Noise level monitoring at Larsemann Hills, east Antarctica

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Abstract

Sound is a disturbance created by a moving or vibrating source in a gaseous or liquid medium or a solid's elastic stage and can be detected by the hearing organs. Noise pollution affects human health, comfort, and efficiency. Hearing is a subjective response of human beings and animals to sound. Continuous noise exposure has been found to cause constriction of blood vessels, which may eventually lead to heart ailments.

Noise monitoring was carried out in and around Bharati Island to know the noise level in the study area. Ambient and indoor noise levels were recorded at 1-hour intervals for 24 hours. Besides ambient and indoor noise, the noise from machinery, earthmovers, helicopters, and during the drilling and blasting was also measured. The background noise level was monitored at Bharati Islands, Fisher Islands, Mcleod Islands, Broknes peninsulas, and Stornes peninsulas.

Key words: Ambient Noise, Decibel, Background Noise, Noise level monitoring

Introduction

Noise is an unwanted sound due to any operation and impacts human health and the environment. Noise pollution has become a common problem, and ambient noise levels are rising all around. This is mainly due to increased man-made activities. The growing noise is threatening the peace and health of the place and hence recognized now by all concerned. The noise, a complex phenomenon, requires much greater effort to understand its ill effects. Its measurement exhibits the immediate effects of the increase in noise on the community.

Significant variations above a base or residual noise level characterize the ambient noise level. The residual noise level is the level below which the ambient noise does not seem to drop during a given time interval and is generally caused by unidentified distant sources. It differs in rural and urban areas. At night, the noise level is low due to lesser elements of noise. The annoyance that people experience depends upon the number and intensity of noise elements that produce noise concurrently at a given time that occur during a time interval.

Sound is a disturbance created by a moving or vibrating source in a gaseous or liquid medium or the elastic stage of a solid and can be detected by the hearing

organs. The sound may be thought of as the mechanical energy of a vibrating object transmitted by pressure waves through a medium to a hearing organ, such as a human ear. For traffic sound, the medium of concern is air. Noise is defined as a sound that is loud, unpleasant, unexpected, or undesired. Sound is a process that consists of three components: the sound source, the sound path, and the sound receiver. All three elements must be present for sound to exist. Without a source to produce sound, there is no sound. Likewise, there is also only sound with a medium to transmit sound pressure waves. Finally, sound must be received; a hearing organ, sensor, or object must be present to perceive, register, or be affected by sound or noise. There are many different sound sources, paths, and receptors in most situations rather than just one. Acoustics is the field of science that deals with the production, propagation, reception, effects, and control of sound.

The sound represents a sinusoidal variation of the air pressure, with a well-defined frequency transmitted in the atmosphere at variable speed. The noise is composed of a random combination of many sounds (Hertig, 1996) without harmony, which can harm the organ of hearing (Ursinoiu & Dumitrescu, 1982). The perception of noise depends on the sound frequency and level (Manescu, 1986), the increment being situated between 10-135 dB(A) and 2-19 kHz (Hertig, 1996).

Noise pollution can be defined as unwanted or offensive sounds that unreasonably intrude into our daily activities (EPA, 1974). Noise pollution is caused by high or medium-intensity noise, which affects the population's health and various human activities. For comfortable hearing, one needs sound at 55 dB(A) level and a relaxed conversation with a background of 45 dB(A) or less.

The excessive magnitude of the sound energy the human ear receives is responsible for the physiological damage to the human mechanism. Noise pollution affects human health, comfort, and efficiency. Hearing is a subjective response of human beings and animals to sound. Continuous noise exposure has been found to cause constriction of blood vessels, which may eventually lead to heart ailments. Health is defined as not merely the absence of disease but the total physical and psychological well-being of a person. Since noise develops annoyance, irritation, and fatigue in Man, together with disturbance in work, rest, sleep, and communication, noise can be a health hazard, like air and water pollution. Among all the sources, motor vehicle noise constitutes the single most significant source of noise pollution. To conduct the Of the noise levels, the areas can be divided into the following zones: Residential, Commercial, Industrial, and Silence Zone. However, the scene is changed in the case of Antarctica. Antarctica has no traffic, and other noise-producing sources like snow vehicles, helicopters, generators, and earthmovers are available to construct the third Indian Scientific Base in Antarctica.

Study Area

Different locations were selected to measure noise levels at Bharati Island and Larsemann Hills in Antarctica. 24-hour noise monitoring was also carried out inside the M/V Ivan Papanin Ship, which was very close to Bharati Island. 24-hour monitoring of ambient noise was conducted near the superstructure of the Vessel. Besides this, the noise monitoring of earthmovers, generators, helicopters, snow vehicles, and drilling and blasting operations was also conducted at Bharati Island, Larsemann Hills.

