05. New Horizons

Data for Circular Cities: The case of circular timber hubs in Amsterdam

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Cities cover 3% of the world's land surface but *consume over 75% of the planet's material resources.* If we successfully transition to a circular economy, cities will be essential to that story. Creating a city following circular economy principles, or a "circular city", requires us to take a spatial perspective, understanding things like *location, distance, and scale*. This is because most circular strategies require a physical location, from recycling to reuse. Land is needed to store and process secondary materials, and infrastructure is needed to transport them.

To make decisions for a circular city, we need data, especially geospatial data. *Geospatial data, or "spatial data", is any data that is connected to location information, such as coordinates.* Over the past decade, spatial data on materials have become increasingly available, especially for the built environment. For example, in many countries, we have good spatial data on material stock. We know exactly where buildings are located, and based on these buildings' characteristics, we also know how many materials are embedded in these buildings. All this data can be used by governments or large companies to make spatial planning decisions for the circular transition.

How exactly can cities use data to make circular economy-related decisions? Let's take a look at the case of *circular construction hubs in Amsterdam.*

Circular construction hubs are initiatives started by both governmental bodies and private companies throughout the Netherlands. They collect, store, and redistribute construction waste so that it can be reused at a new construction site. (While there is a lot of interest in these hubs, it's not clear how big they should be. Should there be one huge one serving an entire city, or lots of small ones, each serving a few construction sites? In other words, our research question was: (What is the optimal scale and location of circular construction hubs in Amsterdam?

Here's how we answered this question. In order to know where the hubs should be, we need to know where the construction materials are. More specifically, we need to know, in the future, where buildings will be demolished, and where they will be constructed. We map this out using a dataset created by industrial ecologists at Leiden University and the PBL. We chose to focus on one specific material: timber. We also picked the potential locations for these hubs according to existing research. There were 150 industrial sites in Amsterdam that were suitable for a circular hub.

We then ran 150 scenarios for Amsterdam, where the first scenario had one big hub serving the entire city, and the last scenario had 150 small hubs each serving the small neighborhood around it. For each scenario, we calculated how much it

would *cost in terms of transportation and storage costs,* and how much *emissions could be saved through timber reuse.* Here, we are looking for the best scenario, which should have the lowest cost and the highest emissions savings. In other words, the best scenario should have the lowest “cost-effectiveness” value, measured in euros per ton of emissions reduction (€/tCO2eq).

So, what did we find? Comparing the scenarios, we found that the optimal number of hubs in Amsterdam is around 29. So, what makes 29 the best number? We found that adding more hubs to the city led to savings in transportation costs because trucks don’t have to travel so far to deliver materials. However, when the number of hubs goes past 29, hubs start to become redundant - they’re barely storing any materials because there are too many other hubs nearby. This pushes up the storage cost. Surprisingly, emissions reduction stayed roughly the same no matter how many hubs there were. So, what makes 29 the optimal number isn’t the emissions savings - it’s the cost.
We also overlapped all the scenarios together into one map and counted how many times each industrial site was chosen as a hub location. We found that some sites, in grey, were not chosen in any of the scenarios. On the other hand, other sites, in red, were chosen at least once. The larger the red circle, the more times it was chosen.

So, what should Amsterdam do now that we have these results? Does this mean we should immediately start building 29 hubs in those specific locations? Definitely not! This study is only the start of a conversation. What’s valuable about the results is that we now understand what actually causes the trade-off between small and larger hubs. Surprisingly, it’s cost, not emissions.

The process where we overlapped the maps is also useful - this can give policymakers an idea of which industrial sites to prioritize for the circular transition, and which to use for other purposes.

As you can see in this case, spatial data analysis is a powerful tool for making circular cities. However, just because a result is quantitative or data-driven, doesn’t mean we should blindly accept it. Interpreting the results requires nuance and awareness of the larger socio-economic context.