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**Risk management framework for
inland transport of dangerous goods:**

**Decision-making for dangerous goods modal shift -
principles and specific implementation**

**Example illustrating the use of the
harmonised Guide for decision-making**

V1.0, August 2022, Annina Gaschen



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Part 1: Introduction

- Context
- Objectives of the risk study



Context: a typical decision-making case for national authorities

Guide for decision-making, chap. 2.3

Table 3. Risk management typology following the geographical scope and primary risk owner

		Typical geographical scope		
Typical risk owner	Local (vicinity of yards, multimodal platforms)	One route (absolute / comparative assessment, including potential comparison of different modes)	Several routes / regional network	Whole network for a given mode or for all modes (calculation of baseline risk)
	States or National authorities, National committees	Addressing Environmental Code requirements	Cases under Chapter 1.9 of RID, or justification of legal enforcement of a risk control measure	Addressing supervision of network safety performance/planning (e.g. CSM on supervision for railways, BasisNet type of approaches) or justification of legal enforcement of a risk control measure, e.g. including application of art 1.4 of 2008/68/EC



DG transport on Simplon pass

DG transport on both steep pass road and via rail tunnel.

Only Swiss pass road with DG transport (40t trucks, 30 trucks/day).

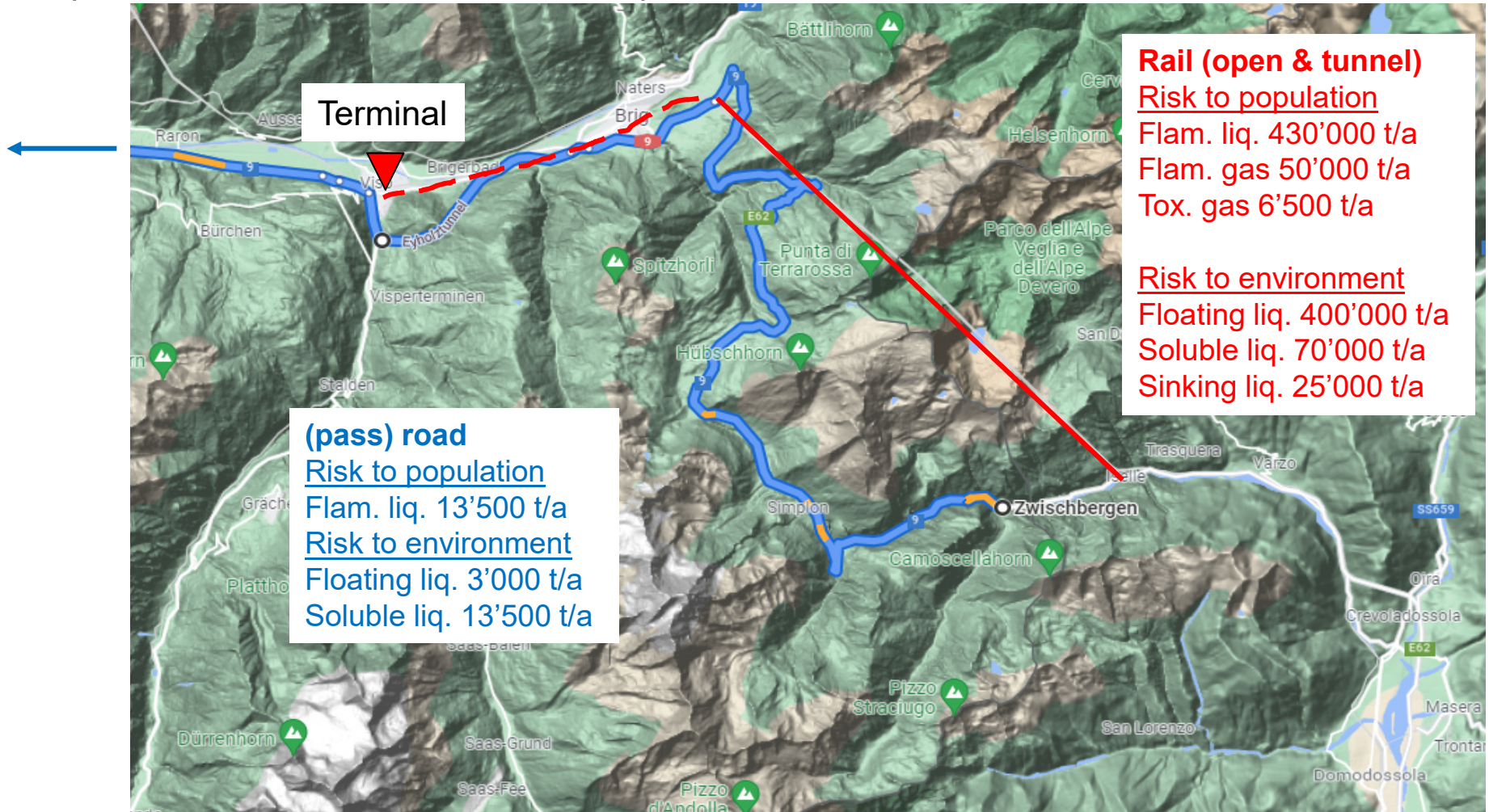
Road controls:
> 30% non-conformities,
2 trucks/week withdrawn
from circulation



