Fact Sheet AllTraIn for WP1

Literature (1)

Potential Impacts of Climate Change on U.S. Transportation

National Research Council of the National Academies (U.S.A.), Committee on climate Change and U.S. Transportation, Transportation Research Board Special Report 290, Washington, D.C., (2008), 280 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Weather Events** associated to Climate Change.	➢ Different land, air and marine transport modes.	➢ State of the art and recommendations.

The report focus is on the consequences of climate change for the infrastructure and operations of U.S. transportation. The report provides professionals with an overview of the scientific consensus on those current and future climate changes of particular relevance to (U.S.) transportation, identifies potential impacts on transportation and adaptation options and offers recommendations for both research and actions that can be taken to prepare for climate change. The primary objective of the report is to provide guidance for transportation decision makers on how best to proceed.
Among others, design changes are one of the topics considered. Conditions such as temperature, freeze –thaw cycles, and duration and intensity of precipitation determine subsurface and foundation Design, choice of materials, and drainage capacity. There is a need for a selective, risk-based approach to making changes in standards that focuses first on long-lived facilities, such bridges and large culverts.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very complete state of the art in what concerns climate change threats and different kinds of vulnerabilities associated to the transportation modes.

Fact Sheet AllTraIn for WP1

Literature (2)

Earthquake Vulnerability of Transportation Systems in the Central United States

Central U.S. Earthquake Consortium and MS Technology,(1996, revised edition 2000),24p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Geohazard-Earhquake (U.S.)	➢ Roads, bridges, runways, port facilities, rail lines, tunnels.	➢ General information related to the importance of the subject.

The monograph examines the nature of the earthquake risk (Central U.S.), discusses the effects of earthquakes on each component of the transportation system, and how well this will affect response and recovery efforts. The monograph looks ahead to the challenges and opportunities for transportation officials, emergency managers and others in the development of a comprehensive approach to reduce the vulnerability of the transportation system to earthquakes in the Central U.S.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a short introduction to the problem of earthquake impacts on the transportation system.

Fact Sheet AllTraIn for WP1

Literature (3)

Bridge Vulnerability Assessment and Mitigation against Explosions

Kiger, S. A., Salim, H. A. and Ibrahim, A.Iowa State University, Institute for Transportation (2010), 64 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Explosions (man-made).	➢ Bridge (road).	➢ Computational simulations (finite elements).

The report focuses on the structural and material response of pos-tensioned box girder bridges under blast loads. The bridge is simulated using the explicit dynamic finite element hydrodynamic code LSDYNA. It is assumed that the explosive material is located on top the bridge deck. The results and the analysis of various parameters of the bridge on the dynamic response and failure mechanism of the bridge under blast loads are discussed in the report. The main parameters of the study were the explosive charge size, explosive location over the bridge, the material properties of steel and concrete, and the effect of prestressing force used as a solution to decrease the damage level.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ Some interesting conclusions and recommendations are presented for the specific set of scenarios.

Fact Sheet AllTraIn for WP1

Literature (4)

Dynamic Vulnerability Assessment of Highway and Railway Bridges

Mehdi Mohseni, PhD Thesis, University of Nebraska-Lincoln (2012), 133p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Dynamic loads – earthquake, high speed trains and vehicular dynamic loads.	➢ Bridges (road and railway).	➢ Experimental data and mathematical dynamic modeling.

The dissertation focuses three dynamic loads applicable for railway and highway bridges.Highway bridge responses to the seismic loads are investigated using fragility (vulnerability) analysis as a reliable probabilistic approach. The analysis results declare higher fragility of multispan curved bridges, compared to straight bridges with the same structural system. Structural reliability of steel tension and compression members in highway bridges, and the effects of the vehicular dynamic load characteristics are studied in the second part of the dissertation. Lastly, the resonance of railway bridge superstructures under passing high-speed trains is examined and the dynamic responses are presented using dynamic load factors digrams. These curves can guide designers to estimate the structural response of railway bridges.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (5)

Identification of sources of failures and their propagation in critical infrastructures from 12 years of public failure reports

Rahman, H. A., Int. J.Critical Infrastructures, Vol.5,No. 3 (2009),pp.220-244.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Telematics failure.	➢ General systems including transportation systems.	➢ Data from public reports.

The paper presents an analysis of the impact of failures on Communication and Information Technology Infrastructure (CITI) on other systems. Failures in other infrastructures can also propagate to CITI and hence disrupt the operation of many of these interconnected systems. By studying the origin of infrastructure related failures and their propagation patterns, we can develop a better understanding of their interdependencies.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☐ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (6)

Risk and Vulnerability analysis of Critical Infrastructures- The DECRIS Approach

Utne, I.B. et alli, SAMRISK Conference, September 1-2, Oslo (2008), 10p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Different events and scenarios.	➢ Different types of systems ➢ Road and rail (tunnel).	➢ Risk and vulnerability analysis.

A method for risk and vulnerability analysis for critical infrastructures was developed in the SAMRISK project DECRIS (Risk and Decision Systems for Critical Infrastructures). The method supports an "all hazards" approach across sectors including, among others, transport systems (road/rail). The main focus is on serious events and emphasizing dependencies between sectors. The paper presents the main features of the method and discuss some preliminary findings from a case study.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (7)

Physical Vulnerability of Reinforced Concrete Buildings Impacted by Snow Avalanches

Bertrand, D. et alli, Nat. Hazards Earth Syst. Sci., 10 (2010), pp.1531-1545.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazard** ➢ **Snow avalanche**	➢ General physical infrastructure (building)	➢ Numerical simulations.

The paper deals with the assessment of physical vulnerability of civil engineering structures to snow avalanches loadings. In this case, the vulnerability of the element at risk is defined by its damage level expressed on a scale from 0 (no damage) to 1 (total destruction). Most existing vulnerability relations have been built from field observations. The paper describes a method based on numerical simulations of reinforced concrete structures loaded by snow avalanches (3D finite element method). A damage index is defined and is based on global and local parameters of the structure. The simulations allow establishing the vulnerability as a function of the impact pressure and structure features. The derived vulnerability functions (fragility curves) can be used for risk analysis in a snow avalanche context.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very interesting paper in what concerns the structural vulnerability assessment and the concepts involved.

Fact Sheet AllTraIn for WP1

Literature (8)

Transport Network Vulnerability-which metrics should we use?

Husdal, J. NECTAR Cluster 1 Seminar, Molde , Norway, 12-13 May (2006)

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ General threats.	➢ General Road Networks.	➢ Vulnerability concepts and quantification.

The paper deals with the vulnerability of road networks. This topic has been the subject of growing attention in recent years, and there are indeed many threats that can cause the road network to fail or to become severely impeded: congestion, an array of natural hazards, structural breakdowns, traffic accidents, power failures, to mention but a few. Any threat to the reliability of the road network constitutes a vulnerable spot, a weakness, that need to addressed in order for the network not to fail, This is of particular concern when considering sparse, rural networks. One hazard to transportation networks that has emerged recently and what may become an increasing concern in the near future are the effects global climate change, with extreme weather and precipitation patterns not seen before, and thus closing or degrading links that were thought invulnerable to such threats. From a user point of view, what matters most in relation to a road network is the following: Can I, at the desired time of departure, get from A to B by using the intended route and means of transport, and arrive at a desired time, which would be the best case. Or, does there exist no route or means of travel at all that can take me from A to B at the desired time of departure, let alone within arriving at the desired time, which to the user would be the worst case. From a freight hauler's point of view, a vulnerable network is a network that is easily disrupted, resulting in unpredictable stops and downtime. This is probably seen as a much larger problem than a congested and slow-moving network that is relatively stable. In the latter, there is at least some guarantee that the goods will arrive at their destination, and most important, the transport costs, though annoyingly inefficient, are still calculable and lead times are still predictable. This paper presents an admittedly selective review of past and present research into the field of road network vulnerability, and seeks to synthesize the different terminologies and metrics, drawing on research not only from the field of transport, but also from other disciplines, in order to assemble a picture of the topics that need to be addressed.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ The paper presents the vulnerability concept for transport networks as well as different ways for its quantification.

Fact Sheet AllTraIn for WP1

Literature (9)

Road Vulnerability Assessment for Earthquakes

Tung, P.T., Ph.D. Thesis, International Institute for Geo-information Science and Earth Observation, Enschede, The Nettherlands (2004),79p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards-Earthquakes**	➢ Road systems-bridges.	➢ Vulnerability and damage assessment.

The study aims to access roads and bridges vulnerability in earthquakes. The study is applied to a case study (Nepal).
The first part of the study reviews existing methods that have been used in physical vulnerability assessment. Based on data obtained by field survey the roads and bridges are classified in terms of their characteristics and geographical locations.
Vulnerability of road is assessed based on surface material and liquefaction level at road locations. Damage levels of the road and the bridge in a selected earthquake scenario are evaluated. Two methods of vulnerability assessment are used: JICA and RADIUS methods.
The second part of the study looks at the function of road in post-earthquake emergency. A methodology is developed to estimate the possibility of road blockage level. The methodology is tested with real data.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very interesting contribution for a practical vulnerability assessment in road systems.

Fact Sheet AllTraIn for WP1

Literature (10)

Seismic Vulnerability Assessment of Highways and Railroads-Application to the Great Lisbon Area

Guerreiro, L. and Azevedo, J., 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6 (2004),11 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards-earthquake**	➢ Road and railway systems.	➢ Vulnerability analysis and damage assessment. Fragility curves. Damage simulation.

The paper presents a methodology for the characterization and analysis of the seismic vulnerability of road and railroad networks. A seismic simulator allows the seismic damage assessment (fragility curves) in the great Lisbon area in Portugal. Some criteria for the definition of damage classes associated to the network elements, such as bridges, considering the dynamic effects of the structural response, liquefaction and landslide occurrence are also presented. A sensitivity analysis of the network performance as a function of the earthquake magnitude is also presented.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☐ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ An interesting paper that presents simulation methods for vulnerability assessment in what concerns earthquake impacts on road and railways systems.

Fact Sheet AllTraIn for WP1

Literature (11)

Climate Change and Infrastructure, Urban Systems, and Vulnerabilities

U.S. Department of Energy and Oak Ridge National Laboratory (2012),106 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Exreme Weather events-Climate Change**	Different built systems including transportation systems.	➢ General overview of the problem.

