



HIGH NATURALNESS ALPINE AREAS ACOUSTICAL CHARACTERIZATION IN AOSTA VALLEY

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ABSTRACT

Aosta Valley is an alpine region characterized by high naturalness of the environment, particularly sensitive to the topic of the natural acoustic climate safeguard. The sonorous landscape must be considered an integrating part of the regional environment and its integrity strongly mark out the common mountain notion. In this work the acoustic climate of different natural areas is characterized in various periods of the year investigating different kinds of natural environments such alpinic refuges surroundings, winter ski excursions itineraries, pastures and different terrains in protected areas (Gran Paradiso National Park, Mont Avic Regional Park). Furthermore the anthropic impacts in these areas are characterized in relation to the tourists presence, the different local activities and, in particular exposure situations, to the combined effects of sonorous sources coming from the bottom of the valley. Differential level is tested to quantify the impact of noisy events on the silent mountain zones as additional acoustic descriptor, as previewed in END 2002/49/CE, employing, if the case, frequency analysis, in order to quantify the deviation from the natural conditions.

1 INTRODUCTION

The EU directive 2002/49/CE pointed out the safeguard of the natural acoustic climate to the general attention. This topic specially regards alpine regions, such as Aosta Valley, characterized by, and appreciated for, its high values of environmental naturalness. We are so led to extend the attention from built and highly infrastructured areas to remote ones, where natural quiet is the main feature, and the notion of sensible receptor extends to include the whole territory. A great variety of situations can occur, with natural environmental noise levels ranging from deep quiet (25 dBA) of high mountain remote snow fields in winter, to the uproar (70 dBA and more) in the vicinity of water falls in summer. Man made noise also originates from various kinds of sources [1]: engines supporting activities in mountain pastures (electrical current generators, chain saws, power mowers ...) or tourist-sporting practices, such as electric motors of cableways or ski-lifts or artificial snow guns. In several summer and winter resorts we have to consider the music from outdoor loudspeakers for recreational purposes. Far from this limit case, human presence brings noise, even if visitors are attracted by the naturalness of the site. So mountain refuges, and frequented footpaths become sources of artificial noise in the surrounding environment. These examples show that there is a great variability of both natural and artificial noise levels in the natural environment, due to the variety of the sources and to the time variability of the noise emissions, which is frequently seasonal [2], [3]. From this fact a general principle comes out: the impacts of artificial sources on the environmental noise need to be considered case by case, not referring to a fixed standard, but assuming the natural environmental noise in a given site as standard for the site itself [4].

Dealing with the environmental protection of the quiet areas, both natural protected ones and simply mountain remote zones, one realize that the environmental noise regulatory system, based on Leq , is intended, in Italy so far, to prevent noise pollution in highly infrastructured areas. Informations about noise levels in quiet mountain areas is important to define suitable indicators and reasonable evaluation criteria for regulatory purposes, at regional and national level.

2 NOISE IN NATURAL MOUNTAIN ENVIRONMENT

A simple indicator is the differential level R [5], [6] between environmental noise, taking into account natural and artificial sources, and the natural environmental soundscape.

$$R = 20 \text{ Log } \frac{\text{Env. noise}}{\text{Soundscape}} = Leq_{\text{env.noise}} - Leq_{\text{soundscape}}$$

In table I different situations are reported:

Table 1. Noise in natural mountain environment.

