



The Swiss way to silent roads

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ABSTRACT

The objective of Switzerland's noise abatement policy is to protect the health of the population and create a high quality of life. In a society in which space for housing development is scarce and there is constant population and traffic growth, as well as increasing individualization, this is a major challenge.

The latest calculations on noise pollution in Switzerland show that during daytime one in five persons, and at night one in six persons, are still exposed to harmful or disturbing road traffic noise. The associated decline of property values and health impacts generate massive costs. A study on long-term megatrends illustrates that the volume of traffic will continue to increase. Therefore forward-looking measures need to be taken today in order to prevent adverse health effects and preserve quietness as a significant location factor for housing, business and recreation. To achieve this goal, it will be essential to focus on measures that eliminate noise directly at source such as the use of low-noise tires and low-noise road surfaces, the lowering of speed limits and optimized driving behavior.

Keywords: road traffic, noise abatement policies, measures at the source

I-INCE Classification of Subjects Numbers: 08, 82

1. INTRODUCTION

Switzerland is known for its mountains, and excellent tourist destinations. Outside these beautiful landscapes, Switzerland is very densely populated. 8 Mio. inhabitants share a surface 40'000 km². Half of this territory is not suitable for housing due to the topographic situation. This leads to a considerable conflict of utilization of the available surfaces. And consequently most of the traffic infrastructure needs to be built close to where people live. Roads and particularly the noise they induce, strongly affect housing in many areas of the country. In this geographical situation, and observing a constant growth of population and traffic volumes, road noise abatement has been a major challenge for many years. Switzerland has made its experiences in noise abatement since 1985 and the Swiss Federal Office for the Environment FOEN currently develops an extended strategy of noise abatement, based on solid data of the noise exposure. The current discussions are summarized in this paper. The possible cornerstones of future strategy reflect the considerations of the author and have not yet lead to binding government decisions or modifications of the legal framework. Considerations in this paper are mainly limited to road noise issues.

2. CURRENT STRATEGY

2.1 Legal framework

Swiss history of noise abatement begins a century ago in 1912. The Civil Code of 1912 obliged everyone to refrain from causing harmful effects onto the property of the neighbor. One of the mentioned potentially harmful effects was noise. In 1934 the federal government introduced a nighttime ban for heavy vehicles in order to protect people from night noise and avoid dangerous situations. In 1971 the federal constitution was amended, obliging the Federal government to introduce a law, which should protect people from any harmful effects or nuisances caused by noise and other effects. In 1985 this Federal Act on the Protection of the Environment² was set into force.

This act introduced mandatory regulations for all facilities and installations, which generate noise,

which could potentially be harmful or a nuisance. In its current version this act sets up several fundamental principles of noise abatement, which define Swiss strategy of noise abatement for all possible installations, including roads:

- In noise abatement, the objective of the act is to protect people against harmful effects or nuisances and to preserve the natural foundations of life sustainably.
- Noise is to be limited by measures taken at their source (limitation of emissions).
- Irrespective of the existing environmental pollution, as a precautionary measure emissions are limited as much as technology and operating conditions allow, provided that this is economically acceptable.
- Emissions are limited more strictly if noise is found or expected to be harmful or a nuisance, taking account of the existing level of environmental pollution.
- The Federal Government stipulates by ordinance the ambient limit values for assessing harmful effects or nuisances.
- Installations, which do not comply with the provisions of this Act or with the environmental provisions of other federal acts, must be improved.
- Any owner of an installation who causes measures to be taken under this Act must bear the costs.
- As part of the use of the net revenue from the mineral oil tax and the national highways charge, the Confederation shall contribute to the cost of noise abatement and soundproofing measures as part of the improving of the road network, when measures are taken by Cantons.
- The federal authority, which is responsible for national roads, is also responsible for the enforcement of the Environmental Protection Act. It must consult the Cantons concerned, the public and FOEN before making its decision.
- New building intended as long-stay accommodation shall only be built in areas where ambient noise levels do not exceed certain values or in areas where these values can be met by the application of planning, design or structural measures

This act triggered a major change in the considering of noise abatement in the process of planning or building roads. Since 1985 when the federal act came into force, noise abatement measures are part of any project of new roads or modification of an existing road. In parallel, programs have been set up to improve existing roads where ambient noise limit values were exceeded. And there have been set deadlines, which must be met to finish the improvements. For Federal roads the deadline will be 2015 and for the Cantonal roads 2018.

