Saving Lives Assessing and Improving TEN–T Road Network Safety

Grant Agreement Number: **INEA/CEF/TRAN/M2018/179967**

Project acronym: **SLAIN**

**Project full title:**
**Saving Lives Assessing and Improving TEN-T Road Network Safety**

**Due delivery date: 30 December 2020**
**Actual delivery date: 15 December 2020**

Organisation name of lead participant for this deliverable:
EuroRAP

# D1.3 Risk Map Greece

Co-financed by the Connecting Europe
Facility of the European Union

## Document Control Sheet

| Version History | Input by Consortium partners |
|---|---|
| **V1.0** | D1.3 by RSI 'Panos Mylonas' |
| **V1.1** | Review by iRAP Technical Coordinator, Kate Fuller |
| **V1.2** | Review by EuroRAP Coordinator, Lina Konstantinopoulou |

## Legal Disclaimer



## Acknowledgement

The SLAIN beneficiaries are grateful to the many data providers in Greece who have provided data for these maps. The maps were assembled by team from Road Safety Institute Panos Mylonas (Greece). The report was coordinated and prepared by iRAP, with final editing and liaison with INEA by the project coordinator EuroRAP.

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## Abbreviations and Acronyms

| Acronym | Abreviation |
|---|---|
| Anas | Azienda Nazionale Autonoma delle Strade |
| RACC | Real Automóvil Club de Cataluna |
| SLAIN | Saving Lives Assessing and Improving Network Safety |
| TEN-T | Trans-European Transport Network |
| | |

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## Executive Summary


Crash Risk Maps have been produced for Greece, for the Core TEN-T.

The maps presented show both individual and collective risk measured in terms of crashes per billion vehicle kilometre and crashes per kilometre respectively. Limitations in the availability and reliability of the data in Greece due to under-reporting mean that in Greece only fatal crashes have been mapped. Results are being launched or released on websites, subject to local consultation and discussion, as appropriate.

Differences in the nature and distribution of these crashes have been analysed and differences in the ratios of fatal to other severities of crash noted on different road types. Such differences have implications for the presentation of Crash Risk Maps and there is discussion of steps to be taken if a map for one country is to be presented alongside others for comparison.

Comment is made on the use of maps for the assessment of risk by road-users and by road operators and the application of such maps in the Road Infrastructure Safety Management Directive 2019/1936/EC.

Recommendations have been made for updating the EuroRAP guidelines on crash rate risk mapping.

# 1 Objectives

## 1.1 SLAIN Project Objectives

The project's Action fits in the EC's 2010 Communication 'Towards a European Road Safety Area' and aims to contribute to the long-term goal for zero road deaths in 2050. With partners in the different countries, Project SLAIN is a transnational project aiming to extend the skills and knowledge base of partners in performing network-wide road assessment.

The main areas to be covered within the SLAIN project are

- Demonstration of a methodology of network-wide assessment
- Assessment of the Safety Performance Management of the TEN-T core road network and, if possible beyond, in 4 European countries: Croatia, Italy, Greece and Spain where road surveys will be performed (10,000 km of mapping)
- Proposals of section-specific, economically-viable crash countermeasures designed to raise infrastructure quality to achieve significant reductions in severe injuries and deaths
- Preparation of the readiness of Europe's physical infrastructure for automation

The SLAIN consortium consists of eight core partners, coming from six EU member states, namely Greece, Italy, Spain, Croatia, UK and Belgium. The list of partners are EuroRAP - Project Coordinator, Anas, FPZ, RSI Panos Mylonas, RACC-ACASA, DGT Spain, SCT Spain, TES Spain (Catalonia), iRAP.

## 1.2 SLAIN Activity 1

The objective of Activity 1 is to produce maps showing crash risk as an overall part of network-wide road assessment for Croatia, Greece, Italy, Spain (and Catalonia). The present deliverable concerns Greece only.

Subject to the availability of appropriate data, the objective of this task was to produce a Crash Risk Map of death and serious injury for each country illustrating both the individual risk and the collective risk for crashes for at least sections of the TEN-T Core Network in each of the four countries. This provides a preliminary and immediate basis for comparison of the safety of the networks being examined and is often used as the basis for further analysis. Such maps can be used to compare current performance and also track that over time. The relevant beneficiaries in each territory have been responsible for producing the map in that territory and for collecting the data from which they are formed.

Crash Risk Maps are a convenient and relatively inexpensive means of portraying risk across a network and how that changes as one travels from one road section to the next. They relate the number of severe crashes to the amount of vehicle travel on each section (crashes per billion vehicle kilometre) or to the length of the section (crashes per kilometre) for given time periods. Mapped over time, the crash rates of individual road sections can track the performance of the road.

The report on this Deliverable (D1.3) is written both from the perspective of an analysis of the maps and data and from the perspective of assessing how useful such information is as a tool in network-wide road safety assessment. This Report is written with refinement of the techniques and analysis being provided in a second round of mapping that was originally performed one year ago (with data for the period 2014-2017). This Report includes assessment of changes over time.

