SECTOR-WIDE CIRCULARITY ASSESSMENT FOR THE CONSTRUCTION SECTOR

SEVILLA

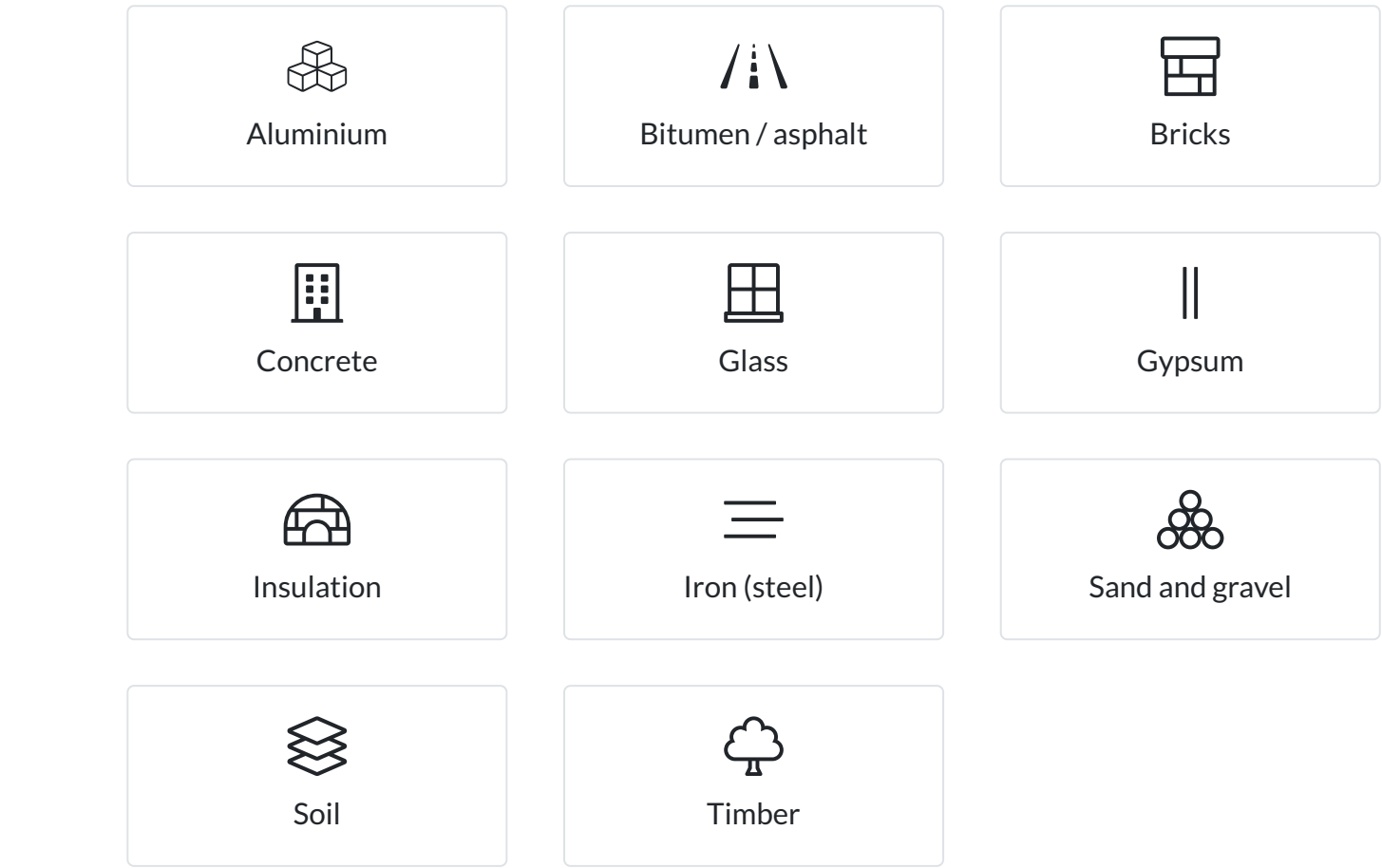
CITYLOOPS

METABOLISM OF CITIES

Introduction

The EU Horizon 2020 funded CityLoops project focuses on closing the material loops of two central sectors of any city in terms of material flows, societal needs and employment, namely the construction and biomass sectors. Due to their sizes, they represent a considerable opportunity for cities to transform their metabolism and economy towards a more circular state.

Within this project, seven European cities, amongst those also the City of Sevilla are planning to implement demonstration actions to kickstart their circularity journey. To better understand what the current circularity status quo is, as well as the impact of these actions, and the efforts needed to transform their sector, a Sector-Wide Circularity Assessment method was developed. This method combines a circular city and circular sector definition, a material flow and stock accounting method, as well as circularity indicators. The sector itself was defined in terms of a number of representative materials that make up a large share of the sector and associated economic activities. The construction sector is made up of 11 materials, depicted as icons here, which were studied along the entirety of their supply chains. Altogether, these elements help to set a solid knowledge and analytical foundation to develop future circularity roadmaps and action plans.



The assessment was carried out by the cities themselves after receiving extensive training in the form of courses on data collection (construction and biomass) and data processing. Numerous additional insights can be found in the individual Data Hubs of each city.

This current Sector-Wide Circularity Assessment report provides contextual information on the city and the economic sector under study. It then illustrates how circular these sectors are through circularity indicators and a Sankey diagram. Finally, it analyses and interprets the results, presents the limitations from the data used and offers recommendations about how to make this sector more circular.

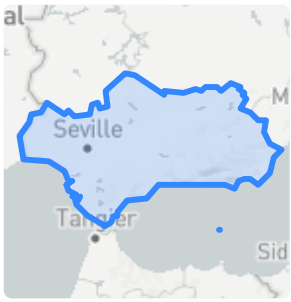
(The italic texts in this report were written by Metabolism of Cities' Aristide Athanassiadis and Carolin Bellstedt. They provide relevant general information and serve as connecting elements of the single report parts.)*

Urban context

To contextualise the results of the sector-wide circularity assessment, this section provides population and land use information data of the city. In addition, population and area of the city under study, as well as its corresponding NUTS3, NUTS2 and country were included. Data for these scales were added to better understand how relevant and important the approximations are when downscaling data from these scales to a city level.

