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IMPLEMENTATION OF ENVIRONMENTALLY FRIENDLY MEASURES AT TALLINN AIRPORT

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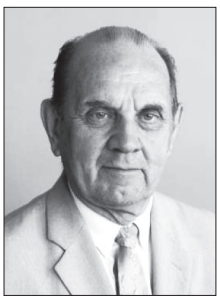

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Abstract. This paper aims at studying the problems of aviation noise and air, soil and water pollution in Tallinn Airport and the implementation of measures to make the airport more environmentally friendly. At present Tallinn Airport has two stationary noise level monitoring terminals and one mobile terminal for metering and modelling the noise level caused by aircraft taking-off and landing. Research shows that Tallinn Airport has not yet exceeded the noise limits stipulated by regulations. The area surrounding Tallinn Airport has been divided into four noise zones. Zone 1, where the noise level does not exceed 55 dB, is suitable for a majority of types of buildings, whereas Zone 4, where the noise level exceeds 70 dB and the highest level measured was 105 dB, is absolutely unacceptable as a building area. In recent years the number of flights flying over the residential areas of Tallinn has been reduced significantly,

i.e. the number of flights taking off from runway 26 and landing on runway 08. In suitable weather conditions, noisy aircraft are directed to land on RWY 26 and take off from RWY08. Thanks to the measures mentioned above, air pollution from aircraft exhaust gases has been reduced considerably in Tallinn. After the completion of the military airfield at Ämari in the nearest future, it is going to be possible to transfer the cargo flights, usually made by large noisy jets, from Tallinn Airport to Ämari. Various measures have also been taken to reduce the pollution of soil and water within the area of Tallinn Airport.

Keywords: airport, environment, aviation noise, noise monitoring, air pollution, soil pollution, water pollution, environmentally friendly measures.

1. Introduction

Nowadays the global community is paying more and more attention to the environment. Air, soil and water pollution issues have been topical for a long time. Airport operations have had a big influence on the environment, and that is why more airports are working towards making themselves more environmentally friendly. This is not an easy task since it requires time and money. The location, current situation, and opportunities of an airport also play a big role in this situation.

Today, a major negative factor in aviation is aviation noise, and it is likely to intensify in the nearest future. Only 2 per cent of the population is currently affected by aviation noise, but analyses reveal that the percentage may grow to 42 by the year 2020 in Europe. In order to reduce this type of environmental pollution, various regulations have been developed and must strictly be observed by airports and airlines (Zaporozhets *et al*. 2011).

Thousands of residents of Tallinn and neighbouring areas are exposed to noise pollution because the airport is located only 4 km southeast of Tallinn city centre. The closest residential area is situated at Mõigu, only about 500 m southwest of Tallinn Airport and one of the districts of Tallinn that is situated under the trajectory of aircraft taking off and landing. While noise has been the number one concern of airline operators, the problem of airport air pollution is also coming into consideration. A number of organisations and programmes have been created to help airports reduce their carbon emissions. These programmes help airports to develop systems to identify, monitor and reduce sources of air pollution. One of these programmes is called the Airport Carbon Accreditation Programme (Welling 2012; Can Airports … 2012).

In an airport's operating area, an important factor influencing the environment is runoff water. This water may have a negative impact on soil and ground water since it contains a relatively high concentration of pollutants. During airport operations, different contaminants can be spilt onto the ground. These include aircraft deicing fluids, lubricants and fuel. They are washed away by rain onto the grassland around the airfield. To avoid harming the environment, airports have developed various drainage systems that trap and treat the water before it is released (Sulej *et al.* 2011).

2. Noise pollution

Over the past decade, numerous studies have been carried out and actions taken to reduce noise pollution at Tallinn Airport.

On 5 September 2001, a joint Danish-Estonian project was signed with the aim of monitoring air traffic noise at Tallinn Airport. During the project, stationary noise monitoring equipment was installed and a special method for calculating noise contours was applied. The project enabled the impact of noise caused by air operations on the surrounding environment to be determined and assessed, and based on the results a noise map can be prepared. The latter was also the final goal of the project.

