohol

Table 23 shows the motorcycle fatalities with respect to weather and driving under the influence of alcohol. In this case, the term “alcoholised” means that either the motorcyclist or the passenger had more than 0,5 mg alcohol per gramme in their blood. As displayed in the table below, hardly any fatal motorcycle accident seems having happened under the influence of alcohol in Austria in 2007. Unfortunately, value of this information is rather poor. Alcohol checks are not allowed to be done with fatally injured persons in Austria, except the respective judge orders the test to be carried out or the police or state attorney ask for the check and the surviving dependants agree, which is hardly ever the case.

Table 23: Motorcycle fatalities with respect to weather and alcohol influence, Austria 2007

Alcohol	Sex	Inside urban area		Outside urban area		Total absolute		Total relative	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
not alcoholised	Male	14	0	66	4	**80**	**4**	**98,9%**	**80,0%**
	Female	0	0	10	0	**10**	**0**		
alcoholised	Male	1	1	0	0	**1**	**1**	**1,1%**	**20,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**15**	**1**	**76**	**4**	**91**	**5**	**100,0%**	**100,0%**
		94%	6%	95%	5%	95%	5%		

12.1.3. Motorcycle accidents by weather and occupant category

In this context, the term “driver” includes PTW riders as well as car drivers and the term “passenger” means both passengers in cars and pillion passengers. Nearly every driver, who was involved in a fatal accident, was male (Table 24). There is hardly any difference to the table above (Table 23) concerning the total number of traffic deaths, although these numbers also include car drivers and passengers involved in crashes with motorcycles. In other words, 97% of all fatally injured in motorcycle crashes are the motorcycle occupants themselves.

Therefore, the results of the subchapters 12.1.1 and 12.1.4 have to be linked: On the one hand, many motorcycle fatalities occur when the motorcycles rider runs off the road under dry weather conditions outside urban areas. Thus, these are single vehicle accidents, where neither a pedestrian nor another driver is involved. On the other hand, because of the lack of a crash zone, motorcyclists are more likely to get fatally injured than car drivers in collisions between moving vehicles.

Table 24: Motorcycle fatalities with respect to weather and occupant category, Austria 2007

Class	Sex	Inside urban areas		Outside urban areas		Total absolute		Total relative	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Driver	Male	14	1	66	4	**80**	**5**	**86,2%**	**100,0%**
	Female	0	0	1	0	**1**	**0**		
Passenger	Male	1	0	0	0	**1**	**0**	**10,6%**	**0,0%**
	Female	0	0	9	0	**9**	**0**		
Pedestrian	Male	2	0	1	0	**3**	**0**	**3,2%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**17**	**1**	**77**	**4**	**94**	**5**	**100,0%**	**100,0%**
		94%	6%	95%	5%	95%	5%		

12.1.4. Motorcycle accidents by weather and collision type

As displayed in Table 25, 30% of the motorcycle fatalities occurred in run-off-the-road accidents. In 46% of the cases, there was a collision between moving vehicles, head on. In both of these categories, most of the accidents happened under dry weather conditions outside urban areas. Single vehicle accidents outside urban areas are generally considered to be linked with inappropriate speed. Head-on collisions have various reasons, e.g. risky overtaking manoeuvres by either car drivers or motorcycle riders or inappropriate speed in bends, where the rider is unable to keep his own lane or falls off the vehicle and skids into oncoming traffic.

Table 25: Motorcycle fatalities with respect to weather and collision type, Austria 2007

Collision Type	Inside urban areas		Outside urban areas		Total absolute		Total relative	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Came off the road	5	0	23	1	**28**	**1**	**30,8%**	**20,0%**
Single vehicle collision with stable/immov. object	1	0	0	0	**1**	**0**	**1,1%**	**0,0%**
Avoiding animal	0	0	1	0	**1**	**0**	**1,1%**	**0,0%**
Single vehicle collision with parked car	0	1	0	0	**0**	**1**	**0,0%**	**20,0%**
Between moving vehicles, at angle	0	0	7	0	**7**	**0**	**7,7%**	**0,0%**
Between moving vehicles, head on	6	0	35	3	**41**	**3**	**45,1%**	**60,0%**
Between moving vehicles, rear end	0	0	3	0	**3**	**0**	**3,3%**	**0,0%**
Between moving vehicles, lateral	3	0	7	0	**10**	**0**	**11,0%**	**0,0%**
Total	**15**	**1**	**76**	**4**	**91**	**5**	**100,0%**	**100,0%**
	94%	6%	95%	5%	95%	5%		

12.1.5. Moped accidents by weather, age and sex

Over 85% of the moped fatalities occurred under dry weather condition in Austria in 2007. Compared to Table 22, neither this nor distribution by sex differ significantly from the respective numbers for motorcycle riders. Maybe due to the lower maximum speed and typical riding environment (i.e. distribution of exposure by riding environment), fatal moped accidents are more evenly distributed by location, whereas 33% were observed inside and 67% outside of urban areas.

Of course, there is a strong difference in age distribution of fatalities between moped and motorcycle. In Austria, a moped licence can be acquired at the age of 15 and, hence, the combination of lack of experience and juvenile overestimation of one's own skills may be contributing factors to 50% of the moped fatalities.

Table 26: Moped fatalities with respect to weather, age and sex, Austria 2007

Age	Sex	Inside urban areas		Outside urban areas		Total absolute		Total relative	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
15 - 17	Male	2	0	8	0	**10**	**0**	**57,1%**	**0,0%**
	Female	1	0	1	0	**2**	**0**		
18 - 24	Male	0	0	0	0	**0**	**0**	**0,0%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
25 - 49	Male	1	2	3	1	**4**	**3**	**19,0%**	**100,0%**
	Female	0	0	0	0	**0**	**0**		
50 - 64	Male	1	0	1	0	**2**	**0**	**9,5%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
65+	Male	1	0	2	0	**3**	**0**	**14,3%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**6**	**2**	**15**	**1**	**21**	**3**	**100,0%**	**100,0%**
		75%	25%	94%	6%	88%	12%		

12.1.6. Moped accidents by weather and influence of alcohol

Table 27 looks like there are hardly any alcohol-related accidents involving moped riders. However, this impression cannot be approved by the numbers in Table 27. Austrian legislation prohibits checking dead or unconscious persons for alcohol intoxication, except the judge or the state attorney orders an examination (which is hardly ever done)

Table 27: Moped fatalities with respect to weather and alcohol influence, Austria 2007

Alcohol	Sex	Inside urban area		Outside urban area		**Total absolute**		**Total relative**	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
not alcoholised	Male	4	2	13	1	**17**	**3**	**90,5%**	**100,0%**
	Female	1	0	1	0	**2**	**0**		
alcoholised	Male	1	0	1	0	**2**	**0**	**9,5%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**6**	**2**	**15**	**1**	**21**	**3**	**100,0%**	**100,0%**
		75%	25%	94%	6%	88%	12%		

12.1.7. Moped accidents by weather and occupant category

In this table (Table 28), the same terms are used like in Table 24, including moped riders and car drivers in “drivers” and automotive and moped passengers in “passengers”. There are a lot of similarities to the fatal motorcycle casualties, distinguished between occupant categories. Once again, the number of fatally injured riders, who were involved in a traffic accident with a moped, hardly differs from the amount of moped riders and their passengers. In 2007, two of the passengers were killed, 89% of the fatalities were drivers and one pedestrian was fatally injured. In general, almost every fatal moped accident happened under dry weather conditions, whereas most of them occurred outside urban areas.

