Long-range transport of e-waste:

Part 1. An inventory of the global generation and trans-boundary exports towards non-OECD countries.

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Background

The transport of discarded electronic and electrical appliances (e-waste) to developing regions has received considerable attention, but it is difficult to assess the significance of this issue without a quantitative understanding of the amounts involved. Rational control strategies require a better understanding of how much e-wastes, containing both valuable constituents as well as toxics, are circulating around the globe.

Objectives

i) to estimate the amount of e-waste generated by countries in 2005,

ii) to estimate the amount exported from OECD to non-OECD countries,

iii) to map the global generation and movement of e-waste.

Methods

The net amount (M_{NET} in kt) of e-waste processed annually in any given country is calculated as

$$\mathbf{M_{NET} = M_{GEN} + M_{IMP} - M_{EXP}}$$

where M_{GEN} is the amount of e-waste generated domestically by its own population, M_{IMP} and M_{EXP} are the amounts of e-waste imported to and exported from the country.

- M_{GEN} was derived using a top-down approach, based on an estimated global generation of e-waste of 35,000 kt (20,000-50,000) in 2005 by UNEP[1]
- Gross Domestic Product [GDP(PPP)][2] was used as a proxy for distributing the UNEP estimate by country, taking advantage of the often tight relationship seen between the generation of e-waste and key economic indicators (Fig 1).
- M_{IMP} to non-OECD was derived on the basis of a review of data available for China, India and five West African countries.
- M_{EXP} from any OECD country was back-calculated as a fixed percentage ($\Sigma_{non\text{-}OECD}M_{IMP}$ / $\Sigma_{OECD}M_{GEN}$) of M_{GEN}

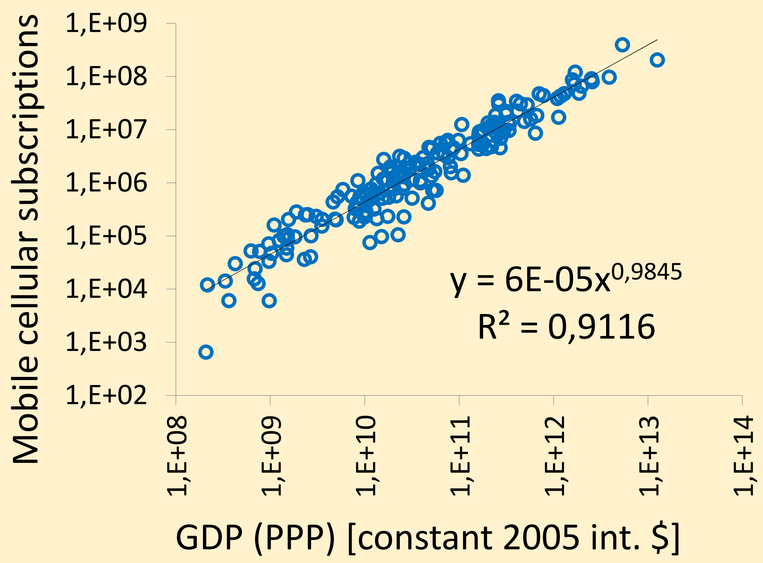

Figure 1: *Mobile cellular subscriptions as a function of Gross Domestic Product (GDP (PPP)) for 181 countries.*

Results

- Our top-down estimates for M_{GEN} compare favorably with independent data (Fig 2)

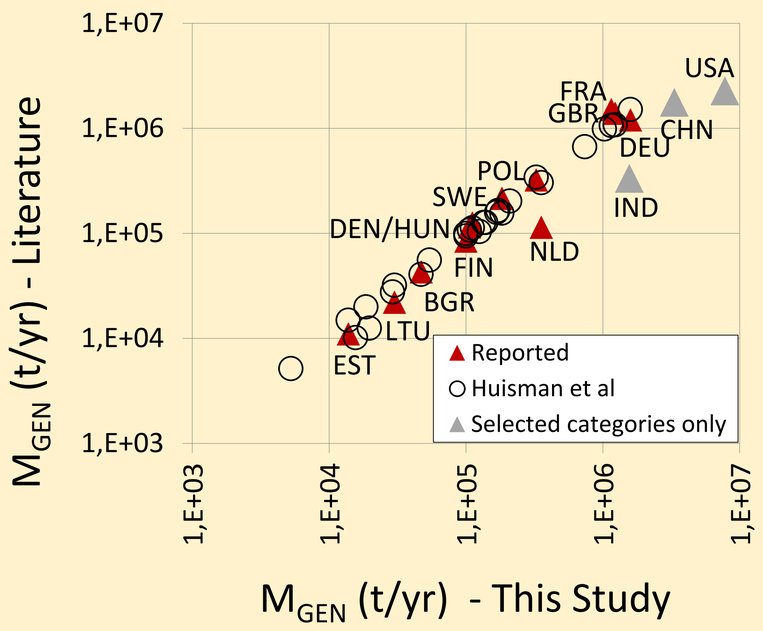

Figure 2: *Estimated domestic generation of e-waste in 2005, compared with independent estimates for selected countries (in t/yr). Black circles represent European countries only, using data from Huisman et al.[3] while red triangles reflect reported data for countries identified with 3-letter country codes. Grey triangles reflect data known to include a limited set of e-waste categories only.*