In 2003 stationary noise monitoring equipment was installed at Tallinn Airport to measure the noise level caused by departing and landing aircraft in anticipation of applying preventive measures or sanctions. The Tallinn Airport monitoring system enables noise from aircraft and airport operations to be analysed and forecasts to be made. Based on noise monitoring and results of measurements, it is possible to draw noise maps.

The following noise meters are currently used at Tallinn Airport (Vanker *et al*. 2009):

a) two stationary noise level monitoring terminals;
b) one mobile terminal;
c) software to monitor flight trajectories (Topsonic);
d) software for modelling noise levels (Danish method).

Measurement of the noise level is carried out on a 24-hour basis, and violation of the established noise level is recorded after it has exceeded the level of 64 dB (Keskküla 2012b). The noise monitoring stations are located at both ends of the runway. One of the stationary monitoring systems, Taisto, is situated on the territory of the airport and is surrounded by the fence. Data transfer from the monitoring terminal to the central station takes place via cable. The second monitoring system, Waterworks, is situated outside of the territory of the airport, on the territory of AS Tallinna Vesi (*Tallinn Water Ltd.*™), and the transfer of the data of that terminal takes place by *Telecom* lines.

One of the terminals is equipped with weather sensors to measure wind speed and direction and air temperature and pressure. (Vanker *et al*. 2009; Keskküla 2012b)

Figure 1 shows the location of Tallinn Airport noise monitoring terminals (called Taisto and Waterworks).

Fig. 1. Noise monitoring station (right) and their locations (left). (Keskküla 2012b)

The highest noise levels were recorded in 2006 and 2009, when the levels measured were 112.2 dB and 108.8 dB respectively. The maximal noise levels in other years were between 97 dB and 112 dB at Taisto terminal and between 80 dB and 102 dB at Waterworks (Fig. 2) (Keskküla 2012b).

The noise limits imposed on different areas were established by the Minister of Social Affairs Regulation No. 42 'Noise standards in residential and recreational areas and in dwellings and buildings for public use, and noise measurement methods' (Keskkonna-alaste … 2012). The noise report drawn up by the Tallinn Airport Ltd. specialist on environmental and aviation safety shows that since there are no recreational areas nearby Tallinn Airport, the long-term average noise measurements do not exceed regulatory limits (Fig. 3) (Keskküla 2012b).

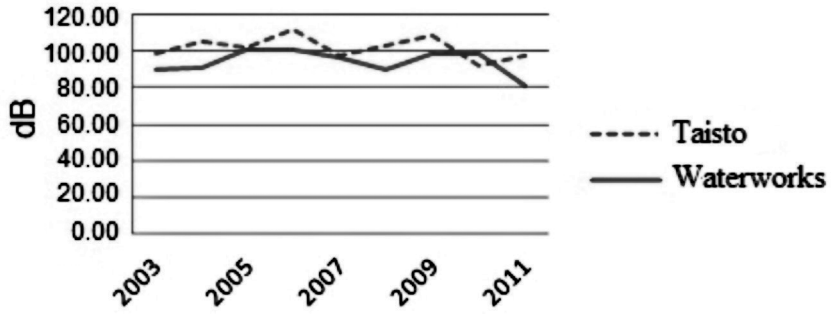

Fig. 2. The highest noise levels in noise monitoring terminals in 2003–2011 (Keskküla 2012b)

