Cost-benefit analysis of road weather stations on highways

M.Eng. Markus Streich

Regional council (Regierungspräsidium) Tübingen

Germany

markus.streich@rpt.bwl.de

Prof. Dr.-Ing. Christian Holldorb

Faculty of Architecture and Construction Engineering

Hochschule Karlsruhe – University of Applied Sciences Germany

christian.holldorb@hs-karlsruhe.de

0. CONTENT

This presentation is based on parts of the research project carried out at the request of the Federal Ministry for Transport, Building and Urban Development, represented by the Federal Highway Research Institute, under research project no. 04.0245/2011/KRB. The authors are solely responsible for the content.

1. Introduction

- Road weather stations (RWS) are important tools for the detection of wintery road and weather conditions
- RWS enable the operators to react in time and according to the requirements during winter services
- Status quo in Germany: RWS are mainly used on motorways and multi-lane highways
- Concentration of RWS on other highways and subsidiary roads is much lower
- A equally high concentration of RWS is restricted by economical and organisational reasons

1. Introduction

The objective of the research was to:

•simplify the collection of road and weather condition data

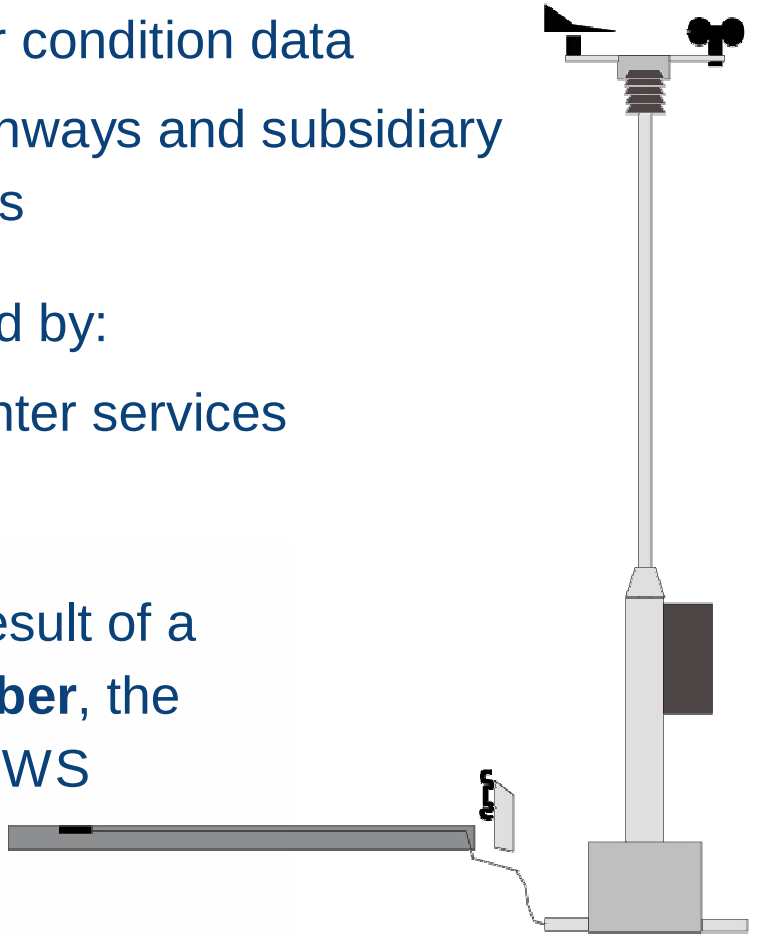
•facilitate the concentration of RWS on highways and subsidiary roads under economically acceptable terms

The cost-benefit relation of RWS is affected by:

•the use of each sensor in daily work of winter services

•the cost of the equipment

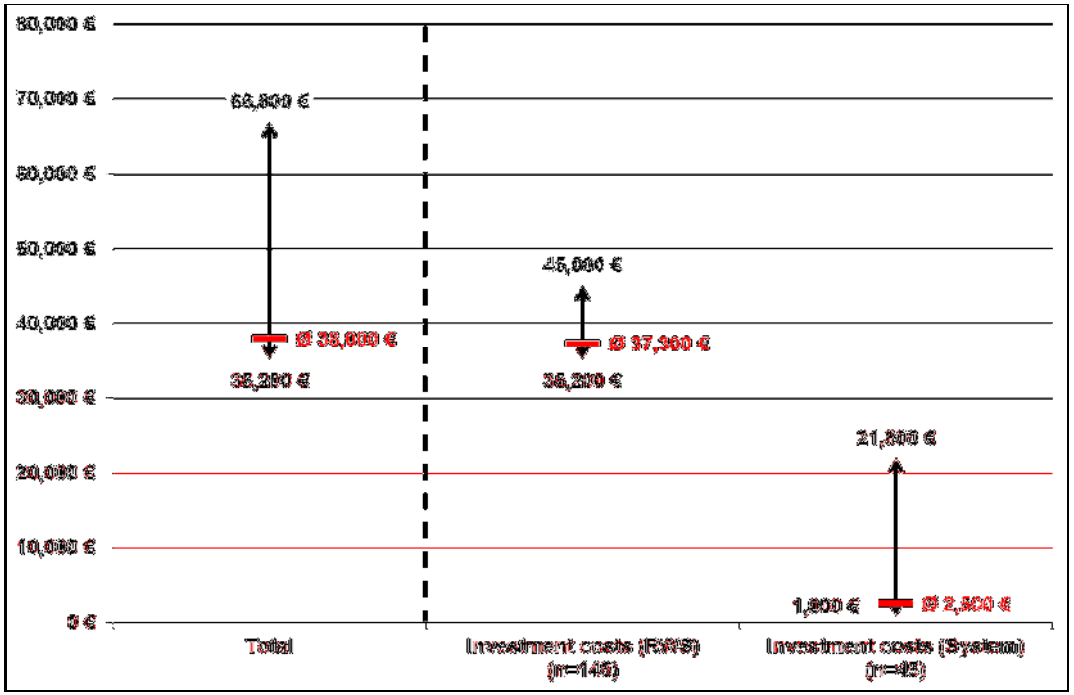
→ A higher cost-efficiency could be the result of a differentiated coordination on the **number**, the **equipment** and the **locations** of the RWS



2. Life-cycle-costs of RWS

Investment costs of RWS

- Average investment costs: 38,000 € / RWS
- Total costs are strongly influenced by investment costs of the background system
- Investment costs for the RWS have a lower variance
- Largest share: acquisition cost for the components (75 %)

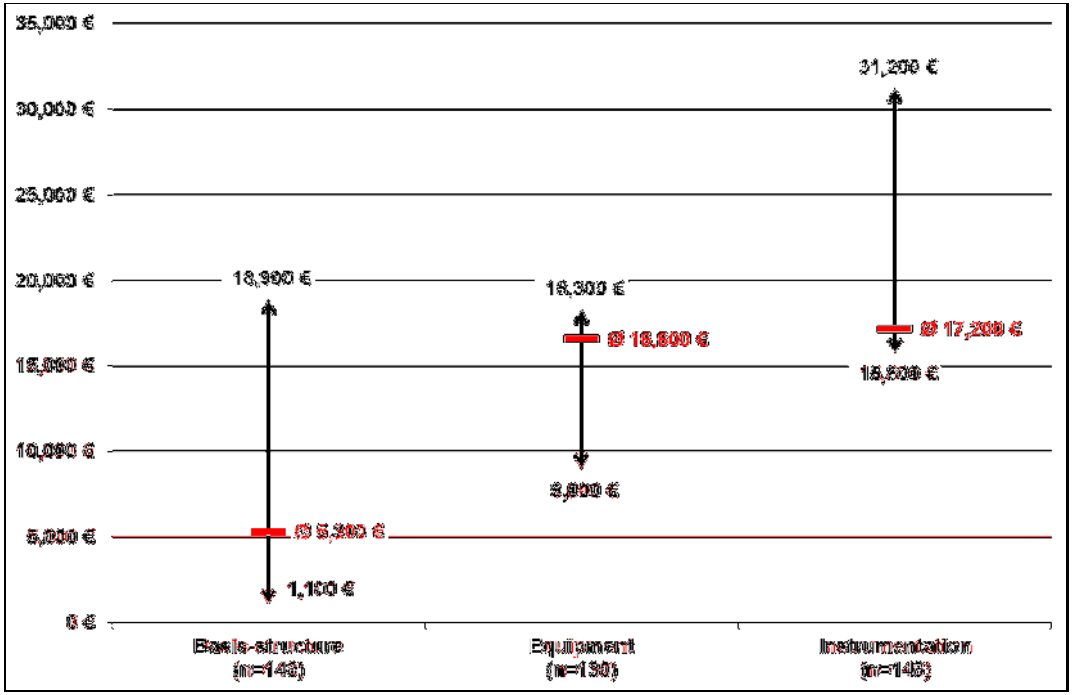


Ø = average

2. Life-cycle-costs of RWS

Investment costs for different parts of RWS

- Cost of the basis-structure depends on the type of power supply
- Cost of the equipment and cost of the instrumentation with similar average costs
- Measurement technology with a large spread depending on the selected instruments:
  - Surface state sensor: Ø 12,000 € / per unit
  - Meteorological equipment: Ø 8,000 € / RWS
  - Camera: Ø 4,000 € / per unit