# 2 Methodology

## 2.1 Task 1.1: Define the Core TEN-T network to be mapped and resources

The network for the Core TEN-T in Greece has been identified and mapped. The methodology used is described in the RAP-RM-2-1 Risk Mapping Technical Specification in the methodology section of the iRAP website:

http://resources.irap.org/Specifications/RAP-RM-2-1_Risk_Mapping_technical_specification.pdf.

RAP-RM-2-1 sets out the technical specification for the production of RAP Risk Mapping to a standardised format. It details how networks are constructed and the rationale for the selection of road sections and their related parameters in building a data set. RAP-RM-3-1 sets out the design and cartographic specification for the production of RAP Risk Mapping to a standardised format and will be considered for use in future productions of these maps. It too is stored on the iRAP website: http://resources.irap.org/Specifications/RAP-RM-3-1_Risk_Mapping_design_specification.pdf.

The mapping in the Grant Agreement is limited to the relevant Core TEN-T network (see Figure 1) although.


**Figure 1: Core TEN-T in the SLAIN Grant Proposal and Agreement**

## 2.2 Task 1.2: Allocate traffic data

This task involves collecting Annual Average Daily Traffic (AADT) volumes for each section from counts provided by the relevant road authorities in Greece.

In Greece, for those Core TEN-T roads operated by concessionaires, data were collected by the relevant department of the Ministry of Transport and Infrastructure. Traffic flows were assigned according to the collected data. The data were the latest currently available (i.e. for the most recent time periods, including years 2014-2019).

## 2.3 Task 1.3: Disaggregate crashes and allocate to network for each section by type and severity

The beneficiaries in Greece have assembled an Excel spreadsheet, with the number of fatal and serious crashes for each road section disaggregated by the principal road user groups and the total.

In Greece, all relevant data on road crashes within the Core TEN-T were collected from the Hellenic Statistical Authority. The data were the latest currently available (i.e. for the most recent time periods, including years 2015-2018). The collected data on road crashes were disaggregated by severity and then assigned to the corresponding road network sections.

The iRAP/EuroRAP methodology sets an aspirational target of 20 fatal and serious crashes per network section but it has been noted in practice that in many circumstances this is impossible to achieve without extending the length of the network to a length that diminishes the ability to differentiate risk (and in particular to identify higher risk road lengths) or means that it is necessary to use data from much longer time periods.

In Greece, but also in the other countries, it is noticeable that there is substantial under-reporting of crashes. In Greece, the number of reported serious crashes was actually lower than the number of fatal crashes whereas one would typically expect the ratio of fatal: serious to be in the region of 1:10. A summary of the potential extent of under-reporting is provided in Appendix 1.

Due to the significant under-reporting of crashes in Greece, only fatal crashes were taken into consideration, in order to compute and assess crash risk per kilometre travelled and density of crashes per kilometre. In addition, the assessment period was extended to 4 years, instead of the standard 3-year period, as the minimum target of 20 fatal and serious crashes per network section could not be achieved. The relevant assessment period considers years 2015 to 2018.

## 2.4 Task 1.4: Review

Data were reviewed for accuracy of allocation and for underreporting. It is well-known for example that some crash types are under-reported, notably low severity and pedestrian crashes. Comment has been passed on the relevant observations in the reporting of results.

## 2.5 Task 1.5: Compute and assess crash risk per kilometre travelled and density of crashes per kilometre

Calculations were based upon crashes divided by the amount of traffic using the road or by the number of crashes per kilometre and ranked using an excel file.

The task computed the crash risks according to the standard procedures for RAP Risk Mapping Type I: Individual crash risk per vehicle km travelled and RAP Risk Mapping Type II: Crash density (Collective or Community risk). Crash risk per kilometre travelled (Type I Crash risk) is expressed as the number of fatal and serious crashes per billion vehicle kilometres travelled. This is the risk for individual road users of being involved in fatal or serious crash whilst using a specific road length. The determined crash risk rates were then allocated into five RAP risk bandings (low, low-medium, medium, medium-high and high risk categories) and the standard Type I and Type II Risk Maps were produced.

## 2.6 Task 1.6: Assemble required data and produce high-quality risk maps

This task was done using mapping shapefiles. In order to produce the EuroRAP Risk Maps, the data on road network geometry, road traffic crashes and road traffic volume data, extracted from the relevant databases were recorded in shapefile (.shp) format, compatible with the webGIS systems which was used for further data processing and calculation of crash risk and crash density rates. The resulting Crash Risk Maps were also stored in shapefile format in order to enable the fast and easy data transfer between stakeholders.

*Unless otherwise stated, the maps presented are normalised for comparison between countries using "Risk Bands 2020". The rationale and methodology adopted is explained at section 8.2.1, from page 35 at:*

*http://resources.irap.org/Specifications/RAP-RM-2-1_Risk_Mapping_technical_specification.pdf*

# 3 Results

One set of results is provided for each Greece with maps of both individual and collective risk and accompanying description of each.  Results are being launched or released on websites, subject to local consultation and discussion, as appropriate.

Maps are presented in the style and design of the beneficiaries' own organisation and in manner familiar to national stakeholders.