2.2 Mitigation measures

Starting from this legal framework important measures have been taken. Between 1985 and 2010, 1,600 million Swiss francs were spent on road noise abatement, while in the period from 1985 to 2012; 1,150 million Swiss francs were spent on reducing railway noise. Most of the investments in roads went into measures to prevent noise transmission (noise barriers) and in the building of sound-insulating windows. Until the end of the deadlines for the improving of roads, there will be noise barriers built of a total length of around 700 km, which is close to 5% of the relevant road network. Only in recent years, some 400 km of low noise surfaces have been built. This enables Switzerland to monitor their performance in terms of acoustics as well as durability. The results are promising for future application and allow to analyze in which situations low noise surfaces are performing better and in which situations existing low noise surfaces are not an appropriate solution. Consistent investment in measures to reduce noise emitted by vehicles was limited to railway rolling stock only. The requirements for road vehicles meet the standards of the European Union, which have only been slightly tightened since 1985.

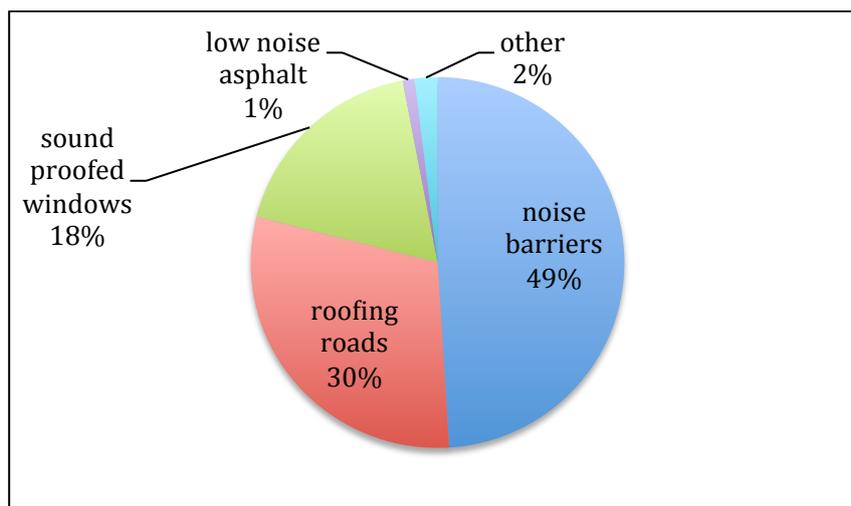


Figure 1 – Percentage of costs of noise abatement measure.

The mandatory legal framework has obliged all owners of roads, e.g. the Federal government, as well as the regional or local governments, to consider noise abatement in every project of road construction. This leads to integrated solutions planned from the beginning of a project. Key factors of the successful noise abatement in Switzerland are on one hand the obligation to improve existing roads within a set time frame. On the other hand the financial support of these measures by important contributions from the mineral oil tax is equally important.

3. STATE OF NOISE POLLUTION

3.1 SonBase – The GIS Noise Database of Switzerland

Since 2009 Switzerland monitors noise pollution over the full surface of the country. The tool, which allows establishing of such data, is SonBase³. SonBase provides scientifically based, nationwide conclusions on the extent of current noise pollution from the main noise sources – road, rail and air traffic – in Switzerland. Various geographical data is integrated with computed noise data in a homogeneous Geographical Information System (GIS). The core of SonBase is a GIS application based on the ESRI ArcGIS components with Oracle as the database. Among other things it supports preparation, editing and central management of the data and a variety of statistical analyses, spatial queries and generation of reports.

With SonBase FOEN has a technical instrument at its disposal that enables decision makers to obtain scientifically based and comprehensive findings concerning the current extent of noise pollution from the main sources in Switzerland. SonBase forms the basis for comprehensively monitoring the noise situation and its chronological and spatial development, as well as for providing the general public with detailed information about the ongoing status of noise pollution. In plus, noise situations can be modeled and analyzed with the aid of scenarios, which is useful for various policy decisions and scientific research.

