

MANAGEMENT OF EXTREME WINTER EVENTS IN GERMANY

Dr.-Ing. Horst Hanke
German Road Administration, Saarlouis (Germany)
DR_HORST.HANKE@YAHOO.DE

ABSTRACT

After the experience of two extreme winter periods with heavy snow falls and with strong shortness in salt delivery in the whole country of Germany it was necessary to think seriously about an optimized management of serious winter conditions. This is also necessary because the climate change brings to Germany in future more heavy snow falls in short time and more strong winds causing snow drifts. Aim is to ensure a minimum flow of traffic also in times of extreme winter events because the whole economy needs a functional road network at every time.

So the Federal Road Maintenance Committee has worked out new strategies for the future winter maintenance in times of extreme winter events with recommendations for organisation, planning and performance of winter maintenance under severe conditions. It contains: Optimized salt management with strong increased salt storage capacities and emergency reserves for heavy snow storms, with strategic salt storage and delivery management. Optimized operation of strong snow removal machines with crisis intervention plans for the whole federal republic. Special winter maintenance operation plans for times with heavy snow falls and with salt shortness:

In the last winter which again was very strong these measures stand the practical test.

1. STRONG WINTER EVENTS IN GERMANY

In Germany three of the last four winter periods were very strong. Figure 1 shows the total salt consumption since the German Reunion 1990. It shows that the strongest salt consumption had these three winters since 2009. The total quantity of salt amounted to roundabout 4.5 million tons for whole Germany, never before was spread as much salt in one winter period.

The winter periods 2009/10 and 2010/11 confronted the German Winter Maintenance Administration with great problems. There were long periods with very cold temperatures and strong snow falls. The medium temperatures were especially in the northern parts of Germany up to 5 degrees lower than the long-term-average-values. The days with snow fall and the snow heights were on a much higher level than in the winters before.

This situation led to heavy problems in the period from January to March 2010 and in December/January 2011. Because of the great salt consumption per day the salt stores demounted rapidly. The big ordered amounts of new salt could not be executed by the salt producers in short time so that there was a great shortness in salt in whole Germany. Many Road Administrations and Cities had not enough salt to do a normally winter maintenance. Consequences of this were big problems for the traffic snow-caused blockings and congestions on the roads and motorways.

Nowadays the whole economy depends on a functional road network, also in winter times, so that these problems of salt supply led also to big disadvantages for the whole country and the economy.