Table 28: Moped fatalities with respect to weather and occupant category, Austria 2007

Class	Sex	Inside urban areas		Outside urban areas		**Total absolute**		**Total relative**	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Driver	Male	5	2	14	1	**19**	**3**	**87,5%**	**100,0%**
	Female	1	0	1	0	**2**	**0**		
Passenger	Male	0	0	0	0	**0**	**0**	**4,2%**	**0,0%**
	Female	0	0	1	0	**1**	**0**		
Pedestrian	Male	0	0	2	0	**2**	**0**	**8,3%**	**0,0%**
	Female	0	0	0	0	**0**	**0**		
Total		**6**	**2**	**18**	**1**	**24**	**3**	**100,0%**	**100,0%**
		75%	25%	95%	5%	89%	11%		

12.1.8. Moped accidents by weather and collision type

Table 29 displays the fatal moped accidents, which happened in Austria in 2007, with respect to weather and collision type. Hardly any of these occurred under rainy weather conditions. Contrary to motorcycles (Table 25), run-off-the-road accidents are very uncommon for mopeds. In fact, in 90% of the fatal accidents another moving vehicle was involved, whereas collisions between moving vehicles, at angle, head on and lateral are nearly uniformly distributed.

Table 29: Moped fatalities with respect to weather and collision type, Austria 2007

Collision Type	Inside urban areas		Outside urban areas		Total absolute		Total relative	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Came off the road	1	0	1	0	**2**	**0**	**9,5%**	**0,0%**
Between moving vehicles, at angle	0	0	6	0	**6**	**0**	**28,6%**	**0,0%**
Between moving vehicles, head on	2	1	3	0	**5**	**1**	**23,8%**	**33,3%**
Between moving vehicles, rear end	1	1	2	0	**3**	**1**	**14,3%**	**33,3%**
Between moving vehicles, lateral	2	0	3	1	**5**	**1**	**23,8%**	**33,3%**
Between movin vehicles, with train	1	0	0	1	**1**	**1**	**4,8%**	**33,3%**
Total	**7**	**2**	**15**	**2**	**21**	**3**	**100,0%**	**100,0%**
	78%	22%	88%	12%	88%	12%		

12.1.9. Comparative study of PTW and passenger car fatalities

This section is dedicated to the comparison between powered two wheeler (PTW) and passenger car (in the following also abbreviated by "PC" or simply "car") fatalities with respect to weather conditions. Therefore, Austrian statistics from 2007 for passenger cars and PTWs were computed in the same way and the main similarities as well as differences were highlighted.

When comparing fatally injured PTW and passenger car occupants, passenger car fatalities are divided into the weather categories “dry” and “other”. Up to this point in the document, not a single accident occurred under other weather conditions than dry or rain. PTW riders seem not be keen of riding on snowy roads, mud or ice. However, passenger car collisions are recorded also on mud and snow. But the number of these collisions is rather low compared to accidents on wet roads, hence, all condition other than dry are summarised to one category called "other" in the following.

In 2007, only 58 fatal accidents happened in Austria, where the weather was not dry. Of these 58 fatalities, 44 happened under rainy, 12 under snowy conditions and a single fatal casualty in sleet as well as one in hail.

12.1.10. Comparing car and PTW crashes by weather, age and sex

For each age class, the number of passenger car fatalities is larger than the number of fatal PTW casualties in Austria in 2007 (Table 30), not a surprise considering there are roughly 10 times more passenger cars registered in Austria than PTW.

In relation, more passenger car than PTW fatalities were registered during rainy and snowy periods. This result includes

- the impact of weather on exposure
- the risk taking behaviour of both categories of road users under rainy conditions
- the intrinsic risk of driving/riding in rain compared to dry weather

Hence, it could be assumed that PTW riders adjust their behaviour to bad weather condition better than car drivers do. It might also be assumed that car drivers do not care very much about bad weather when they decide whether to use their car or not, while PTW riders do. To conclude that driving in rain is less dangerous than on sunny day might be possible as well. Whatever is true, Table

30 does not give the answer, since these effects cannot be isolated from one another by using this method.

With regards to age, the table shows that the percentages of fatal passenger car and PTW accidents are almost equal - just in the age classes from 18-24 and 25-49, there is a minor difference. Again, this comparison does not allow for any conclusions in terms of risk taking behaviour or intrinsic risk of riding vs. driving in rain by age.

Anent the fatal casualties' sex, 90% of the PTW and 76% of the passenger car fatalities were male; combining both PTW and passenger car accidents, 79% of the fatal injuries were sustained by males. However, no possibility for any conclusions: As long as we do not know about mileage and the particular risk of the typical trip of males and females, this information is hardly useful.

Table 30: Comparison between PTW and passenger car fatalities with respect to weather and age/sex, Austria 2007

Age	Sex	PTW				Passenger Car				Total absolute		Total relative	
		Dry		*Rain*		*Dry*		*Other*		Dry	Other	Dry	Other
00 - 14	Male	*0*	*0%*	*0*	*0%*	*5*	*2%*	*0*	*0%*	**5**	**0**	**1,6%**	**0,0%**
	Female	*0*		*0*		*2*		*0*		**2**	**0**		
15 - 17	Male	*10*	*11%*	*0*	*0%*	*7*	*4%*	*2*	*3%*	**17**	**2**	**5,6%**	**3,0%**
	Female	*2*		*0*		*5*		*0*		**7**	**0**		
18 - 24	Male	*11*	*11%*	*1*	*13%*	*79*	*29%*	*5*	*19%*	**90**	**6**	**24,5%**	**18,2%**
	Female	*1*		*0*		*15*		*6*		**16**	**6**		
25 - 49	Male	*55*	*54%*	*6*	*75%*	*95*	*35%*	*15*	*41%*	**150**	**21**	**40,3%**	**45,5%**
	Female	*6*		*0*		*18*		*9*		**24**	**9**		
50 - 64	Male	*17*	*18%*	*1*	*13%*	*36*	*15%*	*6*	*17%*	**53**	**7**	**15,5%**	**16,7%**
	Female	*3*		*0*		*11*		*4*		**14**	**4**		
65+	Male	*7*	*6%*	*0*	*0%*	*29*	*15%*	*7*	*19%*	**36**	**7**	**12,5%**	**16,7%**
	Female	*0*		*0*		*18*		*4*		**18**	**4**		
Total		**112**		**8**		**320**		**58**		**432**	**66**	**100,0%**	**100,0%**
		93%		7%		85%		15%		87%	13%		

12.1.11. Comparing car and PTW crashes by weather and influence of alcohol

Table 31 shows the comparison between PTW and passenger car fatalities with respect to weather and alcohol influence in Austria in 2007. Although hardly any fatal casualties under the influence of alcohol were reported, it is obvious that alcoholised men were more often involved in fatal traffic accidents than women. See 12.1.2 and 0 for explanation!

Table 31: Comparison between PTW and passenger car fatalities with respect to weather and alcohol influence, Austria 2007

Alcohol	Sex	PTW				Passenger Car				Total absolute		Total relative	
		Dry		Rain		Dry		Other		Dry	Other	Dry	Other
not alcoholised	Male	*97*	*97%*	*7*	*88%*	*242*	*97%*	*35*	*100%*	**339**	**42**	**96,8%**	**98,5%**
	Female	*12*		*0*		*67*		*23*		**79**	**23**		
alcoholised	Male	*3*	*3%*	*1*	*13%*	*9*	*3%*	*0*	*0%*	**12**	**1**	**3,2%**	**1,5%**
	Female	*0*		*0*		*2*		*0*		**2**	**0**		
Total		**112**		**8**		**320**		**58**		**432**	**66**	**100,0%**	**100,0%**
		93%		7%		85%		15%		87%	13%		

12.1.12. Comparing car and PTW crashes by weather and occupant category

As shown in Table 32, there are significant differences concerning the PTW and passenger car fatalities with respect to weather conditions and occupant category (see definition in subchapter 12.1.3). 94% of 126 fatal PTW and 86% of 691 fatal passenger car accidents occurred under dry weather conditions.