Local situation

valley floor

alpine route





Description of a typical decision-making case for national authorities

Mission by parliament:

Analysis of the risk situation to provide a basis for decision-making before enforcing a transport ban for DG on this specific road section.

Goal of this study

- comparison of risk situations (population and environment)
- consequences on risk situation when a major part of DG is relocated to rail on a part of the route.



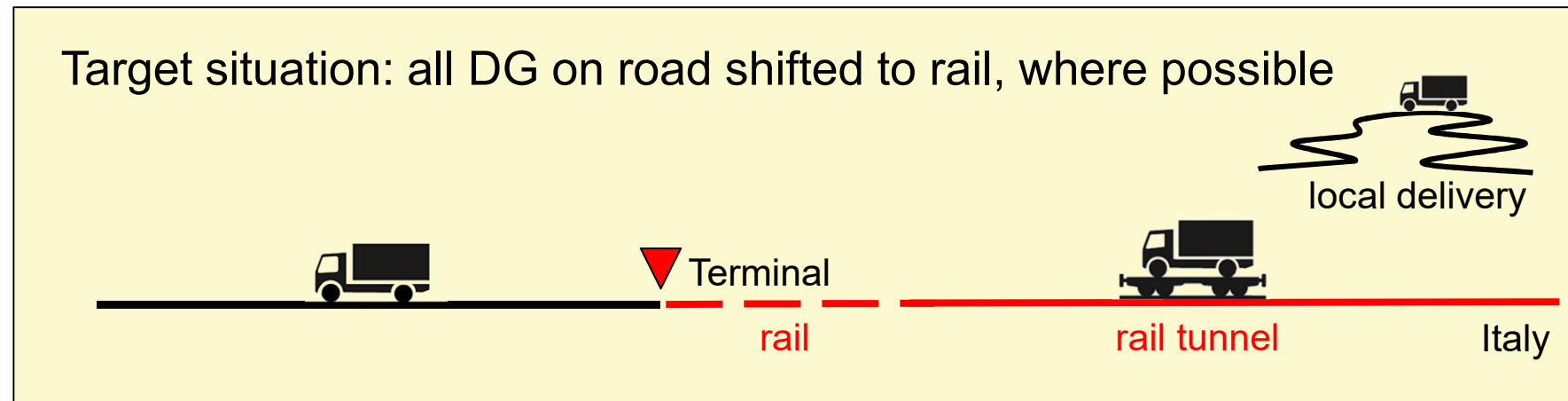
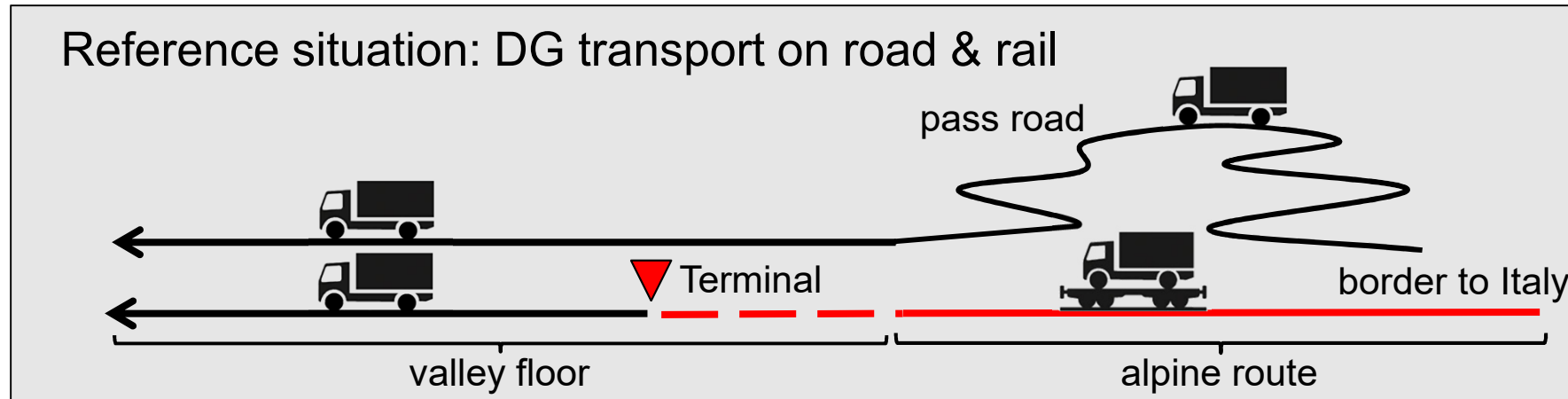
Part 2: Assessment of risks