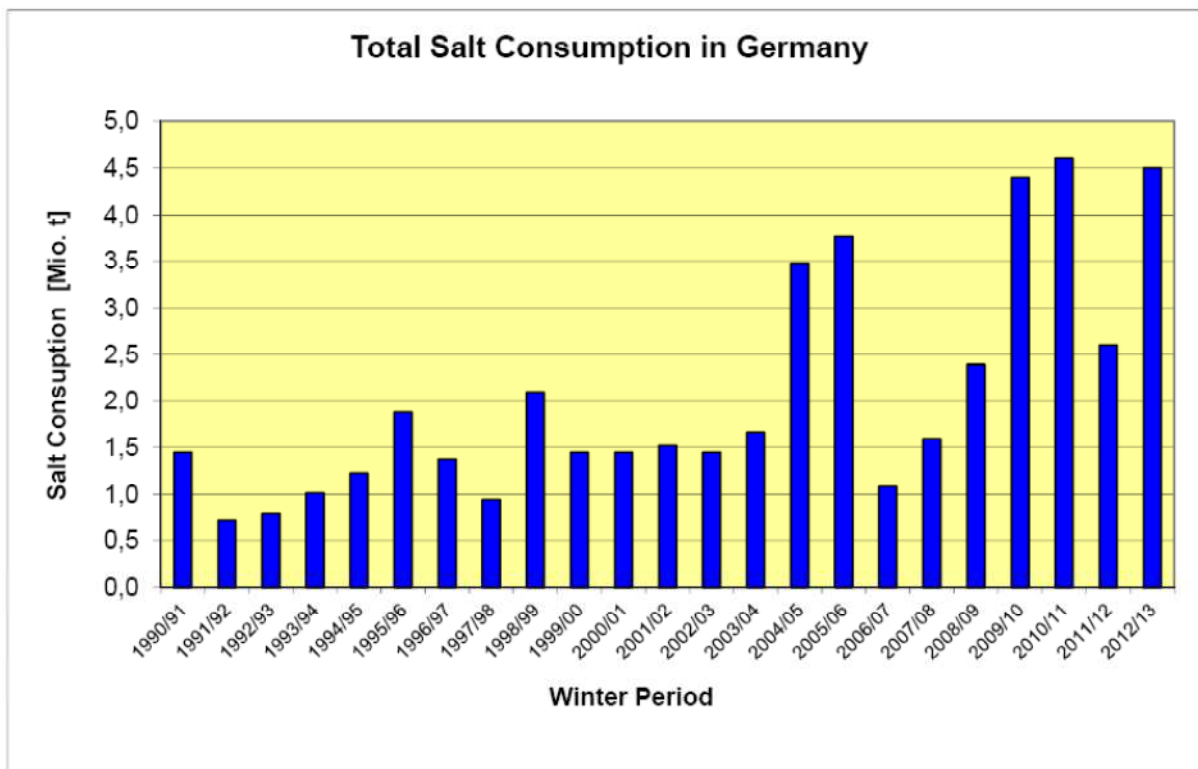


Figure 1: Total Salt Consumption per Winter Period in Germany

Some people thought that the first strong winter was an exception in the face of more mild winters before. But at least after the second strong winter everyone recognized that it is necessary to provide for such winter periods.