The measurements were made under various meteorological conditions, emphasizing the importance of weather in assessing noise pollution. The measurement spots were located in the neighborhood of the primary noise-generating sources to avoid noise level alteration.

Noise level Monitoring

Noise monitoring was carried out in and around Bharati Island to know the noise level in the study area. Ambient and indoor noise levels were recorded at 1-hour intervals for 24 hours by an integrated averaging sound level meter of "Cirrus," making CRL 270. The sensitivity of the instrument was 0.1 dB(A). The standard calibrator was used to check the calibration. The microphone fitted with a windscreen was placed at an elevation of 1.5 meters above the ground level. The current noise level, i.e., equivalent sound level (Cumulative Leq) and peak values were recorded in the one-second data mode of the instrument. The span of measurement extended from Leq to the measurement of noise levels (day & night Leq), recorded at different locations, are presented in the following tables to estimate the actual impact. Besides ambient and indoor noise, the noise from Machinery, earthmovers, helicopters, and during the drilling and blasting was also measured. The background noise level was monitored at Bharati Islands, Fisher Islands, Mcleod Islands, Broken peninsulas and Stornes peninsulas.

Indoor Noise level

Like the air quality, indoor noise also includes all the sounds present inside the residential portion or home. Indoor noise impacts human health, so the measurement of indoor noise level is essential in ambient and indoor conditions. 24 hourly-based noise level was measured inside the M/V Ivan Papanin near Bharati Island at Larsemann Hills, East Antarctica.

Ambient Noise level

Ambient noise includes all sounds present in an environment. The noise level persists in the ambient environment with all the routine and general activities.

The acceptable noise level standards are different for day and night. Daytime is between 6.00 a.m. and 10.00 p.m., and nighttime is from 10.00 p.m. to 6.00 a.m. 24 hourly-based noise level was measured outside the M/V Ivan Papanin near Bharati Island at Larsemann Hills, East Antarctica.

Machinery Noise level

Noise generated due to heavy-duty machinery operation is intense and dangerous to human health. The operation of machines in Antarctica disturbed the environment wrt ambient and indoor noise levels. Machines, including generators, create high noise if proper acoustic enclosure, silencer, or other noise control measures are not provided. Long-term exposure to continuous and loud noise can create a few chronic diseases in exposed individuals. So, control and preventive measures are always required at the time of working beside the machines. Regular measurement of Noise level is essential to check the level of noise. The noise level from machinery operation on different occasions was measured at Bharati Island at Larsemann Hills, East Antarctica.

Drilling and Blasting Noise level

Noise originated from the drilling and blasting operations at the construction site of the new Indian Scientific base and may be dangerous to exposed persons. Exposure to loud frequencies of noise can produce temporary hearing loss, and prolonged exposure to loud noise can lead to gradual deterioration of the ear and subsequent deafness. So, it is essential to take prevention and safety measures to combat loud noise level exposures. Monitoring was conducted to measure the noise level produced at the time of drilling and blasting at Bharati station during the construction phase.

Background Noise level

Monitoring of background noise level of a location is also essential to evaluate the intensity and potential of noise-generating sources. Among all the selected Islands and peninsulas the minimum background noise level was 39.3 dB (A) at Stornes Peninsula. The background Noise level was 40.1 dB (A), 39.8 dB (A), 40.7 dB (A), and 41.6 dB (A) at Bharati Island, Fisher Island, Mcleod Island, and Broken Island, respectively.

Discussion

The noise level results are presented in Table 1, Table 2, Table 3, and Table 4. 24 hourly-based noise level measurements inside the M/V Ivan Papanin indicate that the noise level inside the Vessel depended upon daily routine activities near

Bharati Island at Larsemann Hills, East Antarctica. The noise level was a maximum of 65.2 dB (A) during lunchtime. It was found to be higher at 60.4 dB (A) during general talks. The minimum noise level was 39.5 dB (A) in the morning. It was also recorded higher during lunchtime (64.4 dB) due to the gathering of expedition members.

The noise level (24 Hours) was also measured outside the superstructure of M/V Ivan Papanin near Bharati Island at Larsemann Hills, East Antarctica. The data indicates the irregular rhythm of noise level data throughout the day-night. Generally noise level remains the same at approx. 60 dB (A) during the 24 hours of the study period. The reason for less fluctuation in noise level data was that continuous ocean winds were blowing at different wind speeds. The ship was cracking the ice layer of the water surface, and a few ship equipment were also found in operation, making continuous noise to the ambient environment. The maximum ambient noise level was 67.2 dB (A), and the minimum was 59.8 dB (A). Saran (2002) also observed a similar trend of ambient noise during the ocean voyage.