It is a summary of the currently existing knowledge base on the topic. The report arrives at a number of "assessment findings", each associated with an evaluation of the level of consensus on that issue within the expert community, the volume of evidence available to support that judgment, and the explanation for the finding.
A central theme of the report is that vulnerabilities and impacts are issues beyond physical infrastructures themselves. The concern is with the value of services provided by infrastructures, where the true consequences of impacts and disruptions involve not only the costs associated with the clean-up, repair, and/or replacement of affected infrastructures but also economic, social, and environmental effects as supply chains are disrupted, economic activities are suspended, and/ or social well-being is threatened.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (12)

Vulnerability Assessment of Road Transport Infrastructure

Erath, A. L., Ph.D. Thesis, ETH Zurich (2011),144 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ General threats.	➢ Road transport infrastructure	➢ Assessment of direct and indirect consequences of road network failures.

The aim of the dissertation is to develop a methodology that allows the assessment of indirect consequences of road network failures that, on the hand can be used to enhance the infrastructure management system by the notion of network vulnerability and can be performed with reasonable computational effort. The work focusses on three different issues: the development of an adaptive failure consequences assessment, the estimation of a statistical model and the evaluation of the relevance of joint failure scenarios when prioritizing natural hazard protection measures.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (13)

A Guide to Highway Vulnerability Assessment for Critical Asset Identification and Protection

Science Applications International Corporation, Transportation Policy and Analysis Center, U.S.A. (2002),40 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Terrorist act.**	➢ Highway systems- bridges, tunnels.	➢ Guidelines to vulnerability assessment and decision.

The Guide was developed as a tool to:
-assess the vulnerabilities of their physical assets such as bridges, tunnels, roadways, and inspection and traffic operation facilities, among others;
- develop possible countermeasures to deter, detect, and delay the consequences of terrorist threats to such assets;
- Estimate the capital and operating costs of such countermeasures; and
- Improve security operational planning for better protection against future acts of terrorism.
The Guide can benefit a broad audience including senior officials involved in the initial planning stage of the vulnerability assessment process, midlevel managers charged with developing the assessment plans and procedures, and field personnel who will conduct the assessments of critical assets. The Guide identifies the types of resources typically required by the team to conduct a vulnerability assessment, and it describes the three major phases of the process: pre-assessment, assessment, and post-assessment. The Guide provides six steps for conducting a vulnerability assessment of highway transportation assets. The Guide describes general methods that apply to a wide range of asset types.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ Interesting example of an operational guide.

Fact Sheet AllTraIn for WP1

Literature (14)

Risks associated with Natural Disasters, Climate Change, Man-Made Disasters and Security Threats

World Road Association, Technical Committee C.3 Managing Operational Risk in Road Operations (2013), 252 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Natural disasters and climate change and others.**	➢ Road transportation systems.	➢ Recommendations and guidelines in risk assessment.

The report deals with risks associated with natural disasters, climate change, man- made disasters and security threats. The purpose of the report is the following one:
-to describe a methodology for evaluating risks associated with all hazards;
-to highlight practical techniques for managing risks associated with natural disasters;
-to provide a snapshot of efforts in managing climate change risks and the adaptation of transportation infrastructure around the world;
-To propose the transformation of the risk management toolbox developed by the committee into a web-application tool.
The report presents a method for costing asset protection (CAPTA method) that can evaluate a wide range of assets and transportation modes. An overview of climate change adaptation specific tools is provided.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very complete guideline for risk management associated to road systems.

Fact Sheet AllTraIn for WP1

Literature (15)

La Vulnérabilité structurelle comme outil de comprehension des mécanismes d´endommagement

Gleyze, J.F.and Reghezza, M. Géocarrefour, Vol 2/1 (2007) pp. 17-26 (in French)

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **General risks.**	➢ General transport networks.	➢ Analysis of the structural vulnerability concept.

The focus of the paper is the vulnerability of the systems and not the hazards. The developed analysis pretends to be independent of the type of hazard. The aim is to show that the risk impacts can be more clearly understood by separating material damage from functional damages and by making clear the role of the structural mechanisms that connect them. The case of flood risk in the urban area exemplifies that the analysis of hazardous processes and vulnerability can be very difficult, especially when the area under study is subject to a multiplicity of hazards which may have very different impacts on different territories. So the authors propose a new framework based on the elements at risk and their vulnerability, rather than on hazards.
The structural damage level, between the material level and the functional one, seems to be necessary to understand the chains of damage of the initial hazard.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ The paper seems to propose interesting thoughts about the vulnerability analysis of complex systems.

Fact Sheet AllTraIn for WP1

Literature (16)

Surveillance du risqué hydrologique diffus le long des itinéraires routiers

Versini, P.A., Ph.D. Thesis, École Nationale des Ponts et Chaussées (2007) 257 p. (in French)

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Floods	➢ Road systems.	➢ Risk analysis of road reaches be submerged by a flood.

The aim of the work is to find a probabilistic method for road submersion at basin scale. Based in a specific area of study the author try to find the most relevant geographical and flood hazard factors in order to estimate the level of flood risk (cut of the traffic) in a road system.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (17)

Impacts of Climate change on Transport: a focus on road and rail transport infrastructures

Nemry, F. and Demirel, H., European Commission, Joint Research Center (2012)

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	**Threats associated to climate change.**	➢ Road and rail systems.	➢ Vulnerability assessment based in climate change scenarios and adaptation costs.

The report provides a general EU-wide outlook about the future vulnerability of transport to climate change with focus on the road and rail transport and their infrastructures. It also analyses some specific adaptations measures. It represents a first JRC assessment of future impacts of climate change on transport system in Europe (JRC PESETA II project).
The research has drawn some future trends regarding changing exposure of road and rail infrastructures to weather induced risk under climate change (2040-2070 and 2070-2100), and future infrastructure deterioration and damage costs.
The overall assessment has made use of available climate models based projections, considering three distinct global emission scenarios and model realizations.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very interesting and important study of climate change effects in road and rail infrastructures in Europe.

Fact Sheet AllTraIn for WP1

Literature (18)

Vulnerability and Resilience of the Territory Concerning Risk of Dangerous Goods Transportation (DGT): Proposal of a Spatial Model.

Garbolino, E. et alli, Chemical Engineering Transactions, Vol. 32 (2013) pp.91-96.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Dangerous goods.**	➢ Road and rail transportation systems.	➢ Vulnerability and resilience indexes applied to GIS.

According to the definitions of vulnerability and resilience the authors propose a spatial model based on two indices in order to characterize the level of vulnerability and resilience of the territory induced by dangerous goods. Those two indices are implemented into a GIS in order to define a Spatial Decision Support System dedicated to the decision-makers. The authors discuss the levels of vulnerability and resilience of the territory according to the different kind of transportation systems in order to underline recommendations for dangerous goods transport planning.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☐ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It seems that complements at a larger scale (territory) the object of AllTraIn project.

Fact Sheet AllTraIn for WP1

Literature (19)

Hazard Analysis and Vulnerability assessment for the Philadelphia Center City Rail Tunnel

Mulray, V.P., Philadelphia Fire Department, Philadelphia, Pennsylvania, U.S.A. (2009) 72 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Terrorist act or man made disaster.**	➢ Rail tunnel.	➢ Recommendations based on literature review, personal observation and interviews.

The purpose of the research is to analyze characteristics that would affect emergency operations at a center city rail incident caused by a terrorist act or a man made incident and identify strategies that could improve the performance of a fire department operations.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (20)

De l´intérêt d´une étude sur la vulnérabilité des réseaux routiers et de transport pour la compréhension des vulnerabilities territoriales- Le Cas du District Métropolitain de Quito (Équateur)

Cybergeo: European Journal of Geography, Dossiers,Vulnerabilités urbaines au sud., 446 (2009) 20p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Not specific threats.	➢ Road system.	➢ Territorial vulnerability assessment.

The paper presents an analysis on the relevance of the vulnerability assessment of the infrastructures of the transportation systems. Once defined the concepts involved in the analysis the four steps of the process are detailed

1- to analyze the people 'mobility and the transportation system;
2- to identify key elements within the transport system (critical infrastructures);
3- To assess the critical infrastructure vulnerabilities which expose them to disturbances and failures;
4- to identify all areas which are liable to experiment a reduction of their accessibility due to a loss of critical infrastructures serviceability.

This process allowed assessing through scenarios the spatial backlashes which are likely to occur at the area (in the study the Metropolitan District of Quito).

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (21)

The Identification of Critical road Infrastructures- The Case of Baden-Wuerttemberg

Schulz, C., Dissertation, Karlsruher Institut fur Technologie, KIT Scientific Publishing (2012) 166 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Indeterminate threats. Road disruption (case study-flood and earthquake)**	➢ Road networks.	➢ General risk assessment and advanced estimation of losses.

The aim of the work is to contribute to identify critical spots in the road network that, in the event of a road infrastructure disruption, would entail great indirect losses to society. Indirect losses here refer to the degraded serviceability of a road section and the immediate negative economic impacts on road users associated with the disruption. The size of the economic effects associated with each disruption determines a ranking, which then serves as indicator for its criticality. A logit-based approach therein provides the option to even monetize changes in trip making decisions like destination or modal choice. The thesis builds on such concept, and suggests a new monetized loss calculation methodology based on a single measure that captures changes on various trip making decision levels, and also accounts for the duration of disruption. The works introduces the effects of simultaneous failures of multiple road sections. The thesis offers a reinterpretation of the criticality assessment depending on the combination of affected links, and poses a novelty in this field of research. The methodology is applied to the case study.
Furthermore the thesis combines the estimated indirect losses with a qualitative and a quantitative measure of susceptibility to failure. The results of the risk assessment reveal that the most critical links, based on the indirect loss ranking, are not necessarily the links with the highest level of risk.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It seems to be an important contribution for the indirect losses calculation and for decisions.