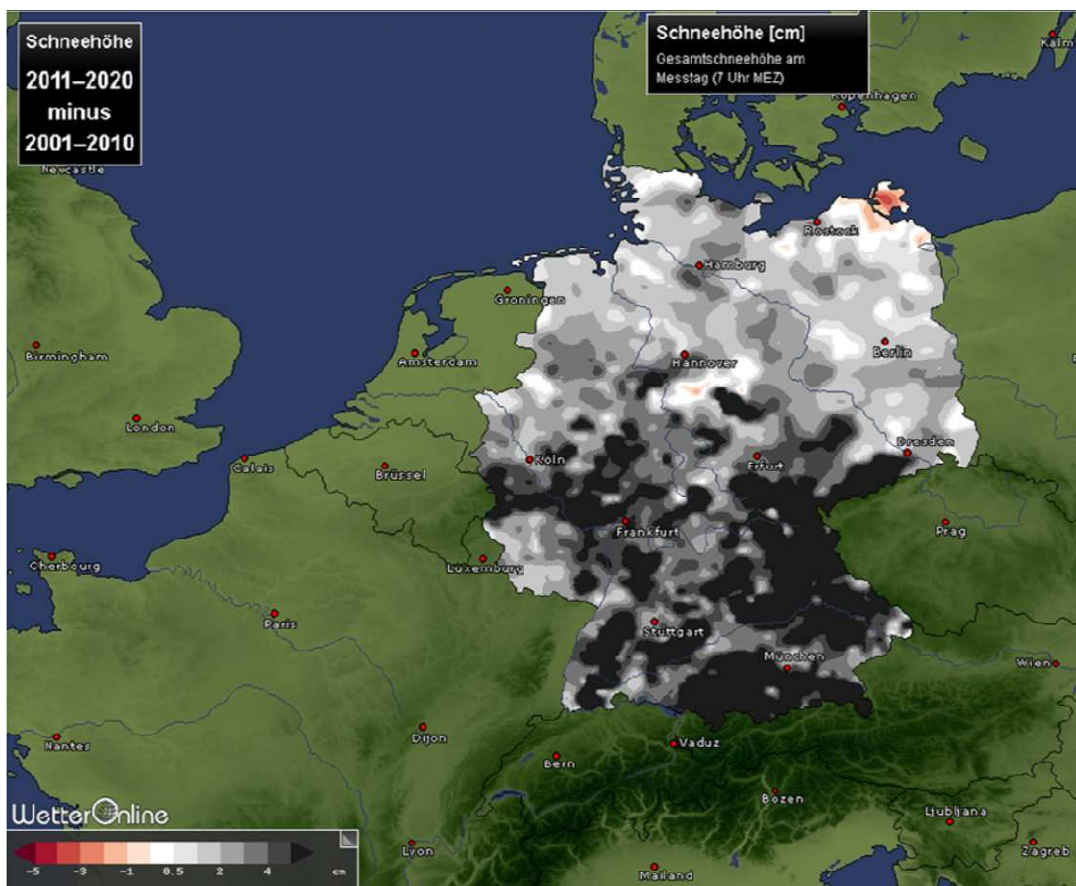


Figure 2: Change of the medium snow height in Germany in the next Decade [1] (white +2 cm, grey +4 cm, black +5 cm or more) [8]

New climate studies show that even the climatic change brings in the near future more cold temperatures and strong snow falls to Middle Europe and to Germany as the last years resulting from cold winds coming directly from the arctic. Figure 2 shows the prediction of medium snow heights in Germany in the next years. It shows that in all regions of Germany rising snow heights are expected especially in Southern Germany.

This shows that we cannot take the last winters as exception, in fact it is necessary to provide for such weather situation in the winter maintenance organisation.

2. ANALYSIS OF THE CAUSES AND DEVELOPMENT OF MEASURES

After the first strong winter there was a great discussion in Germany about the causes of the problems and what to do to avoid these in the future. So the German Winter Maintenance Committee analysed the situation in the different regions, in the operation centres and in the cities. Analysed were the weather data, the salt consumptions, the delivery amounts and the storage capacities. Also analysed was what each operator did when salt was running short.

Result of this analysis was that many operators, especially in Western and Northern Germany had no sufficient storage capacity for salt and no strategic salt delivery management.

But apart from that there could be realized that also in total the system of salt delivery could not match a strong winter period. When there is a day with full winter maintenance the whole day all over Germany it needs up to 200,000 tons per day. But on the other side all salt producers of Germany can produce and deliver a maximum of 40,000 tons per day. But the German salt producerws do not only supply Germany but also other countries around. Looking at this a salt delivery “just-in-time” during the winter is not possible.

This means that it is necessary that the winter maintenance operators provide enough salt in their stores to overcome a longer period of heavy snow fall in winter time.



Picture 1: Empty salt hall

Based on these findings we gave recommendation for optimizing the salt supply: This contains recommended storage capacities (Point 3), recommendations for the strategic salt delivery management (Point 4) and for emergency plans referring times of salt shortness (Point 5).

But it was not possible for the operators to implement all these recommendations given in autumn 2010 in the winter 2010/11. So we got more experience in heavy snowfall problems and salt shortness in December 2010 and January 2011. This December had the coldest temperatures, the highest amount of snow and the biggest salt consumption of any single month before. So it was possible to optimize and adjust all recommendations after this winter period.

Because of the time and the money which is needed to enlarge storage capacities and to renew the vehicle fleet and the machines it needed up to 2013 to set all the recommendations in practice. The winter period 2012/13 which was again very strong showed that the recommendations and the measures taken by this are operable and effective to match the requirements of strong winter periods. It was possible to come over this winter without extreme problems. But this was not possible without enlarged investments in winter maintenance facilities.

In the following chapters there are the actual recommendations for strong winter events represented and the status of their implementation in the practice.

The implementation of the new strategy and the experiences herewith were analysed by questionnaire in 2012 and 2013 compared to 2009 (before the first strong winter period).

3. NEEDED STORAGE CAPACITIES FOR STRONG WINTER EVENTS

As explained before it is necessary to have a sufficient salt storage capacity to endure a longer period of heavy snow fall in winter time because it is not possible to get enough salt by daily delivery.