SUMMER	N	SITE (height)	NATURAL SOURCES	Lsound dB(A)	ARTIFICIAL SOURCES (distance from measuring point)	Lnoise dB(A)	R
	1	Mountain pasture (Champanement, 2350m)	Stream, wind	32.6	Noise from valley, cowbells (20m), voices (20m)	59.9	27.3
	2	Mountain pasture (Champanement, 2350m)	Stream, wind	32.6	Noise from valley, airplane,cowbells (100m)	43.6	11.0
	3	Mountain pasture (Champanement, 2350m)	Stream, wind	32.6	Noise from valley cowbells (500m)	39.1	6.5
	4	Mountain prairie crossed by country road (Plan di Verra, 2100m)	Stream, birds	44.2	Van, motorcycle, jeep (5m)	48.8	4.6
	5	Mountain prairie crossed by country road (Plan di Verra, 2100m)	Stream, birds	44.2	uncharged tractor (5m)	55.3	11.1
	6	Mountain prairie crossed by country road (Plan di Verra, 2100m)	Stream, birds	44.2	charged tractor (5m)	61.2	17.0
	7	Mountain pasture (Comboé, 2200m)	Stream	33.6	Noise from valley, Electric generator (~1000m)	36.7	3.1
	8	Top of mountain, face to valley (Becca di Nona , 3150m)	Stream	34.4	Noise from valley, helicopters (~500m), airplanes	41.7	7.3
	9	Top of mountain, Opposite side to valley (Becca di Nona , 3150m)	Silence	21.3	Airplanes	35.2	13.9
	10	Top of mountain (Becca di Nona , 3150m)	Silence	21.3	Noise from valley	36.1	14.8
	11	Alpine Lake (Muffè-Mont Avic Regional Park, 2100m)	Silence	27.2	Tourists voices (10m)	39.7	12.5
	12	Alpine pass (Lago Bianco-Mont Avic Regional Park, 2300m)	Silence	27.5	Airplane	40.4	12.9
	13	Mountain refuge (Barbustel – Mont Avic Regional Park, 2200m)	Stream, birds	27.5	Tourists voices (10m) Few persons	38.9	11.4
	14	Mountain refuge (Barbustel – Mont Avic Regional Park, 2200m)	Stream, birds	27.5	Tourists voices (10m) many persons	44.0	16.5
	15	Mountain refuge (Sella – Gran Paradis National Park, 2580m)	Marmots	27.0	Cowbells (300m), tourists voices (5m)	43.7	16.7
	16	Mountain refuge (Sella – Gran Paradis National Park, 2580m)	Marmots	27.0	Tourists voices (5m) many persons	47.2	20.2
	17	Mountain refuge (Sella – Gran Paradis National Park, 2590m)	Marmots, stream	27.0	Tourists voices (20m) many persons	46.6	19.6
	18	Mountain path (Gran Paradis National Park, 2500m)	Waterfalls (10m)	70.0		70.0	0.0
19	Mountain prairie served by cableway (Cervinia,Plan Maison, 2500m)	Streams, wind	38.5	Cableway (15m), tourists voices (10m)	50.3	11.8	