At Bharati Island, different types of Machinery and earthmovers were used to construct the third Indian scientific base in Antarctica. The different Machinery, including generators, created a different range of noise levels. The noise levels were measured from the operation of different Machinery at Bharati Island in Larsemann Hills, East Antarctica. The data shows that the stone crusher was found to have the highest noise level among all earthmovers and Machinery, including ice scooters (Skidoo) and helicopters. The noise level of the stone crusher was recorded as 101 dB (A) from a distance of 1 meter and 79 dB from a 30-meter distance during the operational conditions. LG helicopter Kemov was also found to be the second largest noise producer. The noise level of the LG helicopter (Kemov) was recorded as 98 dB from a distance of 1 meter and 81 dB at a 30-meter distance. The noise level of the Airlift helicopter was recorded as 93 dB from a distance of 1 meter and 79 dB from a 30-meter distance. The noise level of Menzi muck with drilling attachment was observed as 93 dB at a distance of 1 meter and 85 dB at a 30-meter distance.

Monitoring was also conducted for the noise level generated at the time of drilling and blasting at Bharati station during the construction phase of the third Indian scientific base at Bharati Island at Larsemann Hills, East Antarctica. The data explains that the noise level during the drilling operation was recorded as 93 dB (A) at a 1-meter distance and 85 dB at a 30-meter distance. The noise level of the blasting operation was measured as 91 dB (A) at a 100-meter distance. Nobody was allowed in the radius area of 100 meters from the blasting point due to safety measures, so noise level could not be taken at the closer location of the blasting point.

Table – 1: Indoor Noise level data at Larsemann Hills/ Ivan Papanin

Monitoring Location : MV Ivan Papanin Ship
Monitoring Date : 10-11 November 2010 **Place :** Dining Hall of Ship

S.N.	Time (GMT)	Leq dB (A)	L_{10}	L_{50}	L_{90}	Leq (Min)	Leq (Max)	Remark	L_{dn}
1	06.00-07.00	**42.1**	43.0	39.0	33.8	28.3	55.8		
2	07.00-08.00	**45.0**	46.1	41.6	36.3	30.2	59.7		
3	08.00-09.00	**55.2**	56.6	51.1	44.3	37.1	73.1		
4	09.00-10.00	**47.5**	48.5	43.9	38.1	31.9	62.9		
5	10.00-11.00	**60.4**	61.9	55.9	48.6	40.6	80.0		
6	11.00-12.00	**58.7**	60.2	54.4	47.2	39.4	77.1		
7	12.00-13.00	**65.2**	66.9	60.3	52.4	43.8	86.3	Lunch time	
8	13.00-14.00	**64.4**	65.9	59.5	52.1	43.3	85.6		
9	14.00-15.00	**58.7**	60.2	54.2	47.1	39.4	77.7		
10	15.00-16.00	**61.0**	62.7	56.4	49.0	41.0	81.3	Tea time	
11	16.00-17.00	**53.2**	55.1	48.0	42.8	35.8	71.4		
12	17.00-18.00	**48.7**	49.9	44.0	39.1	32.7	65.1		
13	18.00-19.00	**62.3**	63.8	56.9	50.6	41.9	81.8		
14	19.00-20.00	**53.2**	54.4	48.0	42.7	35.8	71.4		
15	20.00-21.00	**58.4**	59.2	52.7	47.0	39.2	78.4		
16	21.00-22.00	**54.4**	55.1	49.1	43.7	36.6	73.0		
17	22.00-23.00	**56.2**	57.5	52.5	43.8	37.9	75.2		
18	23.00-00.00	**58.1**	59.4	54.3	45.6	39.2	77.7		
19	00.00-01.00	**52.4**	53.8	48.9	41.0	35.4	70.1		
20	01.00-02.00	**46.8**	47.7	43.8	36.7	31.6	62.6		
21	02.00-03.00	**44.6**	45.9	41.7	35.0	30.1	59.7		
22	03.00-04.00	**42.7**	43.5	40.0	33.5	28.8	57.1		
23	04.00-05.00	**39.5**	40.6	37.0	31.0	26.7	52.9		
24	05.00-06.00	**43.3**	45.1	40.8	34.1	29.2	58.2		
	Average	**51.7**	**53.0**	**47.9**	**41.1**	**34.8**	**69.0**		**56.6**

Table – 2: Ambient Noise level data at Larsemann Hills/ Ivan Papanin

Monitoring Location : MV Ivan Papanin Ship
Monitoring Date : 10-11 November 2010 **Place :** Outside the Superstructure (Deck)