3.2 Noise pollution in Switzerland

Road traffic is by far the most important source of noise in Switzerland. Overall railroad and aircraft noise do not lead to an equally important pollution. The current results of the monitoring show, that despite of all measures taken in the years before, one in five citizens of Switzerland is living in an environment, where the noise limit values for daytime are exceeded. In the night it is one in six with an even higher percentage inside the cities and agglomerations. Around 85 percent of people who are exposed to harmful or disturbing traffic noise live in towns or agglomerations.

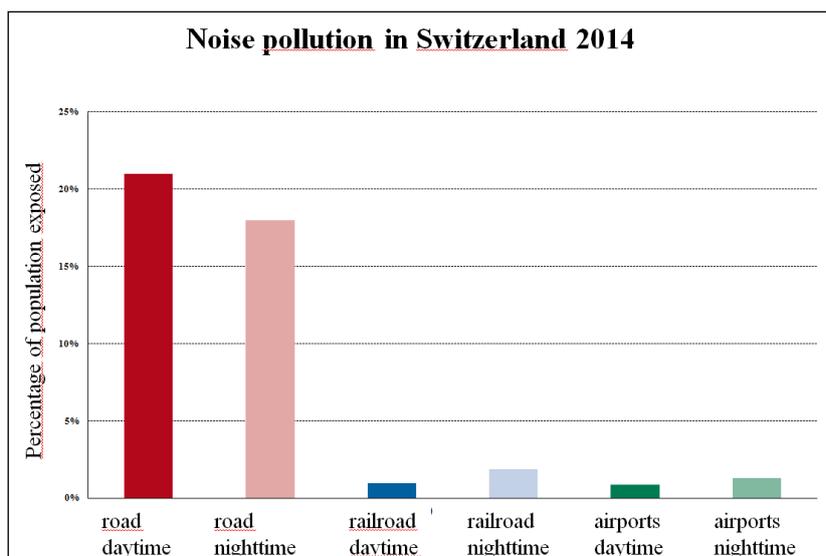


Figure 2 – noise pollution in Switzerland from traffic noise sources

Noise pollution in Switzerland causes important losses of property values and significant health costs. The Swiss Federal Office of Spatial Development FOSD regularly calculates these external effects of traffic. Calculations concentrate on environmental, accident and health-related effects. As external effects, noise causes nuisance, which can economically be described as declining housing prices. And noise also causes harmful effects to health, which are the reason for health costs. The external effects of noise come up to 1,400 Mio. Swiss francs per year only due to road traffic, compared to 300 Mio. caused by railroad traffic. This underlines, that measures to limit noise must also been seen as being beneficiary to reducing external costs of noise.

External effects of road transport from the mode of transport perspective, 2010, by cost component and vehicle category, as well as costs per pkm and tkm