- reference and target situation
- Infrastructure and operations
- dangerous goods: classes and quantities
- vulnerabilities
- results of risk calculation
- evaluation, comparison and monetarization



Description of **reference** and **target** situation & transport mode

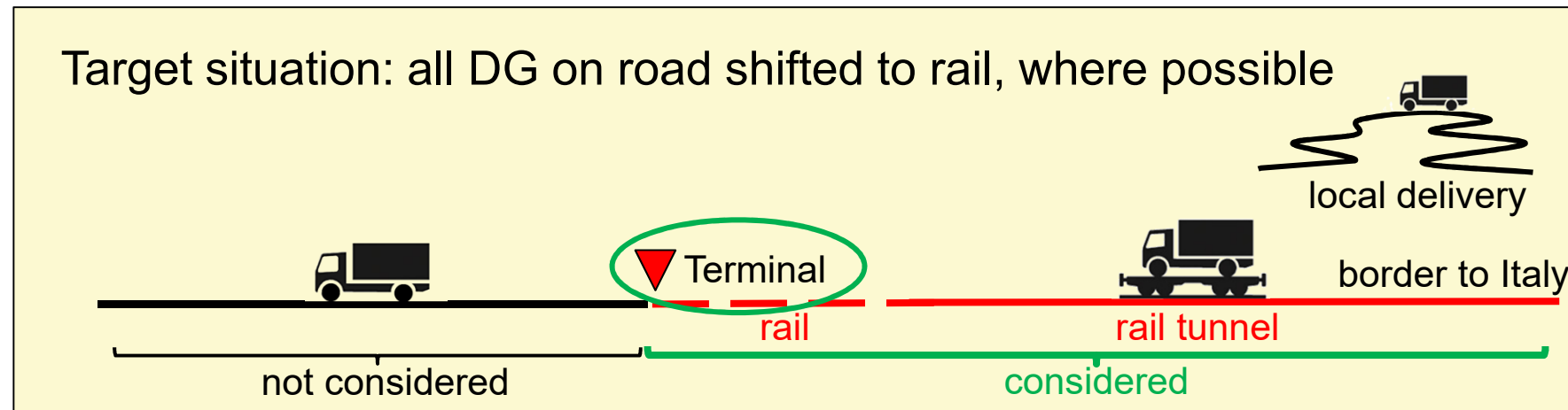
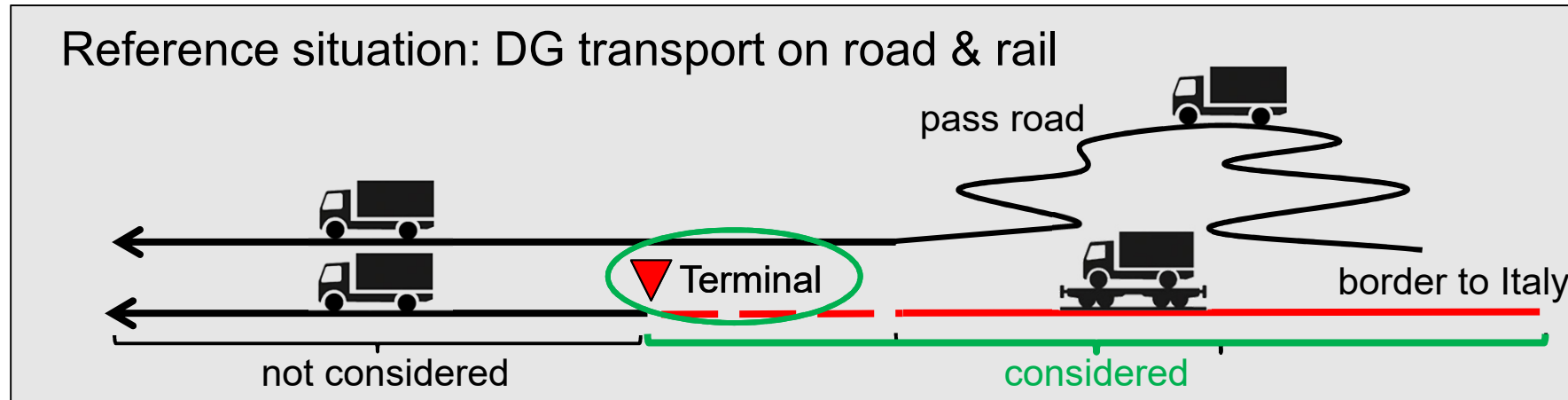
Guide for risk estimation, chap. 4.1 - 4.3





Route sections and activities considered

Guide for risk estimation, chap. 4.1 - 4.3





Activities/operations involved

- 1) Transport by road and rail on mentioned route sections
- 2) Shift from rail to road at terminal



Source: Wikipedia

Trucks loaded directly on the rail at a loading terminal (rolling load)



Description of DG on pass road, reference situation

Guide for risk estimation, chap. 4.1 - 4.3

DG categories	road 2018 [tons/year]	rail 2014 [tons/year]
Risk to population		
Petrol (flam. liq.)	13'552	426'461
Propane (flam. gas)	0	49'172
Chlorine (tox. gas)	0	6'527
Risk to environment		
Petroleum products (floating)	2'866	401'272
Epichlorohydrine (soluble)	13'486	69'596
Perchloroethylene (sinking)	0	25'426

