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AN INNOVATIVE METHOD TO DETERMINE AMOUNT AND COMPOSITION OF BUILDING DEMOLITION WASTE ON A REGIONAL LEVEL – THE CASE OF VIENNA

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SUMMARY: The paper presents an innovative approach to estimate the amount and quality of building demolition waste in Vienna. Image matching based change detection, a tool from the field of remote sensing, is used to generate data about the volume of demolished buildings in a period of one year. Change detection data is generated by comparing two different height models. The height models are derived from oriented aerial images of the city of Vienna. Geographic information system (GIS) gives information about what building volume has been demolished. In a further step the volume of demolished buildings is combined with specific material intensities of different building types to estimate the amount and quality of the waste.

1. INTRODUCTION

Waste resulting from construction and demolition activities greatly contributes to the overall waste generation in most industrialized societies. The European Commission estimated in 2014 that 25-30% of all waste generated in the EU can be attributed to construction and demolition waste (CDW). Contrary to other waste streams (e.g. packaging waste, WEEE, etc.), CDW management is mostly realized on a regional rather than a national level. Thus, regional and local data on CDW generation needs to be established, verified and brought together to obtain coherent information. This is necessary to analyse current practices in managing CDW and to detect optimization potentials.

The hypothesis of the present study is that only a part of the demolition activities in the city of Vienna are covered by statistics on notifications by building owners to the building authority. Hence official demolition statistics do not allow estimating the demolished building volume and related waste streams.

A new approach to characterize amount and quality of waste streams resulting from building demolition, and which is independent from statistical information, is designed and tested. Potential demolition sites are identified based on change detection data, which is generated from image matching, in particular by comparing height models derived from aerial images of the city at different times. The generated data set (location of changes in the building stock) is combined with available GIS data of the building stock of Vienna to determine what types of

buildings (discriminated by construction time and utilization) and what volumes are demolished. Subsequently this information is combined with material intensities of different building types in order to quantify amount and quality of demolition waste generated.

2. MATERIALS AND METHODS

Through change detection, it is possible to detect height changes in the building stock. In order to achieve that, two digital height models of the city are compared. The height models are derived via image matching of oriented aerial images of different years. Negative changes indicate demolition activities.

For this study height models of two aerial image campaigns (2013/2014) were compared and a difference model was generated, indicating negative changes in the building stock. The difference model helps identifying locations of demolition projects for a period of about one year (10.5 months). A GIS model gives further information about size, construction period and utilization of the buildings in place before demolition (Figure 1).

The assessment of the amount and composition of demolition waste from buildings depends, on the one hand, on the overall demolished building volume (number and size of buildings demolished) and, on the other hand, on the specific material composition of the buildings torn down. For the latter the authors have generated a database containing specific material intensities (given in kg/m³ gross volume – GV) for 15 different building categories, which cover the vast majority of buildings present in the city of Vienna (see Kleemann et al., 2016a). This database has been compiled through (i) detailed on-site investigation of buildings prior to demolition (Kleemann et al. 2016b), (ii) evaluation of construction plans of demolished buildings, (iii) data on new buildings from LCAs and final billing documents, and (iv) relevant literature.

3. RESULTS

The developed method allows the overall quantification of waste generated through building demolition at a city level. This is crucial for capacity planning in waste and resource management. By combining the gross volume of demolished buildings with specific material intensities of the respective building categories, the amount and composition of demolition waste can be estimated. The results of the image matching based change detection approach imply waste generation from building demolition in the city of Vienna of about 1.1 million tons per year, which amounts to a yearly per capita generation of about 610 kg (Table 1). This amount represents about 0.3 % of the overall material stock embedded in buildings. The bulk of the material (96%) is mineral, mainly represented by concrete (44%), bricks (28%) and mortar (13%). Organic materials and metals constitute a very small share (4%) of the overall material composition of demolition waste from buildings, of which wood and steel are the major contributors.

Results of the investigations conducted show that statistics of demolition activities based on notifications underestimate the demolition activity by 40%. Image matching based change detection data, therefore, seems to provide good estimates about the total amount of demolitions waste, as most demolition activities are detected by the method.