External costs	Passenger transport											Freight transport				Overall total	
	Private motorised transport				Non-motorised transport			Public passenger transport				LGV	HGV	Artic.	Tr/Mach.		
CHF millions	Car	Coach	M-cycle	Moped	Cycle	VLD	Pedest.	Bus	Trolley	Tram							
Air-related health	1019.2	22.7	8.3	0.6	-	-	-	60.2	n.a.	n.a.	129.3	169.4	94.9	n.a.			1504.6
Air-related building	209.8	4.7	1.7	0.1	-	-	-	12.4	n.a.	n.a.	26.6	34.9	19.5	n.a.			309.7
Air-related crop shortfall	27.0	1.2	0.6	0.0	-	-	-	3.7	-	-	6.1	10.0	6.9	n.a.			55.5
Air-related forest degradation	25.0	1.0	0.5	0.0	-	-	-	2.9	-	-	4.9	8.0	5.5	n.a.			47.9
Air-related biodiversity loss	86.5	2.3	1.1	0.0	-	-	-	6.8	-	-	12.3	18.8	13.0	n.a.			140.8
Noise	644.1	17.2	249.7	1.7	-	-	-	35.4	0.3	1.1	142.6	233.6	137.8	n.a.			1463.5
Climate change	956.2	9.5	17.9	0.8	-	-	-	26.1	-	-	86.5	94.8	68.6	n.a.			1720.6
Nature and the landscape	601.1	4.0	9.0	0.5	4.2	0.1	5.9	9.3	0.1	0.1	45.9	53.5	36.1	n.a.			768.7
Soil degradation	56.8	2.2	1.2	0.1	-	-	-	4.6	0.5	0.0	10.9	26.2	15.5	n.a.			117.9
Upstream and downstream processes	537.3	4.8	8.7	0.5	12.3	0.5	21.6	11.5	1.9	6.2	49.7	56.4	46.8	n.a.			758.1
Accidents	590.7	1.7	257.7	59.0	449.7	45.9	360.0	3.1	2.6	1.5	34.2	13.9	6.6	16.6			1943.3
Urban areas	90.6	0.3	1.9	0.1	-	-	-	2.2	0.4	0.6	9.3	3.5	2.9	n.a.			111.8
Deduction of HVF share	-	-12.5	-	-	-	-	-	-	-	-	-	-375.1	-32.1	-			-718.7
Total	4344.2	58.9	558.1	63.6	466.2	46.5	387.5	178.2	5.8	9.5	558.3	348.0	122.2	16.6			7663.8
As % of overall total	63.2%	0.8%	7.3%	0.8%	6.1%	0.6%	5.1%	2.3%	0.1%	0.1%	7.3%	4.5%	1.6%	0.2%			100.0%
Total, transport type perspective	64.0				372.2	136.7											572.9
Health bens - non-mot. transport	-	-	-	-	-388.5	n.a.	-892.2	-	-	-	-	-	-	-	-	-	-1280.7
Costs: cents/pkm (PT), cents/tkm (FT)	5.3	2.3	23.8	47.9	3.7	40.9	-10.3	7.0	1.1	1.0	52.6	4.4	1.2	n.a.			

M-cycle = motorcycle, VLD = vehicle-like device, Pedest. = pedestrian, LGV = light goods vehicle / delivery van, HGV = heavy goods vehicle, artic. = articulated lorry, Tr = tractor, mach = machinery, n.a. = not available

Figure 3 - External effects of road traffic in Switzerland 2010 determined by FOSD⁴

4. ASSESSMENT AND OUTLOOK

4.1 Assessing what has been done

Until now, measures in road traffic have primarily been focused on the prevention of noise transmission by building noise barriers and on the installation of sound-insulating windows in dwellings. These measures have resulted in significant improvements at local level and need to be consistently pursued in the future.

However, as the results of the monitoring show, they have been insufficient to protect the population against harmful noise to the extent demanded by the Federal constitution. A more in depth assessment points out that numerous noise barriers have been installed along motorways and major traffic routes, but relatively few have been erected in built-up areas, where most people who are affected by excessive noise are living. This makes clear, that inside cities, noise barriers are for several reasons not an effective option to lower noise pollution. Main reasons seem to be the interference with the appearance of the locality, traffic safety and the lack of space. The large number of people still exposed to excessive noise is at the same time also due to the significant increase of inhabitants and traffic in the last two decades. In many places, noise pollution is now much higher than it was 20 years ago despite certain abatement measures, which have been put in place. The assessment finally makes clear, that measures against road traffic noise were not taken at the source of noise and therefore not according to the strategy required by the Federal act for environment protection.

Furthermore, predictions of rising traffic volumes and increasing population lead to the conclusion, that it will be unlikely to meet the requirements of the constitution by continuing noise abatement with the set of measures applied in the past within the given deadlines.

4.2 Outlook 2050

In order to improve efficiency and effectiveness of noise abatement measures in the future, FOEN entrusted a variety of specialists with the task of identifying future noise-relevant trends⁵. Their study shows that forward-looking measures need to be taken today in order to preserve "quietness" as a major factor of the quality of life, the choice of a neighborhood in which to live, conduct business and enjoy leisure-time. The study found that the following main trends will affect noise abatement policy and need to be anticipated:

- Mobility requirements, and thus the volume of traffic, will continue to increase. As in the past, mobility will remain the main source of noise.
- In urban centers, the demand for quiet zones within walking distance from home and workplace, as well as for artificial indoor solutions in the form of rest and relaxation zones is expected to increase.
- Consensus regarding quiet periods at midday, at night and on public holidays will disappear. Preservation of peace and quiet will become an integral part of a comprehensive health concept.
- Technical noise sources such as cars are expected to become quieter thanks to technological progress. In addition, technical standards will to an increasing extent be defined at the international level with less influence of single states.
- Neighborhood noise conflicts and noise from leisure-time activities will gain in importance. With the existing criteria of a quantitative nature it will not be possible to overcome the associated problems in this area.