## 3.1 Maps of individual and collective risk

### 3.1.1 Greece Core TEN-T – individual risk (fatal crashes per billion vehicle kilometre) *with* normalisation to Risk Bands 2020

### 3.1.2 Greece Core TEN-T – collective risk (fatal crashes per kilometre) *with* normalisation to Risk Bands 2020

# 4 Data and analysis

The following tables show histograms for the frequency distributions of low-high risk for individual and collective risk.

In Greece, the Core TEN-T network is approximately 1,700km long and is mostly operated by concessionaires. The major part of the Greek Core TEN-T network is currently comprised of motorways (about 95%), while the remaining part (about 5%) consists of single carriageways.

The examined network was divided into 39 individual road sections, in order to meet all the required conditions and regulations (i.e. uniform traffic flow values, geometrical and functional characteristics) for the purpose of producing the maps for both individual and collective risk.

During the assessment process, data such as number and length of road segments, number of fatal crashes and AADT was used. In addition, 2020 risk bands were used, which were adjusted with a scaling factor calculated specifically for the Core TEN-T network of Greece.

Figures below show a frequency distribution of road sections of Greece by risk band (regarding both individual and collective risk, respectively).

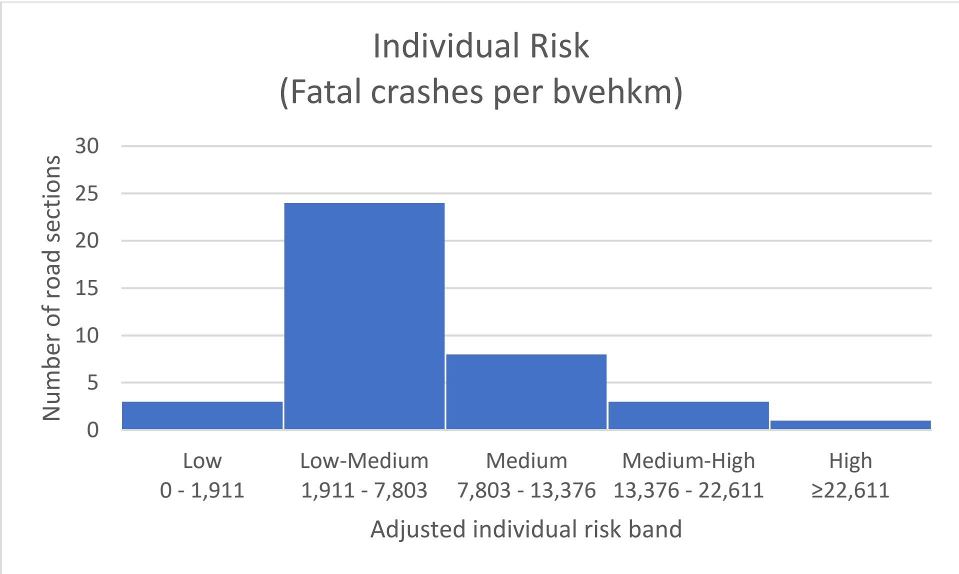



**Figure 2: Frequency of road sections by risk band (individual risk)**

In terms of individual risk (Figure 2), it can be noted that approximately 70% of the road sections fall into the low or low-medium risk rate, while only one segment is characterized by high risk.

The relevant data from which Figure 2 was produced is shown in the next Table.

**Table 1: Frequency of road sections by risk band (individual risk)**

| Risk category | Individual risk (road sections) | Individual risk (road sections) [%] |
|---|---|---|
| Low | 3 | 8% |
| Low-Medium | 24 | 61% |
| Medium | 8 | 20% |
| Medium-High | 3 | 8% |
| High | 1 | 3% |

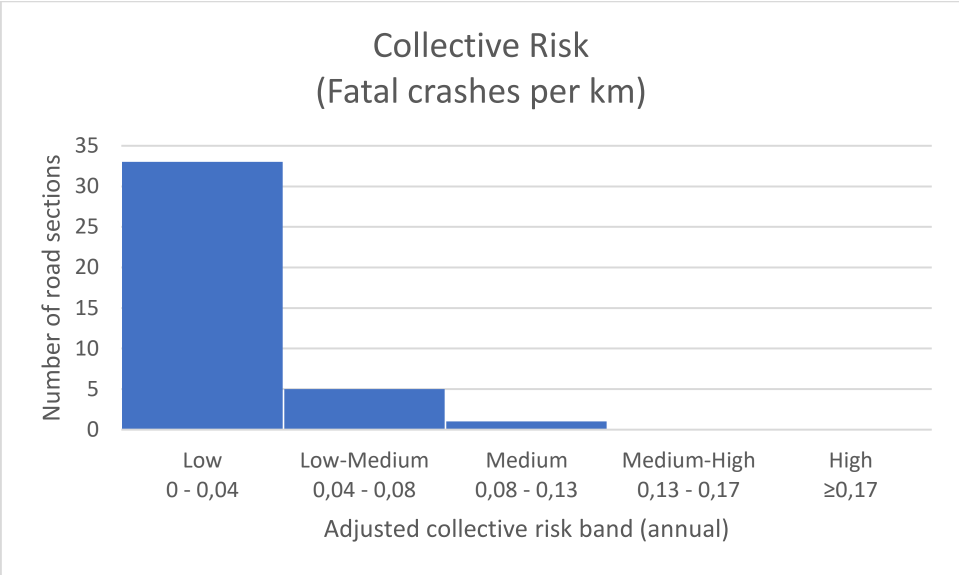



**Figure 3: Frequency of road sections by risk band (collective risk)**

With regard to collective risk, it is observed that almost 85% of the Core TEN-T road sections fall into the low risk rate, while 97% of the total network belongs either to the low or low-medium risk rate. It is also remarkable that no road segment is characterized by medium-high or high risk.