In PTW related traffic accidents, 87% of all fatal casualties were drivers, respectively only 69% of the passenger car occupants killed in road traffic are drivers. Of course, this result depends on the occupancy rate of PTWs respectively of passenger cars: Statistically, this rate is approximately 1.3 people per passenger car and about 1.1 for powered two wheelers. Besides, with regard to the magnitude of fatally injured pedestrians, a passenger car inflicts much more damage on vulnerable road users than a PTW.

Table 32: Comparison between PTW and passenger car fatalities with respect to weather and occupant category, Austria 2007

Class	Sex	PTW				Passenger Car				Total absolute		Total relative	
		Dry		Rain		Dry		Other		Dry	Other	Dry	Other
Driver	Male	99	86%	8	100%	359	69%	46	66%	458	54	71,9%	68,3%
	Female	3		0		52		17		55	17		
Passenger	Male	1	9%	0	0%	46	16%	7	16%	47	7	14,7%	14,4%
	Female	10		0		48		8		58	8		
Pedestrian	Male	5	4%	0	0%	60	15%	12	19%	65	12	13,3%	17,3%
	Female	0		0		30		6		30	6		
Total		**118**		**8**		**595**		**96**		**713**	**104**	**100,0%**	**100,0%**
		94%		6%		86%		14%		87%	13%		

12.1.13. Comparing car and PTW crashes by weather and collision type

Looking at the data in Table 33, there are just minor differences between the percentages of fatal PTW and passenger car accidents anent the listed collision types. For both of the vehicle categories, run-off-the-road accidents are less frequent in rainy weather, while there are more head-on collisions in rain.

Table 33: Comparison between PTW and passenger car fatalities with respect to weather and collision type, Austria 2007

Collision Type	PTW				Passenger Car				Total absolute		Total relative	
	Dry		Rain		Dry		Other		Dry	Other	Dry	Other
Single vehicle collision with parked car	0	0%	1	13%	2	1%	1	2%	2	2	0,5%	3,0%
Came off the road	30	27%	1	13%	151	47%	19	33%	181	20	41,9%	30,3%
Single vehicle collision with stable/immov. object	1	1%	0	0%	0	0%	0	0%	1	0	0,2%	0,0%
Between moving vehicles, head on	46	41%	4	50%	105	33%	28	48%	151	32	35,0%	48,5%
Between moving vehicles, at angle	13	12%	0	0%	13	4%	3	5%	26	3	6,0%	4,5%
Between moving vehicles, with train	1	1%	1	13%	15	5%	5	9%	16	6	3,7%	9,1%
Avoiding pedestrian	0	0%	0	0%	2	1%	0	0%	2	0	0,5%	0,0%
Avoiding animal	1	1%	0	0%	0	0%	0	0%	1	0	0,2%	0,0%
Between moving vehicles, rear end	6	5%	1	13%	21	7%	0	0%	27	1	6,3%	1,5%
Between moving vehicles, lateral	14	13%	0	0%	11	3%	2	3%	25	2	5,8%	3,0%
Total	**112**		**8**		**320**		**58**		**432**	**66**	**100,0%**	**100,0%**
	93%		2%		85%		15%		87%	13%		

12.2. Greece

12.2.1. Motorcycle accidents by weather, age and sex

As in the case of motorcycle, nearly 60% of accident fatalities were reported inside urban areas under dry conditions (Table 34). Interestingly, the majority of accidents are observed in the ages between 25 and 49 years old. Moreover, 37% of motorcycle fatalities were reported under dry weather conditions outside urban areas.

Table 34: Motorcycle fatalities with respect to weather conditions and age/sex, Greece 2007

Age	Sex	Inside urban area			Outside urban area			Total absolute			Total relative		
		Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain
00-14	Male	0	0	0	2	0	0	**2**	**0**	**0**	**0,5%**	**0,0%**	**0,0%**
	Female	0	0	0	0	0	0	**0**	**0**	**0**			
15-17	Male	9	1	1	9	0	0	**18**	**1**	**1**	**5,0%**	**16,7%**	**10,0%**
	Female	2	0	0	0	0	0	**2**	**0**	**0**			
18-24	Male	69	2	2	32	0	0	**101**	**2**	**2**	**26,2%**	**33,3%**	**30,0%**
	Female	3	0	1	2	0	0	**5**	**0**	**1**			
25-49	Male	122	2	2	85	1	4	**207**	**3**	**6**	**54,5%**	**50,0%**	**60,0%**
	Female	9	0	0	4	0	0	**13**	**0**	**0**			
50-64	Male	17	0	0	12	0	0	**29**	**0**	**0**	**7,9%**	**0,0%**	**0,0%**
	Female	2	0	0	1	0	0	**3**	**0**	**0**			
65+	Male	12	0	0	9	0	0	**21**	**0**	**0**	**5,9%**	**0,0%**	**0,0%**
	Female	2	0	0	1	0	0	**3**	**0**	**0**			
Total		**247**	**5**	**6**	**157**	**1**	**4**	**404**	**6**	**10**	**100,0%**	**100,0%**	**100,0%**
		96%	2%	2%	97%	1%	2%	97%	1%	2%			

12.2.2. Motorcycle accidents by weather and occupant category

The majority of motorcycle accidents (97%) occur under dry weather conditions (Table 35). Inside urban areas, 54% of fatalities are riders, while outside urban areas, this percentage drops to 35%.

Table 35: Motorcycle fatalities with respect to weather conditions and occupant category, Greece 2007

Class	Inside urban areas			Outside urban areas			Total absolute			Total relative		
	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain
Driver	217	5	6	142	1	4	**359**	**6**	**10**	**88,9%**	**100,0%**	**100,0%**
Passenger	30	0	0	15	0	0	**45**	**0**	**0**	**11,1%**	**0,0%**	**0,0%**
Total	**247**	**5**	**6**	**157**	**1**	**4**	**404**	**6**	**10**	**100,0%**	**100,0%**	**100,0%**
	96%	2%	2%	97%	1%	2%	97%	1%	2%			

12.2.3. Motorcycle accidents by weather and collision type

Mopeds and motorcycle fatalities observed in Greece in 2007 have similarities with respect to manoeuvring involved. As can be seen in Table 36, going straight ahead manoeuvres account for 90% of motorcycle fatalities. This type of motorcycle accident is mostly observed under dry weather conditions. A large percentage of fatalities is attributed to dry weather and unknown manoeuvring (37% of total motorcycle accidents observed in 2007).