- Our budget for total import to selected non-OECD countries accounts for 5,023 kt (3,642 kt - 7,331 kt), which represents 23% (16.7% - 33.5%) of the e-waste generated within the OECD.
- Available estimates of transboundary exports of e-waste out of the OECD are highly variable, and often at the lower end of estimates of imports to non-OECD.

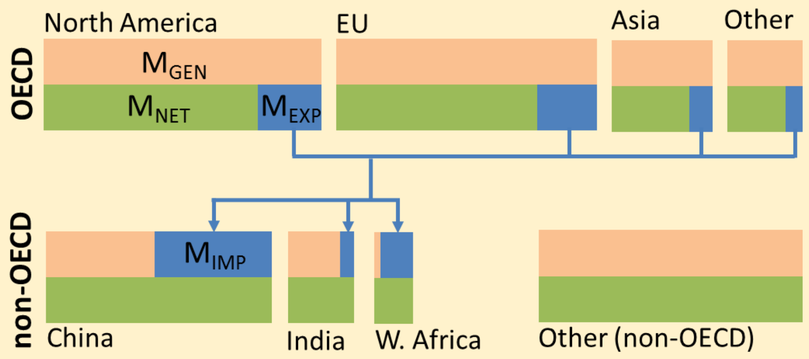

Figure 3: *Graphical representation of the e-waste mass balance. The widths of each box are scaled to reflect M.*

- A graphical representation of the final budget is shown in Figure 3 while results are mapped in Figure 4.

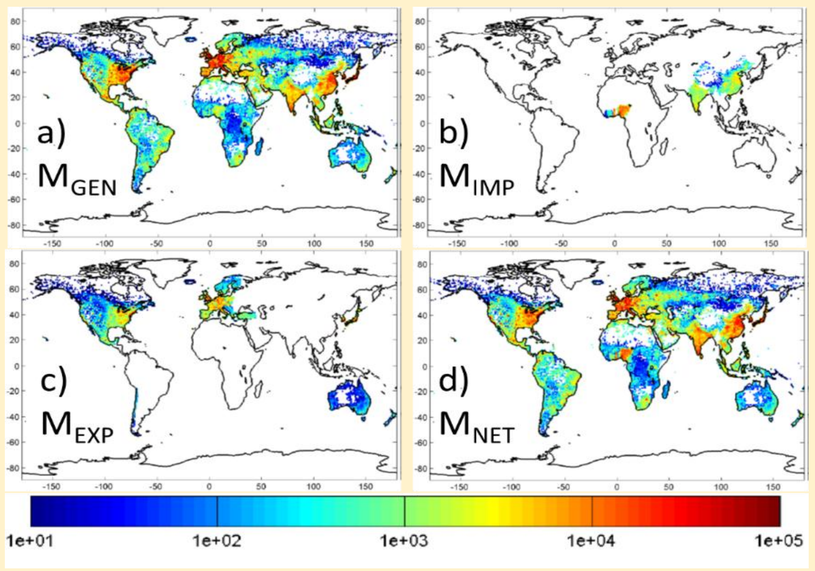

Figure 4: *Estimated domestic generation (a), import to non-OECD (b), exports from OECD (c) and net amount (d) of e-waste around 2005 with 1°x1° longitude and latitude resolution (in tonnes). The national data were spatially distributed using population densities within individual countries (https://na.unep.net/metadata/unep/GRID/GLPOP90.html).*

Discussion

- Uncertainties in our understanding of global flows of e-waste remain and are likely to persist beyond this study because of the lack of data on illicit exports. Estimates of e-waste flows relying on official trade data alone are at risk of being biased low due to ignorance.
- The often illicit nature of exports calls for complementary approaches to track the sources, flows and destinations of e-wastes, such as by use of GPS-based monitoring as well as contaminant forensics and chemical fingerprinting techniques.

References: [1]UNEP, E-waste, the hidden side of IT equipment's manufacturing and use. Environmental Alert Bulletin. United Nations Environment Programme: 2005. [2]World DataBank. *http://databank.worldbank.org/data/home.aspx* [3]Huisman et al. 2008. Review of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE). Final Report.; United Nations University: 2007; p 347.

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