In addition, Table 2 below displays the data used for the production of Figure 3.

**Table 2: Frequency of road sections by risk band (collective risk)**

| Risk category | Collective risk (road sections) | Collective risk (road sections) [%] |
|---|---|---|
| Low | 33 | 85% |
| Low-Medium | 5 | 12% |
| Medium | 1 | 3% |
| Medium-High | 0 | 0% |
| High | 0 | 0% |

Typically, such crash rate distributions show a skewed distribution with many more road sections in the low end of the scale and relatively few at the top end. Those at the top end are likely to be those that attract priority attention for countermeasures.

Particularly in Greece, from Figures 2 & 3, it is fully comprehensible that the majority of the road sections belong to the low or low-medium risk rate, while only a single segment is characterized as high risk. This kind of distribution is easily explained due to the fact that the majority of low or low-medium road segments belong to the motorway network of the country, indicating the crucial efforts that have been made towards road safety improvement during the latest years, with the completion of significant motorway axes. After all, motorways provide the highest standards of road safety to road-users.

Finally, Table 3 displays the distribution of the network length by risk band, for both individual and collective risk.

**Table 3: Distribution of network length by risk band (individual and collective risk)**

| Risk category | Individual risk (length) [km] | Individual risk (length) [%] | Collective Risk (length) [km] | Collective Risk (length) [%] |
|---|---|---|---|---|
| Low | 124,00 | 7% | 1506,50 | 87% |
| Low-Medium | 1115,00 | 65% | 173,00 | 10% |
| Medium | 329,5 | 19% | 44,00 | 3% |
| Medium-High | 95,00 | 6% | 0 | 0% |
| High | 60,00 | 3% | 0 | 0% |

In order to further comprehend the significant contribution of the completed Greek motorway network to the improvement of the road safety level across the country, the "Performance Tracking" of Risk Maps 2014-2017 and 2015-2018 has been undertaken. The EuroRAP "Performance Tracking" protocol allows a comparison to be made between the risk mapping results of two consecutive four-year periods, whereas both the individual and collective risk are considered.

The following Figures depict the development of the relative frequency distribution of the Greek TEN-T network length by risk band, for the compared periods (2014-2017 and 2015-2018), regarding both individual and collective risk, respectively.

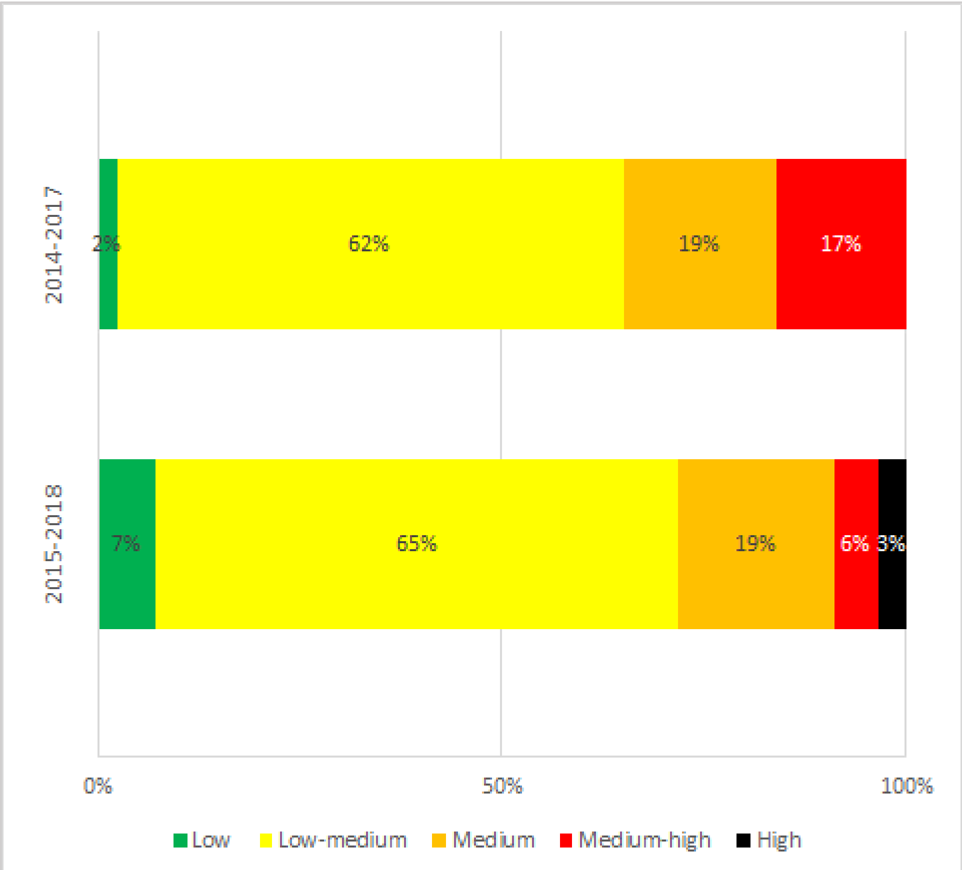



**Figure 4: Development of the relative frequency of the Greek Core TEN-T network length by risk band (individual risk)**