Sevilla
688,592
142 km^2

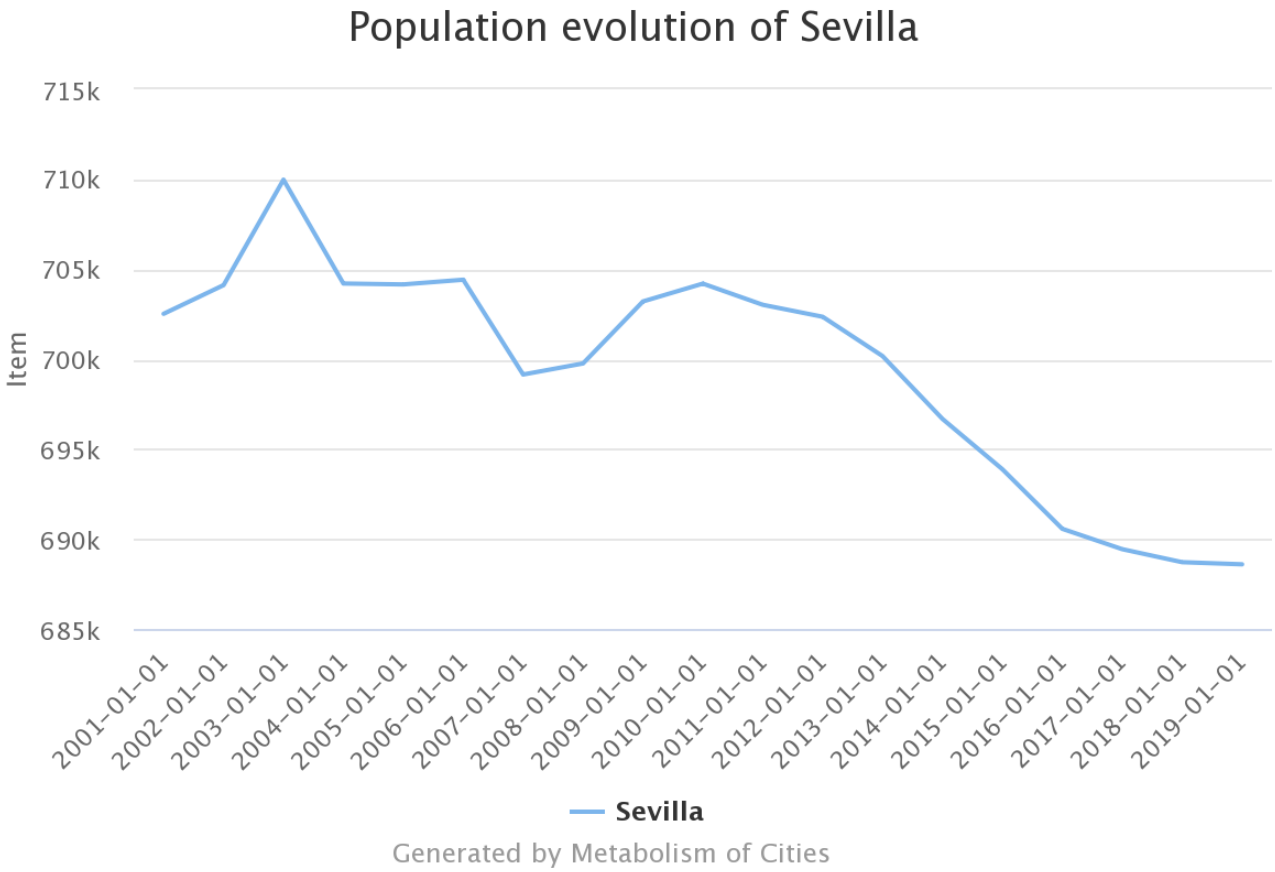
Sevilla
1,942,389
14,036 km^2



Andalucía
8,414,240
87,600 km^2

Spain
47,026,208
505,990 km^2

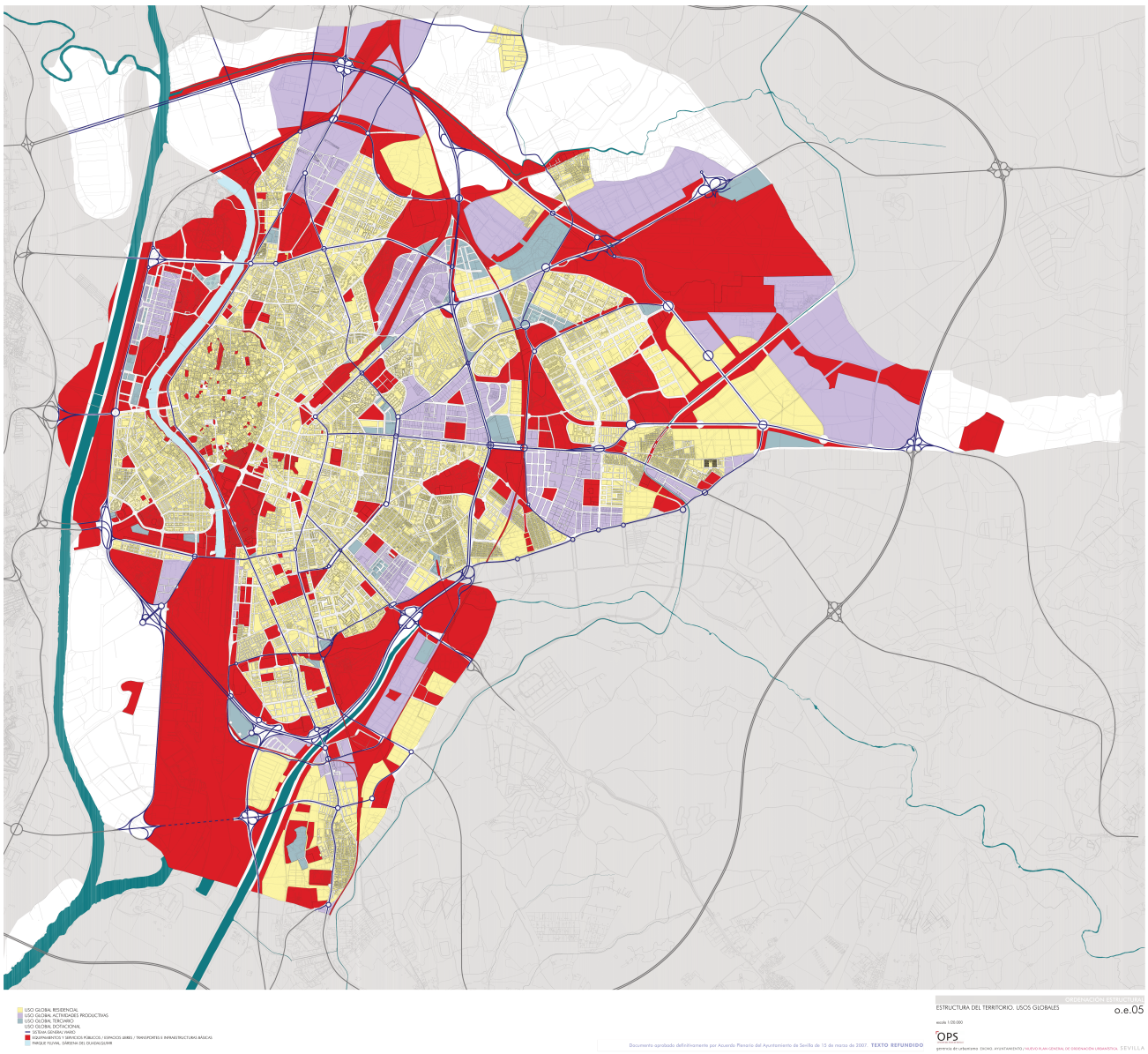
Population of Sevilla



Data source

The municipality of Seville is made up of 11 districts, which are administratively subdivided into 108 neighbourhoods and these, in turn, into 542 census sections. As of January 1, 2019, the population amounted to 688,592 inhabitants, which represents a loss of 10,098 people compared to January 1, 2017, with the South district being the one that loses the most inhabitants. If the comparison is made with respect to January 1, 2013, the loss of people is even greater, reaching 11,577 inhabitants i.e., 1.65% of the total population. The highest concentration of population is found in the East district, where there are 105,964 inhabitants registered. This population represents 15.10% of the total population of the city.

Land use



Data source

Seville's land use is urban and mostly classified as residential, but has public facilities, services, free spaces, transport and basic infrastructures. The historic area is composed of 3.9 km². The green spaces only occupy 1.8 km² of the territory.

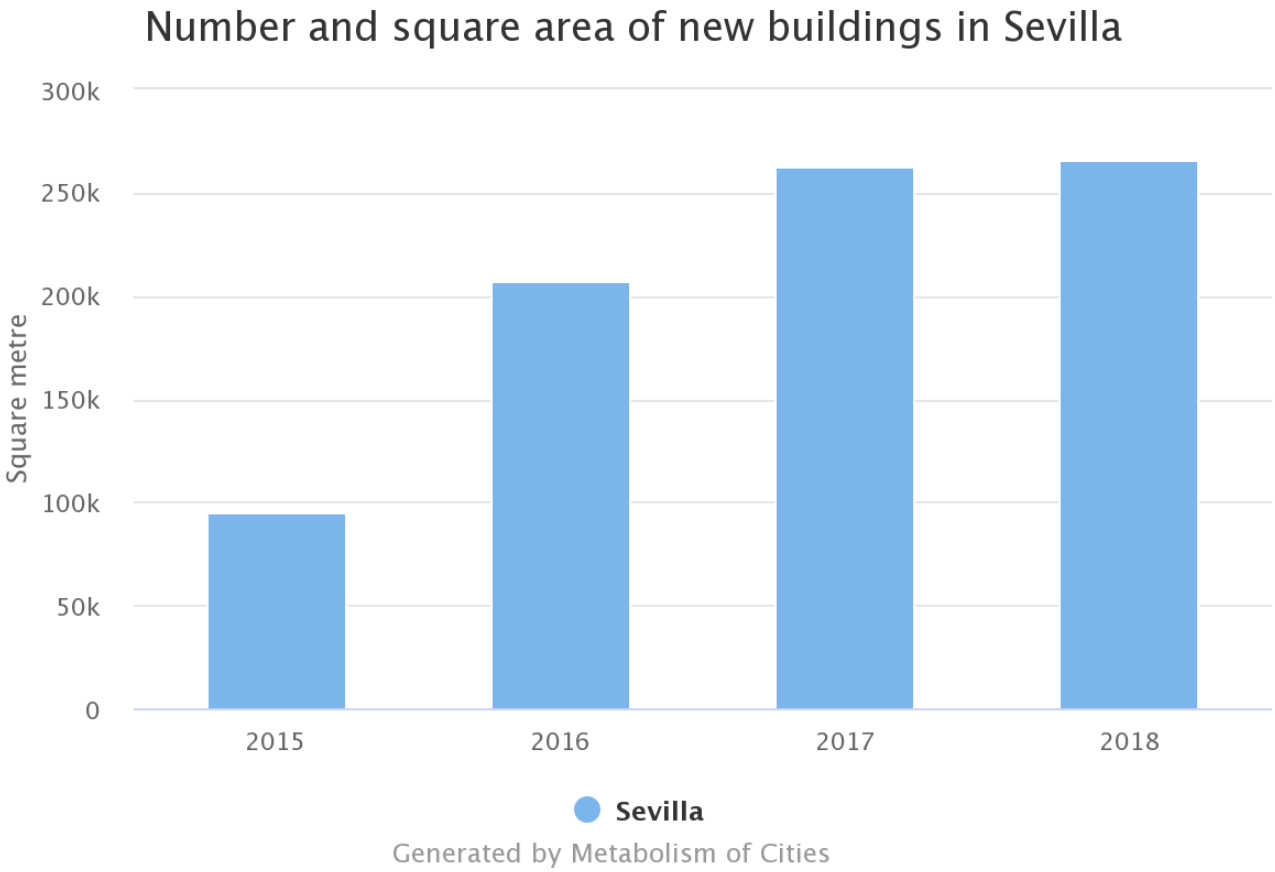
Economic context of construction sector

This section puts into perspective the economic context of the sector under study. It describes how many people are employed in this sector, as well as who the main actors involved (from all lifecycle stages for the sector's materials) are.

	GDP (monetary value, in €)	Employees
Sevilla	781,932,436	13,044
Sevilla	2,214,984,000	43,734
Andalucía	10,694,329,000	214,750
Spain	70,715,000,000	1,295,000

The construction sector in Sevilla

The construction sector employs 5.4% of employees in Seville. The corresponding percentage for the whole country of Spain is 6.4%. The most significant employment sectors in Seville are the Service sector (78.6%). Construction accounts for about 5.6% of Seville's GDP. Based on turnover, the most significant industries in Seville are wholesale and retail trade (11%) and the manufacturing industry (9.75%). (Data of Statistics Andalucia region) Data is from the year 2018 (GPD and employees data from the reference year 2019 was not available). In Seville, the largest construction projects are often managed by national companies and employees can also come from outside the area. According to the 2018 statistics, the number of new buildings Licenses in Seville was 1,602 and the total floor area was 266,266 m².