Fact Sheet AllTraIn for WP1

Literature (22)

Vulnerability and Risk Assessment of a Mountain Road Crossing Landslides

Prina, E. et alli, Revista Italiana di Geotecnia, Nº2 (2004) pp. 67-79.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards-landslides**	➢ Roads	➢ Vulnerability and risk assessments

Risks of natural disasters are increasing according to the authors of the paper. The reason is due mainly to the growing exposure of goods and population to a wide range of hazards. After a brief introduction on the importance of natural catastrophes and the question of an integrated risk management of roads under the threat of landslides, the paper focuses on a case study.
In order to take appropriate preventive measures and avoid catastrophes, it is first necessary to carry out a complete assessment of the risks induced by the road location. The paper indicates several (four) steps for this kind of assessment. The study has led to fix a degree of risk rated from 0 to 4 for each 250m unit stretch of the road.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is an interesting paper because it shows a practical case study of risk and vulnerability assessment.

Fact Sheet AllTraIn for WP1

Literature (23)

Analyzing and Estimating Landslide Risk Impact to Road. A Case Study.

Nugroho, E. S., PhD. Thesis, Gadjah Mada University and University of Twente (2012), 140 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazard-landslides**	➢ Roads.	➢ Direct and indirect damage analysis and risk analysis.

The research aims to analyse and estimate the impact of landslides to roads in a specific area of the world (Samigaluh). In the study a direct risk assessment was developed for various scenarios on the basis of hazard (magnitude, spatial probability and temporal probability), vulnerability and estimating cost of road damage. Indirect risk assessment was derived from traffic interruption. It was used network analysis and community (public) perception to estimate the optimal road which was chosen by the user.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☐ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (24)

Landslide Risk Quantification along Transportation Corridors based on Historical Information

Jaiswal, P., PhD Thesis, University of Twente, ITC (2011) 243 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Geohazards - landslides	➢ Road and railway corridors.	➢ Risk (landslide) analysis including societal risks. Historical information.

The research was conducted along a transportation corridor with road and railway alignments in a region of India. Historical records belonging to the railway and geotechnical units were used to obtain a landslide inventory for a 23 year period.
Several analyses were performed to quantify landslide risk along the road and the railroad including a probabilistic analysis. Rainfall threshold analysis was used to estimate the possibility of landslides, and magnitude-frequency analysis to obtain the probability of landslide size. Landslide vulnerability was established for landslides with different magnitudes and for different elements at risk. As a final output direct risk was quantified for different elements and people.
The results provided a quantitative estimate of total annual landslide losses and death of people. The methodology provides according to the author a cost-effective approach to estimate direct and indirect landslide risks. The methods can be applied elsewhere if a similar historical landslide data is made available.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very interesting work of a practical integrated risk analysis.

Fact Sheet AllTraIn for WP1

Literature (25)

Landslide risk assessment along a major road corridor based on historical landslide inventory and traffic analysis

Nayak, J., Master Thesis, ITC, Enschede, The Netherlands and Indian Institute of Remote Sensing (2010),104 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazard - landslides.**	➢ Road mode.	➢ Risk analysis. Historical inventory. Case study.

The study aims at quantify the amount of direct risk for a part of a highway in India. The risk analysis considers different types of vehicles and different landslide types, magnitudes and expected return periods and indirect risk generated as the loss of profit due to the blockage of the highway by landslides. A multi-temporal inventory of landslides was prepared with the help of available records (14 years) and using remote (spatial) images. From the data 18 scenarios were developed on the basis of two landslides types, three magnitude classes and for three return periods (1,3 and 5 years). For each scenario temporal and spatial probabilities were estimated.
The vulnerability of the road was estimated on the basis of the length of the road damaged due to a particular landslide, taking in account slide material accumulation, removing cost and repairing cost of the damaged road. Direct risk for different vehicles due to all magnitude of debris and rock slides was estimated. Indirect risk was calculated on the basis of road blockage time loss of profit to various business types. This study can be useful to planners and decision-makers in hill areas development.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is another interesting practical study and risk analysis.

Fact Sheet AllTraIn for WP1

Literature (26)

La Vulnérabilité Structurelle des Reseaux de Transport dans un Contexte de Risques

Lhomme, S., Travail d´Etude et de Recherche, Ecole des Ingénieurs de la Ville de Paris, Promotion 50, F. Bourgade- V. Griot (2009-2010), 52 p. (in French).

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Natural hazards and man-made events.**	➢ General transport networks.	➢ GIS, graph and decision theories, ➢ Operational research.

The study provides some tools for managers to estimate or find vulnerability points in the networks. It will also assist them in the protection or mitigation plans.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is an academic work but gives some information on advanced tools of analysis.

Fact Sheet AllTraIn for WP1

Literature (27)

Metodologie di Valutazione del Rischio Sismico sulle Infrastrutture Viarie

D´Andrea, A. and Condorelli, A., World Road Association (sd), 104 p. (in Italian).

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazard – Earthquake**.	➢ Road mode, with bridges, tunnels and also railways.	➢ Guide for Road Risk Analysis in Italy.

The report includes several studies as well as the results of different case studies as the basis for a guide or a set of guidelines related to seismic risk associated to the transportation infrastructures (mainly roads). The report includes the following aspects:

- Fundamental theory and methods related to the topic (risk assessment);
- Presentation the modern techniques of data and information management in the risk management framework;
- Development work applied to case studies in Catania (Italia);
- Example of specific risk assessment of a road;
- Induced effects of earthquake on roads.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ The report has a lot of very interesting information.

Fact Sheet AllTraIn for WP1

Literature (28)

Sviluppo de una Metodologia per la Valutazione della Vulnerabilità di una Rete Stradale

Daniela, M., PhD. Thesis, Università degli Studi di Cagliari (sd), 139 p. (in Italian)

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Different types of threats (natural and man-made).	➢ Road (and railway) modes.	➢ Risk analysis and emergency management (civil protection).

In this work the author presents a methodology for vulnerability assessment of different components of the road systems. The author considers the three main factors of the well-known risk definition and formula: hazard, vulnerability and exposition. The author presents a literature review concerning the vulnerability assessment. Based on the state of the art, it is proposed a new methodology and a vulnerability index (based on the variation of the time of the displacement). The work and the methodology can be useful for the owners of the road and for the civil protection authorities.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very good contribution for the understanding of vulnerability management with multi objectives.

Fact Sheet AllTraIn for WP1

Literature (29)

Landslide hazard and risk assessment on the Scottish road network

Winter, M. G. et alli, Proceedings of the Institution of Civil Engineers, Paper 1200063 (2013), 18 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards – landslides.**	➢ Road mode.	➢ GIs based assessment of debris flow susceptibility.

After a series of debris flow events (August 2004) that affected the Scottish road network, a study was commissioned with the overall purpose of ensuring that the hazards posed by debris flows were systematically assessed and ranked, thus allowing specific sites to be prioritized effectively within available budgets. In this paper the methodology used is described, as is the approach taken to interpret the resulting imagery in order to establish those sections of road alignment subject to hazards. The ranking of hazards based upon the potential exposure of road users to debris flow hazards and the potential socio-economic impacts is also described, and a map illustrates the locations of the highest hazard – ranking sites.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very complete study with practical impact.

Fact Sheet AllTraIn for WP1

Literature (30)

Towards the Development of a Landslide Risk Assessment for Rural Roads in Nepal

Petley, D.N. te alli, Landslide Hazard and Risk, Glade, T. ,Anderson, M. and Crozier, M. J. (editors), J. Wiley (2005), pp.597-619.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards – landslides.**	➢ Road mode.	➢ Risk analysis (case study).

The paper presents the initial results of landslide risk assessment in a rural area of Nepal. The results can be applicable to similar areas.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (31)

Risk and Vulnerability. Analysis of Interdependent Technical Infrastructures.

Johansson, J., Doctoral Thesis, Lund University (2010), 189 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Not specific threats.	➢ General technical infrastructures with an example of railway system.	➢ Vulnerability analysis and theory.

The aim of the thesis is to develop a modeling approach and methods for such analysis, with focus on identifying technical infrastructure vulnerabilities.
The described modeling approach is based on dividing the model of the technical infrastructure into one structural and one functional part, enabling the analysis of interdependent infrastructures.
The methods for the vulnerability analysis have three perspectives in order to address the complexities of vulnerabilities from different viewpoints: global vulnerability analysis, critical component analysis and geographical analysis. As the resilience of the infrastructures depend critically on the restoration capacities of supporting actors, a method addressing this is also presented.
The focus of the methods is on vulnerability analysis, but their use in wider context of risk and vulnerability management is also addressed.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very good support in what concerns the theoretical concepts and general methodologies. ➢ The work gives a valuable foundation for input to proactive policy and decision-making for infrastructure risks and vulnerabilities.

Fact Sheet AllTraIn for WP1

Literature (32)

ECONOMIE-RAILWAY.A New Calculation Method and Tool for Comparing the Effectiveness and the Cost-Efficiency of Protective Measures along Railways

Brundl, M.B. et alli, Proc. 12th Congress INTERPRAEVENT 2012, Grenoble, France (2012), pp. 933-943.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Natural hazards.**	➢ Railway mode.	➢ Risk management. ➢ Cost-benefit analysis

The paper presents a general concept and the methodologies implemented in a new model and show its application by an example (Switzerland). The results of the presented case study indicate, that risk to persons are contributing to the overall risk at most, while economic factors like e.g. interruption costs have less significant influence on the results of a risk analysis. However, this conclusionmight be case-specific.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (33)

IFKIS-a basis for managing avalanche risk in settlements and on roads in Switzerland

Brundl, M.B. et alli, Natural Hazards and Earth Systems Sciences, Nº 4 (2004), pp. 257-262.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards-avalanches**.	➢ Road mode.	➢ Integrated project for risk management.

The project IFKIS aimed at improving the basics organizational measures (closure of roads…) in avalanche risk management. The process included a compulsory checklist for avalanche risk management, a modular education and training course program and an information system for safety services. The results of the work make a contribution to strengthening organizational measures in avalanche risk management and to closing gaps. The process can be adapted for dealing with other natural hazards and catastrophes.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ An interesting case of operational measures for risk management support.

Fact Sheet AllTraIn for WP1

Literature (34)

Natural hazards on national roads: Risk Concept.

Bernard, G. et alli, Federal Department of the Environment, transport, Energy and communications, Federal Roads Office(FEDRO)-ASTRA 89001 (2012), 106 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Natural hazards**.	➢ Road mode.	➢ Guidelines for risk assessment.

