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Sakari Oikarinen, Tietomitta Oy

Monitoring brings more efficiency in waste collection and recycling of materials

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Gate-to-gate approach in monitoring service research and planning

Why monitoring of waste management is needed?

- Promotes source sorting of waste in properties, organizations and enterprises
- Makes waste collection more effective
- Points out costs of waste management and makes them transparent
- Cuts down stress of environment

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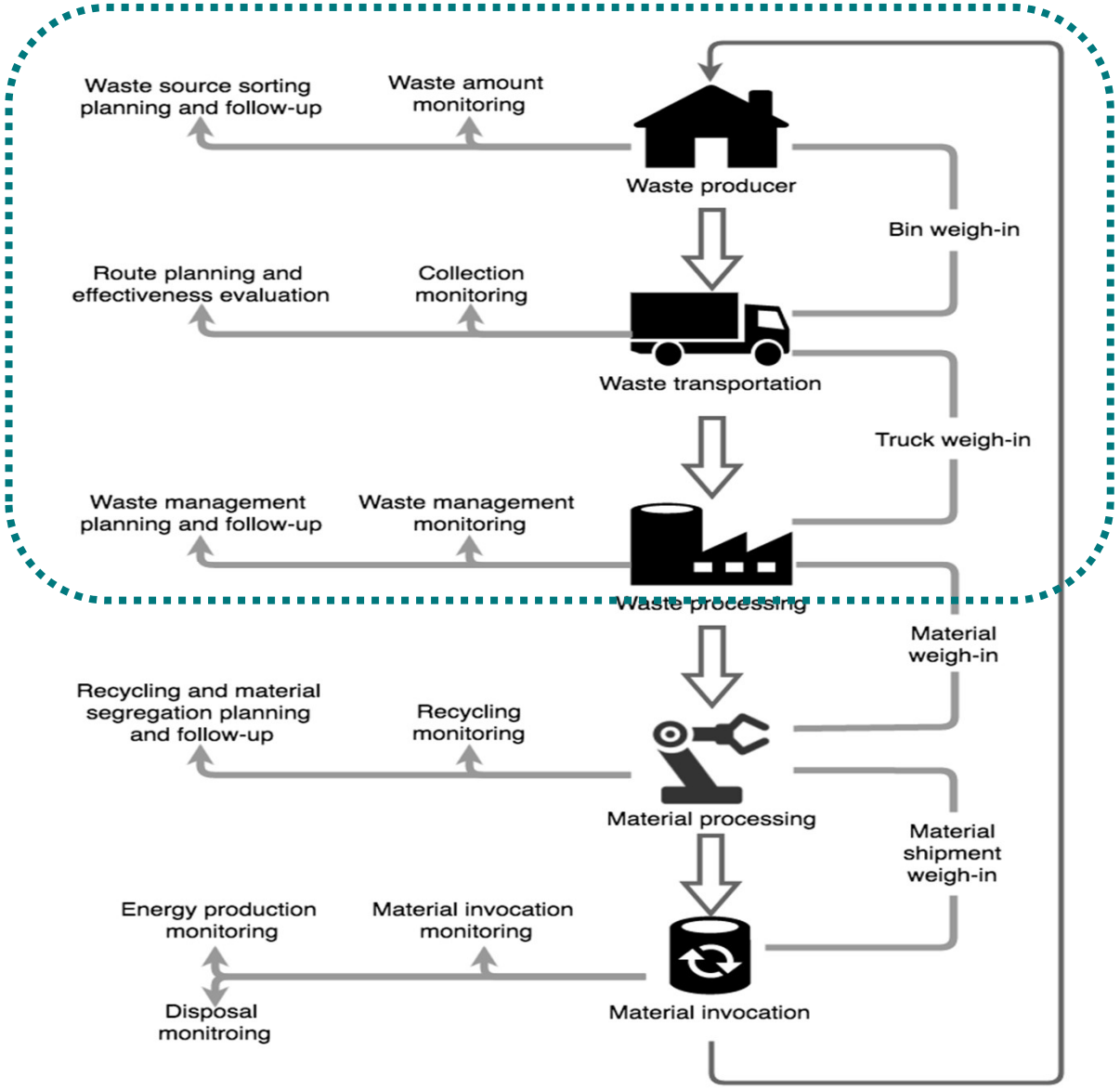
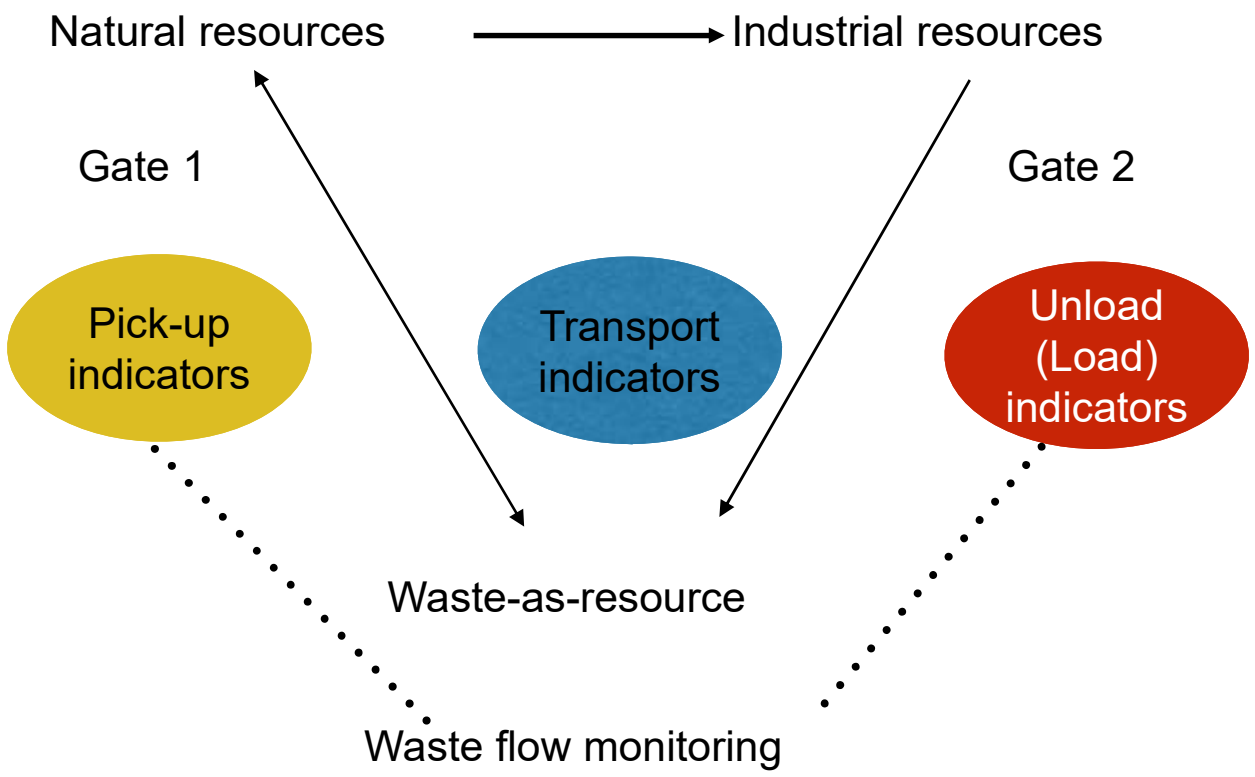