W I N T E R	N	SITE (heigth)	NATURAL SOURCES	Lsound dB(A)	ARTIFICIAL SOURCES (distance from measuring point)	Lnoise dB(A)	R
	20	Alpine Ski resort (Cervinia, Plateau Rosa, 3500m), toward valley	Streams, wind	35.2	Helicopter (~300m) skiers (10m), tourists voices (5m)	52.5	17.3
	21	Alpine Ski resort (Cervinia, Plateau Rosa, 3500m), toward glacier	Wind	28.3	Cableway (2000m)	29.7	1.4
	22	Alpine ski resort (Cervinia, Ventina glacier, 3400m)	Wind	32.1	Skiers (5m), helicopter (~300m), snowmobile (50m)	68.5	36.4
	23	Alpine ski resort (Cervinia, Plan Maison, 2500m)	Wind	30.5	Cableway station, snowpark, many tourists	61.4	30.9
	24	Alpine ski resort (Cervinia, Plan Maison, Lake Goyet, 2500m)	Wind	30.5	Cableway station (20m), tourists voices (10m)	50.0	19.5
	25	Alpine ski resort (Cervinia, Plan Maison, 2500m)	Wind	30.5	Cableway station (20m), various	52.3	21.8
	26	Mountain Village (Trois Villes, 1450m)	Wind, birds	32.1	Water pump (50m)	38.9	6.8
	27	Cross country ski resort (St. Barthelemy , 1900m)	Birds, stream	23.3	Skiers (5m), airplane	39.8	16.5
	28	Cross country ski resort (Valnontey-Gran Paradis National Park, 1680m)	Birds, stream	25.4	Skiers (5m), tourists voices (5m), airplane	41.0	15.6
	29	Cross country ski resort (Cogne - Gran Paradis National Park, 1680m)	Avalanche (100m)	37.3		37.3	0.0
	30	Cross country ski resort (Cogne - Gran Paradis National Park, 1680m)	Birds	27.4	Tourists voices (5m), walkers (5m)	43.5	16.1
	31	Cross country ski resort (Cogne - Gran Paradis National Park, 1680m)	Near the stream	50.9		50.9	0.0
	32	Cross country ski resort (Cogne, 1500m)	(Noise from village)	44.5	Snow machine (50m)	61.9	17.4
	33	Mountain Village (Gimillan, 1780m)	Wind	28.0	Noise from valley	39.0	11.0
	34	Mountain Village (Gimillan, 1780m)	Wind, (noise from valley)	42.5	Noise from valley (with snow machine – 800m)	42.8	0.3
	35	Alpine ski resort (Pila, 1830m)	(noise from surrounding activities)	34.5	Skiers (5m), tourists voices (5m), snowmobile (5m)	62.3	27.8
	36	Alpine ski resort (Pila, 1860m)	(noise from surrounding activities)	34.5	Skiers (5m), tourists voices (5m), chairlift (10m)	65.1	30.6
	37	Alpine ski resort (Pila, 2150m)	Wind, birds	24.7	Airplane	32.8	8.1
	38	Top of mountain (Greuvon, 2660m)	(opposite side to valley),wind	24.7	Chairlift station (50m)	36.5	11.8
39	Alpine ski resort (Pila, 1860m)		34.5	Chairlift (10m), skiers (5m), tourists voices (5m)	53.2	18.7	

In fig.1a and 1b are plotted respectively winter summer and noise exposure situations of table I, in terms of differential level R versus environmental noise level (Leq). In winter the points show a higher degree of alignment, due to very low, and consequently more constant levels of natural environmental noise levels. The impact of man made noise is particularly high in the proximity of restoration points near ski runs (cluster A in fig.1a), where music is sometimes diffused and amplified on the outside. The alpine ski practice (cluster B, fig.1a), also because of the presence of ski-lifts and chair-lifts, has a clearly higher impact than cross-country skiing (cluster C, fig.1a). Summer is characterized by a greater variety of natural sources: waterfalls, streams, birds ..., but high levels of environmental noise are less frequent, and in general they are related to agricultural activities and breeding (fig. 1b).

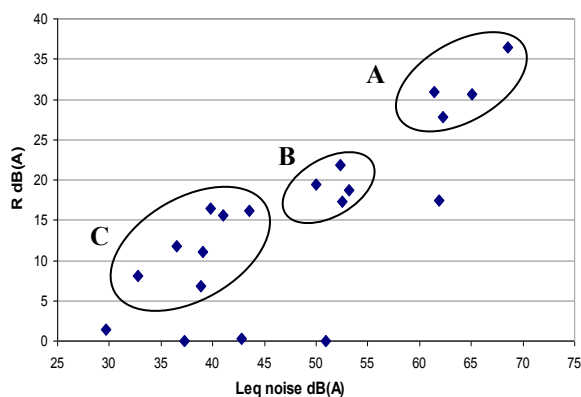


Fig. 1a - Winter exposure situations.
Differential levels vs. environmental noise levels

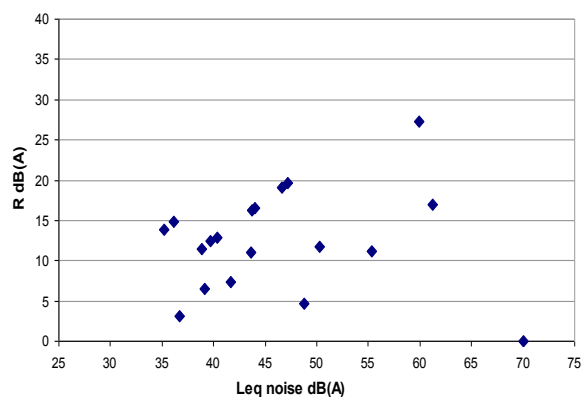


Fig. 1b - Summer exposure situations.
Differential levels vs. environmental noise levels