The findings of this study of the acoustic landscape of Switzerland in 2050 indicate clearly, that in particular road traffic will remain a major source of noise pollution for the coming decades. It also points out, that quiet areas will become more important for people to recover from an increasing number of noise sources they are exposed to during the day. The quietness of residential areas is therefore considered to be an central factor for housing prizes.

5. EXTENDING THE STRATEGY FOR THE FUTURE

As stated above, the purpose of noise abatement in Switzerland is to protect the health of the people and secure or create a high quality of life. This goal will remain unchanged, because it is laid down in the Swiss constitution. The challenge is to develop an extended strategy to achieve the degree of protection for the population that is stipulated in the Federal Constitution within a reasonable time. FOEN is currently establishing proposals for future actions to advance noise abatement in a more holistic approach.

5.1 Measures at the sources of noise

To make noise abatement more effective in the future, the first key is to accelerate the improvements of existing roads by means of noise barriers or other measures on sound propagation path, where this is the most effective solution. It will be important though to implement improvements at a higher pace than in the past years. In order to stimulate more appropriate action along the existing road network more target oriented Federal financial aid will be needed.

The second key to advance towards a sufficient noise protection of the people is to boost action taken directly at the sources of road traffic noise and not along the propagation path. This can primarily be achieved in building and operating of roads. The main actions discussed at the moment can be summarized as follows:

- One main action includes the facilitation of low noise asphalts. More research has to be initiated and co-financed in order to develop new and improve existing low noise asphalts (LNA). Especially the durability of such products must be enhanced and technical means for optimized construction and noise assessment need to be established. In parallel, the integration of existing products in road construction planning needs to be encouraged by optimizing the exchange of knowledge on national and international scale and by granting of significant financial contributions to front runner products. Considering the experience over the last years there is a significant potential of lowering noise inside cities with LNA. FOEN estimates that up to 30 to 40 percent of people suffering from excessive noise could be protected with LNA.
- Low noise tires need to be promoted more effectively. With effect since 2012 the European Union has introduced a label for tires⁶. Manufacturers of tires must specify fuel consumption, wet grip and noise classification of every tire sold. Assessment of existing tire-labels show, that there are tires on the market which are up to 6 dB more silent than other tires of the same size, performing equally well in terms of safety (wet grip) or fuel efficiency. One predominant advantage of low noise tires is, that they lower noise on the road network as a whole. And given, that low noise tires today are not more expensive than other tires, it is a very advantageous approach, which can be realized in a short period of time. Promotion of low noise tires is therefore a very efficient measure to lower road traffic noise. FOEN estimates that up to 20 – 30 percent of people suffering excessive noise could be protected, if all cars would be equipped with low noise tires.
- An equally efficient measure to lower road traffic noise is the reduction of speed on a local scale. On a technical level this calls for secured state of knowledge on how to correctly predict the effect of a specific reduction of noise exposure at a given point. Respective scientific work needs to be initiated and financed. On a more political level, speed limits are frequently challenged for being disproportionate. A convincing strategy therefore needs to equally focus on acceptable rules for implementing speed limits
- Finally it is to take into consideration, that driving behavior is one main source of annoyance from road traffic. Many complaints of citizens are with regard to single events of traffic, e.g. motorcycles accelerating very rapidly. Altering driving behavior towards a more respectful way is a long-term task, which should nevertheless be tackled with information about the health effects of noise and the possibilities of everyone to help reduce road traffic noise.