After analysis of the weather and delivery situation in the strong winter periods there were defined minimum storage capacities to avoid salt shortness in times of heavy snow fall. Additional to that there are also recommended optimal storage capacities to endure longer times.

The recommended amounts refer to the length of the road network which is regularly spread by salt and is differentiated for the road classes depending on their width and level of service.

Road Class	Minimum Storage Capacity [t/km]	Optimum Storage Capacity [t/km]
Motorway (4 lanes*)	15 t/km	30 t/km
Rural Roads (2 lanes*)	5 t/km	7 t/km
Urban Roads (2 lanes*)	3.5 t/km	5 t/km
* roads with more lanes multiply the needed salt in proportion to these number of lanes		

Table 1: New Recommended Salt Storage Capacities in Germany

In the year 2010 during the first strong winter period many operators did not have such storage capacities, especially in Western and Northern Germany and in the cities.

Referring to the experiences in the strong winter periods and the new recommendations many operators enlarged their capacities strongly.

The results of the enlargement of the Storage Capacity is shown in the following figures 3 and 4. It can be seen that there is a big enlargement both in the maintenance centres for motorways and rural roads, but even more in the cities. Hereby you have to consider that the cities had even lower capacities before.

The German States actual have a total storage capacity of 1.83 million tons. Compared to the year 2009 (1.0 million tons) means this over 80 % enlargement. Not the whole enlargement is done in the local maintenance centers, a part is done in regional central salt stores which were additional implemented (563,000 tons).

Referred to the length of the network the total capacities are 32 tons/km for the motorways and 8.2 tons/km for the rural roads so that for the whole country the recommended capacities are reached, but not in every single maintenance centre.