Waste source sorting planning and follow-up
Waste amount monitoring
Waste producer
Bin weigh-in
Route planning and effectiveness evaluation
Collection monitoring
Waste transportation
Truck weigh-in
Waste management planning and follow-up
Waste management monitoring
Waste processing
Material weigh-in
Recycling and material segregation planning and follow-up
Recycling monitoring
Material processing
Material shipment weigh-in
Energy production monitoring
Material invocation monitoring
Disposal monitroing
Material invocation



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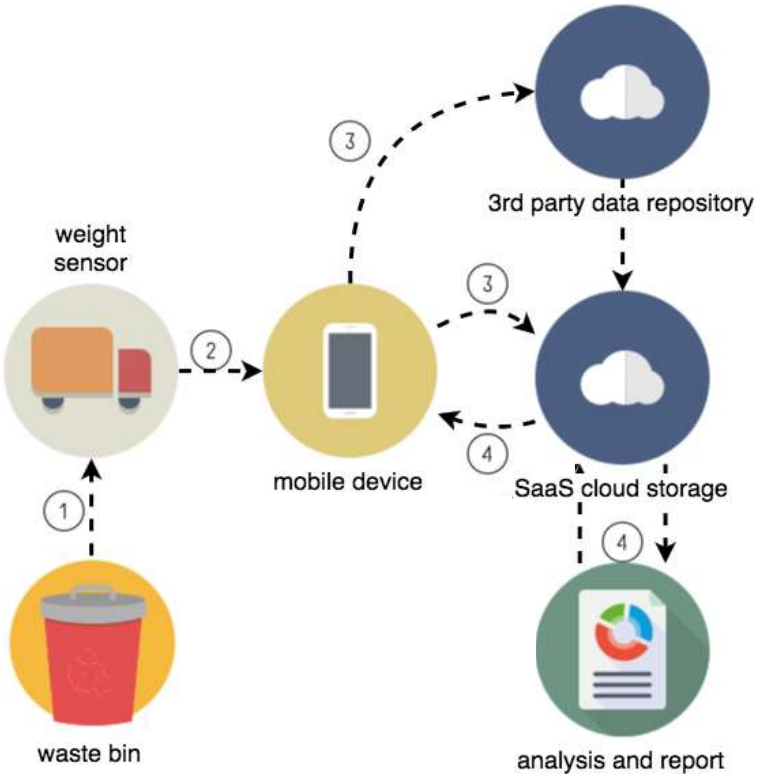
Weigh-in data collection in real time monitoring