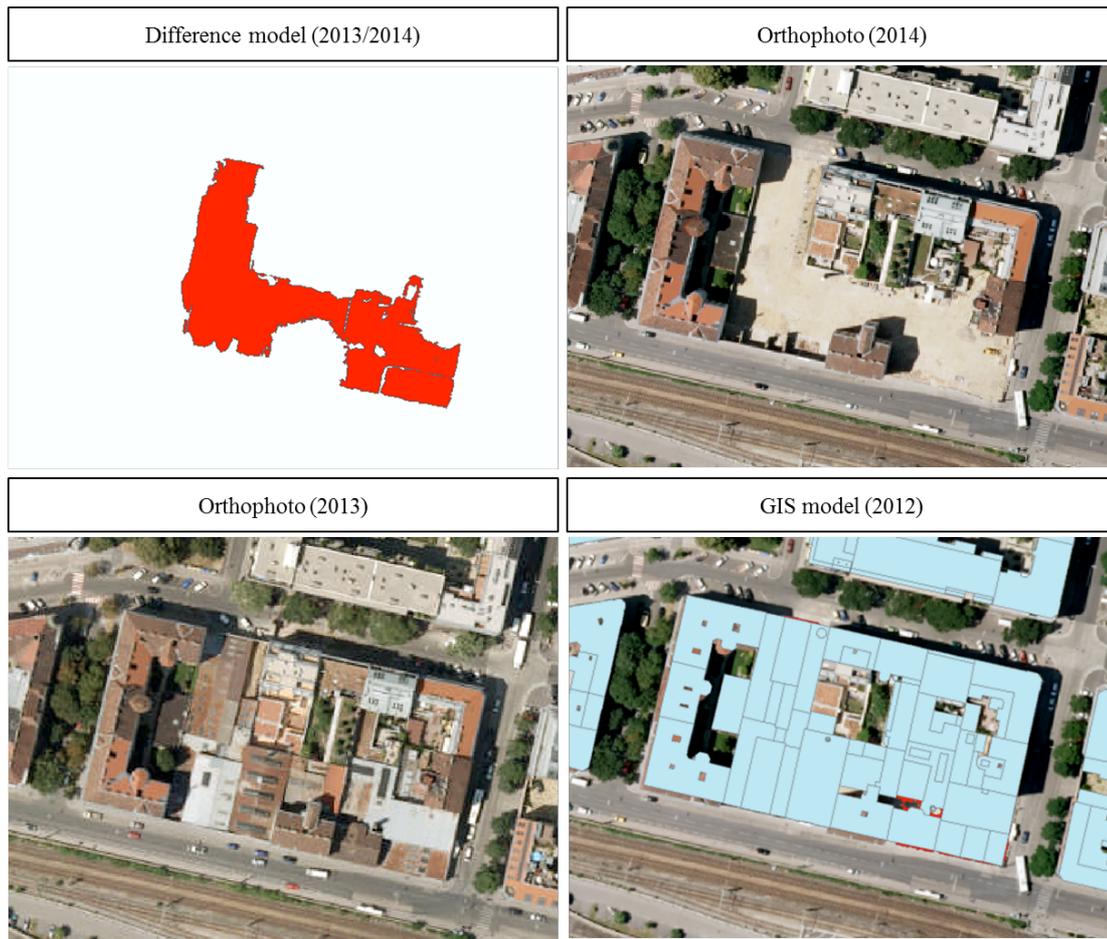


Figure 1: Determination of demolition activities in Vienna using polygons of potentially demolished buildings, based on aerial imagery taken in two different years, in conjunction with a GIS building model (Kleemann et al. (2016c)).

Table 1: Waste amount and quality generated through building demolition in Vienna based on Kleemann et al. (2016c).

Output kg/person/a					
Mineral	570	Organic	15	Metal	12
Concrete	280	Wood	11	Iron/Steel	12
Bricks	180	Asphalt	1.4	Aluminium	0.26
Mortar/plaster	77	Bitumen	1.3	Copper	0.15
Mineral fill	15	Various plastics	0.34		
Natural stone	6.0	PVC	0.27		
Slag fill	5.0	Reed	0.25		
Plaster boards/gypsum	2.9	Carpet	0.19		
Gravel/sand	2.6	Polystyrene	0.11		
Foamed clay bricks	1.2	Paper/Cardboard	0.045		
Ceramics	0.86	Linoleum	0.037		
Glass	0.65	Laminate	0.032		
Mineral wool	0.33				
(Cement) asbestos	0.078			Total	600

4. CONCLUSIONS

The overall amount and quality of material from building demolition available for recycling can be monitored by using the presented approach. The knowledge about the building stock and about recycling material available in the future is an important step towards closing material cycles in demolition waste management, and can be incorporated in city planning activities and promoted among construction and demolition companies

To the knowledge of the author, the suggested method to assess the amount and quality of demolition waste is novel. With increasing availability of aerial images and technologies capable of processing large data sets, the method has the potential to be applied, especially due to its economic benefits compared to alternative approaches such as airborne laser scanning.

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