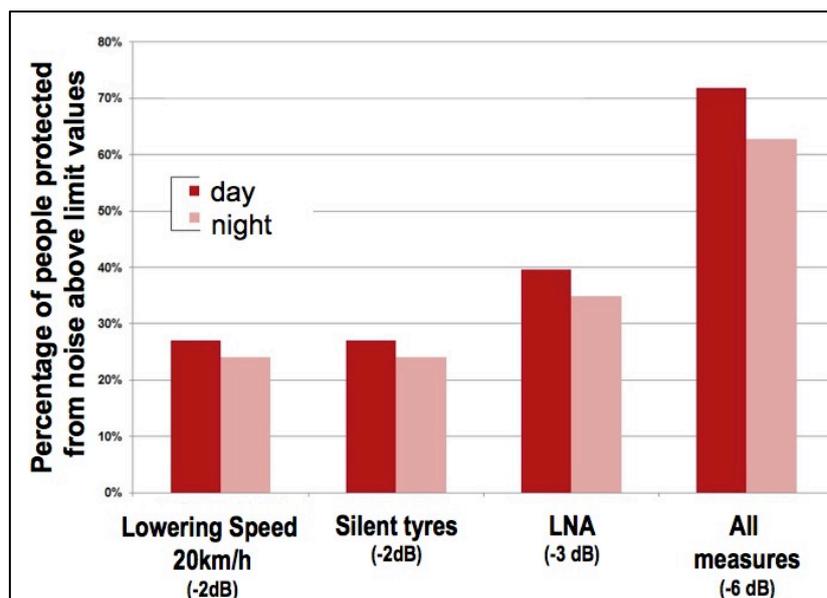


Figure 4 – Estimate of potential benefits from different measures at the source of noise

Besides the aspects described above, road traffic noise is also heavily determined by the emissions of the vehicles. The limitation of noise-emissions of vehicles is regulated on a European scale, which leaves little possibilities to act in favor of noise abatement on a national level. Switzerland follows the European Union (EU) regulations for type approval of vehicles, also in terms of noise emissions. The EU has recently taken decisions on decreasing vehicle noise⁷. Noise limit values will ultimately be decreased by 4 dB(A) for passenger cars, vans, buses and coaches and for trucks by 3 dB(A). Due to the long transition periods of this regulation, the full benefit may not be assessed before 15 to 20 years from now. Improvements in this sector would be far more urgent and need to be more ambitious than they have been decided.

5.2 Protection of calm areas

Assessment and outlook lead to the conclusion, that despite of additional and more stringent measures at the sources of noise, ambient limit values set by Swiss legislation can most likely not be respected nationwide within the next 20-30 years. It is therefore essential, to add measures also in urban planning in order to avoid future conflicts and to provide calm areas for people exposed to excessive noise at their residential neighborhood. A comprehensive strategy must include this aspect as an additional way of improving the protecting of people from noise. The focus will be set as well on areas, which are accessible in a short distance from dwellings, which are exposed to noise as on quiet areas outside agglomerations. The present work on an extended strategy for Swiss noise abatement includes developing criteria to define calm areas and establish legal possibilities to protect such areas inside and outside of developed areas.

Finally the extended strategy needs to take into account, that one driver of noise propagation in urban areas is the structure of buildings and the materials chosen for construction. At present, there is much importance given to the visible appearance of buildings, whereas the acoustical effects are usually not considered. This neglects, that the acoustical environment is very relevant for the well being of the people. More information to planners and architects will be necessary to raise awareness of the acoustical effects of the positioning of buildings and the materials chosen.

6. CONCLUSION

Switzerland has a legal framework, which triggered important investments in noise abatement on roads. Calculations with the monitoring tool SonBase reveal that 2014 one in five persons is exposed to noise exceeding the limit values set to protect health from adverse effects of noise. 85% of the persons affected live in urban areas, where noise barriers cannot be built. The prevailing challenge of the future noise abatement policy is to extend the strategy in order to achieve the degree of protection for the population that is demanded by the Constitution within a reasonable time. FOEN is currently

establishing proposals for future actions to advance noise abatement in a more holistic approach. For road traffic noise enhanced protection can only be achieved if action directly at the sources of road traffic noise will be boosted. In Switzerland in addition to the current measures on the path of noise propagation discussion is to set the focus on low noise asphalts, low noise tires, local speed reductions and a responsible driving behavior. At the same time the natural resource “quietness” needs to be protected inside and outside urban areas. Only this comprehensive set of measures can significantly advance the protection of the people from noise.

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