- Bin or container has an identification ID code (RFID Radio Frequency IDentification).
- Reader identity ID and data is transferred to TCS (Transport Control System) in truck.
- Data transfers wirelessly to waste management server (IT company e.g. Tietomitta) and to our msard-cloud service (www.msard.com).
- Weight and other reference data is analyzed, and reported in real time to producers and waste management companies.
- Communicates over an HTTP resource API (REST API).

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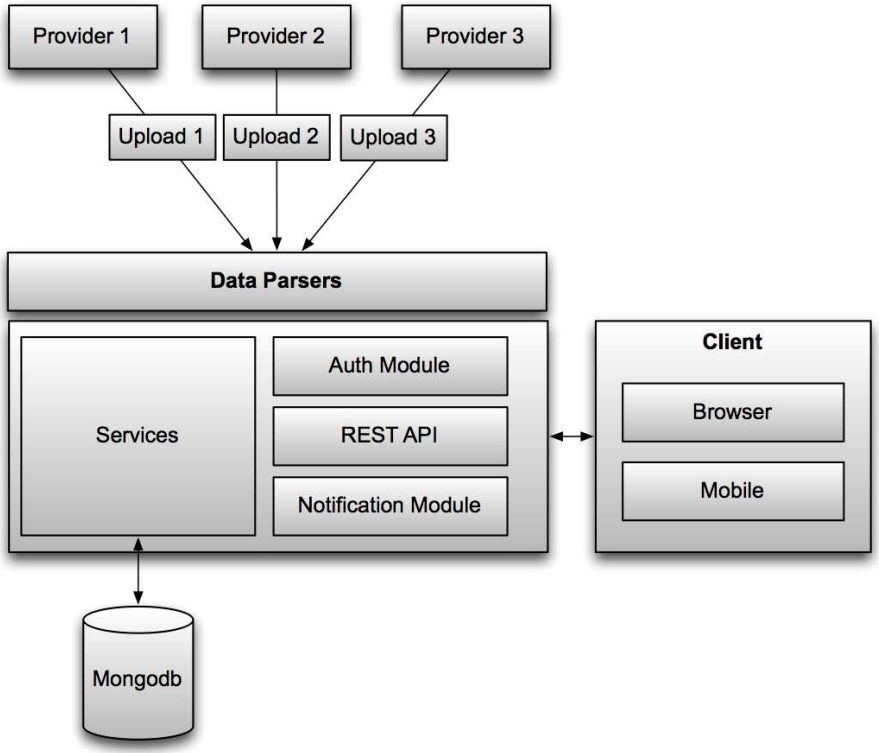
Real time reporting architecture



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Pilot towns in Finland

1. Helsinki: Mixed waste in Laajasalo suburb
2. Kotka: Biowaste in Kotka region
3. Turku: Mixed waste in Turku region
4. Forssa: Security paper waste in Southern Finland
5. Vaasa: Digital consignment note

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Waste monitoring indicators and applications for producers

Indicators for households and other waste producers

Indicator issue	Indicator type	Description of indicator
Producer of waste	Amount	Amount of waste fraction (kg) per container type when emptying (week, month, year)
	Fulfilment procent	Weight (kg) per container litres x capacity weight (kg)
	Utilization rate	Weight of the waste fraction compared to other fractions
	Costs	Costs of waste kg per occupant in one month and year.
	Etc.	

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Waste monitoring reporting for producers

Nimi	Kuukausi	Punnittu paino (tn)	Arvioitu paino (tn)	Materia...	Energia...
▲ Tuoteryhmittäin					
▸ Astia vuokra	09/16 - 12/16	0,000	0,000		
▸ Biojäte	09/16 - 12/16	7,968	0,000	100,00	0,0(
▸ Erilliskerätty yhd.kuntajäte	09/16 - 11/16	0,470	0,000	0,00	100,0(
▸ Kartonki	09/16 - 12/16	0,000	23,900	100,00	0,0(
▸ Lasi	09/16 - 12/16	0,000	2,998	100,00	0,0(
▸ Metalli	09/16 - 12/16	0,000	5,105	100,00	0,0(
▸ Muut palvelut	09/16 - 11/16	0,000	0,000		
▸ Pesut	09/16 - 10/16	1,740	0,000	0,00	0,0(
▸ Polttok. jäte	09/16 - 12/16	84,730	56,783	0,00	100,0(