Table 36: Motorcycle fatalities with respect to weather conditions and collision type, Greece 2007

Collision Type	Inside urban areas			Outside urban areas			Total absolute			Total relative		
	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain
Changing lane	2	0	0	5	0	0	7	0	0	1,7%	0,0%	0,0%
Other	58	2	2	44	1	1	102	3	3	25,2%	50,0%	30,0%
Overtaking on the left	8	0	0	2	0	0	10	0	0	2,5%	0,0%	0,0%
Overtaking on the right	0	0	0	0	0	0	0	0	0	0,0%	0,0%	0,0%
Reversing	0	0	0	1	0	0	1	0	0	0,2%	0,0%	0,0%
Stopping	2	0	0	1	0	0	3	0	0	0,7%	0,0%	0,0%
Straight ahead	70	0	4	44	0	3	114	0	7	28,2%	0,0%	70,0%
Turning left	3	0	0	4	0	0	7	0	0	1,7%	0,0%	0,0%
Turning right	4	0	0	2	0	0	6	0	0	1,5%	0,0%	0,0%
U turn	1	0	0	0	0	0	1	0	0	0,2%	0,0%	0,0%
Unknown	99	3	0	54	0	0	153	3	0	37,9%	50,0%	0,0%
Total	**247**	**5**	**6**	**157**	**1**	**4**	**404**	**6**	**10**	**100,0%**	**100,0%**	**100,0%**
	96%	2%	2%	97%	1%	2%	97%	1%	2%			

12.2.4. Motorcycle accidents by weather and traffic control

As seen in Table 37, motorcycle fatalities are observed under dry weather conditions, in automatic traffic signals, giveaway signs and uncontrolled roadway conditions in urban areas. As for outside urban areas motorcycle fatalities, uncontrolled traffic conditions are the prevailing conditions for motorcycle fatality occurrence.

Table 37: Motorcycle fatalities with respect to weather conditions and traffic control, Greece 2007

Traffic control	Inside urban areas			Outside urban areas			Total absolute			Total relative		
	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain
Authorized person	0	0	0	0	0	0	0	0	0	0,0%	0,0%	0,0%
Automatic traffic signal	19	0	0	3	0	0	22	0	0	5,4%	0,0%	0,0%
Give way sign or markings	27	2	0	5	0	0	32	2	0	7,9%	33,3%	0,0%
Uncontrolled	190	3	6	124	0	3	314	3	9	77,7%	50,0%	90,0%
Unknown	11	0	0	25	1	1	36	1	1	8,9%	16,7%	10,0%
Total	**247**	**5**	**6**	**157**	**1**	**4**	**404**	**6**	**10**	**100,0%**	**100,0%**	**100,0%**
	96%	2%	2%	97%	1%	2%	97%	1%	2%			

12.2.5. Moped accidents by weather, age and sex

Nearly 60% of moped accident fatalities were reported inside urban areas. Moreover, 40% of moped fatalities were reported under dry weather conditions outside urban areas: this percentage rises to 59% for accidents inside urban areas. Nearly half of moped fatalities involve female and male persons (driver or passengers) of more than 65 years old (Table 38).

Table 38: Moped fatalities with respect to weather conditions and age/sex, Greece 2007

Age	Sex	Inside urban area		Outside urban area		Total absolute		Total relative	
		Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
00 -14	Male	0	0	0	0	0	0	0,0%	0,0%
	Female	0	0	0	0	0	0		
15-17	Male	0	0	1	0	1	0	2,4%	0,0%
	Female	0	0	0	0	0	0		
18-24	Male	2	0	1	0	3	0	12,2%	0,0%
	Female	2	0	0	0	2	0		
25-49	Male	6	0	4	1	10	1	26,8%	50,0%
	Female	0	0	1	0	1	0		
50-64	Male	3	1	2	0	5	1	12,2%	50,0%
	Female	0	0	0	0	0	0		
65+	Male	11	0	8	0	19	0	46,3%	0,0%
	Female	0	0	0	0	0	0		
Total		**24**	**1**	**17**	**1**	**41**	**2**	**100,0%**	**100,0%**
		96%	4%	94%	6%	95%	5%		

12.2.6. Moped accidents by weather and occupant category

Inside urban areas, 53% of persons killed were drivers/riders, while, outside urban areas drives/riders fatalities account for the 37% of total moped accidents (Table 39). Almost all moped accident fatalities were observed under dry weather conditions, regardless of the type of area. Moreover, 5% of the moped fatalities occurred under rain conditions.

Table 39: Moped fatalities with respect to weather conditions and occupant category, Greece 2007

Class	Inside urban areas		Outside urban areas		Total absolute		Total relative	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Driver	22	1	15	0	37	1	90,2%	100,0%
Passenger	2	0	2	0	4	0	9,8%	0,0%
Total	**24**	**1**	**17**	**0**	**41**	**1**	**100,0%**	**100,0%**
	96%	4%	100%	0%	98%	2%		

12.2.7. Moped accidents by weather and collision type

Going straight ahead moped accident fatalities account for 90% of moped fatalities observed (Table 40). This type of moped accident is mostly observed under dry weather conditions. There is a large percentage of fatalities attributed to dry weather and unknown manoeuvring (37% of total moped accidents observed in 2007).

Table 40: Moped fatalities with respect to weather conditions and collision type, Greece 2007

Collision Type	Inside urban areas		Outside urban areas		Total absolute		Total relative	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Changing lane	1	0	0	0	1	0	1,2%	0,0%
Other	10	0	6	0	16	0	19,3%	0,0%
Overtaking on the left	1	0	0	0	1	0	1,2%	0,0%
Overtaking on the right	0	0	0	0	0	0	0,0%	0,0%
Reversing	0	0	0	0	0	0	0,0%	0,0%
Stopping	0	0	0	0	0	0	0,0%	0,0%
Straight ahead	2	1	4	1	7	2	8,4%	50,0%
Turning left	0	0	1	0	1	0	1,2%	0,0%
Turning right	0	0	0	0	0	0	0,0%	0,0%
U turn	0	0	0	0	0	0	0,0%	0,0%
Unknown	10	0	6	0	57	2	68,7%	50,0%
Total	**24**	**1**	**17**	**1**	**83**	**4**	**100,0%**	**100,0%**
	96%	4%	94%	6%	95%	5%		

12.2.8. Moped accidents by weather and traffic control

Most moped accidents are observed in uncontrolled roadway conditions under fine weather (Table 41). Give way signs or marking account for the 9% of moped fatalities observed and occur inside urban areas under fine weather conditions.

Table 41: Moped fatalities with respect to weather conditions and traffic control, Greece 2007

Traffic control	Inside urban areas		Outside urban areas		Total absolute		Total relative	
	Dry	Rain	Dry	Rain	Dry	Rain	Dry	Rain
Authorized person	0	0	0	0	0	0	0,0%	0,0%
Automatic traffic signal	3	0	0	0	3	0	7,3%	0,0%
Give way sign or markings	4	0	0	0	4	0	9,8%	0,0%
Uncontrolled	17	1	15	1	32	2	78,0%	100,0%
unknown	0	0	2	0	2	0	4,9%	0,0%
Total	**24**	**1**	**17**	**1**	**41**	**2**	**100,0%**	**100,0%**
	96%	4%	94%	6%	95%	5%		

12.2.9. Comparative study of PTW and passenger car fatalities

The magnitude of fatalities observed in passenger cars is greater that the number of PTW fatalities in 2007 in Greece (Table 42). Interestingly, during rain more passenger car fatalities are observed, mainly due to the fact that PTWs circulation is greatly discouraged by adverse weather conditions.

12.2.10. Comparing car and PTW crashes by weather, age and sex

The majority of fatalities are male rider/drivers. The percentage of female fatalities in passenger cars is larger than the one of PTWs.

Regarding age and weather interactions in PTW and passenger cars, evidently, PTWs fatalities involve young drivers; Most fatalities in ages greater that 50 are observed in passenger cars accidents (Table 43).

