Solid Waste management in mountain refuges – results and implications from a case study

Based on a survey of 100 Alpine mountain refuges, this paper describes the current status of solid waste management and deduces recommendations for sustainable waste management.

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Abstract

Waste management in mountain refuges is characterised by the decentralized position of mountain refuges, difficult transport conditions and the necessity to transport all waste generated to waste collection facilities in the valley. Based upon results from 100 Alpine mountain refuges, this paper describes the current status of solid waste management and provides recommendations, which can be used for other decentralized systems as well. The minimization of waste quantities is a key factor for reducing transport costs, and can be achieved by waste prevention, i.e. measures taken before something becomes waste, as well as by on site composting of biowaste. Attention should be paid to the compliance with legal requirements and the prevention of negative environmental impacts. The results of the project reveal that there is need for information among operators of mountain refuges, in particular with regard to separate collection of hazardous waste, state-of-the-art composting and the illegality of burning wastes.

Introduction

Mountain refuges play an important role in Alpine tourism and local recreation. There are more than 15,000 mountain refuges and inns throughout the Alps, of which approximately 1,600 are owned by Alpine Associations (DBU, 2005). Their location in a sensitive ecological environment, often far away from other infrastructure, difficult transport conditions and sometimes extreme climatic conditions pose a challenge for the supply with water, energy and goods and for the disposal of wastewater and waste. An international project (DAV, 2010; Lebersorger et al., 2011) which was conducted between 2006 and 2010, evaluated the current situation of supply and disposal systems of Alpine mountain refuges and developed guidelines to be applied in the sustainable planning, construction and operation of supply and disposal systems (cf. Deutscher und Österreichischer Alpenverein, 2011). This paper focuses on solid waste management in mountain refuges. The findings presented are based on a detailed investigation of 100 mountain refuges, the majority of which are situated in Austria (70 refuges) and Germany (13) and the others in Italy (8), Switzerland (4) Slovenia (3) and the Czech Republic (2) (for methodological details see Lebersorger et al., 2011).

The examined mountain refuges are situated in countries with predominately well developed waste management infrastructure and existing waste collection systems. Due to the isolated location of mountain refuges – far from other

Key factors for sustainable solid waste management in mountain refuges are:

- Compliance with legal requirements (e.g. no burning of waste, mandatory use of existing municipal collection schemes)
- Minimizing the amount of waste generated - by means of waste prevention and on site composting of biowaste
- State-of-the-art composting (use of covered crates, appropriate application of composting procedures)
- Proper collection and storage of wastes, recyclables and hazardous waste
- Minimizing the number of journeys to be undertaken by minimizing the weight and volume of solid waste and by avoiding empty or partially loaded transports
- Provision of information to operators of mountain refuges and tourists

infrastructure and often difficult to access – all wastes generated have to be transported to waste collection facilities in the valley. This is a basic difference to other buildings whose waste is usually picked up by regular waste collection tours. 19% of the examined mountain refuges could only transport supply goods and waste by helicopter. 34% used a cable car and 47% were accessible via a road. The few available roads are often represented by steep gravel tracks that can only be accessed by means of special vehicles and at certain times. The means of transport represent a crucial factor in terms of costs and climate relevance, with the helicopter constituting the most unfavourable situation. The transportation of goods via cable car implicates the use of fuel-derived energy.

Waste management in mountain refuges should be aimed at sustaining the proper function (offering food, drinks and accommodation to tourists) of the mountain refuge, at avoiding disadvantageous influences on humans and the environment as well as at minimizing waste generation and the amount of waste which has to be transported to the valley. Legislation concerning waste management in Europe and Austria give priority to waste prevention, followed by recycling and finally disposal (Directive 2008/98/EC, BGBl. I Nr. 102/2001). This hierarchy also applies to waste management in mountain refuges and is therefore used for the structure of this paper. Starting with a description of waste generation and composition, measures for waste prevention in mountain refuges are presented, followed by waste collection and finally ways of disposal. The basic principles and findings presented in this paper can also be adopted for other regions including developing countries.

Waste generation

Mountain refuges are very heterogeneous which is exemplified by the survey of 100 mountain refuges. They differ in:

- Management (without staff / with staff) covering a range from 0 to 20 employees
- Seasonal operation (all over the year / summer / winter) covering a range between 70 and 365 days a year
- Frequency of visitors: daytime visitors (the average number ranges from 3 people to several 100 per day), overnight stays (average from 0 up to 100, maximum up to 370 people per day)
- Number of beds (from 5 to 342)
- and comfort (with/ without showers; from simple shelters to restaurant for day-trippers).

The Alpine Associations distinguish 3 classes of mountain refuges: shelters, which are only accessible by foot after at least a one hour´s walk, with very simple facilities and a small variety of offered food and drinks (category I); mountain refuges in touristic areas, usually open all over the year, offering a wider range of food and beverages and more comfort (category II); mountain refuges with mainly daytime visitors, which are accessible for tourists by mechanical means of transport (e.g. cable-car, car) (category III) (Grinzinger, 1999).

The quantities and composition of waste differ accordingly. Main sources of waste generation are meal preparation (preparation residues, leftovers, fats,…), packaging (such as cans, bottles, bags, boxes etc. made of plastics, metal, glass, cardboard), hygienic paper (napkins, paper towels,…), waste brought by visitors (packaging, leftovers, sanitary products,…), waste from the staff resident in the mountain refuge (typical household waste), waste from water and energy supply and wastewater treatment (residues from operating materials, packaging, chemicals, batteries,…). Furthermore, also bulky waste, waste electric and electrical equipment, textiles etc. can occur.

Waste quantities of the 100 examined mountain refuges show a wide variation, so that only rough estimates can be provided. The average waste quantity per employee and month was 61 kg (Lebersorger et al., 2011). Estimates for the average waste quantity per visitor per day amount between 0.110 kg (Lebersorger et al., 2011) and 0.200 kg per day (Grinzinger, 1999).

Waste prevention

Waste prevention means measures taken before a substance, material or product has become waste, that reduce the quantity of waste, the adverse impacts of the generated waste on the environment and human health; or the content of harmful substances in materials and products (Directive 2008/98/EC). Preventing waste before their generation can significantly reduce the quantity of waste which has to be transported from a mountain refuge to the valley. Measures include the avoidance of single-portion packs, paper towels and paper napkins, the use of reusable packaging instead of disposable packaging, the use of larger packaging units or the use of unpacked products if possible. Table 1 shows the number of operators who referred the application of prevention measures.

Table 1. Percent of mountain refuge operators referring the application of various prevention measure

measure	%
avoidance of single-portion packs	27
avoidance of cans	26
avoidance of paper towels/ napkins	11
avoidance of disposable packaging	71
no provision of bins for visitor waste	32
provision of bins for visitor waste in lavatories alone	35

Waste generated by visitors contributes towards an increase in total waste quantities, and is a frequently reported problem (Grinzinger, 1999). 13% of the interviewed operators of mountain refuges complained of problems with visitor-generated waste. Visitors are asked to take all products, items and related wastes (e.g. food packaging, leftovers, tissues) which they brought with them back to the valley for disposal. Alpine Associations provide respective information on their websites, and a lot of mountain refuges inform their visitors by means of signs in or outside the mountain refuges or directly verbally. Only 15% of the examined mountain refuges did not provide any information. Figure 1 shows some examples.

An effective measure for the prevention of visitor-generated waste is to provide no bins for visitor waste. The case study in 100 mountain refuges showed that the lower the number of bins made available to visitors, the lesser the quantities of waste generated (Lebersorger et al., 2011). About one third of the mountain refuge operators interviewed provided no waste bins for visitors; another third provided bins only in lavatories (see table 1) and the remaining third provided bins at strategic points throughout the premises (e.g. in the restaurant, in the entrance hall, on the floors or in dormitories). It is recommended to provide a waste bin in the lavatories. Otherwise some visitors will dispose of waste into the toilets, which can cause severe problems in the wastewater treatment system. 6% of the interviewed operators reported relevant negative experience. According to estimates, waste generated by visitors accounts between 20% and 70% of the waste volume (Grinzinger, 1999) and about 35% by weight of total waste quantity of a mountain refuge (Lebersorger et al., 2011). Therefore it can be assumed that the provision of waste bins only in lavatories and consequent information of the visitors can reduce waste quantities at up to one third.

Figure 1: Information telling tourists to take along their waste and dispose of it in the valley: with additional provision of garbage bags (left), poster inside a mountain refuge (top right), sign with bilingual information (bottom right) (photos IEVEBS)

Waste Collection

According to national legislation, wastes have to be collected and treated separately in the countries which were involved in the project. For example Austria has separate collection schemes for residual waste, biowaste, packaging (plastics, composite materials, glass, metals, paper and cardboard), hazardous household waste and a lot of other types of waste such as waste electrical and electronic equipment or bulky waste. A fee has to be paid for residual waste and biowaste, whereas recyclables such as plastics, metal or paper usually can be disposed of for free at municipal waste collection facilities. Therefore, operators of mountain refuges can save costs by trying to minimize the quantity of residual waste and collecting recyclables separately.

Recycling is beneficial for the environment because of saving energy, greenhouse gas emissions, resource consumption and landfill volume. For example, the use of glass waste in the production of glass results in energy savings of up to 22.5%, and by using 1 metric tonne of cullets for glass production, 5 metric tonnes of sodium carbonate can be saved (Tiltmann, 1993-95 cited by Lechner, 2004). Recycling aluminium saves 95% of the energy which would be necessary for the production of primary aluminium (Lechner, 2004).

The survey of the selected mountain refuges showed that the majority of operators collected recyclables and biowaste separately. As for hazardous waste the situation was not as good. Only 28% of the operators interviewed reported the separate collection of hazardous waste. Smaller refuges separate hazardous wastes to a significantly lower degree than larger refuges (Lebersorger et al., 2011). Hazardous waste comprises chemicals (cleaning agents, chemicals used for the operation and maintenance of supply and disposal systems, drugs), mineral oils and oily wastes, batteries and coating materials. They require separate collection, storage and special treatment (BGBl. I Nr. 102/2001), because their improper treatment (e.g. by means of landfilling) can have negative consequences on the environment (water, air, soil), plants, animals and on human health. Also waste electrical and electronic equipment requires separate collection and treatment due to hazardous components (Directive 2002/96/EC). In order to remedy information gaps and incorrect handling of hazardous waste, specific information should be provided to the operators of the mountain refuges.

In the kitchen, waste should be collected and stored in firm bins with lids and should be removed from the working area at least once a day (Bundesministerium für Gesundheit, Familie und Jugend, 2007). Figure 2 (left picture) shows a positive example of storage containers in the kitchen of a mountain refuge. Until wastes are transported to the valley, they should be stored in sufficiently dimensioned, enclosed rooms or containers in order to prevent exposure to rain, wind and animals (DAV, 2010, Grinzinger, 1999). It is obvious that wastes should not be stored in the water supply catchment area (DAV, 2010). Plastic bags should only be used for wastes which pose no risk of injury; that means e.g. for paper, cardboard or plastics packaging, but not for glass or hazardous waste (Bundesministerium für Gesundheit, Familie und Jugend, 2007). Figure 2 (right picture) shows a positive example for separate waste collection using different containers. The survey revealed that wastes are not always collected and stored in an optimal manner and that there is potential for optimization.

Waste presses or can presses are sometimes used in mountain refuges in order to reduce waste volumes and accordingly the volume of waste for transport. As can be seen in figure 3, different types of waste presses are used: from very simple, self-made and hand-operated solutions to complex electrically driven presses. Some aspects have to be considered, here. As the use of waste presses is restricted by laws in some regions, it has to be checked in advance if a compaction of waste is allowed and to what extent, respectively. Electrically driven presses could be disadvantageous at mountain refuges with difficulties in energy supply. In Alpine mountain refuges, energy is often scarce and can only be produced at high costs. In any case, folding cardboards, and compressing plastic bottles and cans by hand is recommended as an easy and simple means to reduce waste volumes and to avoid squandering transport volume.

Figure 2: Separate collection of wastes in the kitchen (left side) and in a storage room of a mountain refuge (right side) (photos IEVEBS)

Figure 3: different kinds of waste presses used in mountain refuges: simple press for cans (left), hand operated waste press (middle), electrically driven press (right) (photos IEVEBS)

Figure 4: Positive examples for composting (photos IEVEBS)

Ways of waste disposal

As all waste generated at a mountain refuge has to be transported to collection facilities in the valley, there are no other legal ways for disposal for mountain refuges, except for composting on site. In municipal waste management schemes waste is further treated in incineration plants, by mechanical biological pre-treatment, composting, anaerobic digestion, recycling, etc. – according to waste type and the existing facilities in a region. Waste transport from mountain refuges can cause significant costs according to the position and accessibility of the refuge. The number of journeys to be undertaken should be optimized by avoiding empty or only partially loaded trucks.

An effective opportunity to reduce the amount of waste for transport is the composting of biowaste on site, provided that the requirements for controlled composting are met. Composting is the low-loss decomposition of organic compounds and the conversion to stabile humic-substances under aerobic conditions (Lechner, 2004; for details about composting in developing countries see e.g. Linzner and Wassermann, 2006; Linzner, 2010). Alternatively, bio-waste can also be composted in the course of wastewater treatment, together with sewage sludge or brown waters by means of anaerobic digestion. Based upon the results from the survey in the 100 mountain refuges, it is estimated that on site treatment of biowaste can lead to a 20% to 25% reduction by weight of the waste quantity for transport (Lebersorger et al., 2011).

A total of 73% of the 100 mountain refuge operators interviewed referred to treating some degree of biowaste on site by composting or feeding to animals. However, only 1 out of 5 composted biowaste in an appropriate manner by using crates (see figure 4). The others applied no specific composting procedure, simply placing biowaste on a heap or throwing it into a hole in the ground (figure 5), neither of which met the requirements for controlled composting. This rather corresponds to littering than to composting.

Figure 5: Negative example for "composting": This is simply littering, no composting (photo IEVEBS)

Biowaste should not be fed to animals. On the one hand there are legal regulations in the EU and in Austria (RGBl. Nr. 177/1909, BGBl. I Nr. 141/2003) which extensively prohibit the feeding of kitchen waste, particularly those containing animal by-products, to domestic animals and wildlife. On the other hand, feeding wildlife interferes with their natural living conditions and can influence ecological balance in a sensitive environment. Animals such as jackdaws might benefit from a higher food supply in an otherwise scarce environment. However, also problems arise. The example from countries like Canada or the US show that bears which have access to waste from humans lose their innate diffidence and instinctive fear of humans, which leads to the onset of unpredictable dangerous behaviour when encountering humans (Schneider, 2009). Studies also found that bears feeding on human waste had only half the life expectancy of wild bears (NPS, 2008 cited by Schneider, 2009).

Biowaste should only be composted according to the state-of-the-art and if the conditions (such as altitude, weather conditions, legal framework) permit composting. Composting should take place in a stable, naturally aerated crate with a cover as protection against rain, drying-up and animals. The crate should be easily accessible and should be positioned in a partly shadowy place. A regular maintenance is necessary (proper feedstock mixture, periodical turning) (Grinzinger, 1999). After the composting process, the compost may be disposed of in the area surrounding the refuge, if not prohibited by legal provisions, or failing this, should be transported to the valley. If composting on site is not an option, biowaste should be collected separately so that they can be further processed in existing decentralized or centralized composting plants or anaerobic digestion plants in the valley.

Though illegal in Austria, 36% of the 100 operators interviewed reported that they burned certain types of waste, particularly paper and cardboard, but at times also plastics. According to Austrian legislation, wastes are only allowed to be burnt in officially approved plants. The burning of waste in heating systems is prohibited. Therefore only small amounts of paper and cardboard may be used to facilitate the lightning of a fire. The combustion of household waste constitutes a major source for high poly-chlorinated dibenzo-p-dioxins and -furans (PCDD/F) emissions (Hübner et al., 2005). PCDD are persistent organic pollutants which accumulate in soil, plants, animals and in human bodies. They have adverse effect on the human immune system and ability for reproduction, and are suspected of causing cancer (Umweltbundesamt, 2010). In order to prevent the uncontrolled burning of waste for the future, intensified information of the operators of mountain refuges is necessary.

Recommendations / conclusion

Waste management in mountain refuges is characterised by the decentralized position of mountain refuges, difficult transport conditions and the necessity to transport all waste generated to waste collection facilities in the valley. For this reason, all kinds of measures which reduce the amount of waste for transport are very important. Waste quantities can be reduced by means of waste prevention (e.g. prompting visitors to take their waste back to the valley, avoidance of single-portion packs and paper towels, using returnable instead of single-serving packaging), but also by means of on site composting of biowaste. A measure which reduces the volume of waste but does not influence mass is the use of waste compactors and can presses. Many of the investigated mountain refuges are using different strategies for waste reduction. In terms of transport costs, the number of transports should be optimized by avoiding empty or only partially loaded trucks.

However, investigations of 100 Alpine mountain refuges showed that some operators of mountain refuges also chose unfavourable ways to get rid of their waste. Although prohibited by law, paper and cardboard as well as some plastics are burned in heating systems of some mountain refuges, and composting is not performed in an appropriate manner by the majority of operators. Such measures reduce waste quantities for transport at the expense of negative environmental effects and non-compliance of legal regulations, and should therefore be refrained from.

The results of the project reveal that there is need for information among operators of mountain refuges, in particular with regard to separate collection of hazardous waste, state-of-the-art composting and legal requirements.

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References

BGBl. I Nr. 102/2001 (Federal Law Gazette): Bundesgesetz über eine nachhaltige Abfallwirtschaft (Abfallwirtschaftsgesetz 2002, AWG 2002). last modified BGBl. I Nr. 54/2008, Vienna, Austria [in German].

BGBl. I Nr. 141/2003 (Federal Law Gazette): Bundesgesetz betreffend Hygienevorschriften für nicht für den menschlichen Verzehr bestimmte tierische Nebenprodukte und Materialien (Tiermaterialien¬gesetz -TMG). last modified BGBl. I Nr. 13/2006, Vienna, Austria [in German].

Bundesministerium für Gesundheit, Familie und Jugend (2007): Leitlinie für eine gute Hygienepraxis in Schutzhütten in Extremlage (einfache Bergsteigerunterkünfte im Gebirge). Veröffentlicht mit Erlass: BMGF-75220/0040-IV/B/7/2007 vom 6.12.2007. http://portal.wko.at/ (date of visit: 10 May, 2011) [in German].

DAV (2010, ed.): Projekt Integrale Evaluierung der Ver- und Entsorgungssysteme bei Berg- und Schutzhütten. Final report, http://ievebs.boku.ac.at/index.php?lang=ge (date of visit: 10 May 2011) [in German].

DBU [Deutsche Bundesstiftung Umwelt] (2005, ed): Den Umweltschutz auf den Gipfel treiben. Information-sheet: http://www.dbu.de/phpTemplates/publikationen/pdf/101106090257241.pdf (date of visit: 14 December 2009) [in German].

Deutscher und Österreichischer Alpenverein (2011, eds.): Leitfaden für umweltgerecht Hüttentechnik. Planung, Errichtung, Betrieb, Wartung. 1. Auflage, Bergverlag Rother GmbH, München, ISBN 978-3-7633-8083-1 [in German].

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, Brussels, Belgium.

Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), Brussels, Belgium.

Grinzinger U (1999) Die umweltgerechte Schutzhütte. VAVÖ – Verband alpiner Vereine Österreichs Vienna, Austria [in German].

Hübner, C, Boos, R, Prey, T (2005): In-field measurements of PCDD/F emissions from domestic heating appliances for solid fuels. Chemosphere 58: 367–372.

Lebersorger, S., Weissenbacher, N., Mayr, E., Aschauer, C. (2011): Waste management in mountain refuges – an integrated evaluation. Waste Manag Res 29 (5), 549-557.

Lechner, P. (2004, ed.): Kommunale Abfallentsorgung. Facultas, Wien, Austria [in German].

Linzner, R. (2010): Decentralised composting of market waste and use in urban agriculture; Conakry, Guinea. Urban Agriculture Magazine, 23 (April 2010), 20-21; ISSN 1571-6244

Linzner, R., Wassermann, G. (2006): Factors Constraining and Promoting the Implementation of Small-Scale Composting in West African Countries. In: Kraft, E., Bidlingmaier, W., de Bertoldi, M., Diaz, L.F., Barth J. (Eds.): ORBIT 2006. Biological Waste Management. From Local to Global, Proceedings, Part 4 „Policy and Strategy, Climate Change, Pollution and Developing Countries"; Verlag ORBIT e.V, 13. - 15. September 2006, Weimar, 1201-1210; ISBN: 3-935974-09-4 (Digital Proceedings on CD Rom: ISBN 3-935974-10-8),

RGBl. Nr. 177/1909: Gesetz vom 6. August 1909, betreffend die Abwehr und Tilgung von Tierseuchen (Tierseuchengesetz - TSG). last modified BGBl. I Nr. 36/2008, Vienna, Austria [in German].

Schneider, F. (2009): Wasted food – more than a technical challenge. In: Lechner, P. (Ed.):"Prosperity Waste and Waste Resources" – 3rd BOKU Waste Conference 2009, 15-17 April 2009, Facultas, Vienna, Austria, pp 101-109.

Umweltbundesamt (2010): Hintergrund, Dioxine. http://www.umweltdaten.de/chemikalien/dioxine.pdf (date of visit: 10 May 2011) [in German].

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