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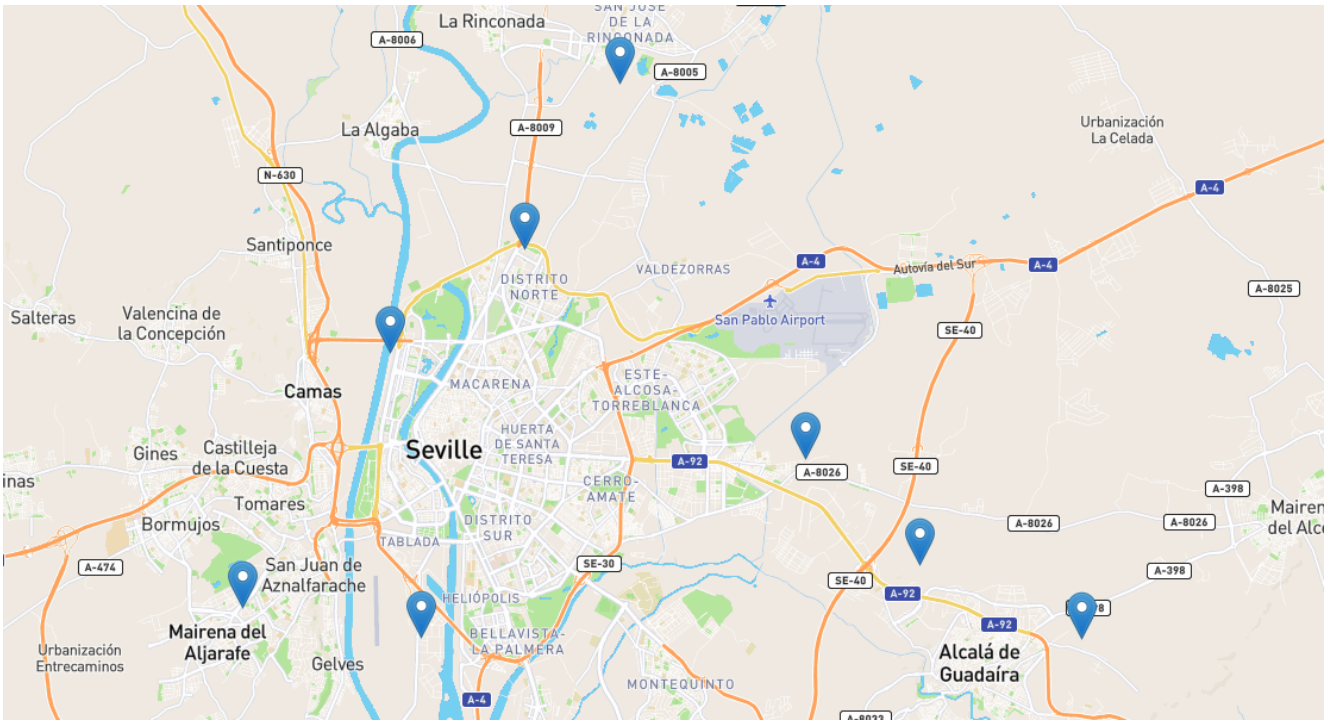
The actors of the construction sector



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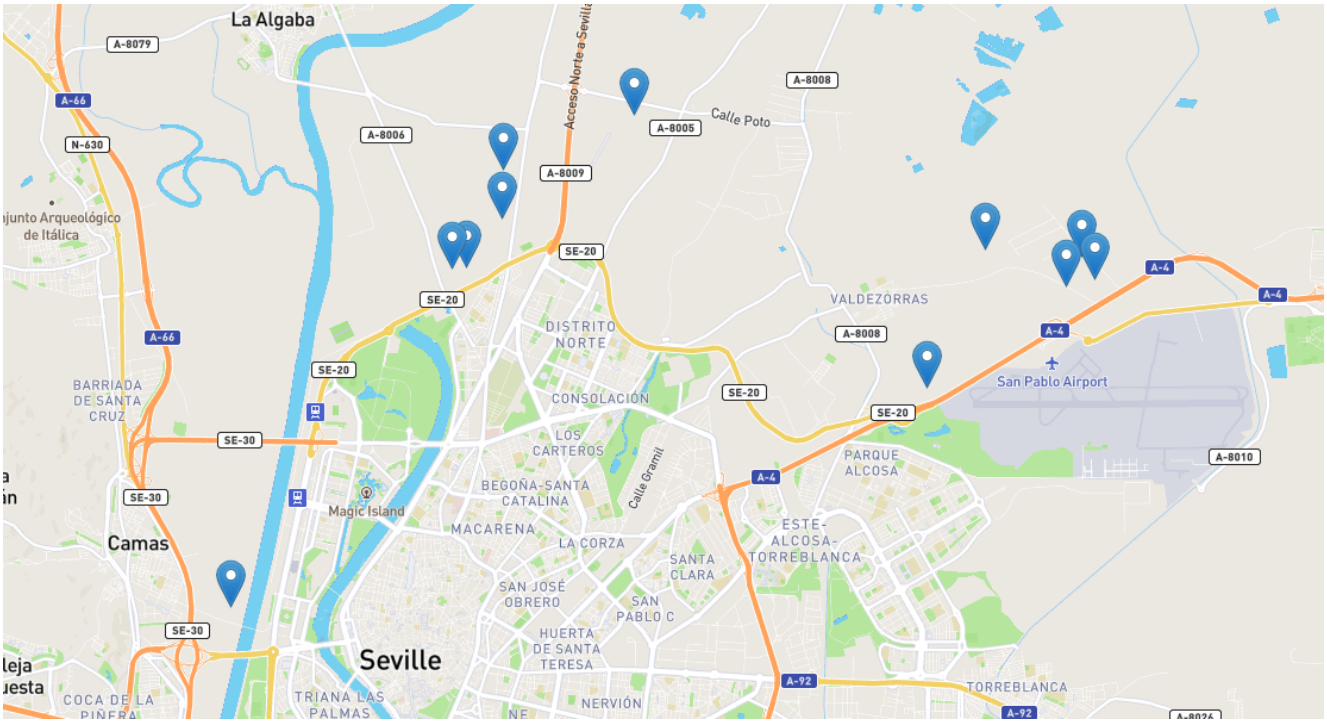
Seville shows 3,032 facilities focused on the construction sector, the corresponding percentage regarding the whole facilities (all economic sectors) located in Seville municipality is 6.5%. The construction facilities are mainly located in the metropolitan area of Seville and there are representatives of all the roles in the value chain i.e., extractive/harvesting, manufacture/use, waste collection and valorisation. The main actors showed in the figure are representative of the entire value chain.