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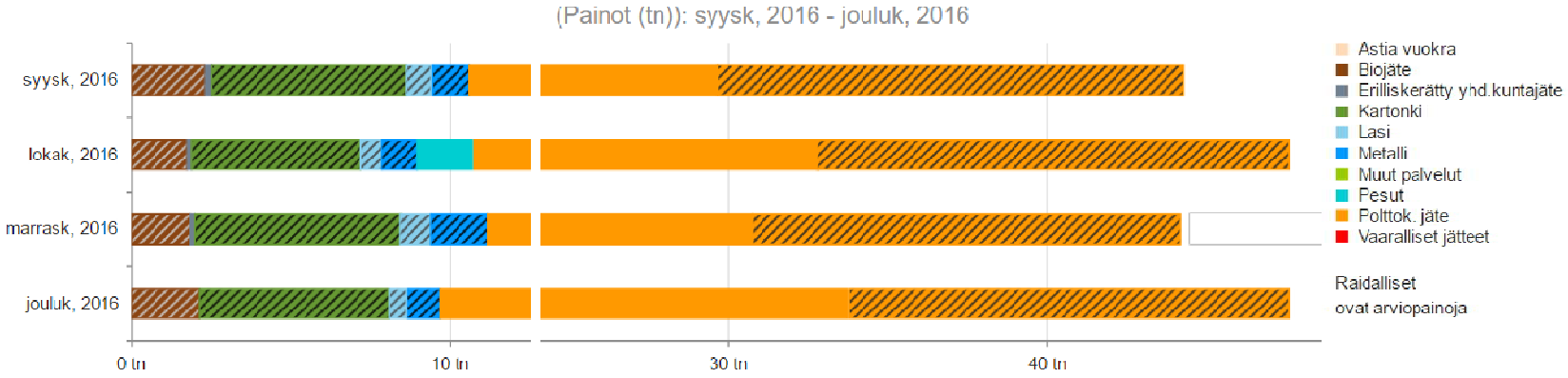
Waste monitoring reporting for producers



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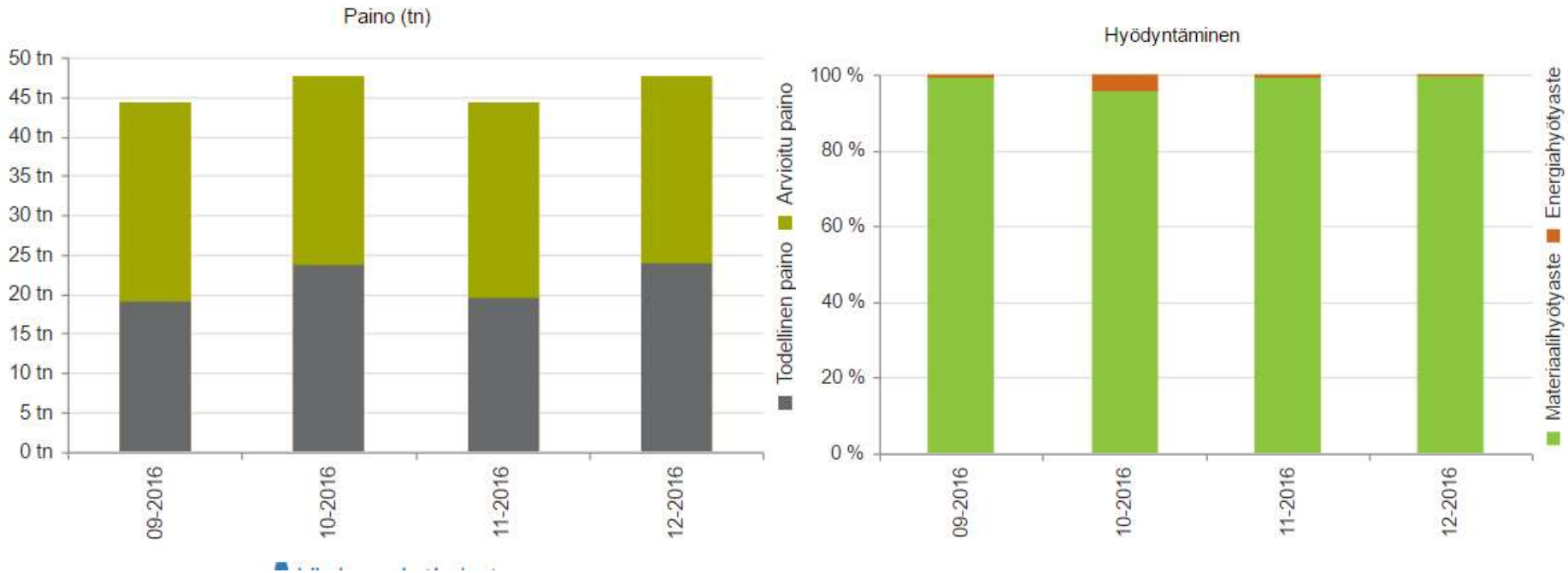
Waste monitoring reporting for producers