remarkably high

→ Consider quality of transport data

- reliability
- actuality
- long-term data

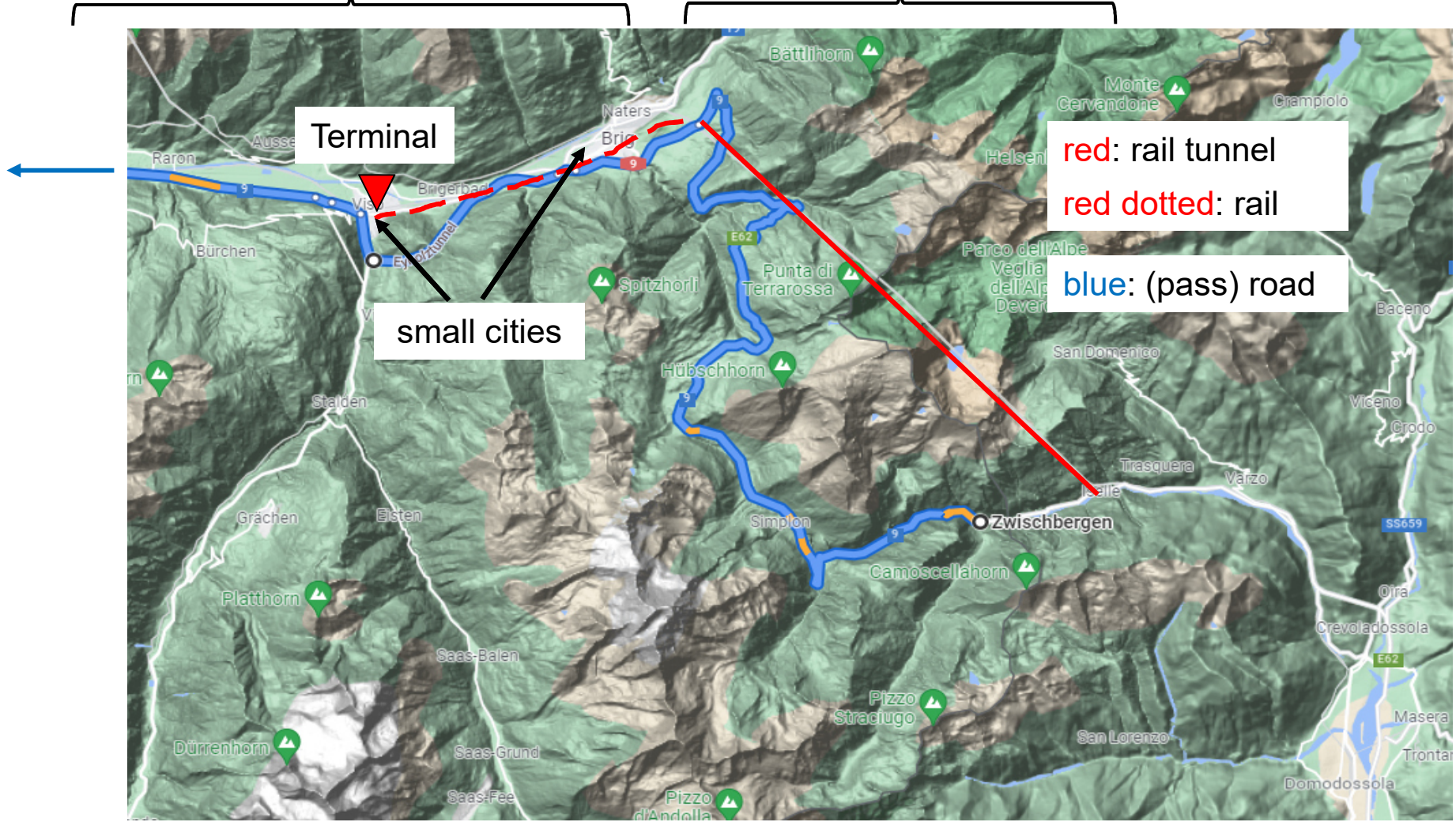


Characteristics of location, population

Guide for risk estimation, chap. 4.4

valley floor

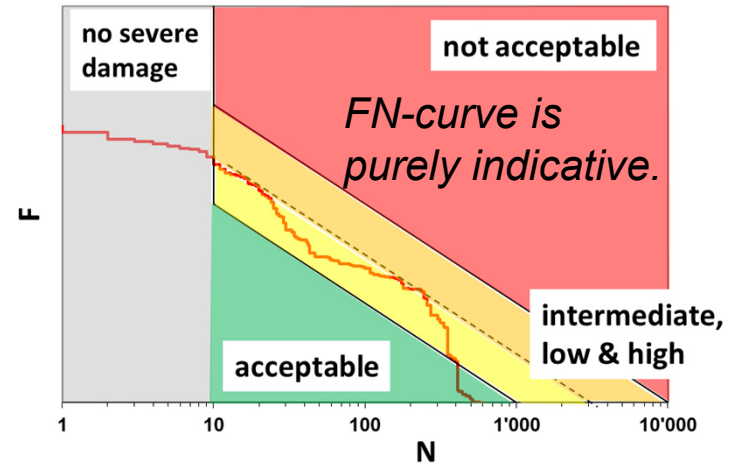
alpine route





Comparison of societal risks

Guide for risk estimation, chap. 2.4.7



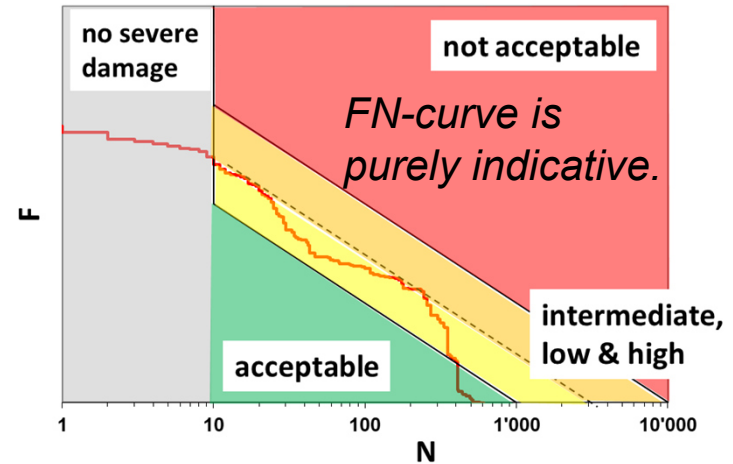
	Reference situation		Target situation	
	road	rail	road	rail
Alpine route (rail: tunnel)	acceptable	acceptable - intermediate low	acceptable	acceptable - intermediate low
Valley floor	acceptable	acceptable - intermediate low	acceptable	acceptable - intermediate low
Terminal	no severe damage (class 3 only, fire wall)			

→ No significant change of risk.
 → Modal shift from road to rail cannot be justified.



Comparison of risks to the environment (surface waters)

Guide for risk estimation, chap. 2.4.7



	Reference situation		Target situation	
	road	rail	road	rail
Alpine route (rail: tunnel)	intermediate high	not acceptable	acceptable	not acceptable
Valley floor	intermediate high	intermediate high	intermediate low	intermediate high
Terminal	no severe damage (drainage system with catch basin)			

