



Addressing the environmental impact of salt use on the roads



PROVINCIA AUTONOMA DI TRENTO





CELAN-ROADS: the actors



Initiative co-founded by the LIFE+ program of the European Commission



Autonomous Province of Trento - Coordinating Beneficiary

- Road Management Service
- Weather Service
- Environmental Protection Agency



Famas System - Associated Beneficiary n.1



TIS innovation park - Associated Beneficiary n.2



CLEAN-ROADS in a glance



Environmental problem targeted

De-/anti icing chemicals used during **winter road maintenance operations** have a negative impact on the surrounding environment, with short- and long-term damages to:

- the aquatic systems
- the vegetation
- the air quality
- the wildlife
- the human health
- the road infrastructure
- the vehicles



Source: Province of Trento

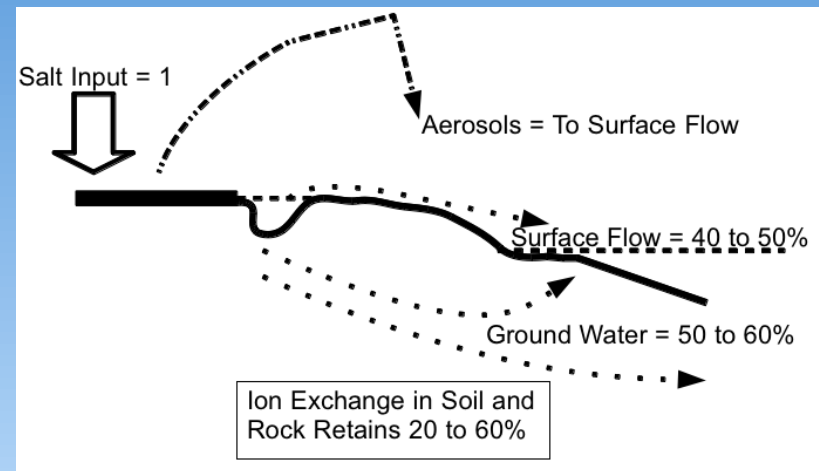


CLEAN-ROADS in a glance



Environmental problem targeted

- more than 50% of salt used for de-icing purposes is typically dispersed through **aqueous solutions**
- sodium chlorides affect surface water, percolate through the soil, and reach the **groundwater aquifers**, with a potential damage that is detectable for several hundreds of meters from treated road
- salt can also be dispersed in **solid form**, remaining on the road surface or getting plowed into the adjacent snow banks.
- small fraction of salt can also be launched as **aerosols** by traffic or wind, landing in snow banks or on nearby vegetation in a region up to 100 meters.



Source: "Maine Winter Roads: Salt, Safety, Environment and Cost" (2010)

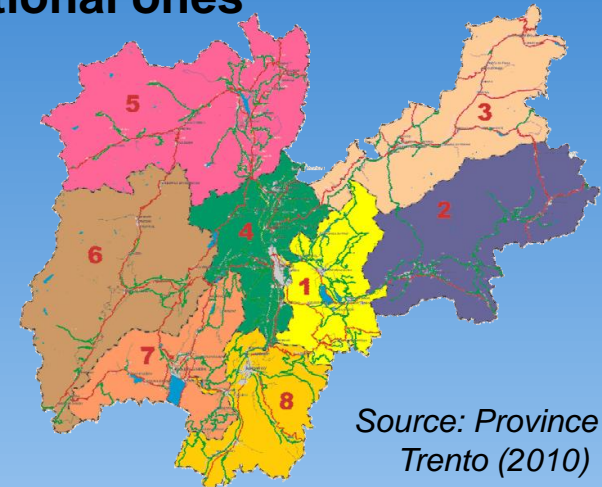


CLEAN-ROADS in a glance

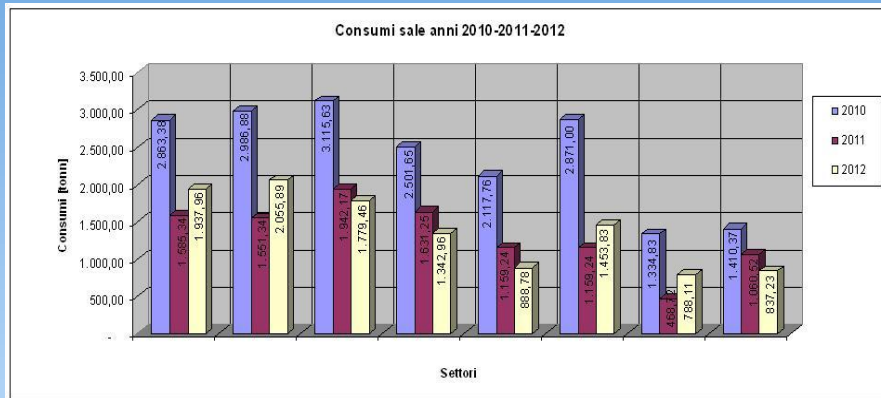


The state-of-art in the Autonomous Province of Trento (PAT)