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Waste monitoring indicators and applications for transportation

Indicators for transportation

Indicator issue	Indicator type	Describtion of indicator
Transportation of waste	Amount	Amount of waste fraction (kg) in unloading container (day, week, month, year)
	Route area	Weight of the waste fraction in the routing area (day, week, month, year)
	Productivity of customer	Number of bins, distance, weight per collection costs
	Costs	Kilometers per costs Kilometers per waste amounts
	Percentage of driving empty	Driving distances without a load / total driving distances x 100
	Etc.	

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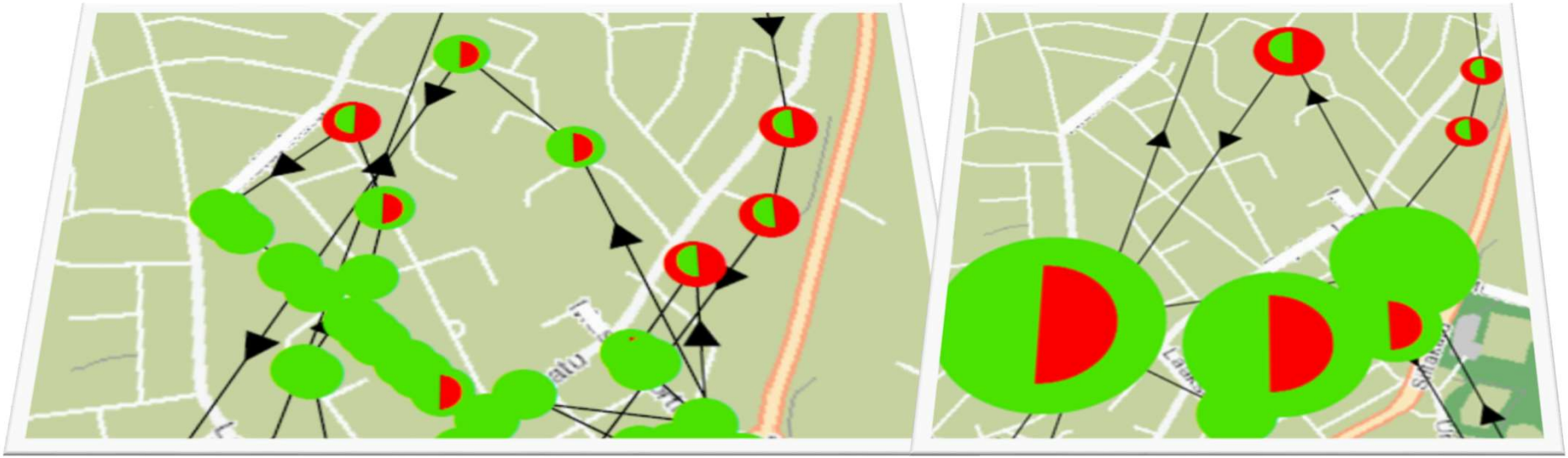
Productivity of customer



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Kotka pilot: Biowaste collection and monitoring in Kymenlaakso Jäte Oy

Indicator issue	Indicator type	Description of indicator
Biowaste management	Mass	Number of container pickups in time series
		Amount of biowaste (kg) per container when emptying
	Weight based billing	Transportation and processing costs per weight > bill
	Etc.	

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Cost of biowaste	Unit	Calculation	Price
Jätemaksu	Average weight of biowaste bin Weight of biowaste in one year Average cost **Weight based billing**	0,240 m^3 × 145 kg/m3 = **35 kg** 35 kg/vko × 52 vko = **1820 kg** 1000 kg **= 88 €** **1,820 t × 8,8 €/kg =**	**160,16**
Tyhjennyskerta	240 l bin	2,91 € × 52 vko =	151,31
Vuokra	240 l bin	1,5 €/kk × 12 €/kk =	18,00
Yhteensä			**329,47**

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Forssa pilot: Security paper collecting and monitoring in Loimi-Häme Jätehuolto Oy &Tietomitta

Indicator issue	Indicator type	Description of indicator
Transportation of waste	Order, customer count	Shortest routes
	Documentation of pickups and destroying reports	Pickup time, kg, destroy time, costs, list of previous bins
	Statistics	Diagrams of time, kg, cost
	Options	Can be used also in case of: hazardous waste, medicine waste and electronic waste.