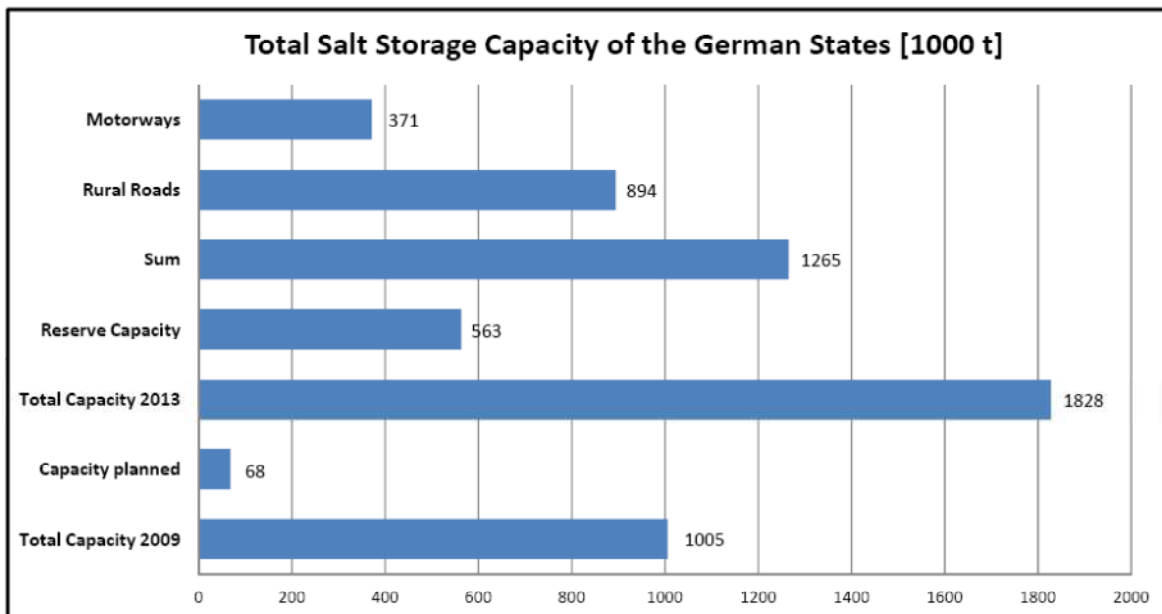


Figure 3: Actual Storage Capacities of the German States compared to 2009

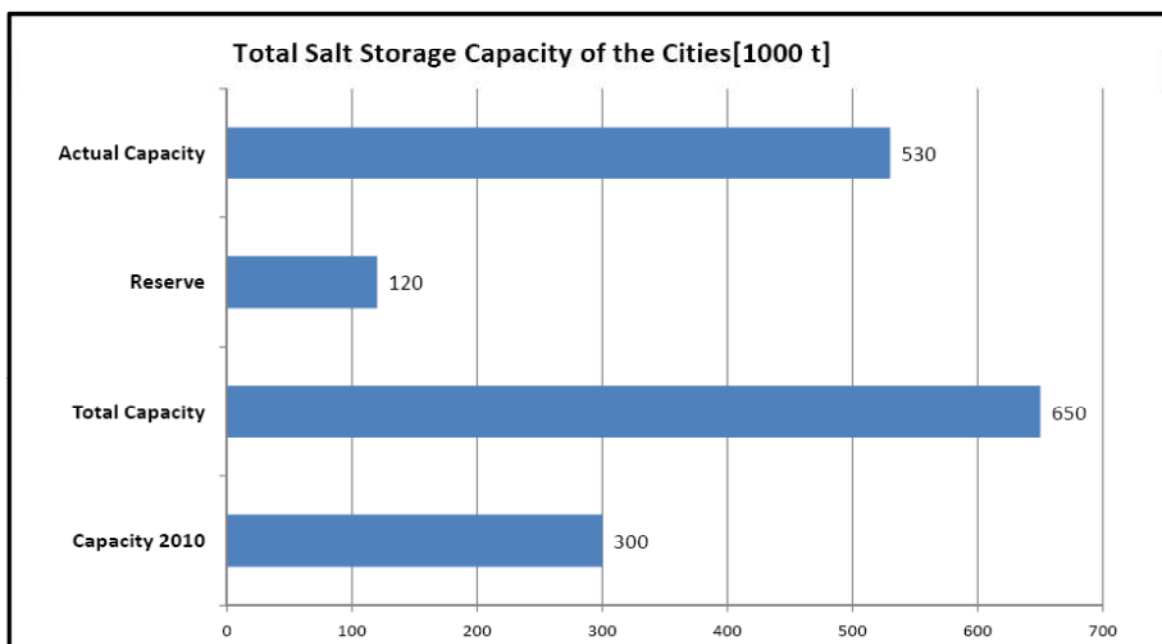


Figure 4: Actual Storage Capacities of the German Cities compared to 2010

The German Cities actual have a total storage capacity of 650,000 tons. Compared to the year 2010 (300,000 tons) means this over 100 % enlargement. Not the whole enlargement is done in the maintenance centres of the cities. Some cities have built central emergency salt stores together with neighbour cities, other have chartered storage capacities in the stores of the salt producers.

Referred to the length of the network the total capacities are 5.3 tons/km so that for the whole country the recommended capacities are reached. But there are great differences in the capacities of the single cities. Most of them reach the recommended capacities, but even 25 % of the cities don't reach these capacities. On the other hand over 15 % of the cities have more than the double recommended capacity. These capacities are more than the consumption of the worst winter period. These cities have an other strategy: they store more salt than they need in the strongest winter period, so that they don't need to get deliveries during the winter and can order cheaper salt in the summer.