The publication can be considered as a practical guide for risk assessment and risk analysis in what concerns natural (geohazards) as avalanches, rockfalls, debris flow and floods as well as landslides. Based on the results of several projects, FEDRO produced a guide with a methodology for assessing risks.
On the basis of this assessment, the consequences (damages) can be determined and compared for road users and operators along with the risks derived from them in quantitative form. The results can be incorporated into a wide risk management concept. Priorities for planning measures can be set as well as cost/effectiveness considerations. The following aspects are covered by the guide: hazard analysis (including practical probability estimation), Exposure and vulnerability analysis, risk assessment and measure planning, individual and collective risks.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very interesting and important work.

Fact Sheet AllTraIn for WP1

Literature (35)

Risk Concept Switzerland Hazard Analysis, Risk Evaluation and Protection Measures.

Daniel, T. and Krummenacher, B., The Second World Landslide Forum, Landslide Science and Practice, C. Margottini et al. (eds), Springer- Verlag (2013), pp. 9-15.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards.**	➢ Several modes (roads, lifelines)	➢ Risk assessment and mitigation measures.

The paper focus is the risk assessment (risk map) as a primary management tool for land-use planning and regulation for settlement developments. For all infrastructures (roads …) the risk map is considered as the appropriate tool to illustrate potential damage. Based on the calculated risks, the cost effectiveness of protection measures can be evaluated.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (36)

Vulnerability and Adaptation Strategies in Alpine Road and Rail Transport-Swiss Case Study

Maibch, M., D. Bertschmann-aeppli, M. Peter (2012), Report from the International Panel of the WEATHER project (2012),23p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards. Climate change.**	➢ Road and railway modes.	➢ State of the situation in Switzerland in what concerns climate change and adaptation.

The paper aims to present the situation in Switzerland with regard to vulnerability and adaptation strategies of the transport infrastructures. A specific focus is given to the alpine area. Based on a short description of the general state of the art of vulnerability research and adaptation strategies, the specific situation of alpine transport infrastructure and policies is analyzed. The analysis is based on own expert knowledge, literature review considering as well the ongoing discussion on the general adaptation strategy (in Swiss) and selected interviews.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (37)

Uncertainty, Vulnerability and Landslides Risk Assessment in Roadways

Montoya, C. A., PhD. Thesis, University of Brasilia, Brazil (2013)250 p. (in Portuguese).

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Geohazards-landslides.**	➢ Road mode.	➢ Risk analysis of landslides on roads.

The main objective of the work is to develop a methodology for assessing risk of landslides on roadways in mountainous tropical areas, including techniques for decision making in environments of uncertainty and geotechnical variability. The work presents a state of the art on risks of mass movements, the most common methods of analysis and identifies the variables involved in the landslide risk on road as well as in the damage degree.
The proposed methodology considers two types of cases: roads with a history of mass movements, and new roadways with no statistical information on mass movements.
The hazard is calculated as the probability of failure due to the action of trigger agents: rainfall and earthquakes. Vulnerability was determined by a which uses descriptive attributes to considerate the exposure of roadway users. The risk is measured as the annual probability of death in the road due to landslides. A case study is presented (Colombia).
The model considers the uncertainty of the geotechnical parameters and trigger factors.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A good example of an integrated risk analysis in real practice.

Fact Sheet AllTraIn for WP1

Literature (38)

An introduction to road vulnerability: what has been done, is done, and should be done.

Berdica, K., Transport Policy, Nº9 (2002), pp. 117-127.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Several types. General threats.	➢ Road mode.	➢ Critical analysis of vulnerability analysis.

The concept of variability associated to an insufficient level of service is presented and discussed in the paper. The paper relates how vulnerability related problems have been addressed so far, current developments and finally what the future should hold in order to provide us with the network analysis tool that our society calls for.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a good thought on conceptual topics related to road vulnerability.

Fact Sheet AllTraIn for WP1

Literature (39)

Importance and exposure in road network vulnerability analysis

Janelius, E. et alli, Transportation Research, Part A, 40 (2006), pp. 537-560.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ General threats.	➢ Road mode.	➢ Vulnerability analysis.

In this paper the concepts of link importance and site exposure are introduced. Several link importance indices and site exposure indices are derived, based on the increase in generalized travel cost when links are closed. A case study is presented (Sweden) and results are collected in a GIS and are presented per link and municipality.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (40)

Documentation of Flood Damage on Railway Infrastructure

Moran, A. P., Thieken, A. H., Schöbel, A., and Rachoy, C. (2010). "Documentation of Flood Damage on Railway Infrastructure." *Data and Mobility, Transforming Information into Intelligent Traffic and Transportation Services, Proceedings of the Lakeside Conference 2010*, J. Düh, H. Hufnagl, E. Juritsch, R. Pfliegl, H.-K. Schimany, and H. Schönegger, eds., Springer Berlin Heidelberg, 61–70.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Flood	➢ Rail	➢ Classification of damage state based on post-hazard observations

The paper proposes a methodology for a standardized documentation of flood damage, following the 2006 floods in Austria. General railway cuts, embankments and bridges are discussed. An application is presented for describing the damage to the Austrian Northern Railway line that occurred during the flood event in 2006.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (41)

Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection

EC. (2008). "Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection." *Official Journal of the European Union*.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢	➢ Transportation critical infrastructure	➢ Adopted legislation

Identifies the general methodology for the identification of European Critical Infrastructures based on cross-cutting criteria (casualties, economic effects and public effects for which thresholds are identified based on the severity of the impact of the disruption or the destruction of a particular infrastructure), sectoral criteria (energy and transport) and the trans-boundary criterion.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ Legislation in effect

Fact Sheet AllTraIn for WP1

Literature (42)

Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade

EEA. (2010). "Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade." *Mapping the impacts of natural hazards and technological accidents in Europe: An overview of the last decade*, Technical report No 13/2010, European Environment Agency, Copenhagen.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Hydrometeorological hazards (Storms, Extreme temperature events, forest fires, Water scarcity and droughts (WSD)and floods) ➢ Geophysical hazards (avalanches, Landslides, Earthquakes and Volcanic Eruptions) ➢ Technological hazards (Oil spills, Industrial accidents)	➢ Road ➢ Rail ➢ Ports ➢ Airports	➢ Overview of past events

The report overviews the impacts of past natural hazards and technological accidents within Europe. The discussed impacts include, but are not restricted to, effects to transportation systems.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☐ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (43)

The January 17, 1995 Kobe Earthquake - An EQE Summary Report. Earthquake

EQE. (1995). *The January 17, 1995 Kobe Earthquake - An EQE Summary Report. Earthquake*, San Francisco, 1–106.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail ➢ Ports	➢ Impact report

The report discusses the impacts of the 1995 Kobe earthquake, including physical damage to rail, road systems and ports. The economic impacts are also estimated.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (44)

Ground damage resulting from torrential rains in Fukui, July 2004.

Japanese Geotechnical Society (JGS). (2006). “Ground damage resulting from torrential rains in Fukui, July 2004.” *Soils and Foundations*, 46(6), 869–884.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Extreme Rainfall	➢ Road ➢ Rail ➢	➢ Damage report

The paper reports the damages caused by torrential rains in Fukui in July 2004 including slope failures along roads, damage due to debris flow and damage to road and rail beds. These damages include a national road due to embankment collapse, rails’ and sleeper’s displacement, a bridge superstructure washed away and a collapse of a railway bridge. The failure mechanisms are discussed and, for slope failures along roads, the influence of the slope, stratum, topographical section, shape of the slope, pre-failure gradient, and type of vegetation is investigated.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (45)

Climate Change and Transportation Engineering: Preparing for a Sustainable Future

Meyer, M. and Weigel, B. (2011). "Climate Change and Transportation Engineering: Preparing for a Sustainable Future." J. Transp. Eng. 137, SPECIAL ISSUE: Transportation, the Environment, and Sustainability, 393–403.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Climate change**: increased precipitation, temperature and wind and sea level rise	➢ Road (earthworks and bridges) ➢ Rail (earthworks and bridges)	➢ Literature overview of the effects of climate change

The paper generally discusses the components of rail and road embankments and bridges influencing the potential impacts of climate change on the infrastructure design: Subsurface Conditions, Materials Specifications, Cross Sections and Standard Dimensions, Drainage and Erosion, Structures and Location Engineering. The paper also discusses and reviews existing literature on the effects of climate change such as Increased Design Temperature Range, Increased Precipitation, Increased Wind Loads and Storm Surges and Increased Wave Height.
An adaptive system management approach is proposed for a strategic perspective on how transportation agencies can respond to changing environmental conditions.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (46)

Bridge Damage and Repair Costs from Hurricane Katrina

Padgett, J., DesRoches, R., Nielson, B., Yashinsky, M., Kwon, O.-S., Burdette, N., and Tavera, E. (2008). "Bridge Damage and Repair Costs from Hurricane Katrina." *Journal of Bridge Engineering*, ASCE, 13(1), 6–14.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road (bridges) ➢	➢ Damage report

The paper discusses the bridge damages caused by Hurricane Katrina. Different damaging mechanisms are discussed: Damage due to Surge-Induced Loading, Impact Damage, Damage Resulting from Scour, Damage due to Water Inundation and Wind Damage.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (47)

Design Standards for Railway Structures - Seismic Design

RTRI. (2007). “Design Standards for Railway Structures - Seismic Design.” Railway Technical Research Institute, Japan.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquakes	➢ Rail (embankments and bridges)	➢ Design Standard

The code provisions for embankments and bridges that account for the possibility of soil liquefaction, responsible for considerable damage during the 1995 Hyogoken-Nanbu Earthquake.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (48)

Vulnerability Assessment of the Transportation Infrastructure Relying on the Global Positioning System

John A. Volpe National Transportation Center. (2001). "Vulnerability Assessment of the Transportation Infrastructure Relying on the Global Positioning System." Office of the Assistant Secretary for Transportation Policy, U.S. Department of Transportation.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ GPS failure	➢ Aviation ➢ Maritime ➢ Road ➢ Rail	➢ Vulnerability assessment and recommendations for mitigation

The report assesses the vulnerability of transportation systems to degradation or loss of GPS signal. The effects of momentary, serious and severe disruptions are discussed for civilian aviation in: navigation, air traffic control surveillance, airport surface guidance and surveillance and communications systems timing. In relation to the maritime vulnerability, the report finds the lack of GPS signal in the ocean, in harbors and in differential GPS in constricted waterways can lead to severe impacts, particularly when combined with events such as bad weather or a mechanical failure in the ship. The report also finds that rail safety is not likely to be compromised by GPS signal outage. The influence of GPS disruption in ITS is, according to the report, particularly important for hazmat and emergency response.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA	➢ AAA

Fact Sheet AllTraIn for WP1

Literature (49)

Performance of transportation systems during the 2004 Niigata Ken Chuetsu, Japan, earthquake.