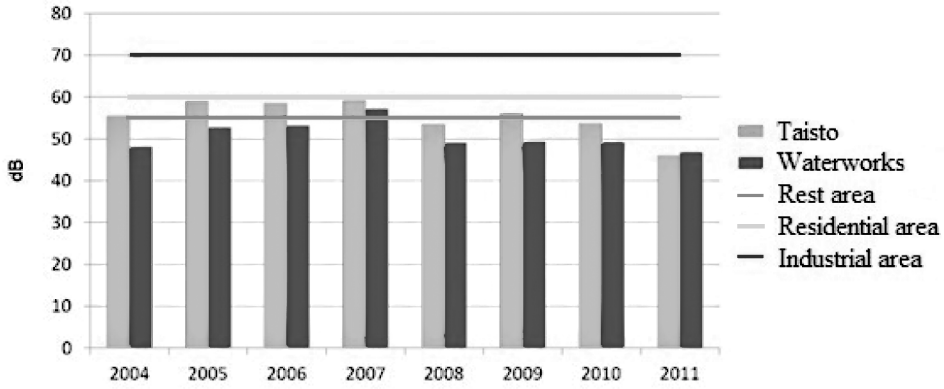

Fig. 3. Average daytime noise indicators at Tallinn Airport in 2004–2011 compared to noise limits established in various areas (Keskküla 2012b)

Table. Noise zones at Tallinn Airport

Zone I	Suitable for the majority of buildings	EFN > 55 dB
Zone II	New residential districts can be built	MFN > 85 dB
	It is not recommended to develop new residential districts or build other noise sensitive buildings	EFN > 60 dB MFN > 95 dB in the daytime (06–23) MFN > 85 dB at night (23–06)
Zone III	Unsuitable area for residential districts, hospitals, schools, etc.	EFN > 65 dB MFN > 100 dB in the daytime (06–23)
Zone IV	Area absolutely unsuitable for any types of buildings	MFN > 90 dB at night (23–06) EFN > 70 dB MFN > 105 dB

The area surrounding Tallinn Airport is divided into four noise zones that have been determined by the combination of EFN and MFN (Tab.). EFN represents the equivalent noise level measured in time for one week, and MFN represents the highest noise level on A-scale recorded regularly at the measuring station (Niglas 2005).

Unfortunately, it is not possible to completely stop flights over Tallinn, but it is possible to take measures that would cut this number. It has been possible to reduce the number of flights taking off from RWY 26 and landing on RWY 08 to the extent that only one-third of flights fly over the city. Estonian AIP (Aeronautical Information Publication) describes the anti-noise procedures used in Tallinn Airport. Special procedures that require certain actions after an aircraft has taken off have been established for the aircraft departing from RWY 26. In addition, restrictions on conducting engine check runs that prohibit check runs from 8 p.m. to 4 a.m. and around-the-clock on Sundays have been established.

As the on-going construction process takes place in Tallinn, including the creation of new private houses in the near vicinity of Tallinn Airport, real estate developers have to take account of anti-noise requirements and follow the noise maps. The noise levels inside buildings have to be taken into account as well, meaning that the daytime noise level in the living room should not exceed 40 dB. The noise limits in residential and recreational areas and in dwellings and buildings for public use have been established by the Minister of Social Affairs Regulation No. 42.

In 2012 thinning out of high vegetation was carried out and trees endangering air traffic and blocking the air traffic controller's view from the ATC tower to the runway were chopped down. The removal of the trees caused the natural noise barrier between a single dwelling and the runway to be eliminated as well, however. Now Tallinn Airport Ltd. should build a new wooden or plastic noise barrier between the dwelling and the runway (Fig. 4).

Several international airports have imposed higher landing fees on noisier aircraft. At Tallinn Airport, noisier aircraft are directed to land on RWY 26, i.e. not to fly over the city, but this method is not always applicable since the landing direction is often determined by weather conditions. In the future, landing fees might be differentiated depending on the noise level generated by different types of aircraft.

No restrictions have yet been established by Estonian AIP on nighttime runway use at Tallinn Airport. Imposing restrictions that would ban noisy aircraft from using the runway from 11 pm to 4 am might be considered.

In the nearest future, after the completion of a military airfield in Ämari, it will become possible to transfer the cargo flights mostly made by big and noisy jets from Ülemiste (the location of Tallinn Airport) to Ämari.

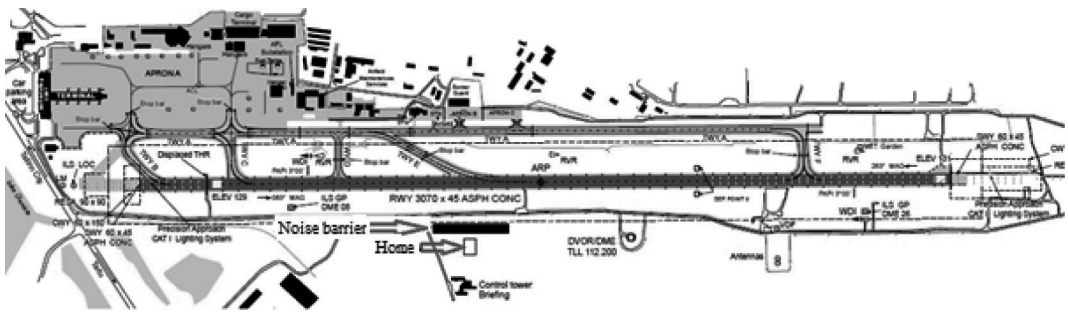

Fig. 4. The recommended location for the noise barrier (Mäsak 2012)

3. Air pollution

Air pollution from aircraft exhaust gases in Tallinn was cut significantly after Estonian Air Navigation Services (EANS) began to reduce the number of flights departing from RWY 26 and those landing on RWY 08, i.e. the flights over the city.

Figure 5 shows the amount of CO_2 emissions of the gas-fired boiler house located at Tallinn Airport. Natural gas is used in the local heating systems of Tallinn (Keskküla 2012a). Electricity is purchased from Latvenergo, the Latvian power company.

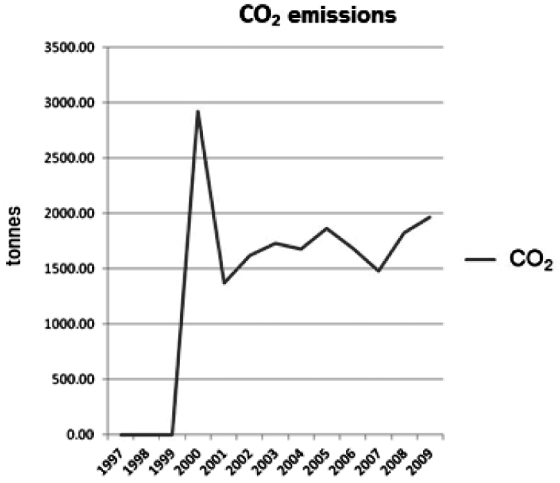

Fig. 5. Tallinn Airport gas-fired boiler house emission of CO_2 in tonnes (Keskküla 2012a)

Tallinn Airport Ltd. owns an ambient air pollution permit from 31 December 2009 that specifies the emission limits of its gas-fired boiler house. Tallinn Airport Ltd. bears the responsibility for keeping to the emission limits set for the boiler house, for the technical condition of its vehicles and their emission of exhaust gases, and for the quality of the fuel used. Holding the ambient air pollution permit also includes the obligation to present a yearly report on emission of pollutants into ambient air.

Tallinn Airport Ltd. is a supportive member of the Estonian Association for Environmental Management, but it is also advisable to join the Airport Carbon Accreditation Programme (ACA(P)) in the near future. The ACA is the only institutionally endorsed carbon management certification standard for airports. The programme independently assesses and recognises the efforts of airports to manage and reduce their carbon emissions with four levels of award: Mapping, Reduction, Optimisation and Neutrality. The ACA would help Tallinn Airport identify the major generators of pollution, carry out pollution mapping, and reduce the environmental impact of pollution.

4. Soil and water pollution

Very often the airport runoff water contains a considerable amount of hydrocarbons originating from the breakdown of crude oil and from de-icing fluids based on glycols, urea or acetate.

At present aircraft de-icing treatment takes place at special stands or platforms fitted with channels leading to the drainage system. De-icing is carried out by specially equipped machinery. The major environmental issue here is that the de-icing agents are not removed from the liquid spilt on the ground and which afterwards seeps into the soil. At Tallinn Airport there is a storm water drainage system that helps reduce the amount of aircraft de-icing chemicals seeping into the soil and ground water (Keskküla 2011), but it is not believed to be efficient enough to stop soil and water pollution at the airport.

Four different types of de-icing chemicals are used at Tallinn Airport: Safewing MP I 1938 Eco and Safewing MP II Flight are used for aircraft; urea and Clearway F5 are used on runways and taxiways (Keskküla 2011). Figures 6 and 7 below show the amounts of de-icing chemicals used to treat the aircraft, runways and taxiways at Tallinn Airport.

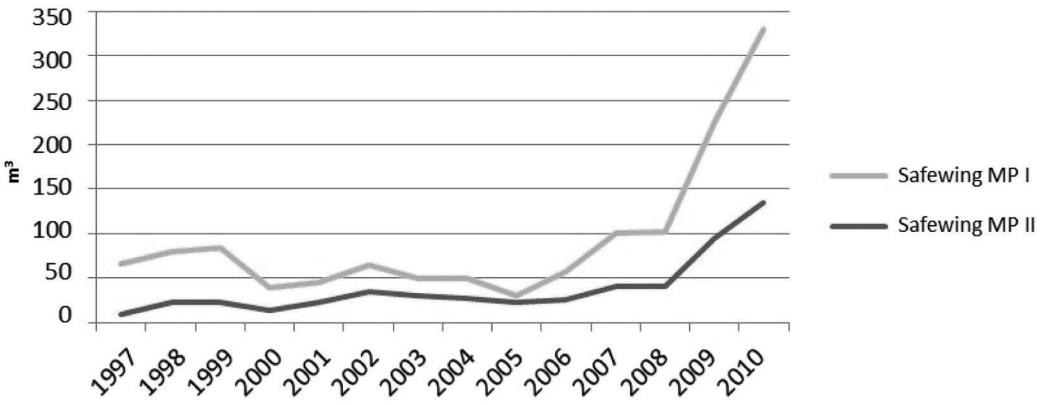

Fig. 6. Amounts of de-icing chemicals used to treat aircraft at Tallinn Airport in 1997–2010 (Keskküla 2011)

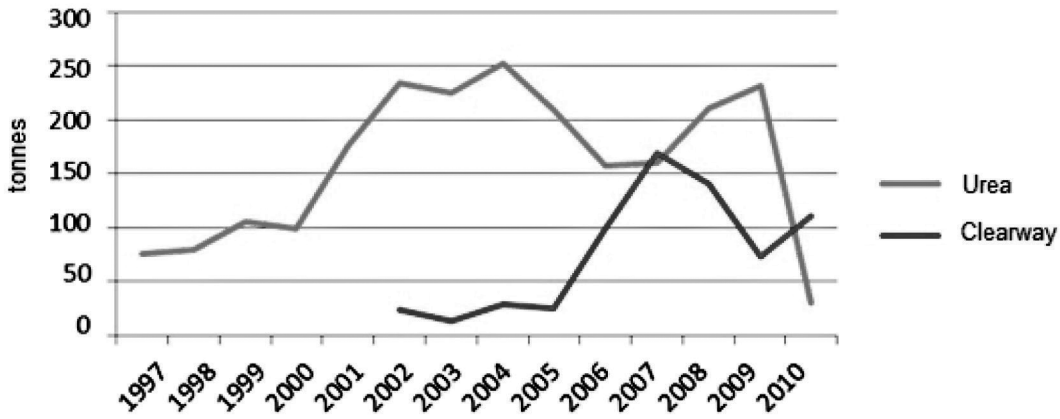

Fig. 7. Use of de-icing chemicals on runways in Tallinn Airport in 1997–2010 (Keskküla 2011)

When taxiing, the de-icing chemicals may be spilt all over the air traffic area and get into the environment from there. In principle the de-icing chemicals are not hazardous, but when more de-icing treatment is needed due to snowy or cold winters, the amount of chemicals used is also bigger. The more the amount of chemicals increases, the bigger a hazard they become, for example causing the destruction of vegetation in airport ditches. To prevent such severe consequences, specially equipped platforms for carrying out de-icing procedures might be built. That would enable the polluted water to be collected into the system, where the hazardous chemicals could be removed.

The de-icing procedures taking place on runways, taxiways and aprons are the principal activities causing soil pollution at the airport. In winter all surfaces covered with tarmac are regularly cleared from snow and huge amounts of de-icing chemicals are directly applied to runways/taxiways and roads. Large amounts of snow amassed when clearing the air traffic area are taken to green areas located in the eastern part of the airport. In snowy winters the airport is not capable of removing all the snow contaminated with de-icing chemicals, and it remains on the green areas by the terminal, runways and taxiways. When spring arrives, the contaminated snow starts melting and the chemicals seep into the soil and water. The most considerable amounts of chemicals seep into the soil in the green areas of the eastern part of the airport where snow is stored in winter (Keskküla 2011).

A settling pond is a reservoir where all storm water and wastewater is directed into and stored until the solids settle to the bottom. Settling ponds are of utmost importance when the runoff water contains a large quantity of a suspended substance that negatively affects the quality of water, meaning that such water must not be returned to the natural water cycle before being properly treated. The settling pond is emptied after the solids have settled; thereafter the sediment has to be removed and neutralized in compliance with local regulations (Galdwell 2006).

Since air traffic in Tallinn Airport has greatly increased in recent years, there is a serious danger of soil and water pollution. In principle, de-icing agents are not hazardous, but they pose hazards when used in large quantities. Therefore, if the number of aircraft using Tallinn Airport increases, the quantity of de-icing agents used will also increase. This leads to larger quantities of chemical contaminants in the snow cleared from various areas of the airport. If that snow is stored in the green areas not supplied with any special melt water collector, it will result in soil and water pollution. To avoid such a situation, Tallinn Airport should create a snow storage site together with a settling pond accompanied with special melt water and storm water collectors and treatment facilities. In addition, the drainage and ditch systems should be renovated.

The present Tallinn Airport drainage system consists of pipelines and open ditches. If there is much rain, the eastern part of the airport is flooded because the drainage system lacks adequate capacity. It is necessary to renovate the airport drainage system in the near future to increase its volume and flow capacity.

Tallinn Airport has a water monitoring station working on the following principle: all the runoff entering the system is monitored, and if it meets the standards established by regulations, it is directed to the storm water drainage system, but if the runoff is contaminated, it is directed into the wastewater collector. Tallinn Airport has signed an agreement with AS Tallinna Vesi (*Tallinn Water Ltd.*) that deals with wastewater operations. One of the conditions included in the agreement is that wastewater has to meet the standards set for pollution Group 3, and in the event the standard is violated, the airport has to pay for excessive pollution.

5. Waste handling

Tallinn Airport passenger terminal has been provided with waste bins with several different openings in them where each opening is meant for disposing different types of waste, e.g. plastic, paper and other waste (Fig. 8).

On the territory of the airport, there are waste sheds where the classified waste is collected in separate containers. Hazardous waste is taken to the hazardous waste collection station managed by the airport maintenance service, which has the task of transporting the waste to the appropriate hazardous waste processing plants. Recyclables such as packages, paper and cardboard are sent to Estonian Pack Cycling for processing, and mixed household waste is dealt with by Ragn Sells. Figure 9 below shows the amount of waste generated at Tallinn Airport in 1997–2009. The uper graph shows the total amount of waste in tonnes, and the lower graph illustrates the waste per passenger and per flight operation in kilogrammes. The upper red line indicates the amount of waste per flight operation, and the lower blue line, the amount per person.

Fig. 8. Waste bin in Tallinn Airport passenger terminal (Keskküla 2012a)

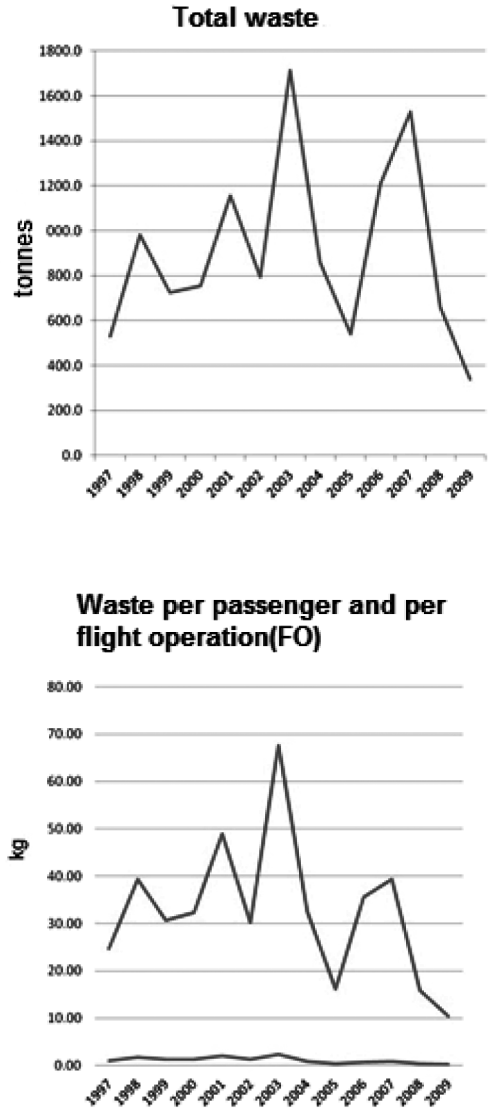

Fig. 9. Amount of waste at Tallinn Airport (Keskküla 2010)

6. Conclusions

One of the most significant negative environmental factors at Tallinn Airport is aviation noise. The maximal noise levels in previous years remain between 80 and 112 dB. The highest noise level was recorded in 2006, when the level measured was 112.2 dB.

Two stationary noise level monitoring terminals are currently being used at Tallinn Airport. The noise level is measured around the clock and violations of the noise level are recorded after they have exceeded the level of 64 dB.

To reduce the noise level, regulations that are to be followed by Tallinn Airport and by the aviation companies that operate at Tallinn Airport have been worked out.

In addition to noise pollution, Tallinn Airport pays attention to the reduction of carbon emissions. Tallinn Airport's emission of CO_2 is only 1500–2000 tonnes per year at present.

Air pollution from aircraft exhaust gases in Tallinn was cut significantly after Estonian Air Navigation Services began to reduce the number of flights departing from RWY 26 and those landing on RWY 08, i.e. the flights over the city.

At Tallinn Airport, an important factor posing an environmental impact is runoff water. Runoff water can have a negative impact on both soil and water since it may contain high concentrations of contaminants. Different contaminants may get on the ground during airport operations, e.g. aircraft de-icing chemicals, lubricants, and fuel leaking during the refuelling of an aircraft. These contaminants are washed from the platform or

from the wider operating area to green areas by storm water.

To avoid damaging the habitat in green areas and ditches, various water drainage systems that help to restore the quality of water have been developed at Tallinn Airport.

Waste management is also carried out at Tallinn Airport, meaning that the waste is classified and sent to the appropriate processing plants, e.g. recyclables such as packages, paper and cardboard are sent to Estonian Pack Cycling.

As research reveals, the average long-term noise indicators have not exceeded any limits established by the regulations at Tallinn Airport; also, in principle the deicing agents used at the airport are not hazardous.

Since air traffic at Tallinn Airport is expected to increase in the nearest future, it is necessary to continuously apply various environmental protection measures to maintain and develop the environmental friendliness of the airport.

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