Extraction activities



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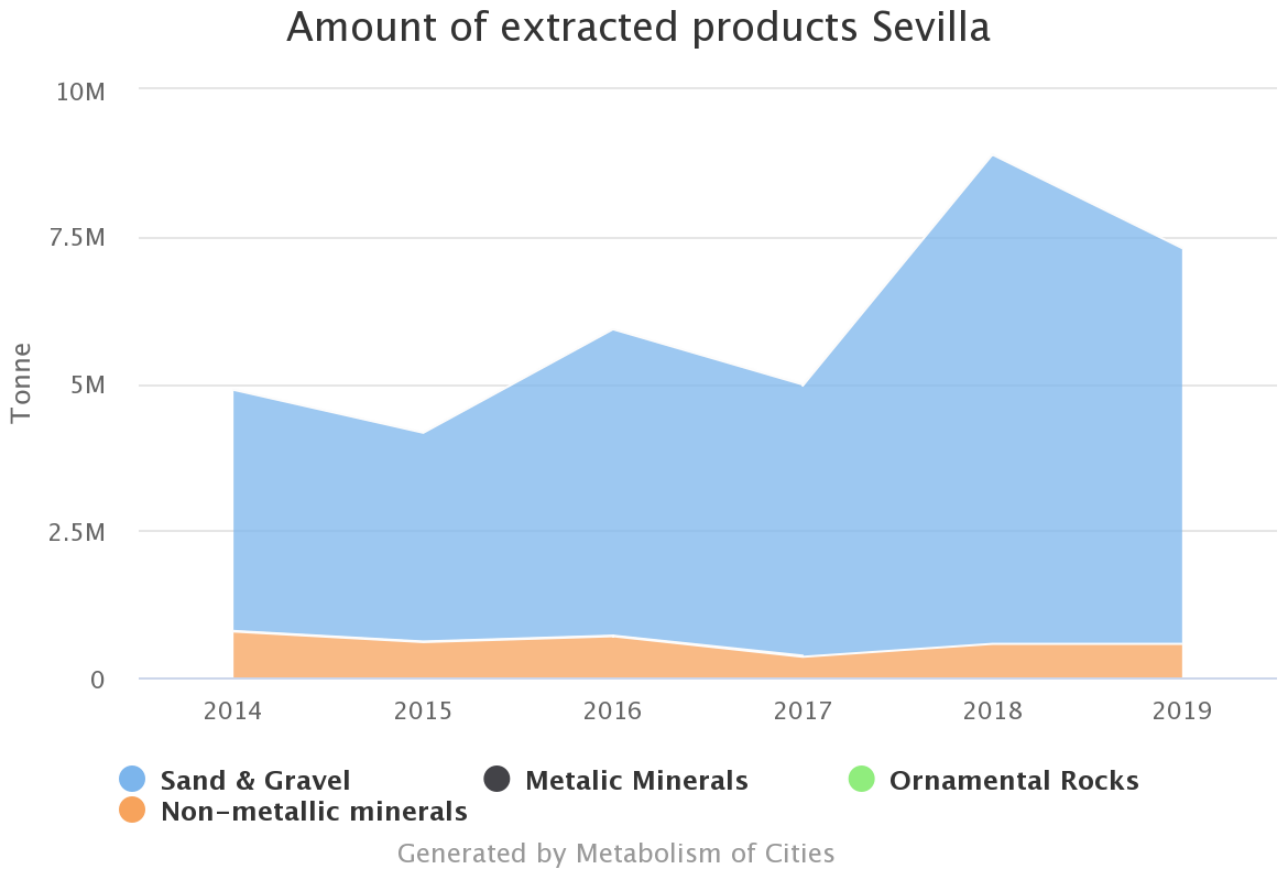

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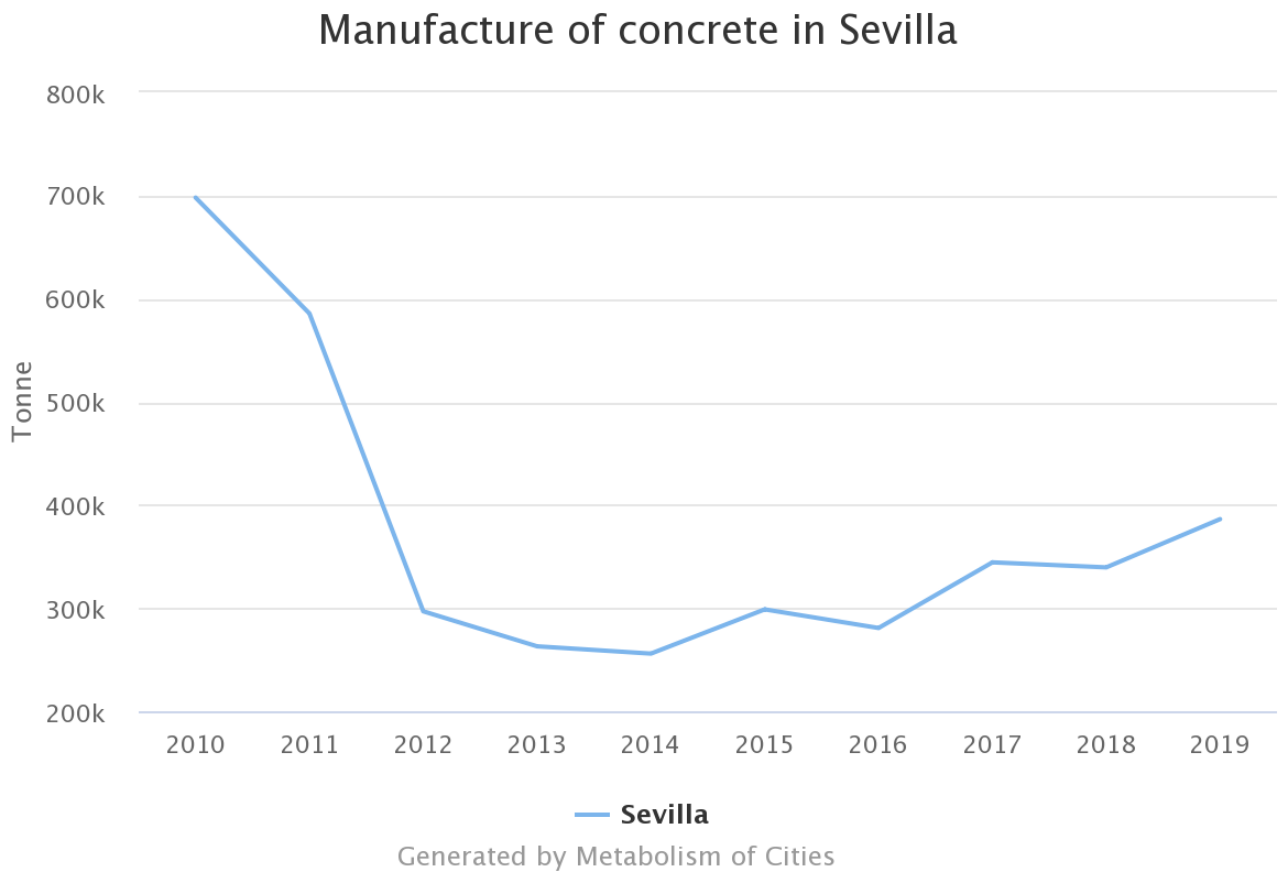

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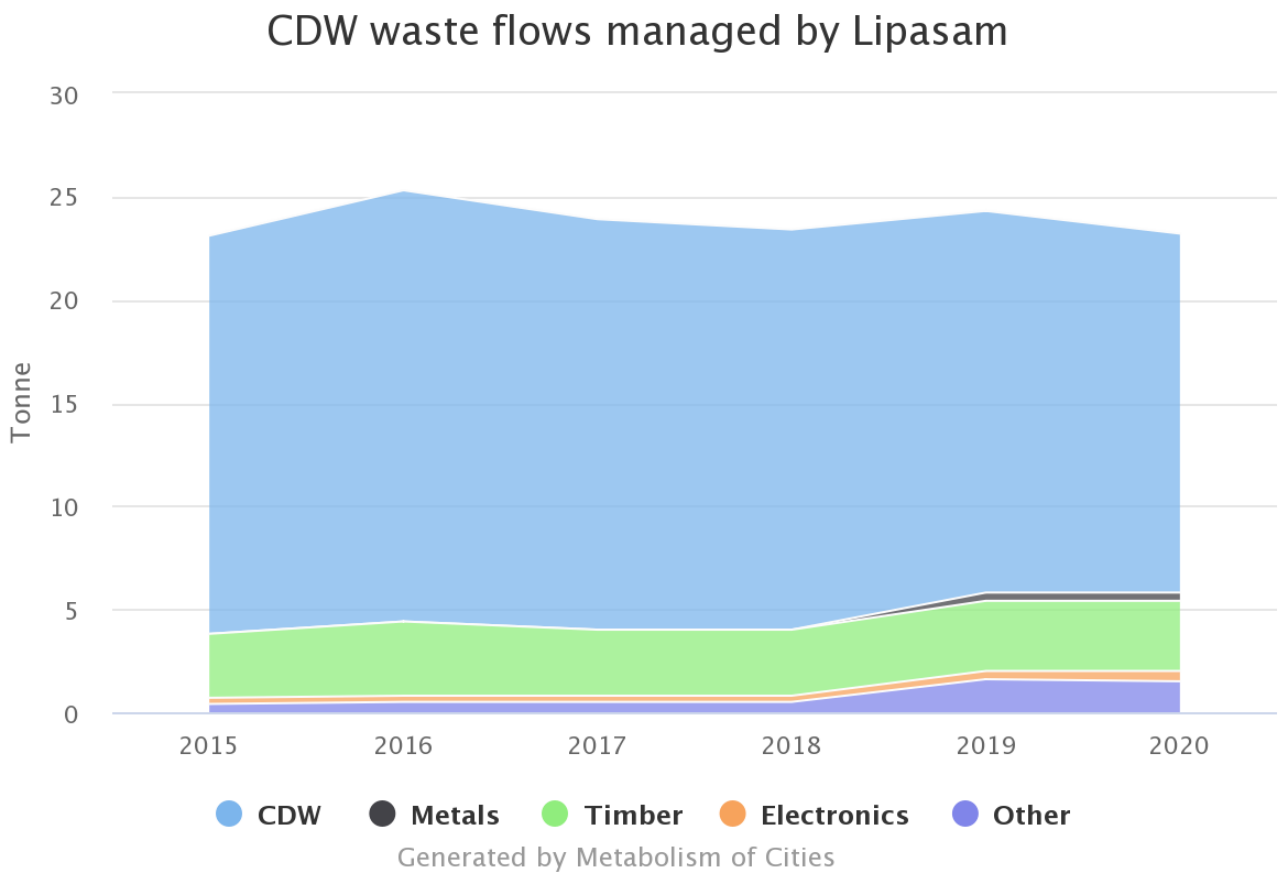


Data source

Indicators

To monitor the progress of this economic sector towards circularity, a number of indicators were proposed and measured. Altogether, these indicators depict several facets of circularity of the sector. As such, they need to be considered in combination rather than in isolation when assessing circularity. In addition, these indicators can be compared to other cities or spatial scales (such as the country level). However, this has to be done with great care and use of the contextual elements in the previous sections of the report. Finally, the value measured from these indicators can be traced over time to track the sector's progress towards circularity.

Indicator number	Indicator	Value	Unit
34	Domestic material consumption (DMC)	1,554,971.10	Tonnes/year
39	Circular Material Use rate	13.8	%

Indicator number	Indicator	Value	Unit
48	EU self-sufficiency for raw materials	1.09	%
55	EOL recycling rate	0.53	%
57	Amount of sector specific waste that is produced	445,041.76	Tonnes/year
58	EOL processing rate	566	%
59	Incineration rate	0	%
61	Landfilling rate	43.32	%

Indicators #34, #39, #48

- Domestic material consumption (DMC) (#34): 1,554,971.10 ton
- Circular Material Use Rate (#39): 13.80 %
- EU self-sufficiency for raw materials (#48): 1.09 %

DMC is the total amount of materials directly used by an economy and is defined as the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports. Formula for domestic material consumption is: DMC = Domestic extraction used (DEI) + Imports (IMP) – Exports (EXP).

The calculated DMC (#34) for Seville is 1,554,971.10 tons per year and 2.25 tons per capita, lower than the value for Spain (3.72 tons per capita). In the case of Sevilla, there are many uncertainties due to downscaling, rough estimations and assumed allocation values.

The Circular Material Use Rate (CMU) for Seville is 13.80 % which is similar compared to 12.4% for EU-28 in 2019 (Eurostat). This value means that secondary materials have substituted for primary raw materials in Seville proportionally to the EU rate. However, the data collection and quality should be developed to get more reliable value.

Formula for EU self-sufficiency for raw materials is: Import Reliance (IR) = Net import / Apparent consumption = (1- (Import - Export)) / (Domestic production + Import - Export).

Data is based on Spanish Statistics data from the Spain government and the Eurostat database. Data has been downscaled to Seville by using employees of the construction sector. The resulting value for EU self-sufficiency for raw materials in Seville is 1.09 %. The reliability of the value is

weakened by the uncertainties of the available data which mostly have been downscaled to Seville due to a huge lack of local data.

Indicators #55, #57

- EOL-RR (End of Life Recycling Rate) (#55): 0.53 %
- Amount of sector specific waste that is produced (#57): 445,041.76 ton

For each material fraction, the End-of-Life recycling rate is defined as the End-of-Life mass recycled divided by the available mass of End-of-Life materials. It is the product of the Processing Rate and the Collection Rate (EoL RR = EoL PR x EoL CR). Formula is: EOL RR = EOL Mass recycled / EOL Mass collected x 100.

In the case of Seville EOL mass recycled include CDW collected by Lipasam which is recycled at Fermovert facilities. Data does not cover the CDW collection of private actors. The resulting EOL Recycling Rate for Seville is 0.53 %. There are many uncertainties and assumptions associated with calculating the value. If only the realised amount of CDW collected by Lipasam and recycled by Fermovert is taken into account, the value of these indicators is much lower than actually could be taking into account, the private sector.

The amount of sector-specific waste that is produced was 445,041 tons. This value is based on Spanish Statistics data from the Spain government and the Eurostat database. The private sector can deliver CDW also to other local waste collectors or export it outside from Seville. Consequently, there are some discrepancies that will be further studied during the development of the demo actions in the CityLoops project demonstration phase.

Indicators #58, #59, #61

- EOL processing rate (#58): 556 %
- Incineration rate (#59): 0.00 %
- Landfilling rate (#61): 43.32 %

The End-of-Life Processing Rate measures the efficiency of the end-of-life processing process. The formula is End-of-Life Processing Rate = End-of-Life mass recycled / End-of-Life mass collected for recycling x 100. The indicator shows only the local situation of the municipality and exported waste flows are not included in the calculation. This aspect helps with local circularity planning. Recycling waste elsewhere means that these materials aren't necessarily available locally anymore.

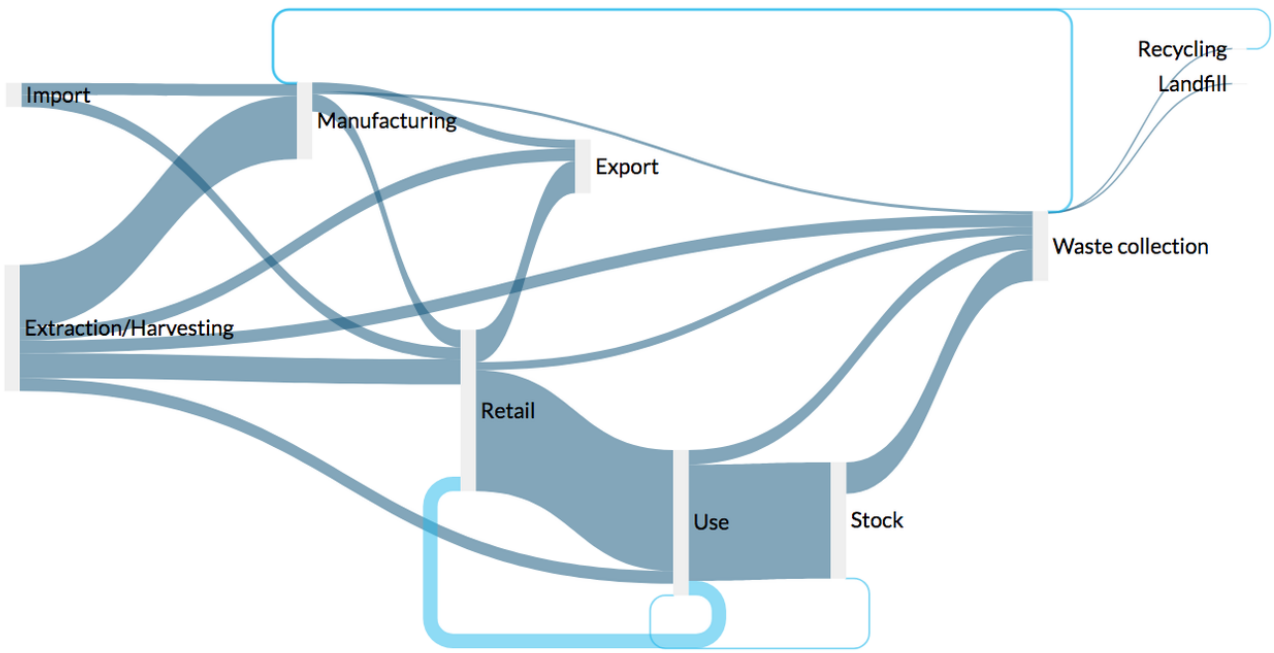
In the case of Seville, EOL mass recycled includes CDW collected by Lipasam (recycled at Fermovert facilities) and Private Sector (Data downscaled from Eurostat and Spanish statistics). The resulting EOL Processing rate is 555 %, which show weakness in the calculation and means that local available Data does not cover the CDW collection of private actors. Consequently, this indicator will be further studied during the development of the demo actions in the CityLoops project demonstration phase.

Incineration rate is the mass percentage of waste that is incinerated. The formula used in SCA is Incineration Rate = Incinerated waste / (Total waste + imported waste - exported waste) x 100. The indicator shows the local incineration only. In the case of Seville, the amount of local incineration is 0.

Landfilling rate is the mass percentage of waste that is landfilled. The formula used in SCA is Landfilling rate = Landfilled waste / (Total waste + imported waste - exported waste). In the case of Seville, landfilled waste consists of reject which cannot be sorted, materials mixed with soil and gypsum. Data cover CDW collected by local private actors or CDW transported outside of Seville.

Visualisations

Measuring circularity is a data heavy exercise. Numerous datasets were collected and visualised throughout the sector-wide circularity assessment process. To synthesise these findings, a Sankey diagram illustrates how material flows from the studied economic sector are circulating from one lifecycle stage to another. The height of each line is proportional to the weight of the flow. This diagram therefore helps to quickly have an overview of all the materials flows that compose the sector and their respective shares. The flows that are coloured in light blue in the Sankey diagram, are return flows. This means that they flow in the opposite direction of the lifecycle stages and are subjected to reuse, redistribution, or remanufacturing. Their size relative to the others is a good indication for the materials' circularity.



Data source

The Sankey diagram describes the large Extraction/Harvesting of materials for the construction sector in Seville compared to the import. This means that for the City of Seville, materials required for the construction sector came from the metropolitan area of Seville especially regarding sand & gravel and gypsum & limestone. There is significant manufacture of concrete and bricks products in Seville. Most part of the imported materials goes to the manufacturing sector, mostly from iron and other metal products. Indeed, the metal industry in Seville is centennial. The Federation of Metal Entrepreneurs (FEDEME) holds the business representation in the negotiation of the four Collective Agreements of the Metal Sector in the province of Seville, affecting a total of 9,076 companies and 83,026 workers. The Sankey diagram shows significant activity in retail and uses in the construction sector mainly in bricks, concrete, gypsum/limestone sand & gravel and metals. The material flows of the retail lifecycle stage illustrated in the Sankey diagram is based only on assumed allocation values. Finally, considering the export, Seville mainly has the export from the retail sector. These numbers were estimated, because it wasn't found data that allows the inclusion of precise and accurate data for the City of Seville.

Data quality assessment

Numerous datasets were collected and considered in the sector-wide circularity assessment. In some cases, datasets were not available for some materials or for some lifecycle stages for the studied sector. Therefore, estimations need to be done by looking at data at higher spatial scales (region or country). This section qualitatively assesses how reliable the data used is.

Data quality

Before describing data gaps and assumptions, the overall data quality is considered. It is expressed through four data quality dimensions that are depicted in the data quality matrix: reliability, completeness, temporal correlation, and spatial correlation. Each dimension has its own criteria for the ranking of high (green), medium (yellow) and low (red), which is based on this Pedigree report and shown in the table below. There can be additional explanations in some cells, as supporting information.

Rating	***Reliability***	***Completeness***	***Temporal correlation***	***Spatial correlation***
high	*Reviewed or measured data*	*Data exists for all of the single materials and their respective economic activites*	*Data less than 3 years difference to the time period of the data set*	*City-level data*

Rating	*Reliability*	*Completeness*	*Temporal correlation*	*Spatial correlation*
medium	*Estimated data*	*Data exists for most single materials and most economic activities*	*Data less than 6 years difference to the time period of the data set*	*Regional-level data (NUTS 3)*
low	*Provisional data*	*Data exists for the sector only for the Life Cycle Stages*	*Data less than 10 years difference to the time period of the data set*	*NUTS 2 and country-level data*

Data quality matrix

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Extraction/Harvesting				
Manufacturing				
Retail				
Use				
Stock				
Waste collection				
Landfill				
Incineration				
Recycling				
Anaerobic digestion				
Composting				
Imports				

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Exports				

EXTRACTION AND HARVESTING

Reliable local data was collected on sand & gravel extraction. The other data for harvesting and extraction are based on regional and national statistics i.e., National Institute of Statistics (INE) and Andalusian Institute of Statistics and Cartography (ICA).

MANUFACTURING

Data covers the main actors in the construction sector in Seville. Data on the manufacturing of metal products were obtained from the country and regional level (INE and ICA) and downscaled to Seville based on employees on relevant NACE-code. Employee data was from the year 2019.

RETAIL

Retail data were obtained by downscaling statistical data from INE and ICA and Eurostat only from some materials.

USE

Statistical data on food consumption, of the different biomass materials, were collected from INE and ICA at the country and regional scale. Data does not cover e.g., the use of concrete and metals in the construction of bridges or railways. Also, data on the use of plastic-based insulation is missing.

STOCK

Reliable data on floor area of existing buildings and length of roads were obtained from Municipal statistics and ICA. However, it was not possible to obtain or to convert this information into tons.

WASTE COLLECTION

Data on waste production were obtained from the country and regional level (INE and ICA) and downscaled to Seville. Reliable data on local waste collection was obtained from Lipasam. Data covers all waste flows from small construction and demolition projects in the City of Seville, but not all waste flows of the private sector. There are some local actors other than Lipasam who collect construction waste. Their waste flows are currently missing from the data. In addition, CDW may be exported outside the area.

IMPORTS AND EXPORTS

Reliable country-level data on imports and exports of construction materials were obtained and downscaled to Seville based employees in the construction sector. There were also uncertainties on choosing relevant products for Seville from the country-level data. Data was not obtained for all materials.

Data gaps and assumptions

Searching for data sources will be continued. Data quality and completeness related to use, retail and stocks could be improved by collecting more data involving private actors. Waste collection flows of different actors in Seville can be complemented if data is available or data can be estimated. Also, import and export data will be complemented, if more accurate data is available.

Data analysis

This section analyses the Sankey diagram developed in the previous section. It discusses and interprets the results for the sector-wide circularity assessment. It also reflects on how the current demonstration actions fit within the bigger picture of the sector, as well as how they could be upscaled to accelerate the transition towards a more circular sector.

Insights on status quo of the construction sector
The main conclusions from the Sankey diagram analysis are:

- Virgin sand & gravel, Gypsum & Limestone and other stone material are easily available for concrete manufacturing and for construction of roads and buildings.
- There are significant manufacture of bricks, metals and timber products in Seville and considerable parts of these are exported outside of the area.
- However, other construction materials like aluminium, glass and insulation materials are imported to Seville.

According to the calculation illustrated in the Sankey diagram, all the data related to local CDW collection and treatment is not currently available. The municipal waste management company Lipasam only collects CDW from small producers and citizens throughout the “Clean points”. Even almost the total amount of CDW collected by Lipasam is recycled, it shows a limited impact on the whole picture of the city. The greatest potential for developing the circular economy of the construction sector in the city is to utilise materials collected as waste in upcycled higher-value products, which could replace virgin materials in the construction sector.

There are still many assumptions behind the distribution of material flows visualised in the Sankey diagram. In the future, the information may be updated based on possible new and more detailed data.

Connection to and upscaling of demonstration actions

The CityLoops demonstration actions (DAs) in Seville is focused on the improvement of CDW management and valorisation.

DAs like the implementation of a methodology for the quality assessment of the CDW from the demolition activity of the pipeline's substitution works carried out by EMASESA will promote more circular destination and valorisation of generated CDW. From the results of this DA, the upscaling to other demolition activities by other actors could have a relevant impact on the circularity of the CDW management in Seville.

Another DA that could have a relevant impact regarding the upscaling of the CDW waste collection and valorisation is the IT software tool developed to optimise the waste collection management in the "Clean points" of Lipasam that collect CDW from small producer and citizens and that will be tested during the CityLoops demonstration phase. This IT software tool was designed to improve the CDW waste collection and valorisation to improve and increase the use of these "Clean points" by citizens and small producers.

Another DA that can improve the circularity in the CDW management is the launch of a campaign to disseminate the DAs under implementation in Seville and search for the commitment of citizens and small producers. The success of these campaigns could upscale the success of these DAs and have a relevant impact on the circularity of organic waste management, in the City of Seville.

Recommendations for making the construction sector more circular

- Promote the increase of furniture and building components reuse or utilised at the city's own sites;
- Promote the recovery of bricks and use in construction instead of crushing;
- Crushed concrete could be used on city´s construction sites instead of virgin soil material although virgin soil material is still readily available;
- New operating models for the recycling and reuse of materials should be developed and tested, and new business could be created so that the circular economy can become part of the normal way of operating in construction and demolition in Seville in the future;
- Disseminate the developed documentation and data collection to improve the assessment of circularity and the interest of the main stakeholders. The CityLoops project plays an important role in the development of these actions in the city of Seville.

References

- Spain
- Andalucía
- Sevilla
- Population of Sevilla line graph
- Land use
- Map of Sevilla Geo localisation of main actors construction sector Imagen