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Documentation of pickups and destroying reports

Nimi	Kuukausi	Määrä (kpl)	Paino (kg)	Kuljetus € ...	K...	V...	Yhteensä € (al...	Hyöty...	E...	E...	RD
– Tietoturvapaperi TTP nouto 240 l	15.12.2016	1,00	27,00					100,00			

Säiliö	Noutoaika	Palvelun suorittaja	Vasteaika
240 L	15.12.2016 12:15		
RFID	**Vastaanottoaika**	**Purkaja**	
	16.12.2016 13:12		1 d 0 h 57 min 0 s
Tuhoustodistus	**Tuhousaika**	**Vastuullinen tuhoaja**	
0500038C	16.12.2016 13:12		
Materiaali			
Tietoturva paperi			
kg/kpl			
27,00			

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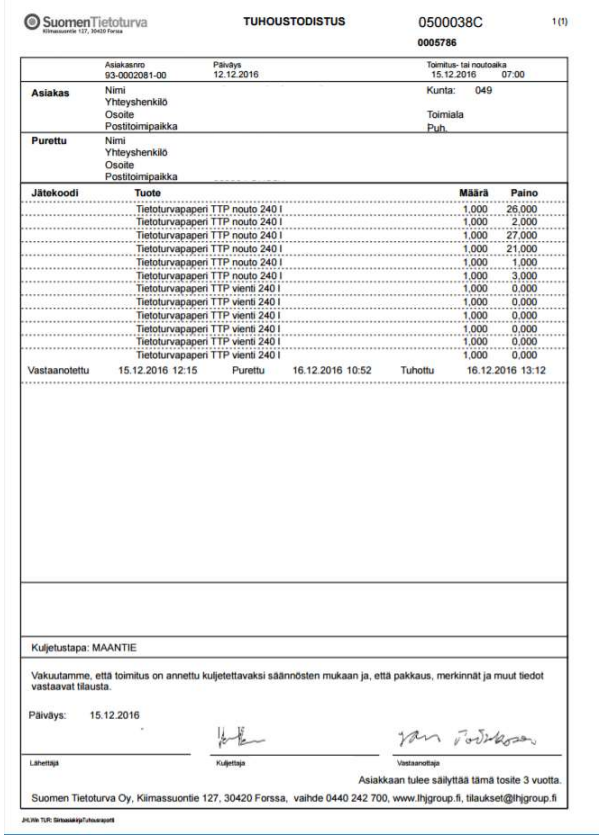
Documentation of pickups and destroying reports



SuomenTietoturva

TUHOUSTODISTUS 0500038C 1 (1)

0005786

Asiakasnro	Päiväys	Toimitus- tai noutoaika
93-0002081-00	12.12.2016	15.12.2016 07:00

Asiakas Nimi
Yhteyshenkilö
Osoite
Postitoimipaikka

Kunta: 049
Toimiala
Puh.

Purettu Nimi
Yhteyshenkilö
Osoite
Postitoimipaikka

Jätekoodi	Tuote	Määrä	Paino
	Tietoturvapaperi TTP nouto 240 l	1,000	26,000
	Tietoturvapaperi TTP nouto 240 l	1,000	2,000
	Tietoturvapaperi TTP nouto 240 l	1,000	27,000
	Tietoturvapaperi TTP nouto 240 l	1,000	21,000
	Tietoturvapaperi TTP nouto 240 l	1,000	1,000
	Tietoturvapaperi TTP nouto 240 l	1,000	3,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000
	Tietoturvapaperi TTP vienti 240 l	1,000	0,000

Vastaanotettu 15.12.2016 12:15 Purettu 16.12.2016 10:52 Tuhottu 16.12.2016 13:12

Kuljetustapa: MAANTIE

Vakuutamme, että toimitus on annettu kuljetettavaksi säännösten mukaan ja, että pakkaus, merkinnät ja muut tiedot vastaavat tilausta.

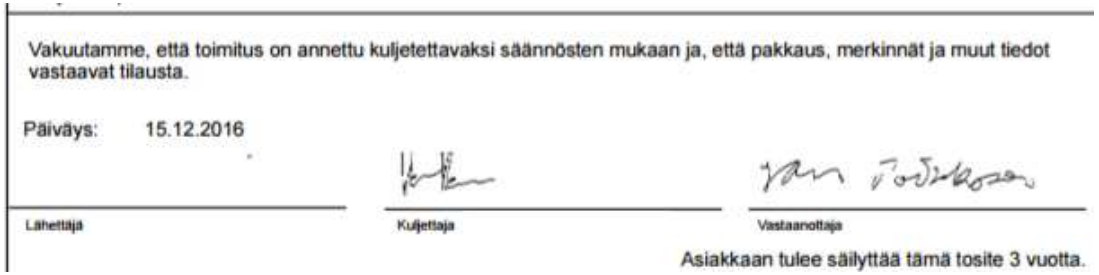
Päiväys: 15.12.2016

Lähettäjä Kuljettaja Vastaanottaja

Asiakkaan tulee säilyttää tämä tosite 3 vuotta.