Ashford, S. A., and Kawamata, Y. (2006). "Performance of transportation systems during the 2004 Niigata Ken Chuetsu, Japan, earthquake." Earthquake Spectra, 22(1), S111–S132.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail	➢ Impact report

The paper discusses the damages to transportation systems of the 2004 Niigata Ken Chuetsu, Japan, earthquake. The authors state that no collapses occurred. A train of the Joetsu Shinkansen Line, in operation since 1982, derailed on a viaduct crossing a rice field. The authors propose the large amplitude of the viaduct displacement induced by the softening of the liquefied soil as one of the possible causes of the derailment. Other HSR infrastructures, conventional railways and roads were also affected by the earthquake and landslides accounted for an important part of the disruption

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (50)

Climate change and the railway industry: a review

Baker, C. J., Chapman, L., Quinn, A., and Dobney, K. (2010). "Climate change and the railway industry: a review." *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, SAGE Publications, 224(3), 519–528.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Climate change	➢ Rail	➢ Review

The paper discusses possible effects of climate change to rail infrastructure and operation. Hot dry summers, warm wet winters, increased frequency of extreme storms and sea level rise are considered. The authors observe the main effects are likely to be an increase in the track buckling problem, strain on railway drainage systems and the increased likelihood of disruption due to extreme weather events.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (51)

Climate change and the railway industry: a review

Baker, C. J., Chapman, L., Quinn, A., and Dobney, K. (2010). "Climate change and the railway industry: a review." *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, SAGE Publications, 224(3), 519–528.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Climate change	➢ Rail	➢ Review

The paper discusses possible effects of climate change to rail infrastructure and operation. Hot dry summers, warm wet winters, increased frequency of extreme storms and sea level rise are considered. The authors observe the main effects are likely to be an increase in the track buckling problem, strain on railway drainage systems and the increased likelihood of disruption due to extreme weather events.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (52)

A comparative study of bridge damage due to the Wenchuan, Northridge, Loma Prieta and San Fernando earthquakes

Wang, Z., and Lee, G. (2009). "A comparative study of bridge damage due to the Wenchuan, Northridge, Loma Prieta and San Fernando earthquakes." Earthquake Engineering and Engineering Vibration, 8(2), 251–261.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road	➢ Impact study

The paper discusses bridge damages caused by earthquakes. According to the authors, more than 400 bridges were damaged by the 2008 Wenchuan earthquake. The impacts of different earthquake effects and different bridge configurations are discussed, including: ground fault displacement induced damage, landslide-induced damage, unseating of near fault bridge spans and effects of complex bridge configuration and damage to bridge piers. The paper also compares provisions of Chinese and U.S. seismic design codes for the earthquake design force, unseating prevention and transverse reinforcement.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (53)

Seismic vulnerability of lifelines in the greater Lisbon area

Azevedo, J., Guerreiro, L., Bento, R., Lopes, M., and Proença, J. (2009). "Seismic vulnerability of lifelines in the greater Lisbon area." Bulletin of Earthquake Engineering, 8(1), 157–180.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail	➢ Impact report

The paper discusses the seismic vulnerability of lifelines, including roads and railways. Five damage states are considered for the transportation systems. Fragility curves are proposed to estimate the damage levels, similar to those proposed by HAZUS99. The HAZUS99 methodology is also adopted to account for damages induced by earthquake-triggered liquefaction and earthquake-triggered landslides. An application to the greater Lisbon area suggests that the damages to roads and rails (including bridges) are significantly influenced by the occurrence of liquefaction.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (54)

Measuring post-disaster transportation system performance: the 1995 Kobe earthquake in comparative perspective

Chang, S. E., and Nojima, N. (2001). “Measuring post-disaster transportation system performance: the 1995 Kobe earthquake in comparative perspective.” Transportation Research Part A: Policy and Practice, 35(6), 475–494.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road	➢ Performance assessment

The paper proposes summary measures of transportation system seismic performance. The methodology considers simple measures requiring readily available data on network configuration, damage, and pre-disaster origin/destination traffic.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (55)

Assessment and Mitigation of Liquefaction Hazards to Bridge Approach Embankments in Oregon

Dickenson, S. E., McCullough, N. J., Barkau, M. G., and Wavra, B. J. (2002). "Assessment and Mitigation of Liquefaction Hazards to Bridge Approach Embankments in Oregon." Report No. FHWA-OR-RD-03-04, Oregon Department of Transportation Research Group, Salem, Oregon and Federal Highway Administration, Washington, D.C.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail	➢ Damage Assessment

The report overviews current methods for estimating earthquake-induced liquefaction and discusses mitigation measures for bridge approach embankments. A catalog of selected case-histories is presented: each bridge in the catalog is assigned one of four subjective damage severity degrees. Data pertaining to seismological, geotechnical and structural are presented in order to facilitate the development of empirical guidelines for the identification of vulnerable foundation and bridge elements.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (56)

The January 17, 1994 Northridge, California Earthquake

EQE. (1994). The January 17, 1994 Northridge, California Earthquake, An EQE Summary Report. San Francisco, 1–66.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Airport	➢ Impact report

The report indicates the collapse of 11 road overpasses in some of the Los Angeles busiest areas with some disruptions extending beyond one month. The majority of the collapses are attributed to inadequate reinforcing and strength in older structures. In some cases, the ground accelerations exceeded those used in the design of new structures. The report further indicates that none of the retrofitted structures collapse. Airports were briefly closed and damages included broke glass panels of the control tower.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (57)

Evaluation of seismic damage to Memphis bridges and highway systems

Hwang, H., and Jernigan, J. (2000). "Evaluation of seismic damage to Memphis bridges and highway systems." Journal of Bridge Engineering, ASCE, 5(4), 322–330.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road (bridges)	➢ Fragility curves, PGD thresholds

The paper proposes a methodology for estimating seismic damage to bridges and highway systems in Memphis and Shelby County, Tennessee. Fragility curves are considered for a bridge classification system based on a bridge and highway inventory. The expected damage to bridges and highway systems is estimated for a moment magnitude of 7.0 considering the intensity of ground shaking and liquefaction-induced permanent ground deformation (PGD). The estimation of liquefaction induced damages considers PGD thresholds.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (58)

Damage caused to concrete structures along the Tohoku Shinkansen line and methods used to restore the damage

JR East. (n.d.). “Damage caused to concrete structures along the Tohoku Shinkansen line and methods used to restore the damage.” <http://www.jsce.or.jp/committee/concrete/e/newsletter/newsletter27/index_files/sperep.htm> (Mar. 1, 2012).

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Rail (HSR)	➢ Impact report

The report summarizes the damage caused by the Great East Japan Earthquake to concrete structures along the Tohoku Shinkansen line and the restoration works performed. The collapse of bridge beams was avoided and those bridge and piers that suffered damage could be restored quickly as a result of the program of seismic reinforcement implemented after the 2004 Mid Niigata Prefecture Earthquake. The majority of the damage is observed in viaduct columns and similar structures, at about 100 locations, displaced bridge girders, at 2 locations, and damaged support points for bridge girders, at 30 locations.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (59)

HAZUS Earthquake Loss Estimation Methods

Kircher, C. a., Whitman, R. V., and Holmes, W. T. (2006). "HAZUS Earthquake Loss Estimation Methods." Natural Hazards Review, 7(2), 45–59.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢	➢ Methodology overview

The paper establishes the background and historical perspective of the development of the earthquake loss estimation method HAZUS. Damage states are defined based on fragility curves. Transportation losses and utility lifeline losses are combined in one package with buildings- and essential facilities-associated losses. Ground shaking is characterized using peak ground motions and spectral response.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (60)

Estimation of Earthquake Loss due to Bridge Damage in the St .Louis Metropolitan Area I : Direct Losses

Luna, R., Hoffman, D., and Lawrence, W. T. (2008). “Estimation of Earthquake Loss due to Bridge Damage in the St . Louis Metropolitan Area . I Direct Losses.” Natural Hazards Review, 9(1), 1–11.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road (Bridges)	➢ HAZUS-MH

The paper estimates the earthquake-induced bridge damage using HAZUS-MH V1.0 (Hazards United States—Multi Hazard) developed by FEMA. Earthquake parameters, site class, and liquefaction data layers served as input to HAZUS-MH.
The study observes the majority of the damages are expected to occur in river crossings, old structures, and in East St. Louis.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (61)

Post-earthquake bridge repair cost and repair time estimation methodology

Mackie, K. R., Wong, J.-M., and Stojadinović, B. (2010). "Post-earthquake bridge repair cost and repair time estimation methodology." Earthquake Engineering & Structural Dynamics, 39, 281–301.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Bridges (Rail/road)	➢ Impact report

The paper proposes a improved methodology for developing probabilistic estimates of repair costs and repair times of seismically-induced bridge damage. The approach is based on the local linearization of the dependence between repair quantities and damage states, resulting in a model that follows a linear relationship between damage states and repair points. The methodology considers the damage and repair of individual bridge components and subassemblies.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (62)

The Niigata Chuetsu Earthquake —Railway Response and Reconstruction

Ogura, M. (2006). "The Niigata Chuetsu Earthquake —Railway Response and Reconstruction." Japan Railway & Transport Review, 43/44(March), 46–63.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Rail	➢ Impact report

The paper discusses the railway response and reconstruction to the Niigata Chuetsu Earthquake. Damages are observed for embankments, tunnels and bridges/viaducts. Damages to High-Speed Rail (HSR) tunnels include: (1) Fallen pieces of arch; (2) Separation in side wall (3) Upheaval of roadbed concrete; (4) Tilted concrete side walls of central passageway and(5) Cracks in some inverts. Damages to HSR bridges include: (1) Longitudinal reinforcement bars buckled and loosened (2) Cracks in concrete (3) Fallen concrete. Full HSR operation was restored in December 28, 2004 (the earthquake occurred on the 23rd of October, 2004). Damages to bridges and embankments of the conventional rail system are also discussed.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

pFact Sheet AllTraIn for WP1

Literature (63)