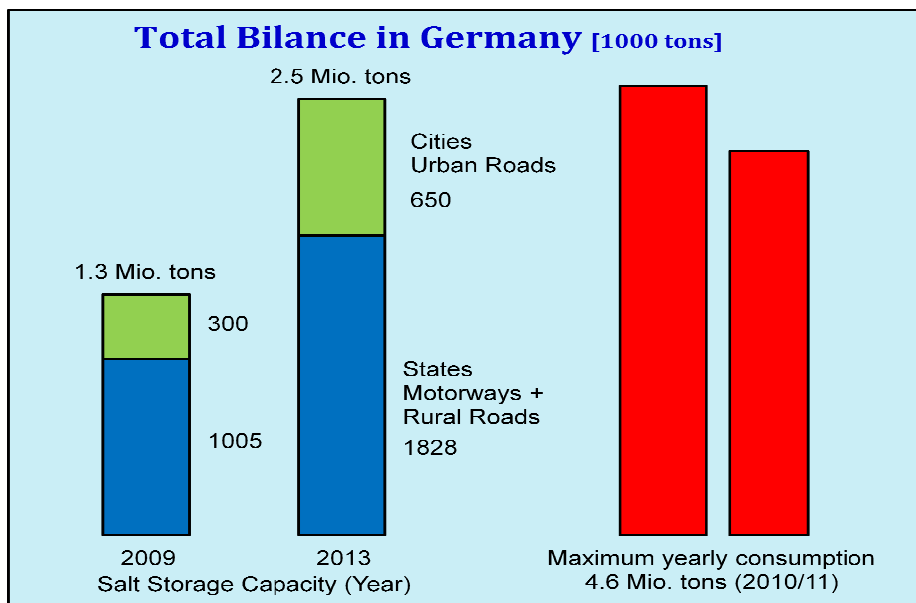


Figure 5: Comparison maximum salt consumption and total salt Storage in Germany

In total in Germany all operators have a salt storage capacity of around 2.5 million tons. Although the storage capacities were strongly enlarged in the last years the total storage capacity is not much higher than the half of the highest salt consumption in a strong winter. This means that these enlarged capacities are not too high and need a optimal salt delivery management during the winter (Figure 5). Other countries in Europa have more relative storage capacity.

4. OPTIMIZED SALT DELIVERY MANAGEMENT

As said before even the enlarged capacities are not sufficient for a whole strong winter period, there must be a delivery of salt during the winter period.

To ensure the provision of salt during the winter in periods of heavy snowfall it is necessary to have a strategic salt delivery management. For this the following measures are recommended on basis of the experiences of the last winters:

- Filling all storage capacities early enough before the winter period
- Conclude a delivery contract before the winter period including minimum amounts of delivery per day
- Establishment of a salt-storage-monitoring-system which gives an actual overview over all stores and their filling amounts
- Optimized delivery management via orders of new salt as early as possible; the new order should be done at latest when there is only 80 % filling status.
- Forecast of spreading amounts during the winter period for the next 2 weeks

Optimum is a computer-aided system for the capacity-monitoring including automatically collection and display of the filling data, automatically ordering of new salt and forecast of spreading amounts on basis of weather forecasts. With this system is not only an optimal delivery possible, but also an early warning system in strong winter periods. The warning is done when the forecast of spreading and delivery amounts show that a critical filling status will get below a preset limit.

The automatically collection of the filling amounts can be done by automatic scales or infrared detectors in silos or by webcams with image evaluation.

Figure 6 shows a computer-aided monitoring of filling amounts of the storage units of one German state (Saarland).



Figure 6: computer-aided monitoring of the filling status of the storage units

5. EMERGENCY WINTER MAINTENANCE

Although the storage capacities are enlarged and the salt-delivery-management is optimized it can not be precluded that in a strong winter period the salt becomes short. For this situation there were developed recommendations to ensure that a minimum of traffic flow can nevertheless be ensured.

Based on the experiences of the strong winter periods it is important not to wait until all storages are empty, but make a forecast for delivery and consumption. If this forecast leads to a filling status below a critical margin it is recommended to switch the normal winter maintenance to a emergency winter maintenance with low salt consumption. This should guarantee that at every time a minimum of salt is available to save the traffic on the main roads and the most dangerous points.