Suomen Tietoturva Oy, Kiimassuontie 127, 30420 Forssa, vaihde 0440 242 700, www.lhjgroup.fi, tilaukset@lhjgroup.fi

Vastaanotettu 15.12.2016 12:15 Purettu 16.12.2016 10:52 Tuhottu 16.12.2016 13:12



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Päiväys: 15.12.2016

Lähettäjä Kuljettaja Vastaanottaja

Asiakkaan tulee säilyttää tämä tosite 3 vuotta.

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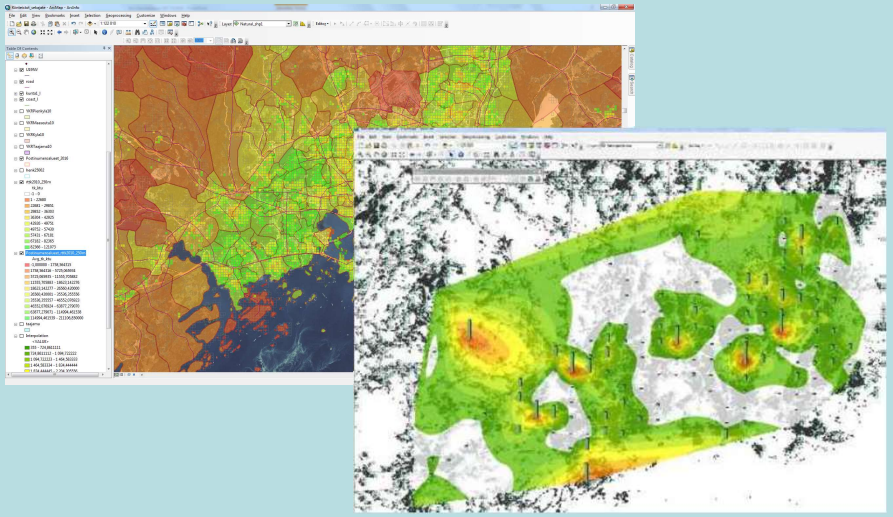
Spatial indicators and analytics based on monitoring data



Objectives

To study spatial indicators based on:

1. the utilization of (open) public data – big data
2. state-of-the art mathematical analytics methods (e.g. neurocomputing, deep learning)
3. integrated analysis with other tools (e.g. LCA, mass and energy balance computations)

Resulting spatial outputs:

- **Trends, type profiles, scaled quantities**
- **Classification and comparison information (between areas and waste producers)**
- **Forecasts**

Harri Niska, University of Eastern Finland

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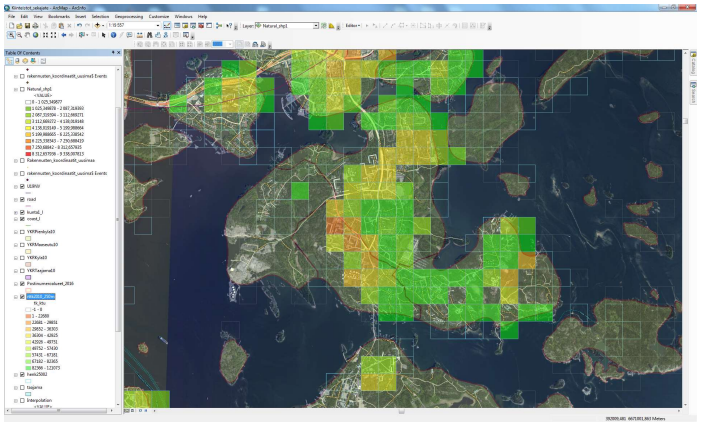
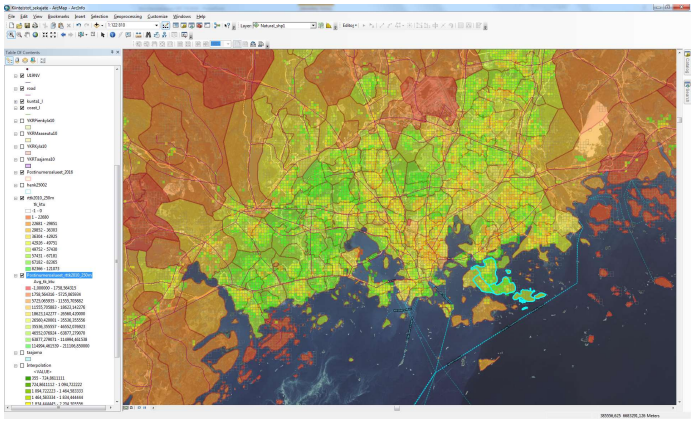
Pilot Helsinki Laajasalo: Mixed waste collection in HSY