Damage to Bridges during the 2001 Nisqually Earthquake

Ranf, R. T., Eberhard, M. O., and Berry, M. P. (2001). Damage to Bridges during the 2001 Nisqually Earthquake, PEER Report 2001/15. 1–46.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail	➢ Estimation based on structure, hazard and location characteristics

The paper studies seismically-induced bridge damage, aiming at correlating damage with bridge and ground-motion characteristics. The following bridge characteristics are studied: latitude and longitude of the bridge, the type of bridge (e.g., movable, truss, etc.), the material used for the main span (reinforced concrete, prestressed concrete, or steel) and the year of construction. The corresponding values, for each bridge, of peak ground acceleration and the spectral acceleration were obtained from ShakeMaps developed by the Pacific Northwest Seismograph Network.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (64)

Quantitative vulnerability estimation for scenario-based landslide hazards

Li, Z. H., Nadim, F., Huang, H. W., Uzielli, M., and Lacasse, S. (2010). "Quantitative vulnerability estimation for scenario-based landslide hazards." Landslides, 7(2), 125–134.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Landslides	➢	➢ Vulnerability assessment

The paper presents a literature review on vulnerability to landslides and proposes a model for the vulnerability assessment of structures and persons. Vulnerability is considered the expected degree of loss resulting from a specific landslide.
The model defines vulnerability based on the landslide intensity and the resistance of the exposed elements.
The landslide intensity varies with velocity and debris depth of a landslide or the deformation of structures due to the landslide. The resistance reflects the ability of the exposed elements to withstand certain intensity. Four factors are used for assessing the resistance: foundation depth, structure type, maintenance state, and height.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (65)

Probabilistic landslide risk analysis considering direct costs in the area north of Lisbon (Portugal)

Zêzere, J. L., Garcia, R. A. C., Oliveira, S. C., and Reis, E. (2008). "Probabilistic landslide risk analysis considering direct costs in the area north of Lisbon (Portugal)." Geomorphology, 94(3–4), 467–495.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail	➢ Impact report

The paper analyses the landslide risk for roads and buildings in a 20 km2 north of Lisbon (Portugal). The vulnerability of these elements at risk is classified for 3 landslide groups considering: landslide magnitude (mean depth, volume, velocity); the damage levels produced by past landslide events in the study area; and literature. Vulnerability is considered the expected degree of loss resulting from a specific landslide. For each of the 3 landslide groups, a vulnerability map (values from 0 to 1) of the exposed elements is presented.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (66)

Significant Floods in the United States During the 20th Century - USGS Measures a Century of Floods.

Perry, C. A. (2000). "Significant Floods in the United States During the 20th Century - USGS Measures a Century of Floods." USGS Fact Sheet 024-00, <http://ks.water.usgs.gov/pubs/fact-sheets/fs.024-00.html>.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Flood	➢	➢ flood categorization according to origin

The fact Sheet reviews the major origins of floods in the United States: regional floods, flash floods, ice-jam floods, storm-surge floods, dam- and levee-failure floods and debris, landslide and mudflow floods. It is pointed out that most flood-related deaths are due to flash floods and fifty percent of all flash-flood fatalities are vehicle related. Thirty two of the most significant floods (in terms of number of lives lost and (or) property damage) in the United States during the 20th century are listed according to the various types of floods.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☐ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (67)

Assessment of damage in mountain tunnels due to the Taiwan Chi-Chi Earthquake.

Wang, W. L., Wang, T. T., Su, J. J., Lin, C. H., Seng, C. R., and Huang, T. H. (2001). "Assessment of damage in mountain tunnels due to the Taiwan Chi-Chi Earthquake." Tunnelling and Underground Space Technology, 16(3), 133–150.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road (tunnels) ➢ Rail (tunnels)	➢ Impact report

The paper discusses tunnel damages due to the magnitude 7.6 Taiwan Chi-Chi Earthquake in 1991. Investigations revealed that many tunnels were damaged to various extents. The paper indicates that among 57 tunnels investigated, 49 were damaged. The damage patterns are summarized based on the characteristics and the distribution of the lining cracks. The study considers geological conditions, design documents, construction and maintenance records of the tunnels for assessing the potential factors influencing the damage and the earthquake loading for the tunnels. The paper observes the degree of damage is influenced by the geological condition and by structural characteristics. Crossing of fault zones is certain to provoke damages. Additionally, the extent of geological weak zones, distance from the epicenter, and the existence of a slope face are considered important factors.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (68)

Quantitative assessment of direct and indirect landslide risk along transportation lines in southern India.

Jaiswal, P., Westen, C. J. V., and Jetten, V. (2010). "Quantitative assessment of direct and indirect landslide risk along transportation lines in southern India." Natural Hazards and Earth System Science, 10(6), 1253–1267.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Landslides	➢ Rail	➢ Risk assessment

An approach for quantitative assessment of direct and indirect landslide risk along transportation lines is proposed. Applications to a road and a railway in India are presented. An inventory of 901 landslides is catalogued is grouped into three magnitude classes based on the landslide type, volume, scar depth, run-out distance. Their probability of occurrence is obtained using frequency-volume distribution. The vulnerability of both the road and the railways is based on damage records and the vulnerability of vehicles and people was subjectively assessed based on historic data. The direct loss for the railway and road infrastructures, the vehicles (train, bus, lorry, car and motorbike) is assessed in US$. Life loss (also considered a direct loss) is assessed in term of the annual probability of death. Indirect specific losses are all the losses arising from service interruption and are assessed in US$.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (69)

Vulnerability Analysis of Transportation Network Under Scenarios of Sea Level Rise.

Lu, Q.-C., and Peng, Z.-R. (2011). "Vulnerability Analysis of Transportation Network Under Scenarios of Sea Level Rise." Transportation Research Record, (2263), 174–181.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Sea Level Rise	➢ Road ➢ Rail	➢ Impact report

The paper develops an accessibility-based approach to assess transportation network vulnerability under different sea-level rise scenarios. An application the south Miami area is presented, which, according to the paper, is among the world's top ten most vulnerable coastal cities. The results, accessibility reduction for sea-level rise scenarios, are discussed. Areas inundated correspond to 100% accessibility reduction whereas areas with some or no road affected have their accessibility reduced up to 30%.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (70)

Economic Principles, Issues, and Research Priorities in Hazard Loss Estimation

Rose, A. (2004). "Economic Principles, Issues, and Research Priorities in Hazard Loss Estimation." Modeling Spatial and Economic Impacts of Disasters, Y. Okuyama and S. Chang, eds., Springer, Berlin, 14–36.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ General	➢ General	➢ Discussion of loss assessment issues

The author identifies major issues for the quantification of economic losses from natural and manmade hazards. Basic principles such as double counting and direct/indirect effects are discussed. Current issues to the quantification include the non-market effects, timing and recovery, resiliency and public decision-making. Comprehensive hazard loss estimation methodologies are discussed.
The authors state that, in general, the sounder the data is, the more reliable the results are.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☐ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (71)

The Loma Prieta , California , Earthquake of October 17 , 1989-Highway Systems

USGS. (1998). “The Loma Prieta , California , Earthquake of October 17 , 1989-Highway Systems.” U.S. Geological Survey Professional Paper 1552: Performance of the Built Environment, M. Yashinsky, ed., U.S. Geological Survey, Denver, CO.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road	➢ Impact report

The report analyses the damages caused to highway systems by the Loma Prieta Earthquake.
Individual bridges are characterized along with the damages and the damage repair. Damages to roads, tunnels, culverts and earth-retaining structures are discussed.
The report indicates most bridge damage occurred due to construction over soft soils, in older bridges without post-San Fernando Earthquake seismic detail, site amplification contributed to damages far from the epicenter and most of the damage was the result of inadequately designed connection details. Landslides, liquefaction, and ground deformation that occurred caused substantial damages to earthworks. However, the cost of bridge damage far exceeded earthworks’, given the large costs of repairing or replacing the double-deck bridges.
According to the report, culverts and retaining walls, sustained more damage from soil movement and ground deformation, than from shaking, with the report stating that, in general, landslides were more damaging in cuts and while settlements were more damaging in embankments.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (72)

The Loma Prieta, California, Earthquake of October 17, 1989—Lifelines

USGS. (1998). "The Loma Prieta, California, Earthquake of October 17, 1989—Lifelines." U.S. Geological Survey Professional Paper 1552: Performance of the Built Environment, A. J. Schiff, ed., U.S. Geological Survey, Denver, CO.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Rail ➢ Airport ➢ Port	➢ Impact report

The report discusses the damages of the Loma Prieta Earthquake to lifelines, including airports, seaports and railways. The report concludes the most significant impact of the earthquake on airports was the damage to the runways due to liquefaction, stating that the intensity and duration of ground shaking in the earthquake at airports was just above the threshold for liquefaction of highly susceptible soils and that liquefaction should recur in future earthquakes that generate an equal or greater intensity and duration of ground shaking. Port damage was unevenly distributed. The primary cause of damage was liquefaction of the fill materials resulting in settlements. In one case settlement continued weeks after the earthquake. The report concludes that extensive earthquake damage to seaport facilities can be expected from settlement and soil liquefaction. Almost no earthquake damage was sustained by the rail systems in the San Francisco Bay region.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Literature (73)

Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR3 Technical Manual

FEMA. (2003). "Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR3 Technical Manual." Department of Homeland Security Emergency Preparedness and Response Directorate FEMA Mitigation Division, Washington, D.C.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Road ➢ Rail ➢ Port ➢ Airport	➢ Earthquake loss estimation

The manual describes the HAZUS-MH MR3 methodology for assessing earthquake losses, including to transportation systems. Fragility curves are used, considering soil amplification. Both ground shaking and ground failure are considered. The first is quantified with the estimation of the peak ground acceleration (PGA). Three ground failure mechanisms are considered (liquefaction, landslides and surface fault rupture), each quantified by permanent ground deformation (PGD). A database characterizing the infrastructure and the area to analyze in considerable detail is necessary, in addition to the characterization of the earthquake event itself.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant cited literature	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Projects (1)

Assessing Vulnerability and Risk of Climate Change Effects on Transportation Infrastructure-Hampton Roads Virginia Pilot

Virginia Department of Transportation, University of Virginia, Virginia Center for Transportation Innovation and Research, Hampton Roads Planning District Commission (2012?),32p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Weather Events** associated to climate change.	➢ **Transportation Infrastructure**- ➢ Roads ➢ Bridges ➢ Tunnels	➢ **Vulnerability and Risk Analysis** ➢ **General Model** for multicriteria decision analysis

The report describes how anticipated impacts of climate change on transportation infrastructure in the Hampton Roads of Virginia (U.S.A.) were assessed via a decision model to help prioritize elements of the region` long range strategic plan. The scenarios combine the conditions of climate change with several other types of conditions that could either increase or decrease the severity of the impacts (economic recession, national security events and population growth). The expected impacts include increased precipitation, extreme weather events, hurricanes, sea level rise and extreme heat days.
The report contains a detailed description of how to use the developed model. The model has been effective in education and training of officials and staff. The model supplements and complements on-going scientific engineering and planning effort to understand and recognize the possibilities for adapting to climate change in the transportation planning process.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ An interesting proposal for a model of decision.