As well not so important in term of absolute environmental noise level (in general less than 50 dBA), human noise in the immediate surrounding of mountain refuges (voices, cries) has a great impact on the natural quiet of the environment, producing differential levels up to 20 dBA. Far from single noise sources, but exposed to the coalescence of a multitude of sounds, sites on the top of mountains two thousand and more meters over the valley represent a very interesting case of quiet disruption due to human presence and activity: differential levels in winter (site 38; 11,8 dBA) and in summer (site 10; 14,8 dBA) were evaluated at a distance of a few meters, from one side to the other of the sharp top-edge of two mountains facing the central valley of the region, in a very unusual context for phonometric activity.

3 DIFFERENTIAL LEVEL AND FREQUENCY ANALYSIS

In some situations the differential level is unfit to adequately describe the noise impact on the natural soundscape. The site 34 refers to the environmental noise on mountain slope 800 meters far from an artificial snow gun running in the bottom of the valley (the same of the site 32). The noise is clearly audible by ear, but, because of the windy day too, its level is very variable and it is anywhere not able to produce a significant increase in global differential level. By considering the frequency analysis in 1/3 octave (fig. 2a), it become evident the acoustical footprint of the noise source at the 400 Hz band, with a differential 1/3 octave band level of 10 dB with respect to the adjacent bands. Figure 2b shows a similar situation (site 21).

In this case the noise source is a cable way approaching the mount station. The measuring site is on an other side of the mountain range surrounding Cervinia Valley, at a linear distance of 2 thousand meters. Both noise source and mesuring site are more than 3 thousand meters a.s.l.. In this case, too, the increase in global differential level is moderate, even though natural environmental noise is very very low (high altitude, remote site, snow, no wind ...), but the differential 1/3 octave band level at 250 Hz is 10 dB!

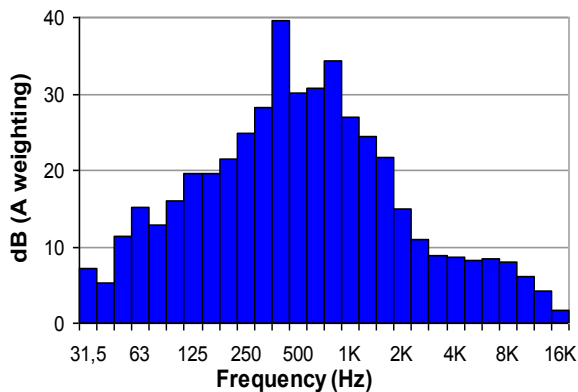


Fig. 2a, Site 32 – spectrum 1/3 octave

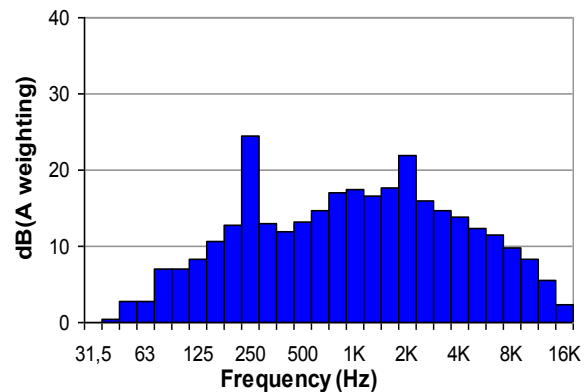


Fig. 2b, Site 21 - spectrum 1/3 octave

4 CONCLUSIONS

According to the italian natural law, the most restrictive diurnal environmental noise limit, for hospitals, schools, parks ..., is 50 dBA. The variety of acoustical situations found in mountain environment shows that non-negligeable acoustic impact and disruption of natural soundscape can occur at levels below this threshold. The cases presented in this paper show that a simple indicator based on the level, eventually on single 1/3 octave frequency band, allows a more efficacious protection of the natural soundscape.

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