From Figure 4, comparing the data concerning the assessed time periods, it is observed that:

- The share of roads rated as high risk is increased from 0% to 3% of the total network length. This increase concerns only a specific road segment (Ioannina-Kakavia), which is not part of the Greek motorway network and, therefore, does not provide high standards of road safety to road users.
- The share of roads rated as medium-high is decreased by 11% to 6%.
- The share of roads rated as medium risk remains at a steady level (19%).
- The share of roads rated as low-medium is increased by 3% (from 62% to 65%).
- The share of roads rated as low risk is increased by 5% to 7%.

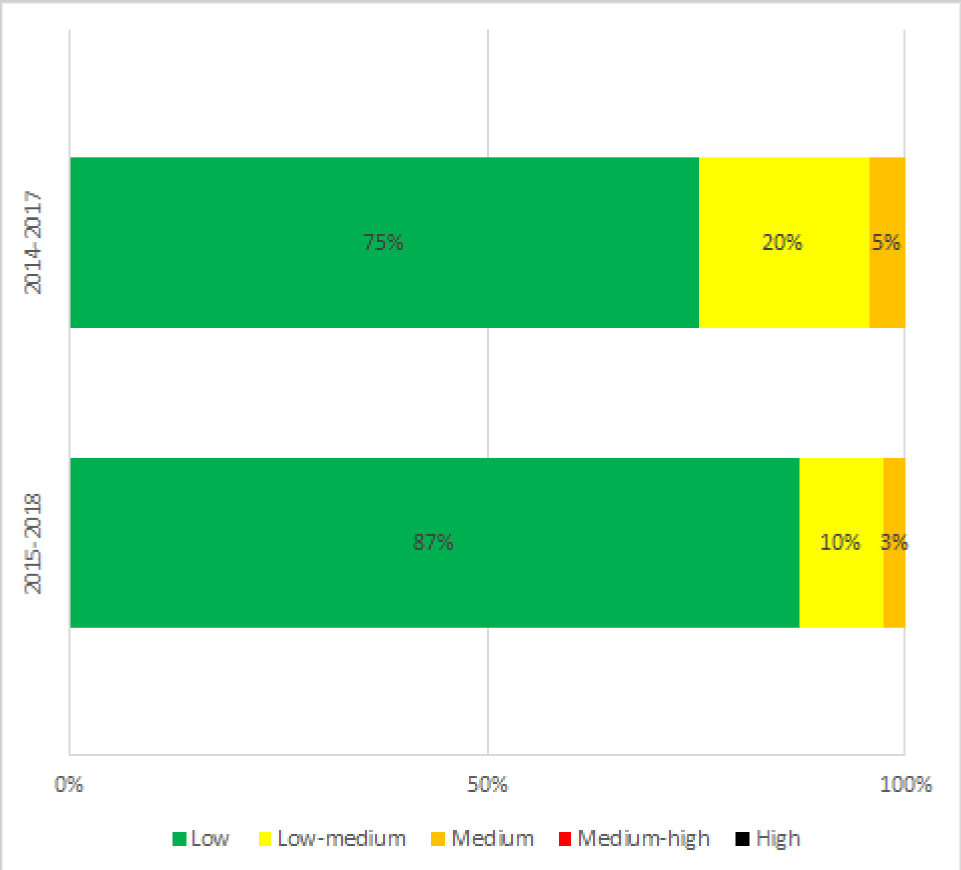



**Figure 5: Development of the relative frequency of the Greek Core TEN-T network length by risk band (collective risk)**

In terms of collective risk, the following conclusions are reached:

- The share of roads rated as high risk remains at a zero level for both of the examined periods.
- The share of roads rated as medium-high risk remains steady, equal to 0% for both of the assessed periods.
- The share of roads rated as medium risk is decreased from 5% to 3%.
- The share of roads rated as low-medium is decreased to half (10%).
- The share of roads rated as low risk is increased by 12% to 87%.

From the comparison of the crash data concerning the examined consecutive four-year periods, it is concluded that the final outcome, in terms of road safety improvement, is considered to be positive. Once more, the key role that the Greek motorway network has played in reducing the relative crash risk rates (individual and collective), during the recent years, emerges.