Fact Sheet AllTraIn for WP1

Projects-(2)

Impacts of climate change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I

CCSP, 2008: Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I. A report by the US Climate Change Science Program and the Subcommittee on Global Change Research [Savonis, M.J., V.R. Burkett, and R.J.Potter (eds)] Department of Transportation, Washington DC, USA, 445 pp.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Weather Events** associated to climate change	➢ **Different transport modes.**	➢ AAA ➢ BBB ➢ CCC ➢ DDD

The report describes how climate change affects the design, construction, safety, operations and maintenance of transportation infrastructure and systems. The prospect of a changing climate raises critical questions regarding how alterations in temperature, precipitation, storm events, and other aspects of the climate, as the sea level rise, could affect the roads, airports, rail, transit systems, pipelines, ports and waterways. The report describes the impacts on the transportation system in a very specific area: the Gulf Coast in the U.S.A. The main goal is to incorporate climate change and weather variability in the transportation planning. The approach is based on the quantitative or qualitative assessment of exposure to potentially disruptive impacts, the vulnerability, the risk of loss, and possible adaptation strategies to mitigate the impacts and prolong the service.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☐ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ It is a very detailed and interesting Case Study.

Fact Sheet AllTraIn for WP1

Projects (3)

Fragility functions for railway system elements

Syner-g UE project, Deliverable D3.8 (2011), 47 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Earthquake.**	➢ Railway elements.	➢ Damage analysis (fragility curves).

The report focus on the assessment of fragility functions for railway network elements. The following components are considered: tunnels, embankments, trenches, slopes, tracks and bridge abutments. The report has four parts:1) a short review of past earthquake damages, the identification of main causes of damage and the classification of failure modes;2) identification of the main typological features of railway components description of existing methodologies, including damage states definitions and intensity measures;3) fragility functions for the components; and 4) summary of the proposed vulnerability functions.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Projects (4)

WEATHER PROJECT. Vulnerability of Transport Systems

Enei, R. et alli.,WEATHER-Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions. Deliverable 2.Main Report (2011), 120 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Extreme Weather Events**	➢ Road, railways, urban public transport, aviation, maritime transport and intermodal.	➢ Systemic risk assessment and damage costs evaluation.

The report describes research results on impacts of the various types of weather extremes on the different modes of transport. In the first part of the report the general accounting framework is introduced. Evidence from major climate models on the likely development of extreme weather events are discussed, and results on network critically modeling are also presented. In the second part the conclusions of the assessment of the extreme weather events for seven transport modes are briefly presented. For each of the main modes (road, rail, waterborne and air) three categories of damages were considered: infrastructures damages and impacts on infrastructure maintenance; vehicle fleet damages and impacts on costs of service provision; and user travel time costs and perceived service quality. The research concentrates on singular weather events which have considerable negative impacts on assets and operations, or which affect human health or lives. In terms of the cost assessment the total costs involved are estimated by the project team as about 2.5 billion euros yearly.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ An interesting report on Weather impacts and cost assessment of the associated damages in European zones.

Fact Sheet AllTraIn for WP1

Projects (5)

Weather hazards and vulnerabilities for the European transport system- a risk panorama

Molarius, R. et alli, EWENT project D5.1, VTT, Technical Research Center, Finland (2012), 95 p. plus 8 annexes.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Weather hazards.**	➢ Road, railway, air, sea and inland waterways.	➢ Risk and Vulnerability assessment.

This report estimates the risks of extreme weather events on the European transport system. The main object was to perform a risk analysis based on impact and probability assessments carried in earlier work packages. The results can be used as a starting point when deciding on the risk reduction measures, strategies and policies in the European Union. The methodological approach of EWENT is based on the generic risk management standard (IEC 60300-3-9) and starts with the identification of hazardous extreme weather phenomena, followed by an impact assessment and concluded by mitigation and risk control measures.
The risk assessment is based on a definition of transport systems` vulnerability to extreme weather events in different countries and on calculations of the most probable causal chains. According to the definition adopted, the vulnerability of a particular mode is a function of exposure, susceptibility and coping capacity. Based on this analytical approach, risk indicators for each mode and country are presented.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ A very interesting work with practical proposals for quantitative vulnerability assessments.

Fact Sheet AllTraIn for WP1

Projects (6)

Tunnel Safety

OECD Studies in Risk Management, Norway(2006),74 p.

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Fire in tunnels**.	➢ Road transport system.	➢ AAA ➢ BBB ➢ CCC ➢ DDD

The study would lay the ground for self-assessment and review of Norway`s risk management policies concerning fires in tunnels, with the objective of identifying and addressing current problems related to the balancing between risk (reduction) in the form of preventive, preparedness and response measures against fires and accidents involving dangerous goods and the desire to optimize the transportation of humans as well as goods in such traffic. The first part of the study reviews the lessons learnt from some important accidents that have occurred in tunnels and other underground transport systems in recent years. Safety management at the international level is analysed in the second part, and the third part examines the Norwegian situation and policy context, and the major challenges the country faces in the field of tunnel safety.

Relevance for AllTraIn WPs	☐ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Projects (7)

Weather hazards and vulnerabilities for the European transport system - a risk panorama

EWENT, Extreme weather impacts on European networks of transport, WP5, EU project (2012),

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ **Extreme weather events.**	➢ Several transport modes.	➢ Risk management.

The report estimates the risk of extreme weather on European transport system.. The main object of WP5 in EWENT project was to perform a risk analysis based on impact and probability assessments carried out in earlier work packages. The results of WP5 can be used as a starting point when deciding on the risk reduction measures, strategies and policies in E.U. The methodological approach of EWENT is based on the generic risk management and starts with the identification of hazardous extreme weather phenomena, followed by an impact assessment and by mitigation and risk control measures. The vulnerability of a particular mode in a particular country is a function of exposure, susceptibility and coping capacity. Risk indicators for each mode and country are presented. In general, countries with poor quality infrastructures combined with high transport volumes and population densities are naturally at most risk.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Projects (8)

SYNER-G: Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructures Safety Gain

Project Coordinator: Aristotle University of Thessaloniki (AUTH); **Partners:** Middle East Technical University, Karlsruhe Institute of Technology (KIT), Norwegian Geotechnical Institute (NGI), European Commission Joint Research Centre (JRC), Willis Group Holdings, Bureau de Recherches Géologiques et Minières (BRGM), Mid-America Earthquake Center, University of Pavia, Analysis and Monitorinf of Environmental Risk (AMRA, University of Naples), Sapienza University of Rome, VCE - Vienna Holding GmbH, University of Patras, Aristotle University of Thessaloniki, Research Center for Urban Safety and Security, (Kobe University). **From** 2009-11-01 to 2012-11-01. **Co-funded** by the European Commission under the 7th Framework Programme, Collaborative Project. **EU contribution**: EUR 3,500,000€

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquakes	➢ Rail ➢ Roads ➢ Port (harbor)	➢ Definition of Fragility Curves

The project focuses on the systemic seismic vulnerability and risk analysis of buildings, lifelines and infrastructures.
Seismic scenarios are defined and the vulnerability of the elements at risk is estimated. In order to achieve this, the physical vulnerability is defined through fragility curves, in a European context. The elements at risk include roads, rail systems and ports.
The project deliverables are available at the website http://www.vce.at/SYNER-G/

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ D2.6 ➢ D2.7 ➢ D2.13 ➢ D3.6 ➢ D3.7 ➢ D3.8 ➢ D3.9	➢

Fact Sheet AllTraIn for WP1

Projects (9)

Project Impact - A Partnership between King and PierceCounties, “Creating Disaster Resistant Communities”

FEMA. (2001). “Port-to-Port Transportation Corridor Earthquake Vulnerability Study.” *Project Impact - A Partnership between King and PierceCounties, “Creating Disaster Resistant Communities,”* Washington, D.C.,

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquake	➢ Roads (highways)	➢ AAA

The vulnerability of the transportation corridor between the Port of Tacoma and the Port of Seattle, United States, to Earthquake hazards is studied. Six earthquake scenarios are formulated by the USGS, including the definition of the epicenter, moment magnitude, site amplification and liquefaction hazards maps. The individual bridge and route performance is estimated for the six earthquake scenarios using HAZUS 99. This evaluates the direct losses by defining five bridge damage states related to the damage ratio (i.e. the repair-to-replacement cost). The HAZUS restoration curves are used to estimate the restoration time. An economic analysis is performed to estimate how the earthquake scenarios would impact local businesses and the regional economy.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ AAA ➢ BBB ➢ CCC ➢ DDD	➢ AAA ➢ BBB ➢ CCC ➢ DDD

Fact Sheet AllTraIn for WP1

Projects (10)

ShakeOut

Project Coordinators: Chief Scientist: Lucile Jones (USGS);Project Manager: Dale Cox (USGS); Staff Scientist/Writer: Sue Perry (USGS); Earthquake Design: Kenneth Hudnut (USGS); Secondary Hazards: Daniel Ponti (USGS), Michael Reichle (California Geological Survey) and Jerry Treiman (California Geological Survey); Physical Damages: Keith Porter (University of Colorado); HAZUS Loss Estimations: Hope Seligson (MMI Engineering) Emergency Response: Dennis Mileti (California Seismic Safety Commission), James Goltz (Governor's Office of Emergency Services) Health and Safety: Kimberley Shoaf (University of California, Los Angeles) Economics: Anne Wein (USGS) Richard Bernknopf (USGS) **Contributors:** Over 300. **Funding** for the HAZUS database enhancements and HAZUS runs was provided by the Governor's Office of Emergency Services. The SCEC ShakeOut Simulation Group was **funded** by NSF grants EAR-0623704 and OCI-0749313

	Which Threats?	Which Transport Modes?	Methodological Approach?
Content	➢ Earthquakes	➢ Rail ➢ Roads ➢ Port (harbor)	➢ Damage estimation for earthquake scenario

The project aims at to identifying the physical, social and economic consequences of a major earthquake in southern California, including to transportation systems. A magnitude (*M*) 7.8 earthquake on the southern San Andreas Fault is modeled. The following earthquake effects are accounted for: surface fault rupture, landslides and liquefaction. FEMA's HAZUS is used for loss estimation. The California Department of Transportation (Caltrans) estimates it will take up to seven months to restore highway segments affected by bridge damage, fault offsets, landslides and liquefaction for such an event. The physical damages to the rail infrastructure are discussed for the main lines. Small damages are estimated for the Port of Los Angeles and the Port of Long Beach, mainly due to the occurrence of liquefaction.