- ➔ Significant decrease of risk on road.
- ➔ Risk on rail remains the same.
- ➔ Modal shift from road to rail is justified.



Monetized overall risk → Comparison of different categories of risk

[1] Define marginal costs for the damage.

- Societal risk: prevention of 1 fatality justifies allocation of 6.5 Mio CHF
- Environmental risk: prevention of polluted surface waters justifies allocation of 750 CHF/m².

[2] Sum up all route sections per transport mode for all risk categories.

Example of monetizing polluted surface waters:

	Route [km]	Ref. situation [m ² /a]	Targ. situation [m ² /a]	Δ [m ² /a]	Δ [%]	Monetized [CHF/a]
road	57	931	212	-719	-77	-539'250
rail	20	231	294	63	28	+47'250
total	77	1162	506	-656	-49	-492'000

→ Shift of DG transport from road to rail results in a monetized risk reduction for environmental risks of 0.5 Mio. CHF/a or 49%.



Conclusions

Perspective of risk

- Modal shift of all DG transport from road to rail is justified: Significant reduction of environmental risks on road, while minimal risk increase on rail.

Cost-benefit-ratio

- The benefit from modal shift (monetized risk reduction on road, CHF 0.5 Mio.) is higher than the costs (monetized risk increase on rail, CHF 48'000.-).