# 5 Discussion

## 5.1 Role and purpose

The Crash Risk Mapping technical specification gives a good description of the role and purpose of this tool:

- “Risk Maps are statistically designed to support national road safety strategies and add an extra layer of information alongside existing approaches. As such, RAP Risk Mapping typically covers roads outside of towns and cities, where deaths and serious injuries are concentrated. Using an international and common basis of measurement that can be used to assess priorities, Risk Mapping identifies the safest and most dangerous road sections within a region or country. Comparisons between countries enable benchmarking and progress to be tracked. Knowing where risk has been reduced and the measures that have worked are essential in building best practice and knowledge transfer.
- Although Risk Mapping shows that some sections carry higher risk than others, it does not necessarily mean that road authorities will and should regard these as the highest priority for improvement. Authorities rank roads for safety improvement, taking account of both the number of crashes likely to be saved through improvements and the cost of implementation. Discussion with authorities and police has shown that these bodies review high risk roads, comparing the output with road sections flagged by their own internal processes and in seeking to develop practical measures to reduce the risk to road users.
- While not all roads can be managed to the same risk level, emphasis should be on keeping risk within acceptable boundaries. The RAP route structure is based on simple rules aimed at keeping as coherent a design as possible within any road section, while at the same time extending the section length far enough to give sufficient crash numbers to minimise year-on-year variation. Crash and traffic flow data are assigned to each section, typically compiled into three year periods to give a robust estimate of risk. The assessment period can be extended where crash numbers are low.
- Risk Mapping, by its very nature, relies on the use of historic crash and traffic flow data. As such, when published, some routes may already have had road safety improvements. Others may be more difficult to change and on these roads it is particularly important for road users to be aware that they face higher risks than they might expect. Crash Risk Mapping should therefore be updated at regular intervals to ensure that they represent the most up-to-date picture.”

## 5.2 Project learning – considerations for the RISM directive

This application of the technique in Greece has identified several items of note that are relevant to the application of the technique as part of EC/2019/1936.

### 5.2.1 Messages for road-users and operators

Crash Risk Rate Maps showing individual risk are primarily useful for showing the risk to an individual road user of being involved in a fatal or serious crash as the road user moves from one section to the next. Often that risk may be to the vehicle occupant but, and notably when passing through urban areas, the risk may include colliding with, and causing injury to, pedestrians or cyclists. The involvement of these road users on the TEN-T will be the subject of further study.

The technical specification document captures this well:

“The public are often most interested in their risk on the road as individual users. The simplest way to represent this is in terms of crash risk in relation to exposure. Rates per vehicle kilometre travelled can show the likelihood of a particular type of road-user (e.g. car driver, motorcyclist, lorry driver, pedestrian or cyclist), on average, being involved in a road crash.

An essential focus of RAP is to improve recognition among road-users that they must share in the responsibility for a safe road system. In producing maps aimed at individual risk, it is therefore important to counter the common assumption that their purpose is to inform the road-user of how best to modify the route taken to minimise their likelihood of being involved in a crash. This is especially true where mapping covers only higher-tier road networks, since it is known that roads off the main road network typically have higher crash rates.

The main purpose of mapping individual risk is to:

- inform road-users of how and where their behaviour needs to be modified to minimise risk and, in doing so, to help them to understand the role of road infrastructure in determining the risks they face. It is hoped that, over time, this will aid clearer recognition of the influence of road design on risk and how it can vary on different types of road;
- illustrate more generally how high-level infrastructure variables, such as carriageway type and road standard, influence risk.”

A Crash Rate Risk map showing crash density is designed to be useful to the road operator, showing where road sections have a high number of crashes and therefore may be used to target remedial action. Again, the technical specification explains:

“Collective (or ‘community’) risk is used by road providers to reflect more broadly how the total risk to all road users is distributed across a network. This information is crucial in determining how to spend available budgets effectively.

At the simplest level collective Crash Risk Maps show the density, or total number, of crashes on a road over a given length. However, rates expressed in this way are largely influenced by the number of vehicles using a particular road section or link, given the positive correlation between fatal and serious crashes with traffic flow.

To assess how best to improve collective risk, it is important to understand not just the present level of risk, but also the extent to which a lower level can be achieved on a particular road at reasonable cost. By showing how much in total it is worth investing at one site compared with another, collective Crash Risk Maps enable the road provider to consider not just the safety quality of a network that should be planned for in the future, but also the level of funding required.

An alternative insight into safety performance is provided by crash rates related to road type averages. These demonstrate road sections with higher or lower risk after the expected variability between different road groups (i.e. motorways, dual carriageways, single carriageways, mixed carriageways) is taken into account. Benchmarking in this way involves highlighting roads that should be targeted, exploring why they fall short of the average safety standards for their road type, and assessing whether it is appropriate to apply countermeasures known to be effective on roads with similar design and usage characteristics.

Information provided in collective Crash Risk Maps can also be used as the basis for considering investment decisions, providing authorities and policy-makers with a valuable tool for estimating the total number of crashes that could potentially be avoided if safety on a road were improved. Used with cost information, this can indicate locations where the largest return on investment can be expected.”

### 5.2.2 Allocation of data, normalisation, ratios and thresholds

In Greece, where the mapping has been on the basis of fatal crashes, the need for statistically robust crash numbers has meant that the analysis has been limited to 39 road sections and this in turn limits the usefulness of the tool as a differentiator of risk in that country.