Relevance for AllTraIn WPs	☑ WP2 - Threats ☑ WP3 - Infrastructure ☑ WP4 - Assessment

Insert Names of relevant Reports	Comments
➢ Jones, Lucile M., Bernknopf, Richard, Cox, Dale, Goltz, James, Hudnut, Kenneth, Mileti, Dennis, Perry, Suzanne, Ponti, Daniel, Porter, Keith, Reichle, Michael, Seligson, Hope, Shoaf, Kimberley, Treiman, Jerry, and Wein, Anne, 2008, The ShakeOut Scenario: U.S. Geological Survey Open-File Report 2008-1150 and California Geological Survey Preliminary Report 25 [http://pubs.usgs.gov/of/2008/1150/].	

1. Analysis of Categories

Our first general query regards the categorization system used which is difficult to perceive: are the threats divided in categories related to the nature of the events or are they connected with the origin of each event? It was our understanding that, within each category, we should focus only on the final event (the threat itself) and not so much on the string of events that precedes it. Also, should the relevant different types of events be considered according to their specific characteristics?

The relevance of this issue can be illustrated by the following example: a flood is undoubtedly a threat for transport infrastructures but it can be the consequence of a weather event or a technological/man made event like a dam burst. This differentiation is important since similar events sometimes have different characteristics (predictability, intensity, etc) thus making it relevant to identify each threat according to its origin (albeit within the same category).

Nevertheless, by making an overall analysis of all threats presented and assuming this structure is the one agreed, we suggest the division into only 4 categories: man made – unintentional, man made – intentional, weather events and geohazards. The category "Telematics" should be included in the "Man made" categories since the origin of its threats are created and connected to human behavior. As for the threats classified in the "Climate change" category we believe they could be seen as weather related events thus avoiding the political and technical discussions about this topic. Alternatively still, an even broader category division could be developed: "man made" and "natural".

2. Analysis of threats

For the first category, "Man Made – unintentional" we suggest the inclusion of the following threats:

Threat	*Mode - Type of infra*				*Notes / (Examples)*
	rail	road	seaport	airport	
air traffic accident	x	x	x	x	external to the network (plane crash)
marine/fluvial traffic accident	x	x	x		external to the network (ship collision)
radiological release	x	x	x	x	(nuclear power plant accident or incident)

n our view the first two threats suggested are of great importance in Europe due to the large and growing air and ship traffic, especially fluvial. Although not only European countries have nuclear power plants, we think that the "radiological release" threat is of major importance and its impact on any transport infrastructure can affect several countries.

Within the categories "Man Made (unintentional and intentional)" we found two threats to be insufficiently described, which, in our opinion, can lead to a possible misunderstanding: we are referring to "tunnel collapse" and "bridge collapse". Firstly, with this document being a list of

threats for transport infrastructures the event “tunnel/bridge collapse” has always to be regarded as the likely consequence on the transport system of any possible threat and not as threat itself. On the other hand, we agree that these two threats can be preserved if the goal was to refer to the threat of a tunnel/bridge collapse due to construction or design flaws, thus finding a better designation. Following this argument, we have added a third threat resulting from any design or construction flaws promoted by inappropriate standards.

In addition to the inclusion of the threat “fire”, which we have understood as a fire in some part of the system associated with the transport network, we suggest the inclusion of “wildfire” as a fire located in the surroundings of the network.

In the area of “Telematics”, which in our opinion should be embedded in the “Man Made” categories, we could also include the threat of “Lack of an appropriate safety automatics system” that has proved to be a real threat, like in the latest Spain’s train accident.

We reckon “poor maintenance” as one of the major present threats for transport infrastructures. In our view it should be extended to the “Man Made – intentional” category in order to account for the lack of appropriate human or financial resources of transport infrastructure’s owners/stakeholders which result in reduced control operation and poor maintenance. We also think that inappropriate use of transport infrastructures can lead to cases beyond safety limits thus classifying as threats. Therefore, we have added the threat “unauthorized/unforseen use”.

In the category “Extreme weather” for which we have suggested the name “Weather events” in order to take in the threats classified as “Climate change”.

We wonder if the threat “flood” as an event induced by rainfall should be divided by types, such as: flash flood and slow river flood. We are presenting this idea for discussion as we are unsure of the level of detail intended.

Further weather events we found relevant are presented next:

Threat	*Mode - Type of infra*				*note*
	rail	road	seaport	airport	
fog	x	x	x	x	
hail	x	x	x	x	
strong winds	x	x	x	x	
extreme coldness	x	x	x	x	

Even though the two first threats (fog and hail) are often linked to traffic accidents, when severe, these phenomena can also lead to disruptions in the transport networks.

We have also moved the threat “tsunami” to a different category, because being a consequence of a seismic event it belongs in the “Geohazards” category rather than in the weather related events.

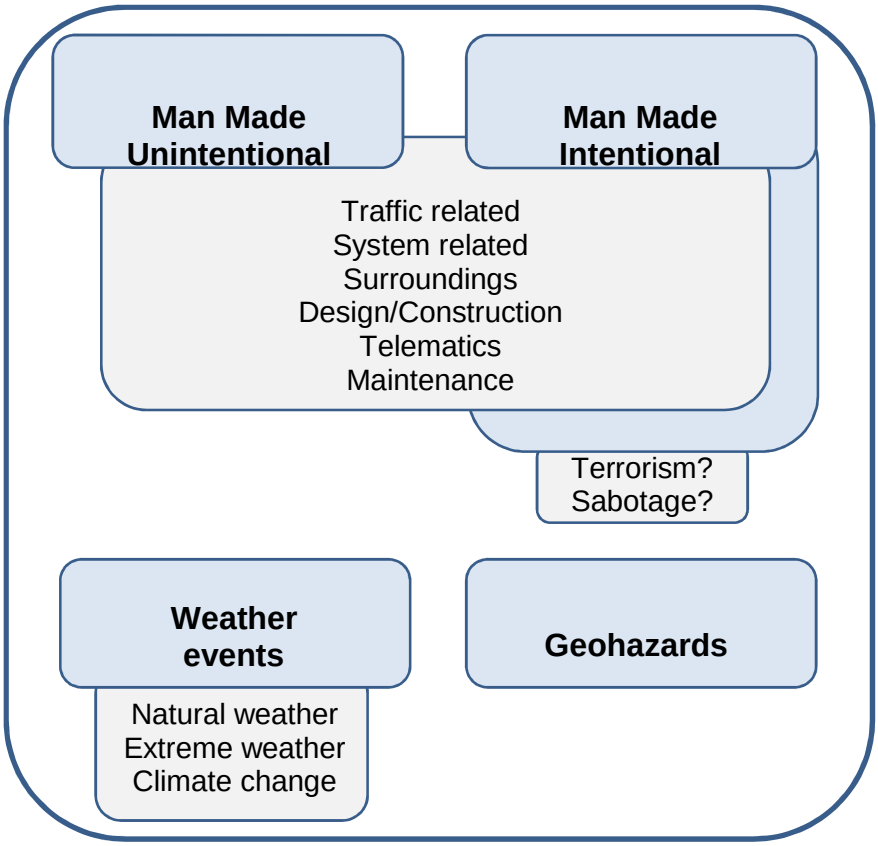
In the last category, “Geohazards”, we consider important branching the threat “landslide” in the particular events of avalanche and rockfall due its difference in nature and regional prevalence. Similarly, we suggest adding “ash cloud” due to its potential very far reaching impact, as opposed to the actual magma/debris flow, which should have a reduced impact on major European infrastructures (source example: http://www.volcanodiscovery.com/europe.html).

As previously discussed for the categories “Man made”, we too consider inappropriate the use of the designation “tunnel/bridge collapse” for this category, thus we suggest the term “seismic-geological fault”.

3. Other general remarks

As a result of all considerations presented previously, we suggest a simpler organization for the threat’s categories while retaining the structure already proposed. It is our better judgment that four main categories would translate a clearer approach for organizing all threats considered. For a better understanding of the modifications suggested, the schematic image shown below pretends to illustrate the major topics that fall under the four categories suggested.

It is important to stress that the threats we have added to the first category, and described in the previous chapter, were not placed in the “Man made – intentional” category because, in our view, all lie within the “terrorist act” or “sabotage” range. Furthermore, and following this argument, we would like to be clarified about the reasons that distinguish certain intentional threats from the “terrorist act”, namely: intentional traffic accident, intentional traffic incident, intentional fire/explosion.



For the purpose of the work development, that is the study of transport infrastructures' vulnerabilities, we would like to establish, if possible already in this document of WP2, two more columns for differentiate bridge and tunnel structures. Although this is not the main subject being discussed in the present document, we believe it can improve future work. We are hoping to analyze and discuss this idea with all participants in the next meeting.

Along with all the suggestions, we have added a few examples into the List. It is our belief that this improvement may render a better reading of events which are difficult to identify as threats.

We hope our remarks may add to an extensive discussion and ultimately to a more cohesive list.