S.N.	Time (GMT)	Leq dB (A)	L_{10}	L_{50}	L_{90}	Leq (Min)	Leq (Max)	Remark	L_{dn}
1	06.00-07.00	**62.7**	64.1	58.1	50.3	42.1	83.1	Ocean winds	
2	07.00-08.00	**64.2**	65.7	59.3	51.7	43.1	85.1	Ocean winds	
3	08.00-09.00	**62.1**	63.7	57.5	49.8	41.7	82.3	Ocean winds	
4	09.00-10.00	**63.4**	64.8	58.6	50.8	42.6	84.1	Ocean winds	
5	10.00-11.00	**61.5**	63.0	56.9	49.5	41.3	81.5		
6	11.00-12.00	**62.4**	64.0	57.8	50.2	41.9	82.7	Ocean winds	
7	12.00-13.00	**65.5**	67.2	60.6	52.6	44.0	86.9	Ocean winds	
8	13.00-14.00	**60.2**	61.6	55.6	48.7	40.5	79.8		
9	14.00-15.00	**61.3**	62.9	56.6	49.2	41.2	81.3	Ocean winds	
10	15.00-16.00	**64.1**	65.9	59.2	51.5	43.1	85.0	Ocean winds	
11	16.00-17.00	**62.7**	65.0	56.6	50.4	42.1	83.1	Ocean winds	
12	17.00-18.00	**63.4**	64.9	57.3	50.8	42.6	84.1	Ocean winds	
13	18.00-19.00	**59.8**	61.2	54.6	48.6	40.2	79.3		
14	19.00-20.00	**61.6**	63.0	55.6	49.4	41.4	81.7	Ocean winds	
15	20.00-21.00	**62.8**	63.6	56.7	50.5	42.2	83.3	Ocean winds	
16	21.00-22.00	**64.1**	64.9	57.9	51.5	43.1	85.0	Ocean winds	
17	22.00-23.00	**67.2**	68.8	62.8	52.4	45.4	89.9	Ship tools	
18	23.00-00.00	**66.8**	68.3	62.4	52.4	45.1	89.4	Ice crushing	
19	00.00-01.00	**64.7**	66.4	60.4	50.6	43.7	86.6	Ice breaking	
20	01.00-02.00	**63.1**	64.4	59.1	49.5	42.6	84.4	Ice breaking	
21	02.00-03.00	**61.2**	63.0	57.3	48.0	41.3	81.9	Ice breaking	
22	03.00-04.00	**62.7**	63.9	58.7	49.2	42.3	83.9	Ice breaking	
23	04.00-05.00	**63.1**	64.9	59.1	49.6	42.6	84.4	Ice breaking	
24	05.00-06.00	**64.4**	67.1	60.7	50.7	43.5	86.6	Ice breaking	
	Average	**63.4**	**65.0**	**58.7**	**50.3**	**42.7**	**84.5**		**70.4**

Table – 3: Noise Level generated by various machinery/vehicles at Bharati Island

S.N.	Machinery/Vehicle/Equipments	Noise Level dB (A) (30 meter from source)	Noise Level dB (A) (1 meter from source)
1	Menzi Muck with drilling attachment	85	93
2	Menzi Muck normally	74	79
3	Caterpillar Dozer	71	81
4	Caterpillar Excavator	73	84
5	Ausa Concrete Mixer	72	77
6	Compressor	65	71
7	Himoinsa Generator KVA	74	90
8	Generator 7 KVA	57	70
9	Generator 3.5 KVA	55	67
10	Mantis Crane	67	75
11	Pisten Bulley	65	73
12	Casagrande Drilling/ Boring Machine	85	93
13	Skidoo	56	64
14	Airlift Helicopter	79	93
15	Kemov Helicopter	81	98
16	Stone crusher	79	101

Table-4: Noise level during Constructional and operational activities at Bharati Island

S.N.	ACTIVITY	Noise Level dB (A) (30 meter from source)	Noise Level dB (A) (1 meter from source)
1	Road Leveling	73	84
2	Stone Crushing	79	101
3	Drilling	85	93
4	Blasting	91*	-
5	Fuel transfer/ Heli operation	80	91

** more than 100 meter distance (30 meter distance was not allowed)*

Table-5: Background Noise Level at various Islands/Peninsulas

S.N.	Island/Peninsula	Background Noise Level dB (A)
1	Bharati Island	40.1
2	Fisher Island	39.8
3	Mcleod Island	40.7
4	Broknes Peninsula	41.6
5	Stornes Peninsula	39.3

Conclusion

Continuous exposure to heavy noise levels may be dangerous to exposed persons. Exposure to loud frequency noise can produce temporary hearing loss (Dhere et al., 2009). However, prolonged exposure to loud noise frequencies can lead to gradual deterioration of the inner ear and subsequent deafness (EPA, 1974) So, it is essential to take prevention and safety measures like earplugs to combat loud noise level exposures.

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