Crash Risk Map thresholds are determined by the ratio of fatal and serious crashes to fatal crashes for the network being examined. The study has shown that, where this ratio varies widely between road types (e.g. Core TEN-T compared with other Comprehensive roads), there may be an argument for providing separate Crash Risk Map thresholds for these different categories of roads. If this is not done and only one ratio is provided for the entire network, then it may over- or understate the risk for some roads near the threshold boundaries.

### 5.2.3 Under-reporting

There is clearly a problem with the collection of serious road crash data in Greece. The number of serious crashes is recorded as less than the number of fatal crashes. In earlier work during the period 2002-2006 EuroRAP called for data in Italy to be improved – both the locational coding of crash data and the increased availability of traffic volume data. In the intervening 10-15 year period, data appear to have improved in Italy (with, for example, greater availability of traffic data), but it is clear that in Greece and in other countries too, there must be improvements.

### 5.2.4 Documentation

Whilst addressing procedures and protocols, it should be noted that that the EuroRAP description of the Crash Risk Mapping procedure was written originally for an assessment of the British Motorway, trunk and primary road network. The guidelines suggest that an aspirational target for 20 crashes per section when mapping. There is a balance to be struck between the number of years of data necessary to collect this total or indeed the length of the road section required. This target is not often achieved, even in the UK where data collection is good. The guidance should be revised so that countries can work towards achieving the balance of:

- a statistically reliable crash total for the section
- a time span that will not have seen substantial road changes over time, and
- a road length that can be addressed in its entirety with improvements or an improvement package.

Further, it is proposed that the guidance be revisited to incorporate some of the salient material in the calculation of thresholds for Crash Risk Mapping described above.

### 5.2.5 Scope of mapping

Not all the maps that have been produced show substantial variation in risk to road users as they move from one road section to the next and some show relatively low individual risk. This highlights the importance of the amendments to the RISM directive extending its scope to the primary roads. It is often useful to go below the Core TEN-T to obtain results that are useful both in policy-setting and in determining targets for engineering casualty reduction. As this illustration from the UK (Figure 6) shows, individual risk is relatively low (green) on the major motorways (TEN-T) but increases sharply on the more minor roads nearby (red and black).


**Figure 6: Risk varies substantially when lower tiers of roads are also mapped**

An important issue to address is the suitability of the data for comparison between countries and indeed the appropriateness of showing different national networks on one map, thereby implying that the same colour on one network shows the same risk as on another. Among the factors to be considered in making that call are:

- The accuracy of location coding of the crash data
- The likely under-reporting of both fatal and serious crashes
- Whether the procedures in setting the thresholds have been the same between countries, whether for example the maps are portraying similar tiers of road hierarchy and whether the fatal: serious ratios set for each are similar

# 6 Conclusions

Crash Risk Rate maps have been produced of the relevant Core TEN-T network in accordance with the deliverables required in Activity 1, namely D1.3 for Greece.

Detailed description of the data has been provided.

Results are being launched or released on websites, subject to local consultation and discussion, as appropriate.

- Applications of the data have been demonstrated in the analysis.  The maps:
- show the risk to individual road-users of being involved in crashes as they move from one road section to another.
- provide guidance for operators on where there has been a concentration of crashes.
- can be used to show where crash rates deviate from the norm expected for roads of a particular type.
- have regional applications in showing how to compare risk on the major road network with risk on adjacent roads
- Data deficiencies involving the reliability of data in Greece have meant that in Greece only fatal crashes have been mapped.

## References

Lawson S (2017) Analysis of changes in the rate of severe crashes for typical road infrastructure investments. Report to the European Bank for Reconstruction and Development. Road safety framework procurement (Reference 41196) consultancy services, December https://www.irap.org/2018/01/analysis-of-changes-in-the-rate-of-severe-crashes-for-typical-road-infrastructure-investments/

## Appendix 1 – Reporting of crashes and casualties[1]

Bull and Roberts (1973)[2] were among the early reporters on casualty under-reporting and showed how this may vary by casualty severity and road-user group and others by location and road class.

In many High-Income Countries there is near-complete reporting of road fatalities but serious casualties may be substantially under-reported (by a factor of around 2-3) and slight casualties by a similar rate or more. Great Britain is an interesting High Income Country example. For example, more than 2 million damage-only crashes are estimated to have occurred but are not recorded in official statistics in Great Britain. The reported ratio of fatal: serious: slight casualties is around 1:10:100. The "true" ratio is likely to be closer to around 1:40:350 (see Table A1).

| | **Reported** | **Approx. ratio to deaths -- Reported** | **Unreported** | **Potential actual total** | **Approx. ratio to deaths – using potential "actual totals"** |
|---|---|---|---|---|---|
| **Total casualties** | About 186,000 | -- | About 500,000 unreported | Total casualties 660-880k with 730k as central estimate [1] | |
| **Fatal** | About 1,700-2,000 (A) | 1 | 1% not in records? (B) | About 1,700-2,000 ((A) + (B) | 1 |
| **Serious** | 22,000 (C) | 10 | 57,000 (D) | About 80,000 (C) + (D) | 40 |
| **Slight** | 162,000 (E) | 100 | 471,000 (F) | "More than 600,000" (E) + (F) | 350 |
| **Damage only** | -- | -- | -- | About 2.3 million [2] | -- |