Shortcomings of this study

- Risk calculations are based on a weak data basis: Check data before imposing measures (e.g. quantity of DG)!
- Existing safety measures on road have not been considered in this study: retention basins, sewage pipes, guard rails etc. can additionally reduce risk.



Part 3: Decision-making

- decision-making principles
- documentation of risk assessment and decision-making



Decision-making, dealing with uncertainties

After completion of the risk estimation, the risks must be evaluated before decisions are made (e.g. for risk reduction measures). A risk estimation alone is not sufficient to make a decision.

A risk assessment will never be “accurate” in the sense that all parameters can be clearly determined or all facts are known. In the harmonised risk management framework RMF, these uncertainties can be taken into account, if they are described and analysed.

The following categories can be used to describe the relevance of such uncertainties to the risk situation:

- a) risk is small and controlled
- b) risk is substantial but can be controlled and managed
- c) risk is substantial and/or unknown



Decision-making principles

Guide for decision-making, chapter 3.2

In the harmonised RMF, risk-based decisions are based on the following decision-making (DM) principles

1) Existing system safety is not reduced

Any change made to technical, human and operational systems shall not introduce new uncontrolled safety risks.

2) Continuous safety improvement

Requirement over time to reduce risks as far as is reasonably practicable.

3) Utility for society

Achieve a reasonable proportionality between advantages/benefits for society and disadvantages/costs/risks arising from DG transport

4) Fair treatment of individuals and groups of individuals

Identify all individuals/groups that are concerned and compare their exposure to risk (individual risk). Risks should not be unduly concentrated on or transferred onto particular individuals or communities.


5) Avoidance of uncontrolled risk transfer

Risk control measures can have unexpected consequences.





Compliance with decision-making principles

The following slides show how the dangerous goods modal shift on the Simplon pass route is examined and evaluated according to the five DM principles:



Decision-making principles	Reference situation versus Target situation
<p>1) Existing system safety is not reduced</p> 	<p>Qualitative:</p> <ul style="list-style-type: none">• The modal shift did not involve any changes to technical, human and operational systems. Thus, no new uncontrolled risks are introduced. <p>Quantitative:</p> <ul style="list-style-type: none">• F/S-curves of societal risk show no significant increase due to the modal shift.• F/S-curves of environmental risks show decrease of risk on road. <p>→ Decision-making principle is fulfilled.</p>





Compliance with decision-making principles

Decision-making principles	Reference situation versus Target situation
<p data-bbox="353 533 748 624">2) Continuous safety improvement</p> <div data-bbox="495 660 831 807"></div>	<p data-bbox="981 533 1196 571">Qualitative:</p> <ul data-bbox="981 592 1877 906" style="list-style-type: none"><li data-bbox="981 592 1877 735">• Enforcing transport ban for dangerous goods on this specific road section ensures that risk remains low.<li data-bbox="981 762 1877 906">• The survey of dangerous goods risks on the rail network is regularly updated. Any increase in risk will be detected. <p data-bbox="981 932 1727 975">→ Decision-making principle is fulfilled.</p>

Compliance with decision-making principles

Decision-making principles	Reference situation versus Target situation
<p data-bbox="376 475 741 518">3) Utility for society</p> <div data-bbox="495 635 831 778"></div>	<p data-bbox="1003 475 1220 518">Qualitative:</p> <ul data-bbox="1003 534 1877 970" style="list-style-type: none"><li data-bbox="1003 534 1877 630">• The disadvantages mainly arise from the implementation of a transport ban on road.<li data-bbox="1003 646 1877 805">• Acceptance of modal shift within local population is controversial, several interest groups are involved.<li data-bbox="1003 821 1877 970">• The benefits are to satisfy societal needs (transport of DG still possible) and reduce water pollution along the road. <p data-bbox="1003 997 1906 1189">→ The acceptance of a transport ban of DG on road is subject of current political discussion and negotiation between industry and local authorities.</p> <p data-bbox="1003 1212 1906 1308">Thus, fulfillment of this DM principle has not yet been conclusively assessed.</p>