Table 42: Comparison between PTW and passenger car fatalities with respect to sex and weather, Greece 2007

Sex	PTW			PC			Total absolute			Total relative		
	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain	Dry	Other	Rain
Male	416	6	11	460	16	89	**876**	**22**	**100**	**82,3%**	**81,5%**	**75,8%**
Female	29	0	1	160	5	31	**189**	**5**	**32**	**17,7%**	**18,5%**	**24,2%**
Total	**445**	**6**	**12**	**620**	**21**	**120**	**1065**	**27**	**132**	**100,0%**	**100,0%**	**100,0%**
	96%	1%	3%	81%	3%	16%	87%	2%	11%			

Table 43: Comparison between PTW and passenger car fatalities with respect to age and weather, Greece 2007

Age	PTW						PC						Total absolute			Total relative		
	Dry		Other		Rain		Dry		Other		Rain		Dry	Other	Rain	Dry	Other	Rain
00-14	2	0,4%	0	0,0%	0	0,0%	19	3,1%	1	4,8%	4	3,3%	**21**	**1**	**4**	**2,0%**	**3,7%**	**3,0%**
15-17	22	4,9%	0	0,0%	1	8,3%	12	1,9%	0	0,0%	2	1,7%	**34**	**0**	**3**	**3,2%**	**0,0%**	**2,3%**
18-24	111	24,9%	2	33,3%	3	25,0%	125	20,2%	4	19,0%	24	20,0%	**236**	**6**	**27**	**22,2%**	**22,2%**	**20,5%**
25-49	232	52,1%	3	50,0%	6	50,0%	284	45,8%	10	47,6%	55	45,8%	**516**	**13**	**61**	**48,5%**	**48,1%**	**46,2%**
50-64	37	8,3%	0	0,0%	1	8,3%	86	13,9%	3	14,3%	17	14,2%	**123**	**3**	**18**	**11,5%**	**11,1%**	**13,6%**
65+	41	9,2%	1	16,7%	1	8,3%	94	15,2%	3	14,3%	18	15,0%	**135**	**4**	**19**	**12,7%**	**14,8%**	**14,4%**
Total	**445**		**6**		**12**		**620**		**21**		**120**		**1065**	**27**	**132**	**100,0%**	**100,0%**	**100,0%**
	96%		1%		3%		81%		3%		16%		87%	2%	11%			

12.2.11. Comparing car and PTW crashes by weather and occupant category

Regarding occupant category, fatalities involve mainly drivers/riders in PTW accidents rather than passenger too as in the case of passenger cars (Table 44). As in PTWs fatalities, most passenger cars fatalities are observed in dry conditions regardless of occupant category involved in the accidents.

Table 44: Comparison between PTW and passenger car fatalities with respect to occupant category and weather, Greece 2007

Class	PTW						PC						Total absolute			Total relative		
	Dry		Other		Rain		Dry		Other		Rain		Dry	Other	Rain	Dry	Other	Rain
Driver	398	89,4%	5	83,3%	11	91,7%	460	74,2%	16	76,2%	89	74,2%	**858**	**21**	**100**	**80,6%**	**77,8%**	**75,8%**
Passenger	47	10,6%	1	16,7%	1	8,3%	160	25,8%	5	23,8%	31	25,8%	**207**	**6**	**32**	**19,4%**	**22,2%**	**24,2%**
Total	**445**		**6**		**12**		**620**		**21**		**120**		**1065**	**27**	**132**	**100,0%**	**100,0%**	**100,0%**
	96%		1%		3%		81%		3%		16%		87%	2%	11%			

12.2.12. Comparing car and PTW crashes by weather and collision type

Moreover, passenger cars seem to be more sensitive to weather conditions and collision types (Table 45); a significant percentage of fatalities are observed in weather conditions that differ from dry or rainy.

Table 45: Comparison between PTW and passenger car fatalities with respect to collision type and weather, Greece 2007

Collision Type	PTW						PC						Total absolute			Total relative		
	Dry		Other		Rain		Dry		Other		Rain		Dry	Other	Rain	Dry	Other	Rain
Changing lane	8	1,8%	0	0,0%	0	0,0%	5	0,8%	0	0,0%	1	0,8%	13	0	1	1,2%	0,0%	0,8%
Other	118	26,5%	3	37,5%	3	30,0%	292	47,1%	8	38,1%	64	53,3%	410	11	67	38,5%	37,9%	51,5%
Overtaking on the left	11	2,5%	0	0,0%	0	0,0%	6	1,0%	0	0,0%	4	3,3%	17	0	4	1,6%	0,0%	3,1%
Overtaking on the right	0	0,0%	0	0,0%	0	0,0%	2	0,3%	0	0,0%	1	0,8%	2	0	1	0,2%	0,0%	0,8%
Reversing	1	0,2%	0	0,0%	0	0,0%	1	0,2%	0	0,0%	0	0,0%	2	0	0	0,2%	0,0%	0,0%
Stopping	3	0,7%	0	0,0%	0	0,0%	4	0,6%	0	0,0%	0	0,0%	7	0	0	0,7%	0,0%	0,0%
Straight ahead	120	27,0%	2	25,0%	7	70,0%	173	27,9%	7	33,3%	29	24,2%	293	9	36	27,5%	31,0%	27,7%
Turning left	8	1,8%	0	0,0%	0	0,0%	13	2,1%	2	9,5%	5	4,2%	21	2	5	2,0%	6,9%	3,8%
Turning right	6	1,3%	0	0,0%	0	0,0%	10	1,6%	0	0,0%	2	1,7%	16	0	2	1,5%	0,0%	1,5%
U turn	1	0,2%	0	0,0%	0	0,0%	4	0,6%	0	0,0%	0	0,0%	5	0	0	0,5%	0,0%	0,0%
Unknown	169	38,0%	3	37,5%	0	0,0%	110	17,7%	4	19,0%	14	11,7%	279	7	14	26,2%	24,1%	10,8%
Total	**445**		**8**		**10**		**620**		**21**		**120**		**1065**	**29**	**130**	**100,0%**	**100,0%**	**100,0%**
	96%		2%		2%		81%		3%		16%		87%	2%	11%			

12.2.13. Comparing car and PTW crashes by weather and traffic control

Finally, passenger cars fatalities follow the same pattern with PTW fatalities concerning the interactions of weather and roadway traffic control (Table 46).

Table 46: Comparison between PTW and passenger car fatalities with respect to traffic control and weather, Greece 2007

Traffic control	PTW						PC						Total absolute			Total relative		
	Dry		Other		Rain		Dry		Other		Rain		Dry	Other	Rain	Dry	Other	Rain
Authorised person	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0,0%	0	0	0	0,0%	0,0%	0,0%
Automatic traffic signal	25	5,6%	0	0,0%	0	0,0%	26	4,2%	0	0,0%	3	2,5%	51	0	3	4,8%	0,0%	2,4%
Give way sign or markings	36	8,1%	0	0,0%	2	33,3%	24	3,9%	0	0,0%	4	3,3%	60	0	6	5,6%	0,0%	4,8%
Uncontrolled	346	77,8%	11	91,7%	3	50,0%	474	76,5%	20	95,2%	77	64,2%	820	31	80	77,0%	93,9%	63,5%
Unknown	38	8,5%	1	8,3%	1	16,7%	96	15,5%	1	4,8%	36	30,0%	134	2	37	12,6%	6,1%	29,4%
Total	**445**		**12**		**6**		**620**		**21**		**120**		**1065**	**33**	**126**	**100,0%**	**100,0%**	**100,0%**

12.3. Italy

12.3.1. Motorcycle accidents by weather, age and sex

In the case of motorcycles and scooters (above 50 cc), 53% (626 cases) of the fatalities occur in urban areas, and the largest share is represented by fatalities with clear weather and dry road condition (49% - 576). Inside urban areas, 3% (19 cases) of the fatalities occurred in rainy weather, and those with other weather conditions (clear / other) and not dry road are 2% (14 cases). Outside urban areas (47% - 556 cases) the fatalities occurred with rainy weather are 2% (13 cases) and those with other weather conditions (clear / other) and wet road are 2% (9 cases). The total share of fatalities with road conditions, where the road was not dry, independently of the area and weather condition, is 5% (58 cases). Thus rainy weather has the same relevance of wet road with other weather conditions. However motorcycles and large scooters demonstrate a lower proportion of fatalities in wet road conditions compared to mopeds.