Table A1: Under-reporting of road casualties in Great Britain in a recent year (rounded data)

([1] see page 5 – estimates of unreported serious and slight. [2] See page 3 – total damage-only Great Britain)

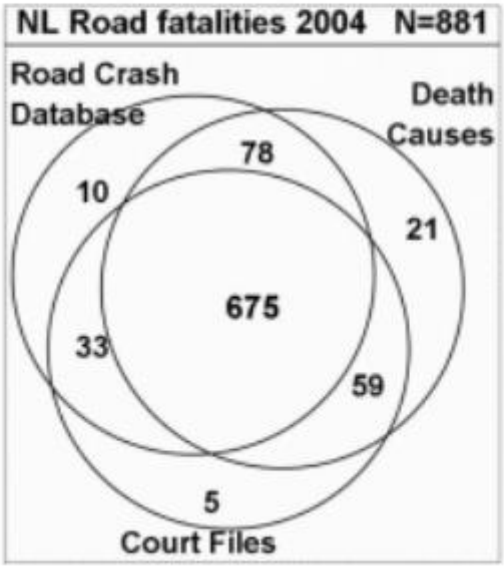
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/9275/rrcgb2011-02.pdf

[1] derived from Lawson (2017)

[2] Bull JP and Roberts BJ (1973) Road accident statistics – a comparison of police and hospital information. *Accident Analysis & Prevention* 5(1), 45-53

Even in the Netherlands, another road safety leader, it is recognised that not all fatalities may be reported to all data systems. Stipdonk ((2004) has argued that that there are road fatalities missing in all files. As this number in the example he provides is small (5) and there is no information about them, these fatalities are omitted in the overall estimation of reporting (Bos and Derriks (2009)). The example serves to illustrate why some sources are more complete than others and the different reporting mechanisms.

**Figure A1: Databases and recording of fatal road casualties (from Bos and Derriks 2009)**




http://www.itf-oecd.org/sites/default/files/docs/4-bos.pdf

WHO (2015) has compared road reported fatality data with that estimated as closer to the true number (from other national data sources such as morbidity statistics) and presents the data shown in Table A2.

The degree of under-reporting is unlikely to be uniform and on the inter-urban roads that are predominantly of interest here, will vary between not only between country, but by location (e.g. proximity to villages), urban/rural, injury severity, type of road-user involved and dependent upon factors such as the level of police presence on the network.

In many countries a simple check of the ratio of reported pedestrian casualties to all casualties, or the ratio of serious casualties to deaths, may be a good indicator of the quality of the crash data and of the reporting. Implied low numbers of pedestrian or serious casualties may cause concern.

One implication of this variation is that simple comparison of fatality rates between individual countries may be of limited benefit. It is likely to be more useful to compare roads of different kinds in individual countries by comparing ratios of crash and injury rates.

**Table A2: Deaths and reporting[3] in Croatia, Italy, Greece and Spain [1]**

| | Reported deaths 2016 | WHO estimate deaths 2016 | Reporting level [3] | Deaths 2013 per 100,000 |
|---|---|---|---|---|
| Croatia | 307 | 340 | 90% | 8.1 |
| Italy | 3283 [2] | 3333 | 98% | 5.6 |
| Greece | 824 | 1026 | 80% | 9.2 |
| Spain | 1810 | 1922 | 94% | 4.1 |

[3] Notes to Table A2 Source: [1] 2016 data from Global status report on road safety 2018; [2] www.istat.it; [3] "Reported"/"WHO estimate" – including definition discrepancies and under-reporting

# Appendix 2 – Country meta-analysis

## Greece

| Item | Units / Description | Data |
|---|---|---|
| Network description | | TENT Core Road Network of Greece |
| Current year | | 2020 |
| Data sources | Crash data | Hellenic Statistical Authority |
| | Traffic data | National Transport Plan of Greece & Concessionaires |
| Data period 1 | year | 2015 |
| | total fatal | 44 |
| | total serious | 40 |
| | total serious and fatal | 84 |
| Data period 2 | year | 2016 |
| | total fatal | 38 |
| | total serious | 14 |
| | total serious and fatal | 52 |
| Data period 3 | year | 2017 |
| | total fatal | 38 |
| | total serious | 19 |
| | total serious and fatal | 57 |
| Data period 4 | year | 2018 |
| | total fatal | 37 |
| | total serious | 20 |
| | total serious and fatal | 57 |
| Data period all | | 2015 to 2018 |
| | total fatal | 157 |
| | total serious | 93 |
| | total serious and fatal | 250 |
| Scaling factor | F&S / F | 1,59 |

| Risk Bands | Band | Collective | Individual |
|---|---|---|---|
| Standard | Low | 0 | 0 |
| | Low - medium | 0,08 | 1,2 |
| | Medium | 0,16 | 4,9 |
| | Medium - high | 0,24 | 8,4 |
| | High | 0,32 | 14,2 |
| Adjusted | Low | 0 | 0 |
| | Low - medium | 0,04 | 1,911 |
| | Medium | 0,08 | 7,803 |
| | Medium - high | 0,13 | 13,376 |
| | High | 0,17 | 22,611 |