- Being an autonomous region, the PAT is in charge not only of the maintenance of the **local roads**, but also of the **national ones**
- The whole road infrastructure managed by the PAT extends for about **2,445 [km]**. The **10%** of the network is characterized by an **Average Daily Traffic (ADT)** of more than **10,000 vehicles**



Source: Province of Trento (2010)



Source: CLEAN-ROADS consortium

- **Sodium chloride (NaCl)** is the most used de-icing chemical to prevent ice formation, with consumptions that can reach up to **20.000 tons** for winter season



The state-of-art in the Autonomous Province of Trento



- The **regional winter road maintenance service** avails of:
 - about 250 winter maintenance vehicles
 - about 280 operators, divided in around 45 teams
- An **extraordinary monitoring activity** is organized during each winter season. **Road operators** are in turn requested to control the meteorological conditions at night and during the weekend, and to alert their colleagues in case of emergency
- A **reference emergency coordination plan**, shared among different public organizations, has been introduced for the definition of the specific procedures to be followed in the case of intense snow events



Source: Province of Trento



CLEAN-ROADS in a glance

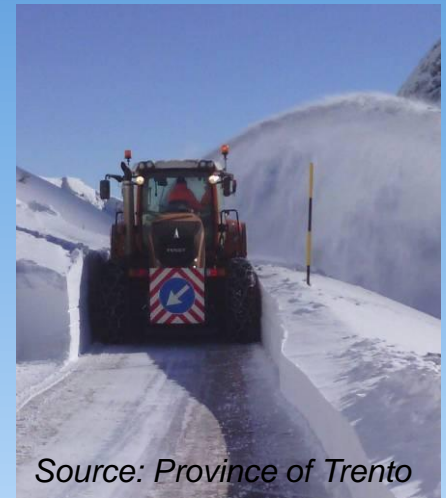


The vision of the CLEAN-ROADS project

The aim of the project is to demonstrate that is possible to:

Reduce the environmental impact of winter road maintenance service, through a **more efficient management of the available resources**, and all this by ensuring the **same level of winter road safety**

- In order to achieve this, a demonstrative advanced **Road Weather Information System (RWIS)** combined with a **Maintenance Decision Support System** will be introduced. The (MDSS) will be able to automatically:
 - gather real-time data about road weather conditions
 - process the collected data in order to determine the actual road conditions
 - compute short-term forecasts
 - provide a quantitative support in the decision-making process concerning road treatments



Source: Province of Trento



The triple innovation introduced

Technological innovation

Introduction and validation of an **integrated RWIS** and **MDSS**, capable to automatically provide user-friendly recommendations, information and alerts to road operators about the current and forecasted road weather situation

Organizational innovation

Improvement of the current winter road management organizational structure

Social innovation

Cooperation with the target audience, which are road operators and local road travellers

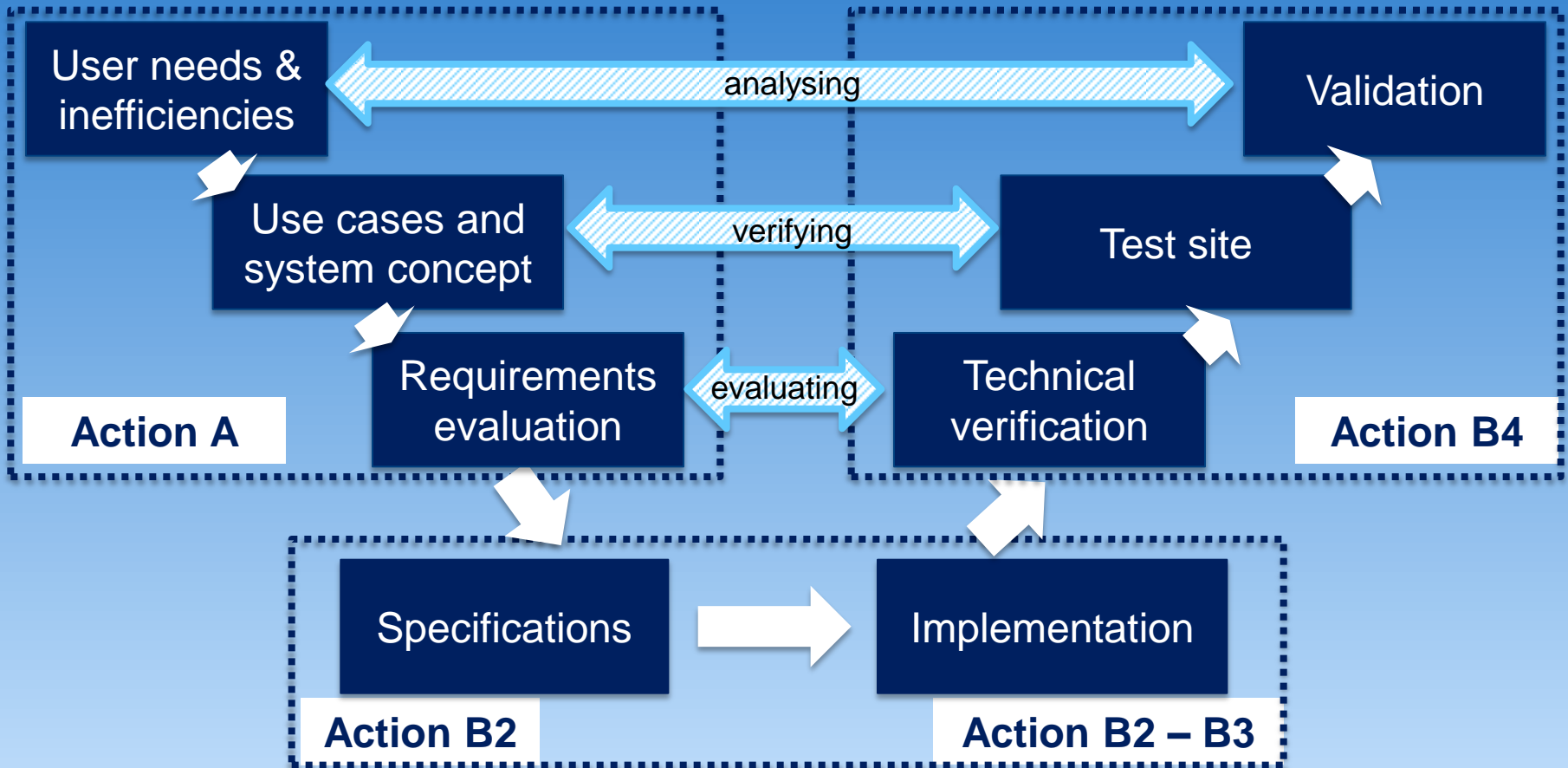




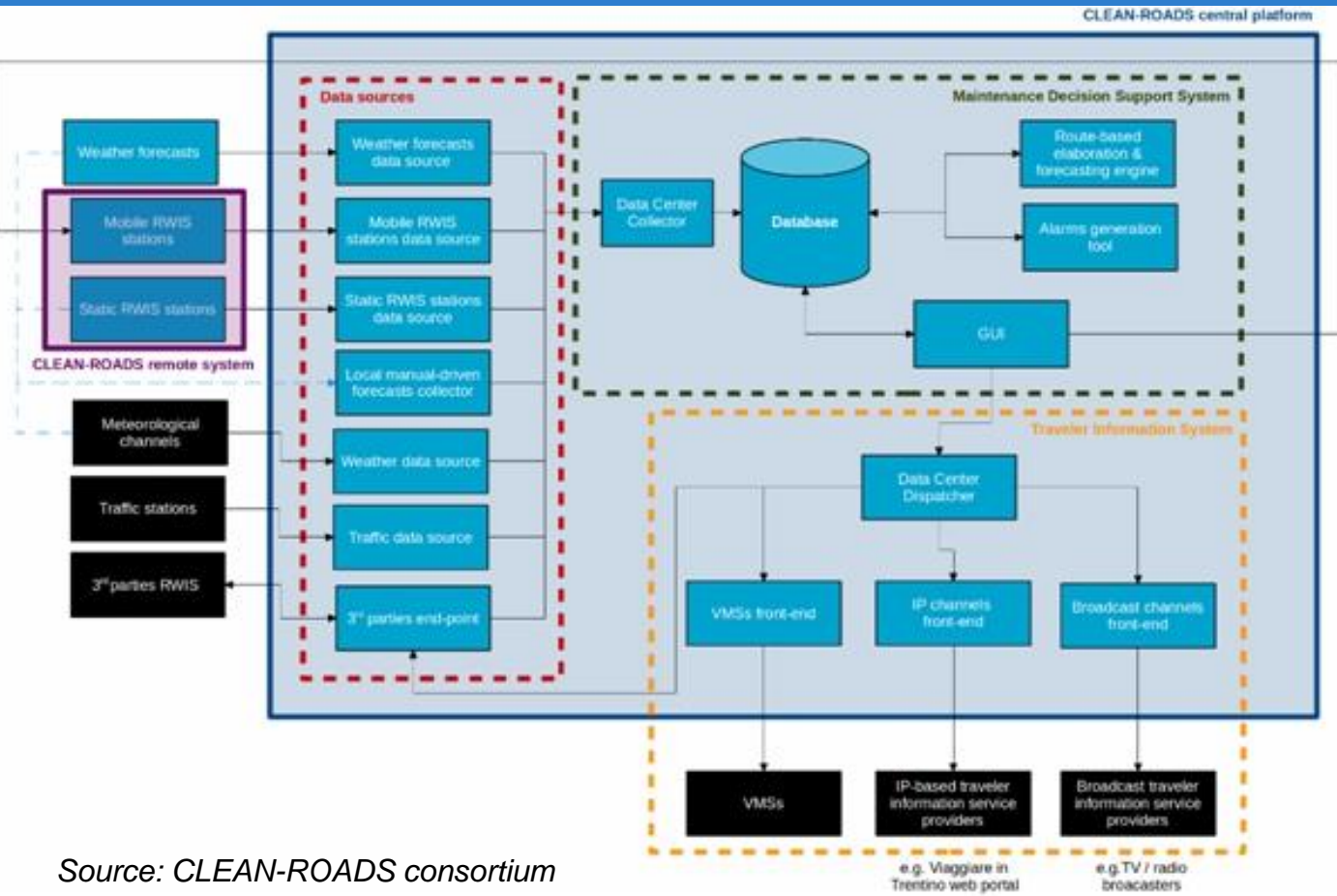
The V-model approach



The technical part of the project follows a typical V-model engineering approach.



CLEAN-ROADS proposed system architecture



The most interesting elements are:

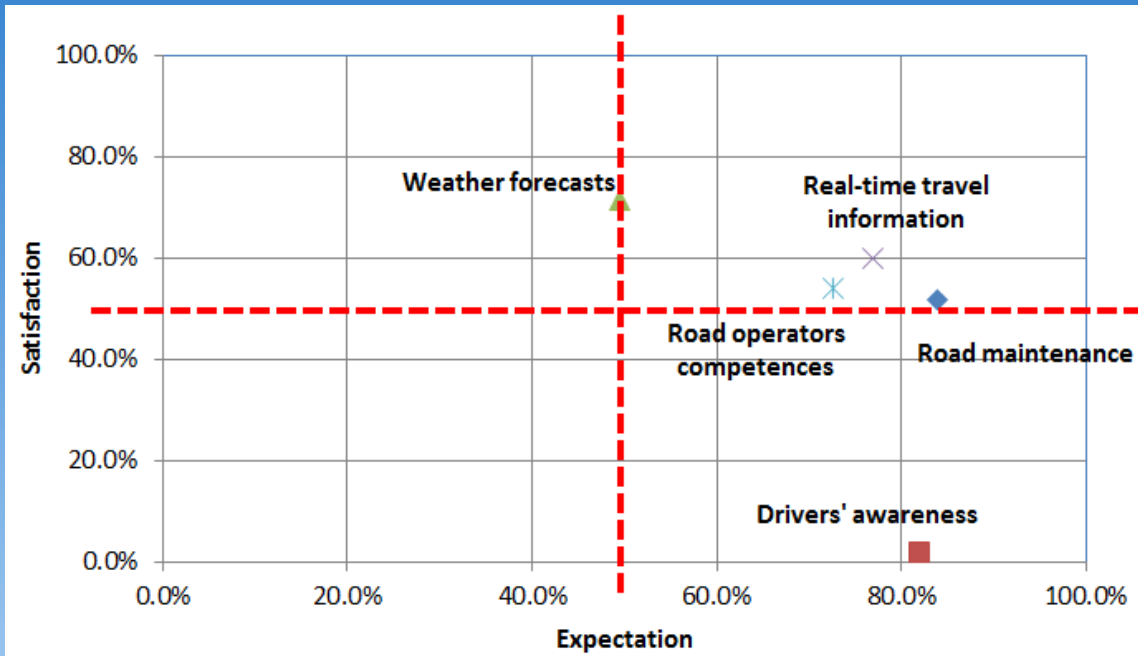
- efficient combination of data gathered by **fixed stations** and **mobile probe vehicles**
- **route-based** elaborations and **forecasts**
- **tailored** (non-probabilistic) **weather predictions**
- full integration with other **ITS systems**
- full integration with an **advanced ATIS**



User needs and inefficiencies



Customer Satisfaction Analysis



Source: CLEAN-ROADS consortium

Expectation towards the local road maintenance service:

- much **higher** in users in which the **relationship** with the private car is **weake**
- the general **opinion** is that most of the observed **inefficiencies** is related to the **inexperience** and the reduced preparation **of road travellers**

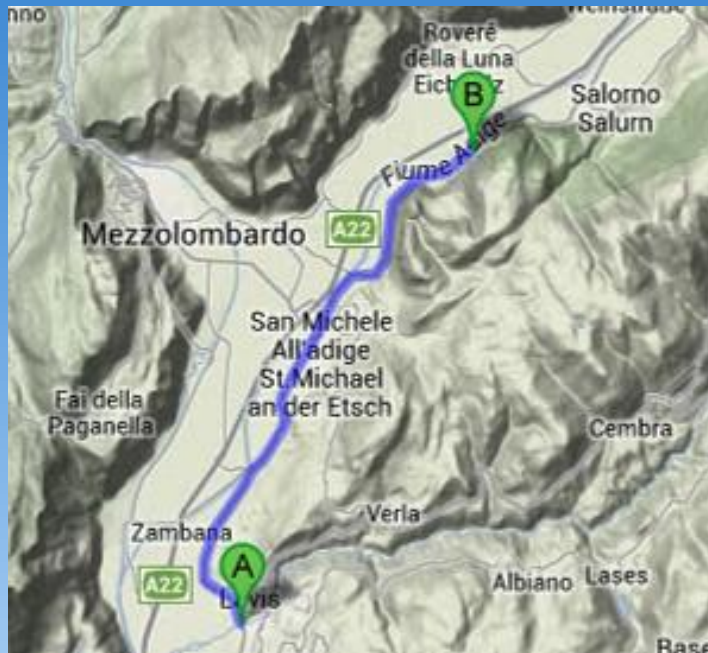


The field operational test



The selected route: a stretch of route SS12

The first RWIS and environmental monitoring station



Source: Google maps



Source: CLEAN-ROADS consortium

The environmental impact evaluation



Water quality monitoring system:
chloride concentration in the superficial runoff with evaluation of consequences for biotic component



Air quality monitoring system:
PM10 concentration through gravimetric standard



Road weather monitoring station



Road sensors:
temperature and salinity



Present weather sensor; *wind speed and direction sensor*



Air temperature and humidity sensor; *global radiation sensor*



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Thermal mapping



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Thermal mapping survey



Project plan



Winter season	Activity set	Monitoring phase
Winter season 2012/2013	<ul style="list-style-type: none"> the winter road maintenance procedures are empirically evaluated; a comparison with a first reference dataset is performed, consisting of: <ul style="list-style-type: none"> traffic data measured in correspondence of the test site; meteorological data and forecasts 	Ex-ante evaluation (part 1)
Winter season 2013/2014	<ul style="list-style-type: none"> a first complete data collection campaign is carried out, availing of: <ul style="list-style-type: none"> the first complete roadside road weather station; the mobile probe; first test sessions of the CLEAN-ROADS components are performed, in particular different road weather models will be tested on top of the available field measurements 	Ex-ante evaluation (part 2)
Winter season 2014/2015	<ul style="list-style-type: none"> the whole CLEAN-ROADS system is tested, calibrated and technically validated; the road operators start to consider the data and the information provided by the MDSS, but in a unstandardized way 	Progress evaluation
Winter season 2015/2016	<ul style="list-style-type: none"> the CLEAN-ROADS system is finally evaluated and demonstrated through the introduction of optimized and standardized winter maintenance procedures 	Ex-post evaluation



Conclusions



Novelty of the CLEAN-ROADS project:

- its **location**
- **multi-disciplinary** approach
- investigation of the **local concerns** related to the **environmental impact** of salting treatments

CLEAN-ROADS objectives:

- specifically understanding if and how **technological solutions** such as a MDSS can lead in a particular environment to an optimal use the available resources through an evolution of the already well-structured winter road management organization
- activating a process towards **local travellers** for decreasing their actual expectations
- involving the **end-users** in the system loop in order to reach a more effective balance point between users' expectation and levels of service





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Thanks for the attention



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