In 87% (1032) of the fatally injured motorcyclists, the rider is less than 50 years old and within this subset, male riders represent 95%. These general trends can be observed for all areas, weather conditions and road conditions (Table 47). It is worth to notice that in case of fatalities occurred with motorcycles and scooters 67% (787) of the people were between 25 and 49 years old.

Table 47: Motorcycle fatalities with respect to weather conditions and age/sex, Italy 2007

Age	Sex	Inside urban area						Outside urban area						Total absolute						Total relative		
		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
		Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
00-14	Male	1	0	1	0	0	0	3	0	0	0	0	0	4	0	1	0	0	0	0,4%	1,5%	0,0%
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
15-17	Male	23	0	2	1	0	1	10	0	0	0	0	1	33	0	2	1	0	2	3,1%	4,5%	6,3%
	Female	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0			
18-24	Male	108	1	1	2	0	4	60	0	5	1	0	1	168	1	6	3	0	5	16,8%	19,4%	18,8%
	Female	9	0	1	1	0	0	4	0	2	0	0	1	13	0	3	1	0	1			
25-49	Male	346	4	9	5	0	11	341	3	21	2	0	8	687	7	30	7	0	19	67,1%	59,7%	62,5%
	Female	17	0	0	0	0	1	16	0	2	1	0	0	33	0	2	1	0	1			
50-64	Male	51	0	3	0	0	2	40	2	4	0	0	1	91	2	7	0	0	3	8,9%	10,4%	12,5%
	Female	1	0	0	0	0	0	2	0	0	0	0	1	3	0	0	0	0	1			
65+	Male	9	0	0	0	0	0	16	0	1	0	0	0	25	0	1	0	0	0	2,5%	3,0%	0,0%
	Female	1	0	0	0	0	0	1	0	1	0	0	0	2	0	1	0	0	0			
Unknown	Male	3	0	0	0	0	0	3	0	1	0	0	0	6	0	1	0	0	0	1,2%	1,5%	0,0%
	Female	6	0	0	0	0	0	1	0	0	0	0	0	7	0	0	0	0	0			
Total		576	5	17	9	0	19	497	5	37	4	0	13	1073	10	54	13	0	32	100,0%	100,0%	100,0%
		92%	1%	3%	1%	0%	3%	89%	1%	7%	1%	0%	2%	91%	1%	4%	1%	0%	3%			

12.3.2. Motorcycle accidents by weather and occupant category

The majority of fatalities with motorcycles and scooters (91% - 1073) occur under dry weather conditions (Table 48). In terms of occupant category, 92% (1088) of the fatalities involve the rider, while only 8% involve the pillion rider (equally partitioned between accidents inside and outside urban areas).

Table 48: Motorcycle fatalities with respect to weather conditions and occupant category, Italy 2007

Class	Inside urban area						Outside urban area						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Rider	532	5	15	8	0	19	458	5	32	4	0	10	990	10	47	12	0	29	92,3%	88,1%	90,6%
Passenger	44	0	2	1	0	0	39	0	5	0	0	3	83	0	7	1	0	3	7,7%	11,9%	9,4%
Total	576	5	17	9	0	19	497	5	37	4	0	13	1073	10	54	13	0	32	100,0%	100,0%	100,0%
	92%	1%	3%	1%	0%	3%	89%	1%	7%	1%	0%	2%	91%	1%	4%	1%	0%	3%			

12.3.3. Motorcycle accidents by weather and traffic control

Most of fatalities with motorcycles happen in situations where both the vertical and horizontal traffic signals are present (62% - 737; Table 49). Out of these, 704 fatalities occurred under dry road conditions. The proportion among urban and extra urban areas is analogous to that observed previously (49.4% inside; 50.6% outside).

The type of traffic control has no influence on the fatalities with wet road conditions (Table 49), since they represent between 2.2% and 4.8% of the total fatalities reported for each type of traffic control. The same result is obtained with an analysis restricted to wet roads and rainy weather: fatalities are in the range 1.5% and 2.2% of the total fatalities reported for each type of traffic control.

Table 49: Motorcycle fatalities with respect to weather conditions and traffic control, Italy 2007

Traffic control	Inside urban area						Outside urban area						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Authorized person/ Automatic traffic signal	34	0	0	0	0	1	10	0	1	0	0	0	44	0	1	0	0	1	4,1%	1,5%	3,1%
Vertical signals	65	1	1	2	0	0	60	0	4	1	0	2	125	1	5	3	0	2	11,6%	11,9%	6,3%
Horizontal signals	69	0	0	0	0	4	48	0	1	2	0	0	117	0	1	2	0	4	10,8%	4,5%	12,5%
Vertical and horizontal signals	335	3	13	5	0	11	326	2	30	1	0	11	661	5	43	6	0	22	61,5%	73,1%	68,8%
Absent signals	73	1	3	2	0	3	53	3	1	0	0	0	126	4	4	2	0	3	12,0%	9,0%	9,4%
Total	**576**	**5**	**17**	**9**	**0**	**19**	**497**	**5**	**37**	**4**	**0**	**13**	**1073**	**10**	**54**	**13**	**0**	**32**	**100,0%**	**100,0%**	**100,0%**
	92%	1%	3%	1%	0%	3%	89%	1%	7%	1%	0%	2%	91%	1%	4%	1%	0%	3%			

12.3.4. Moped accidents by weather, age and sex

64% (214) of fatalities, were a moped rider was involved, were reported inside urban areas and within that the largest share is represented by fatalities with clear weather and dry road condition (81% - 173). Inside urban areas, 4% (9) of the fatalities occurred with rainy weather, and those with other weather conditions (clear / other) and wet road are 6% (12). Outside urban areas (35% - 117), the fatalities occurred with rainy weather are 6% (7) and those with other weather conditions (clear / other) and a road, which was not dry, are 6% (7), too. The total share of fatalities with wet road conditions, independently of the area and the weather condition, is 10% (35).

In 69% (229) of the cases, the rider is less than 50 years old and, within this subset, male riders represent 89% of the fatal casualties. In the dataset used for the analysis, no female riders more than 64 years old were reported as dead. These general trends can be observed for all areas, weather conditions and road conditions (Table 50).