Compliance with decision-making principles

Decision-making principles	Reference situation versus Target situation
<p>4) Fair treatment of individuals and groups of individuals</p> 	<p>Qualitative:</p> <ul style="list-style-type: none">• No new groups of individuals are exposed to risk.• Risk is reduced for individuals living along the mountain pass road. <p>→ Decision-making principle is fulfilled.</p>
<p>5) Avoidance of uncontrolled risk transfer</p> 	<p>Qualitative:</p> <ul style="list-style-type: none">• The survey of DG risks on rail and road is regularly updated.• Any increase in risk will be detected. <p>→ Decision-making principle is fulfilled.</p>



Recording implementation of a DM process

According to the harmonised RMF, the following records are required for a complete/transparent documentation of the decision-making process:

Guide for decision-making, chapter 5



5. Recording implementation of a DM process

Guidance to the user on recording the application of the DM process to any DM case is set out for each step:

- ▶ triggering the DM process ([Section 5.1](#))
- ▶ description of the DM reference situation ([Section 5.2](#))
- ▶ risk estimation step ([Section 5.3](#))
- ▶ assessing against the DMPs ([Section 5.4](#))
- ▶ validation of the optimised risk-based future situation ([Section 5.5](#))
- ▶ ending the DM-process ([Section 5.6](#))
- ▶ quality of decision-making ([Section 5.7](#))
- ▶ communication activity ([Section 5.8](#))



Recording implementation of a DM process

The following records are required for a complete, traceable and transparent documentation of all considerations made in the decision-making process (part 1):



Requirement: provide recording of ...	Implementation in this use case
... the trigger(s) of the DM process <ul style="list-style-type: none">• Description• Assessment• Information sources	<ul style="list-style-type: none">• Road controls reveal non-conformities: slide 5• Elevated risk: slides 14&15• Annual record of DG transport quantities → Improvement of environmental risk situation needed
... the description of the DM reference situation	<ul style="list-style-type: none">• Description of the local situation, activities and operations: slides 9-11• Risk owner: infrastructure manager• Concerned decision makers: national & local authorities, political entities
... of the risk estimation step	Technical reports, risk assessment according to harmonised risk estimation guide or other RE method which complies to the RMF



Recording implementation of a DM process

The following records are required for a complete, traceable and transparent documentation of all considerations made in the decision-making process (part 2):



Requirement: provide recording of ...	Implementation in this use case
... of the assessment against the DMPs	As described on slides 16-19.
... of the validation of the optimised future situation	Validation is the weighing of the DM principles on a meta-level: Arguments for and against planned risk reduction measures and their practicability.
...of the ending the DM-process	A suitable recording could be e.g. a formal conclusion of the national authorities on the future improvement of the risk situation.
... quality of decision-making	See next slide. Nine quality objectives have been defined in the RMF.
... of the communication activity	Press releases by e.g. Parliament and National Authorities Technical reports (when published)



5.7. Recording the quality of decision-making

A record of the quality of the decision-making with respect to the nine quality objectives (from [Section 2.5](#)) should be established as follows:

Quality objectives	Measures used for achievement	Assessment of achievement
RMO1. Consider compliance with legal requirements as a minimum standard		
RMO2. Manage risks in accordance with best practice (including the management of uncertainties)		
RMO3. Inform and involve all concerned parties about the risk situation as required		
RMO4. Reduce the risk level if economically practicable and proportionate to the issue to be solved		
RMO5. Identify whether the risk situation can be addressed appropriately by the primary risk owner alone		
RMO6. Avoid solutions involving uncontrolled risk transfer		
RMO7. Ensure risks at all levels are monitored on a regular basis		
RMO8. Evaluate whether the solutions implemented deal sufficiently with the risk situation that has been identified		
RMO9. Separation of risk management duties		

Template from Guide for decision-making chapter 5, to record the quality of DM

Overall assessment of quality of decision-making: