“Specific waste generation rate of recyclable materials in households: Time-series of eighteen months for three households in Greece”

F. Tsagas\textsuperscript{1,2}, K. Liolios\textsuperscript{3} and A. Paschalidis

\textsuperscript{1}Department of Civil Engineering, School of Engineering, Democritus University of Thrace, Xanthi, 67100, Greece
\textsuperscript{2}Waste Management Authority of Eastern Macedonia - Thrace, DI.A.A.MA.TH, S.A., Komotini, 69132, Greece
\textsuperscript{3}Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sofia, 1113, Bulgaria

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Presentation’s outline

- Introduction
  - Recycling and “blue bin” in Greece
- Objective
- Materials and Methods
- Results
- Conclusions
Introduction

Recycling and blue bin

- Recycling of Municipal Solid Waste (MSW) is high on the waste management hierarchy
- Households main producers of packaging waste recyclable materials, in a municipality or city
- Source-separation of recyclable materials directed to a commingled bin "blue bin" system
- Paper, cardboard, glass, metals, like aluminum and tin, and various types of plastics
Introduction

Photos of blue bin system
Introduction

Sorting in MRF

- Mechanical and hand sorting of materials in Material Recycling Facilities (MRFs)
- Recovered materials are being sent to recycling industries for the production of new products

Source of Photo: HERRCO
http://www.herrco.gr/default.asp?siteID=1&pageid=13&langid=1
Introduction

Blue bin in Greece (1/2)

- Operation in Greece for over 10 years, especially in highly populated cities
- Experience of small municipalities or islands
- In Greece only a fraction of MSW is being recycled, one average performance comparing with other countries of European Union
Introduction
Blue bin in Greece (2/2)

- Extensive knowledge on the quality of materials recovered by the blue bin in MRFs in Greece
- 30 MRFs operate in Greek mainland & islands
- Average recyclables waste generation rate of \(~20 \text{ kg/cap/yr}\) for Greek mainland municipalities while \(~30 \text{ kg/cap/yr}\) in Greek islands
- Effect of tourism in waste generation rates
Objective

- Extensive knowledge on waste generation rate of recyclable materials in national level in Greece
- No study of production of recyclables materials in a household level for a medium to long term period of over 12 months in Greece
- **Aim:** to add experience and provide primary data on specific waste generation rate of recyclable materials from households in the Greek context
Materials and Methods

- Record of production of recyclable materials in 3 households for a period of 18 months
- Location: small city of Xanthi, Greece (~65,000 inhabitants)
- Time period: April 2013 to September 2014
- 3 households chosen named H1, H2 and H3 had a number of three (3), four (4) and one (1) resident respectively
Materials and Methods

Location

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### Materials and Methods

**Profile of households**

<table>
<thead>
<tr>
<th>N. of household</th>
<th>Members</th>
<th>Sex</th>
<th>Age profile (years)</th>
<th>Education level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>0-20 21-40 41-60 60&lt;</td>
<td>Elementary  Secondary  Higher</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>0 1 0 2</td>
<td>0 1 2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>3</td>
<td>0 2 1 1</td>
<td>0 0 4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0 1 0 0</td>
<td>0 1 0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>6</td>
<td>0 4 1 3</td>
<td>0 2 6</td>
</tr>
</tbody>
</table>
Materials and Methods

- Small plastic open bins (boxes) of a volume of 30l
- The residents of H1, H2 and H3 were sorting recyclables from rest of households’ MSW
- Bins full of recyclables were weighted systematically
- Weight scales had a fraction of 0.01 g with a maximum weight limit of five (5) kg
Materials and Methods

- Recyclables included common packaging: paper, Tetra Pak®, cardboard, glass, aluminum, tin & plastics (PET, PP, HDPE, LDPE)
- Weighing data were recorded regularly in spreadsheets
  - Date and weight (gr) of materials
- Collected recyclables were directed in blue bins for recycling in a MRF
Materials and Methods

- Recorded data were grouped and summed in a monthly basis for each month from April 2013 to September 2014 in [total grams/month]
- Monthly weight divided by number of residents in each household: 3 for H1, 4 for H2 & 1 for H3
- For each month specific generation waste in [grams/(capita*month)] could be calculated
- For each month specific waste generation rate was calculated in terms of [kg/(capita*year)]
Results and discussion

Monthly average generation rate of recyclable materials, in kg/capita/year for 3 households.