Table 50: Moped fatalities with respect to weather conditions and age/sex, Italy 2007

Age	Sex	Inside urban area						Outside urban area						Total absolute						Total relative		
		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
		Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
00-14	Male	9	0	0	1	0	0	4	0	1	0	0	0	13	0	1	1	0	0	5,5%	7,0%	0,0%
	Female	1	0	1	0	0	0	1	0	0	0	0	0	2	0	1	0	0	0			
15-17	Male	33	0	2	1	0	2	22	1	0	1	0	1	55	1	2	2	0	3	23,2%	9,3%	18,8%
	Female	3	0	0	0	0	0	4	0	0	0	0	0	7	0	0	0	0	0			
18-24	Male	24	0	4	2	0	1	7	0	1	0	0	1	31	0	5	2	0	2	12,5%	18,6%	12,5%
	Female	1	0	0	0	0	0	2	0	1	0	0	0	3	0	1	0	0	0			
25-49	Male	41	2	7	5	0	3	21	1	3	1	0	2	62	3	10	6	0	5	26,8%	41,9%	37,5%
	Female	5	0	0	1	0	1	3	0	1	0	0	0	8	0	1	1	0	1			
50-64	Male	17	0	2	0	0	1	6	0	0	0	0	2	23	0	2	0	0	3	10,3%	4,7%	18,8%
	Female	4	0	0	0	0	0	1	0	0	0	0	0	5	0	0	0	0	0			
65+	Male	34	0	3	0	0	1	21	1	2	2	0	1	55	1	5	2	0	2	20,6%	16,3%	12,5%
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Unknown	Male	1	0	1	0	0	0	2	0	0	0	0	0	3	0	1	0	0	0	1,1%	2,3%	0,0%
	Female	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Total		**173**	**2**	**20**	**10**	**0**	**9**	**94**	**3**	**9**	**4**	**0**	**7**	**267**	**5**	**29**	**14**	**0**	**16**	**100,0%**	**100,0%**	**100,0%**
		81%	1%	9%	5%	0%	4%	80%	3%	8%	3%	0%	6%	81%	2%	9%	4%	0%	4%			

12.3.5. Moped accidents by weather and occupant category

All the fatalities reported for mopeds are referred to riders. In fact, under the Italian legislation it is not allowed to have a pillion rider on mopeds and thus the exposure of (illegal) pillion riders is extremely low, whereas none of them was killed in 2007 (Table 51).

Table 51: Moped fatalities with respect to weather conditions and occupant category, Italy 2007

Class	Inside urban area						Outside urban area						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Rider	173	2	20	10	0	9	94	3	9	4	0	7	267	5	29	14	0	16	100,0%	100,0%	100,0%
Passenger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0%	0,0%	0,0%
Total	173	2	20	10	0	9	94	3	9	4	0	7	267	5	29	14	0	16	100,0%	100,0%	100,0%
	81%	1%	9%	5%	0%	4%	80%	3%	8%	3%	0%	6%	81%	2%	9%	4%	0%	4%			

12.3.6. Moped accidents by weather and traffic control

Most of fatalities with mopeds happened in situations where both the vertical and horizontal traffic signals are present (53% - 174; Table 52). Out of these, 153 fatalities occurred under dry road conditions. The proportion among urban and extra urban areas is analogous to that observed previously (64% inside; 36% outside).

The type of traffic control has the following influence on the fatalities with wet road conditions (Table 52):

- Controls which include horizontal signals, vertical and horizontal signals, and automatic traffic signal or authorized person are linked to a slightly higher fatality rate on a road, which is not dry (between 10% and 15% of the total fatalities reported for each type of traffic control);
- With vertical signals, only 7% of the total fatalities occur with wet roads;
- Without having any signals, only 4.9% of the total fatalities occur with wet roads.

The same analysis, restricted to wet roads and rainy weather, shows that the type of traffic signals has no influence since the share is always in the range from 4% to 6%. However, when no signals were installed, no fatality was reported under wet roads and rainy weather. Although the numbers are limited, it seems that under the latter conditions the traffic signals have a negative effect on rider safety.

Table 52: Moped fatalities with respect to weather conditions and traffic control, Italy 2007

Traffic control	Inside urban area						Outside urban area						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Authorized person / Automatic traffic signal	13	0	3	1	0	0	3	0	0	0	0	1	16	0	3	1	0	1	5,9%	9,3%	6,3%
Vertical signals	30	0	3	1	0	1	11	0	1	0	0	1	41	0	4	1	0	2	15,1%	11,6%	12,5%
Horizontal signals	18	0	5	2	0	1	17	2	1	0	0	1	35	2	6	2	0	2	13,6%	18,6%	12,5%
Vertical and horizontal signals	93	2	5	6	0	7	49	1	5	2	0	4	142	3	10	8	0	11	53,3%	41,9%	68,8%
Absent signals	19	0	4	0	0	0	14	0	2	2	0	0	33	0	6	2	0	0	12,1%	18,6%	0,0%
Total	173	2	20	10	0	9	94	3	9	4	0	7	267	5	29	14	0	16	100,0%	100,0%	100,0%
	81%	1%	9%	5%	0%	4%	80%	3%	8%	3%	0%	6%	81%	2%	9%	4%	0%	4%			

12.3.7. Comparative study of PTW and passenger car fatalities

As already done for the Austrian and Greek data, this section is dedicated to a comparative study of PTW and passenger car fatalities in Italy in 2007.

12.3.8. Comparing car and PTW crashes by weather, age and sex

The magnitude of fatalities observed in passenger cars is greater than the number of fatalities occurred with PTWs in Italy in 2007 (2305 with passenger cars; 1513 with PTWs; Table 53). Interestingly, when driving on a road, which was not dry, more passenger car fatalities are observed (25% - 567) compared to PTWs (6% - 90).

With reference to sex, the majority of fatalities are male rider/drivers. The percentage of female fatalities in passenger cars is larger than in PTWs (24% to 7%, Table 54). Regarding the age and weather interactions, PTW fatalities are mostly concentrated in the range from 18 to 49 years (75%), while for passenger cars, there are only 59% of the fatalities in this range. With regard to passenger car fatalities, the contribution of older drivers (above 50 years old) is more relevant, while for PTWs, the category from 15 to 17 years is more relevant (Table 53).

Table 53: Comparison between PTW and passenger car fatalities with respect to sex and weather, Italy 2007

Sex	PTW						PC						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Male	1256	15	74	24	0	44	1188	64	137	156	0	207	2444	79	211	180	0	251	84,2%	79,0%	76,5%
Female	84	0	9	3	0	4	368	20	45	47	0	73	452	20	54	50	0	77	15,8%	21,0%	23,5%
Total	1340	15	83	27	0	48	1556	84	182	203	0	280	2896	99	265	230	0	328	100%	100%	100%
	89%	1%	5%	2%	0%	3%	68%	4%	7%	9%	0%	12%	75%	3%	7%	6%	0%	9%			

Table 54: Comparison between PTW and passenger car fatalities with respect to age and weather, Italy 2007

Age	PTW						PC						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
00-14	19	0	3	1	0	0	68	2	5	5	0	5	87	2	8	6	0	5	3,0%	2,8%	1,5%
15-17	96	1	4	3	0	5	35	0	2	8	0	3	131	1	6	11	0	8	4,4%	3,4%	2,4%
18-24	215	1	15	6	0	8	300	15	34	48	0	40	515	16	49	54	0	48	17,7%	20,8%	14,6%
25-49	790	10	43	15	0	26	592	44	71	87	0	133	1382	54	114	102	0	159	47,9%	43,6%	48,5%
50-64	122	2	9	0	0	7	219	12	34	28	0	38	341	14	43	28	0	45	11,9%	14,3%	13,7%
65+	82	1	7	2	0	2	315	11	35	27	0	60	397	12	42	29	0	62	13,7%	14,3%	18,9%
Unknown	16	0	2	0	0	0	27	0	1	0	0	1	43	0	3	0	0	1	1,4%	0,6%	0,3%
Total	1340	15	83	27	0	48	1556	84	182	203	0	280	2896	99	265	230	0	328	100%	100%	100%
	89%	1%	5%	2%	0%	3%	68%	4%	7%	9%	0%	12%	75%	3%	7%	6%	0%	9%			

12.3.9. Comparing car and PTW crashes by weather and occupant category

Regarding the occupant category, fatalities involve mainly drivers/riders. However, in PTW accidents, rider fatalities are higher than the respective figures for fatal passenger car crashes (94% for PTWs to 71% for passenger cars; Table 55).

Table 55: Comparison between PTW and passenger car fatalities with respect to occupant category and weather, Italy 2007

Class	PTW						PC						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Driver	1257	15	76	26	0	45	1080	67	131	146	0	212	**2337**	**82**	**207**	**172**	**0**	**257**	**80,8%**	**76,6%**	**78,4%**
Passenger	83	0	7	1	0	3	476	17	51	57	0	68	**559**	**17**	**58**	**58**	**0**	**71**	**19,2%**	**23,4%**	**21,6%**
Total	**1340**	**15**	**83**	**27**	**0**	**48**	**1556**	**84**	**182**	**203**	**0**	**280**	**2896**	**99**	**265**	**230**	**0**	**328**	**100%**	**100%**	**100%**
	89%	1%	5%	2%	0%	3%	68%	4%	7%	9%	0%	12%	75%	3%	7%	6%	0%	9%			

12.3.10. Comparing car and PTW crashes by weather and traffic control

The aggregate evaluation of all PTW data shows no influence on fatalities due to any kind of interaction with weather and traffic signals, since the higher numbers of fatalities with motorcycles and scooters are in line with the global trend. This is confirmed by the data in Table 56: Distributions of accidents under diverse signing conditions hardly differ between dry, rainy and other conditions.

The same analysis performed for passenger cars shows that the type 'Authorized person/automatic traffic signal' has a higher share of fatalities with wet road (36% to 22%). To the contrary, at horizontal signals as well as at absent signals, less fatal accidents occurred compared to the average (16% and 17% to 22%). A similar trend is observed for fatalities with road, which was not dry, and rainy weather:

- Higher share of fatalities (26% instead of 12%) anent the type 'Authorized person/automatic traffic signal';
- Slightly lower share of fatalities (9% instead of 12%) anent the type 'Horizontal signals'.

Table 56: Comparison between PTW and passenger car fatalities with respect to traffic control and weather, Italy 2007

Traffic control	PTW						PC						Total absolute						Total relative		
	Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear		Other		Rain/Hail		Clear	Other	Rain/Hail
	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other	Dry	Other			
Authorized person / Automatic traffic signal	60	0	4	1	0	2	47	3	3	6	0	22	**107**	**3**	**7**	**7**	**0**	**24**	**3,7%**	**2,8%**	**7,3%**
Vertical signals	166	1	9	4	0	4	174	9	25	22	0	33	**340**	**10**	**34**	**26**	**0**	**37**	**11,7%**	**12,1%**	**11,3%**
Horizontal signals	152	2	7	4	0	6	220	11	26	19	0	26	**372**	**13**	**33**	**23**	**0**	**32**	**12,9%**	**11,3%**	**9,8%**
Vertical and horizontal signals	803	8	53	14	0	33	989	56	113	145	0	177	**1792**	**64**	**166**	**159**	**0**	**210**	**62,0%**	**65,7%**	**64,0%**
Absent signals	159	4	10	4	0	3	126	5	15	11	0	22	**285**	**9**	**25**	**15**	**0**	**25**	**9,8%**	**8,1%**	**7,6%**
Total	**1340**	**15**	**83**	**27**	**0**	**48**	**1556**	**84**	**182**	**203**	**0**	**280**	**2896**	**99**	**265**	**230**	**0**	**328**	**100,0%**	**100,0%**	**100,0%**
	89%	1%	5%	2%	0%	3%	68%	4%	7%	9%	0%	12%	75%	3%	7%	6%	0%	9%			

13. Annex VI: Validation extended to 2004

While the report was being revised due to several reviews, another dataset was provided by UNIVIE. This most recent one contained the rain information of the year 2004. Thus, another analysis was carried out to prove the results of chapter 5.10. With respect to the findings of this chapter, the same analytical method was conducted once again. But this time, the accidents of 2004 were estimated on the basis of so-called "historical data", which was made up as a mean of the values of 2002 and 2003.

Table 57: Statistical basis concerning daily motorcycle accidents per precipitation category

Precipitation	Accidents			
	2002	2003	mean 2002 & 2003	2004
0%-15%	2610	3179	2895	2548
15%-30%	265	321	293	383
30%-45%	192	77	135	244
45%-60%	128	32	80	94
60%-75%	35	7	21	33
75%-100%	9	1	5	16
Total	**3239**	**3617**	**3428**	**3318**

To get these statistical values, the daily accidents per precipitation category were calculated for each year. Then, the average daily accidents per category of rain as well as the corresponding variance were evaluated (Table 58).

Table 58: Statistical basis concerning daily motorcycle accidents per precipitation category

Precipitation	Accidents/Day			
	2002	2003	Average	Variance
0%-15%	12,40	12,48	12,44	0,00
15%-30%	7,85	10,46	9,15	1,71
30%-45%	5,73	5,51	5,62	0,01
45%-60%	4,88	4,14	4,51	0,14
60%-75%	3,20	1,06	2,13	1,15
75%-100%	2,64	0,75	1,69	0,89
Total	**6,12**	**6**	**5,92**	**0,65**

With these given figures, the motorcycle accidents of 2004 could be estimated. But afore, based on UNIVIE's information about the daily rain measurements per federal state, the national rain likeability was calculated. As already mentioned before, this parameter represents the national precipitation average of all included weather stations over one day. Then, the motorcycle accident database of 2004 was adapted by adding the corresponding weather parameter to each accident. Afterwards, these extended motorcycle accident records were classified according to the six different categories of precipitation.

In chapter 5.10, it was assumed that the quantity of accidents per precipitation class would depend on the number of days per categories of precipitation. Thus, if the number of days per categories of precipitation changes, the corresponding accidents change proportionally. This means that the number of daily accidents per categories of precipitation is constant. On this theoretic basis, the motorcycle accidents, which happened in 2004, were estimated. The input parameters for the further calculations are shown in Table 58. These are the average number of daily accidents per precipitation category as well as the corresponding variance. Both parameters are made up of historical data, which is based on the extended motorcycle accident datasets of 2002 and 2003.

In Table 59, the outcome of the motorcycle analysis is shown. To get the lower limit of the number of motorcycle accidents in 2004, the standard deviation was subtracted from its corresponding average accidents per day. Then, this figure was multiplied with the corresponding amount of days per precipitation category. The same procedure was carried out to calculate the upper limit, but instead of subtracting the standard deviation from the average accidents per day, these two statistical values were added together.

Table 59: Estimated motorcycle accidents in 2004 on the basis of historical data

Precipitation	Days	Accidents/Day		Accidents		
	2004	Average (Historical Data)	Variance (Historical Data)	Estimated lower limit in 2004	Estimated upper limit in 2004	Recorded in 2004
0%-15%	157	12,44	0,00	1948	1959	1922
15%-30%	62	9,15	1,71	487	649	736
30%-45%	43	5,62	0,01	237	247	185
45%-60%	53	4,51	0,14	219	259	313
60%-75%	31	2,13	1,15	33	99	86
75%-100%	20	1,69	0,89	15	53	76
Total	**366**	**5,92**	**0,65**	**2939**	**3266**	**3318**

As can be seen in Table 59, the estimated quantity of motorcycle accidents is lower than the actually recorded one. All in all, there is a difference of 52 accidents (i.e. 1,6%) between the estimated upper limit and the recorded accidents. The number of motorcycle accidents is not significantly high; in fact, it is between the numbers of accident of 2002 and 2003. Nevertheless, there were more accidents recorded than expected, if the accident record is corrected for the impact of weather. Hence, either other impacting factors have changed the accident record or this difference is just a random variation.

In other words, only looking at the numbers, we would assume that collision counts increase from 2002 to 2003 and the decrease to 2004. But the truth is, that weather was different in these three years and, if corrected for the impact of weather the exact opposite was the case.