In Germany the legal duty for spreading exists only on main roads with dangerous points. Nevertheless in winter maintenance normally more roads are spread to ensure a good and save traffic flow in winter. When salt becomes short it is possible to reduce the number of roads spread without problems with the legal duty. So it is recommended in this case to concentrate the spreading on the main roads and the dangerous points. Naturally it is necessary to inform the public in this case by media and give information about the reason and the aim of this measure, also give information about the consequences of non-spreading.

This measure was exercised in Winter 2010/11 by several cities and Road Administrations to save salt. When looking at the consequences it was realized that people accept this lower level of service as an exception in this special case of salt shortness and they are ready to drive slowly and cautious.

As result of this we recommend for the future to reduce the level of service in this way when salt becomes short. For this it is necessary to work out plans for the reduced winter maintenance and the concomitant public relation.



Picture 2: reduced lanes



Picture 3: lane blocked by signs

A second measure for reduced winter maintenance in times of salt shortness is to reduce the number of lanes on roads with more lanes in one direction. This is only possible when traffic is reduced because of strong winter weather, but it saves much of salt because these roads have a high service level. In this case on one of the lanes the snow is not removed and no salt spread, so that everyone can see that here is no winter maintenance. If there is a dynamic traffic management system it is the best to block this lane by traffic signs. Picture 1 and 2 show examples of such lane reduce in winter maintenance.

In the new recommendations for reduced winter maintenance in times of salt shortness the measure of lane reduce is specified in detail: what roads are suitable for this, how to block the lane and how to end this blocking.

6. TRAFFIC MANAGEMENT IN TIMES OF HEAVY SNOWFALL

Based on the experiences of the strong winter periods there were also measures of traffic management in times of heavy snowfall worked out.



Picture 4: Blocked Motorway by heavy traffic after strong snow fall

The biggest problem in these times is the heavy traffic because trucks which cannot pass critical road sections (especially gradients) block the whole motorway and the traffic for several hours (Picture 3).

To avoid this are the following measures recommended:

- Large scale deviation for trucks in the motorways network: Aim is to guide the trucks from critical road sections to others which are flat or where not so much snow fall is expected
- Block Dispatching for the heavy traffic at critical road sections: The heavy traffic is stopped before these sections and guided over the section with snow removal trucks before
- Temporary bans for trucks in the whole regional road network

The last measure should be avoided and only the last possibility during extreme weather conditions because the heavy traffic is very important for the economy. Nevertheless in January 2011 it was necessary on a few days in some regions of Germany.

In the new recommendations detailed parameters are given in which cases these measures should be taken and in which way.

7. REMOVAL OF BIG AMOUNTS OF SNOW

Beside the problems of salt shortness in the last winter periods German Winter Maintenance Operators had also problems to remove the big amounts of snow fallen in short times.

As reaction on these problems many operators invested in additional trucks and snow plows. Especially for the small side roads in the cities many operators did not have suitable trucks and plows for strong mechanical plowing. This is changed now, and there are worked out special plans for the removal of all roads.



Picture 5: Big snow amounts in a city in Northern Germany

Additional there are worked out new plans for loading and transportation of snow in cases of heavy snow fall. For this task there are concluded special contracts with road building companies to support the winter maintenance.



Picture 6: Snow removal machine with rotating tools on a German motorway

For removal of big amounts of snow and snow drifts the German Road Administrations have heavy removal machines with rotating tools. In the new strategy there is worked out a crisis intervention plan for these machines which contains plans for transnational switches of these machines when there is a regional snow problem.

8. CONCLUSION

After two winters with heavy snow fall and salt shortness in Germany new recommendations and strategies were worked out to match these problems and ensure a functional and save traffic even in strong winter periods.

The recommendations include measures to ensure the salt supply, procedures for emergency winter maintenance with less salt, heavy traffic guidance and removal of big amounts of snow.

With these measures Germany is well-prepared for strong winter periods which probably will appear more often in the future. This showed the last winter period 2012/13 which was again very strong but without bigger problems in winter maintenance.

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