Ø = average

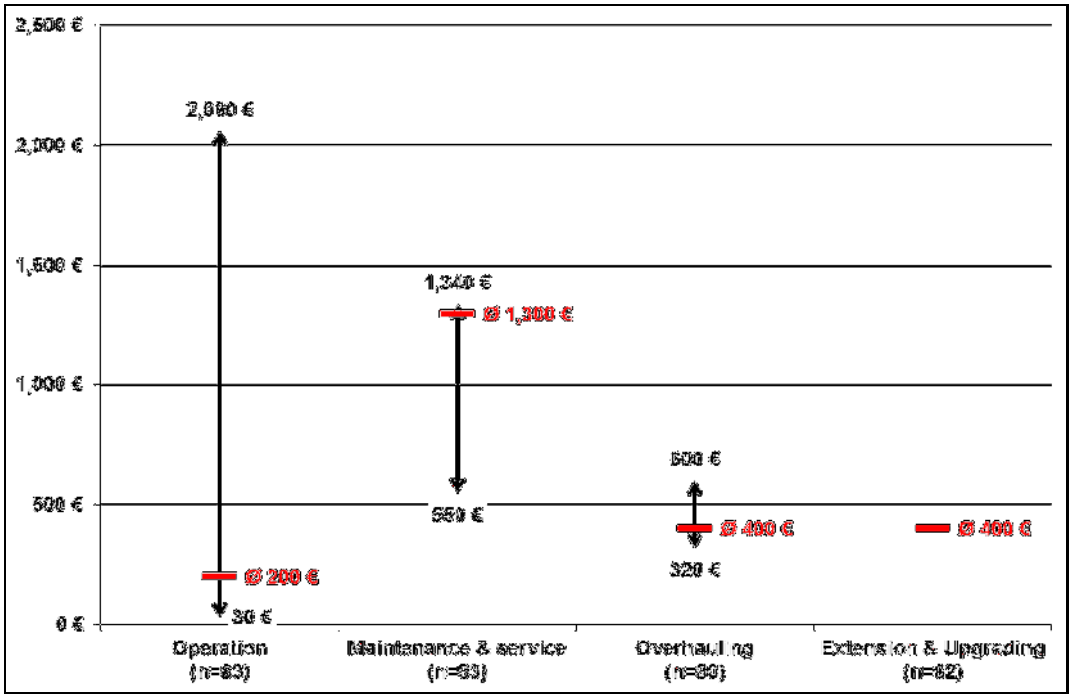
2. Life-cycle-costs of RWS

Follow-up costs of RWS

•Average follow-up costs: 2,000 € / year

•Largest share: Maintenance & service

•Follow-up costs depend on the size and the organization of the whole system

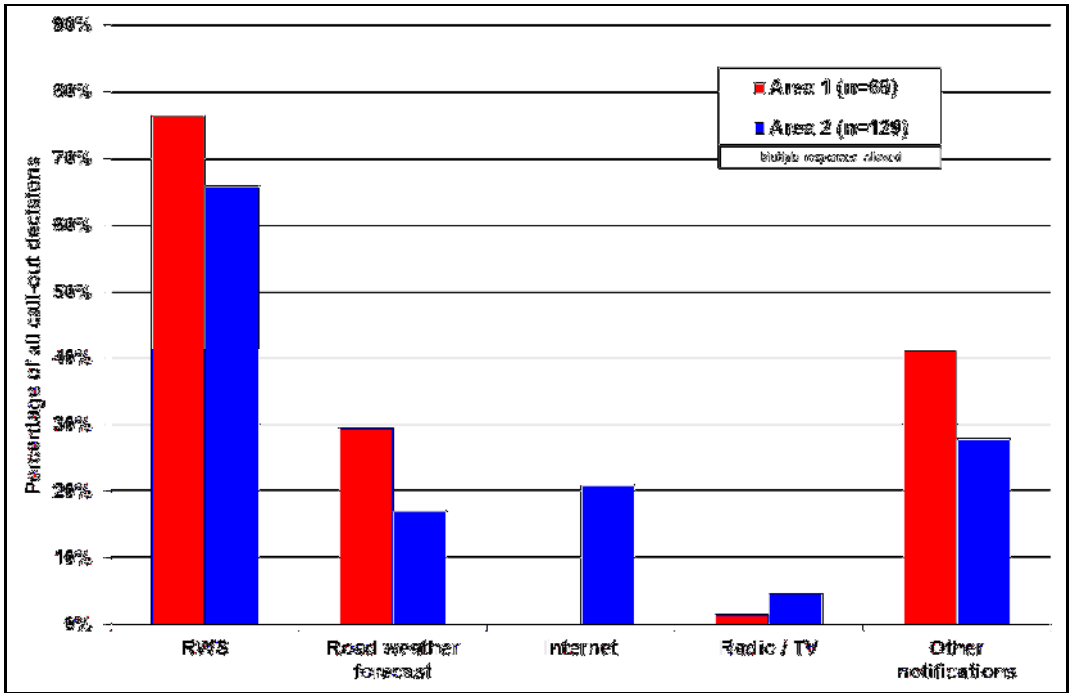


→ After 10 years of use, the follow-up costs amount to 50% of the total investment cost.

Ø = average

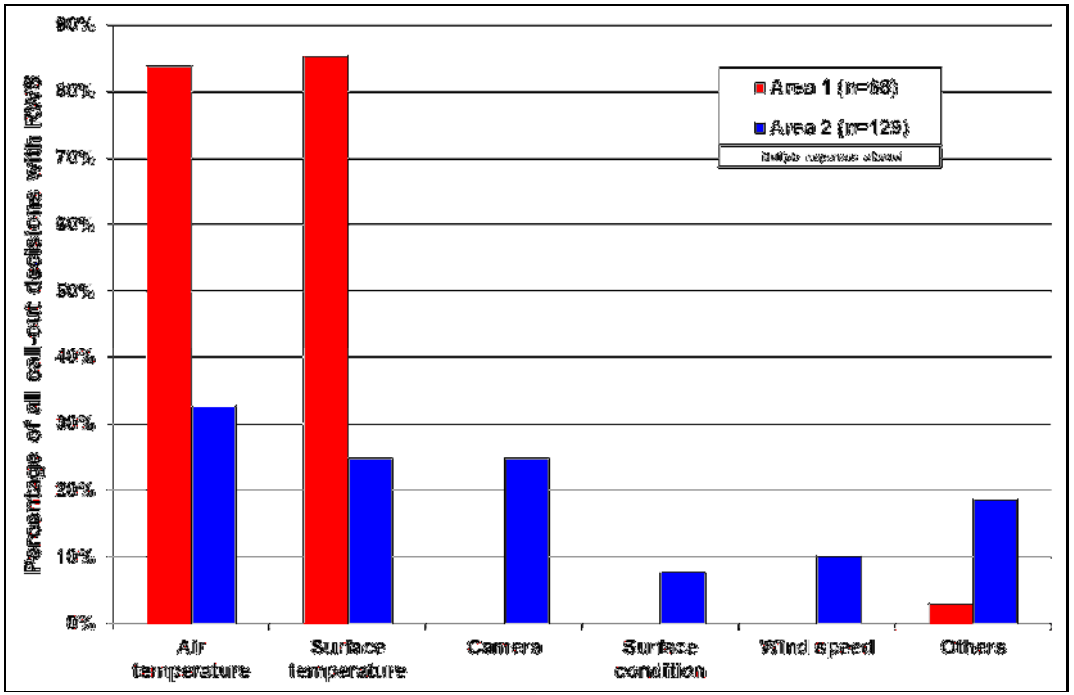
3. Use of RWS

- RWS are the most important of several sources of information
- Decisions are always made in combination of diverse sources
- Personal information and individual perception are very important
- Great individual preferences exist in the use of:
  - Internet
  - Road weather forecast
  - Radio / TV
- Frequency of use depends on the confidence in and the knowledge about the indicators



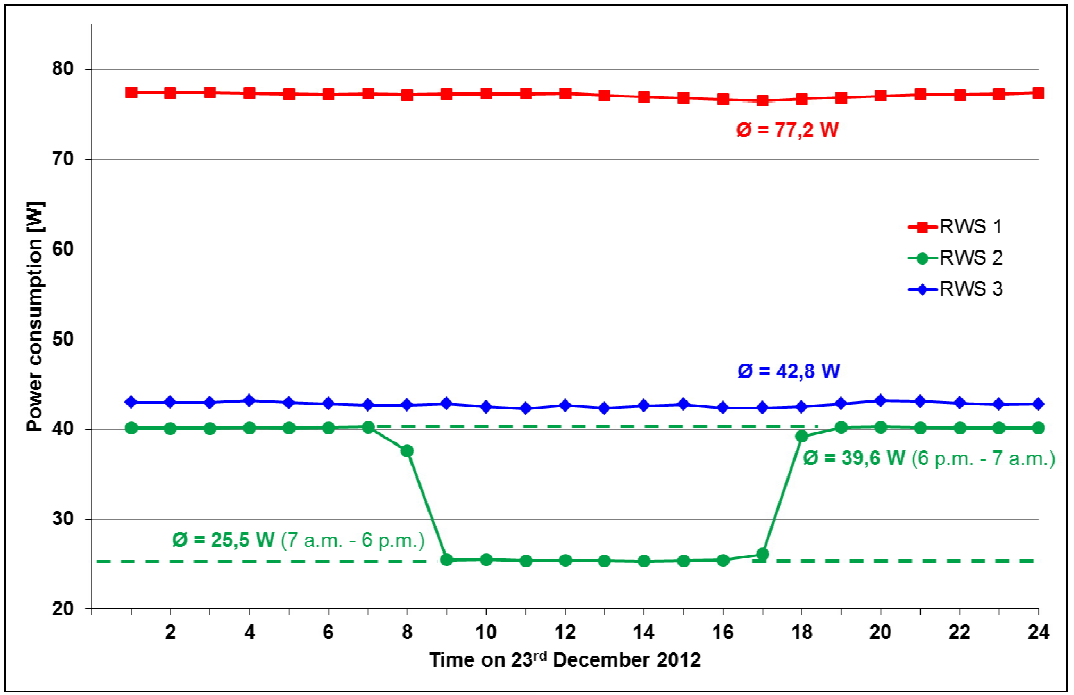
3. Use of RWS

- Air temperature and road surface temperature are the most commonly used parameters
- Camera images – if available – are very important for plausibility checks
- Surface condition is rarely used
- Wind speed is only used in adequate situations
- Other parameters (<5 % of all call-out decisions)
  - soil temperature
  - skid resistance
  - precipitation
  - dew point temperature



4. Autarkical power supply for RWS

- Differences between the RWS greater than 50 % (± 40 W)
- Power consumption depends on
  - sensor type
  - measuring cycles
  - data transmission
  - weather conditions



- Energy-optimized configuration and an intelligent and targeted controlling is necessary for an autarkical power supply
  → Autarkical power systems can be made smaller and more efficient

Ø = average

4. Autarkical power supply for RWS

- Fuel cell with lowest investment costs but high operating costs due to fuel
- Hybrid systems are expensive, inefficient and with little higher benefit
- Photovoltaic or small wind turbines are recommended because of economical and environmental reasons
- Power grid – if available – is to be preferred in most cases

	Investment cost	Operation cost
Photovoltaic	12,000 €	-
Wind power	15,000 €	-
Fuel cell	6,500 €	1,200 € / year *
Example: Southern Germany, power consumption: 80 Watt		

- Power consumption, required reliability, local weather conditions and other local characteristics have to be considered

* plus renewal of fuel cell every five years

5. Consequences for practical situations

The use of RWS on highways and subsidiary roads is recommended

Lower costs and an economical concentration of RWS can be achieved by paying attention to:

- a location-based selection of the equipment considering external conditions
- selection of the equipment considering possible follow-up costs
- use of autarkical power supply only under special conditions and ideally for energy-optimized RWS

5. Consequences for practical situations

The use of RWS on highways and subsidiary roads is recommended

The **benefit** of RWS can be increased by paying attention to:

- selection of representative locations with the participation of all institutions
- a standard configuration of RWS with at least:
  - Air temperature
  - Precipitation type
  - Humidity
  - Surface temperature and condition

  } Possible as all-in-one sensor
  - High-resolution and night vision camera
- an user-friendly compilation of all information in one user-oriented system

Cost-benefit analysis of road weather stations on highways

Thank you!

M.Eng. Markus Streich

Regional council (Regierungspräsidium) Tübingen

Germany

markus.streich@rpt.bwl.de

Prof. Dr.-Ing. Christian Holldorb

Faculty of Architecture and Construction Engineering

Hochschule Karlsruhe – University of Applied Sciences Germany

christian.holldorb@hs-karlsruhe.de