<table>
<thead>
<tr>
<th>Month</th>
<th>H1 [kg/(capita*year)]</th>
<th>H2 [kg/(capita*year)]</th>
<th>H3 [kg/(capita*year)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 April 2013</td>
<td>63</td>
<td>36</td>
<td>35</td>
</tr>
<tr>
<td>2 May 2013</td>
<td>50</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>3 June 2013</td>
<td>48</td>
<td>37</td>
<td>73</td>
</tr>
<tr>
<td>4 July 2013</td>
<td>45</td>
<td>15</td>
<td>51</td>
</tr>
<tr>
<td>5 August 2013</td>
<td>57</td>
<td>36</td>
<td>62</td>
</tr>
<tr>
<td>6 September 2013</td>
<td>78</td>
<td>29</td>
<td>35</td>
</tr>
<tr>
<td>7 October 2013</td>
<td>40</td>
<td>17</td>
<td>38</td>
</tr>
<tr>
<td>8 November 2013</td>
<td>60</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>9 December 2013</td>
<td>42</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>10 January 2014</td>
<td>39</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>11 February 2014</td>
<td>28</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>12 March 2014</td>
<td>25</td>
<td>29</td>
<td>18</td>
</tr>
<tr>
<td>13 April 2014</td>
<td>64</td>
<td>27</td>
<td>29</td>
</tr>
<tr>
<td>14 May 2014</td>
<td>49</td>
<td>16</td>
<td>78</td>
</tr>
<tr>
<td>15 June 2014</td>
<td>27</td>
<td>39</td>
<td>33</td>
</tr>
<tr>
<td>16 July 2014</td>
<td>33</td>
<td>37</td>
<td>30</td>
</tr>
<tr>
<td>17 August 2014</td>
<td>31</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>18 September 2014</td>
<td>37</td>
<td>17</td>
<td>35</td>
</tr>
<tr>
<td>Average values</td>
<td>45</td>
<td>26</td>
<td>39</td>
</tr>
</tbody>
</table>

Average waste generation rate of 37 kg/cap/yr
Results and discussion

Time series of monthly average generation rate of recyclable materials in 3 households for 18 months

[Graph showing time series data for H1, H2, and H3 in kg/(capita*year) from April 2013 to September 2014]
Results and discussion

- This study (2016):
  - Average rate 37 kg/cap/yr
  - Individual rates 45, 26, 39 kg/cap/yr

- Other similar study (Tsagas et al 2014)
  - Average rate 31 kg/cap/yr
  - Individual rates 32, 42, 4, 70, 28, 56, 43 & 26

- Fairly good estimation compared to other studies

- Comparing results to ~20 kg/cap/yr calculated by nationwide secondary data of blue-bin system in Greece → **important margins of improvement on recycling**
Results and discussion

  - Tinos Island Municipality, Greece
  - Average rate of recyclables of 67 kg/cap/yr

- Comparing results to ~30 kg/cap/yr calculated by nationwide secondary data of blue-bin system in Greek islands → important margins of improvement on recycling rates also in Greek islands.
Results and discussion

- More information and awareness campaigns are needed on the source separating practice of recyclables with the use of the blue bin system
  - Targeting households and family members
  - Targeting tourists, touristic attractions and groups of tourists visiting destinations in Greece like the islands
- Initiatives in education system and special events in schools can assist to this direction.
Conclusions (1/ 2)

- A study on the behaviour of 3 households in the production of recyclable materials is presented.
- Primary data of packaging waste generation rates are provided.
- Time period of 18 months in the Municipality of Xanthi, Greece.
Conclusions (2/2)

- On average a specific waste generation rate of recyclables of 37 kg/cap/yr is estimated.
- Results confirmed the dynamic nature of the households as municipal solid waste producers.
- There are margins of improvement on recycling rates and the role of information campaigns is crucial to this end.
Acknowledgements

The assistance of households' members during this study is greatly acknowledged.
Thank you for your attention!
End of slideshow, click for exit.