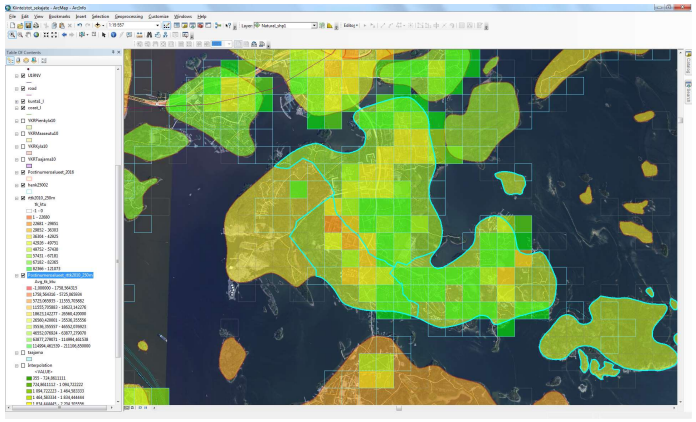
Weight data (kg) in monitored containers

+

Socioeconomic grid database (Statistics Finland) (250 x 250 m)







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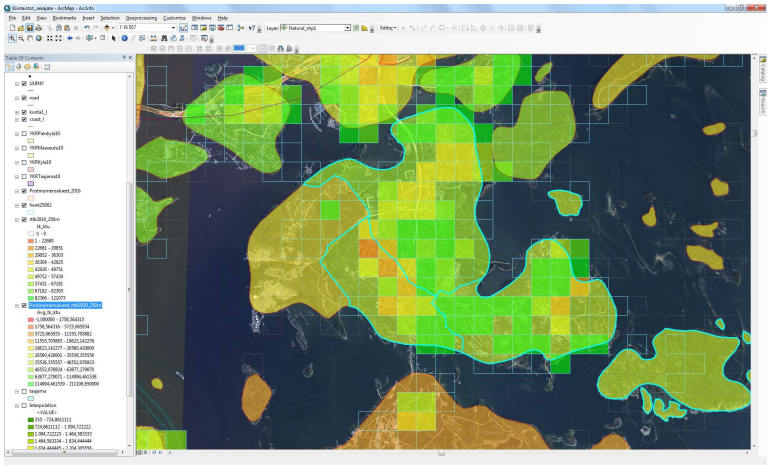
Pilot Helsinki Laajasalo: Spatial indicators based on external data

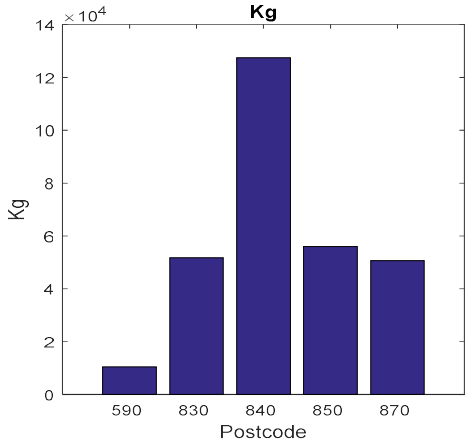
Waste generation in different regions

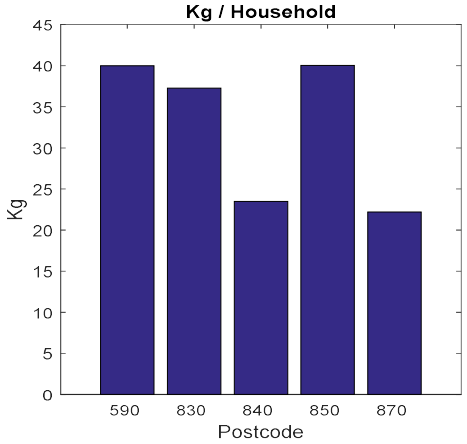
- Generation (kg) per household, per capita (eur), per built area (m2), etc.

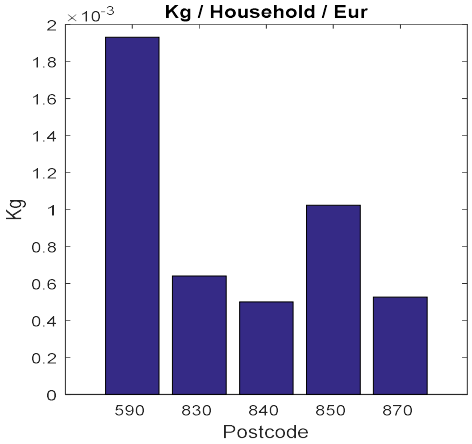
Efficiency of waste management in different regions

- Fullness rates (%) of containers
- Transportation distances (km), costs (euro) and emissions (CO2) per quantity (kg)









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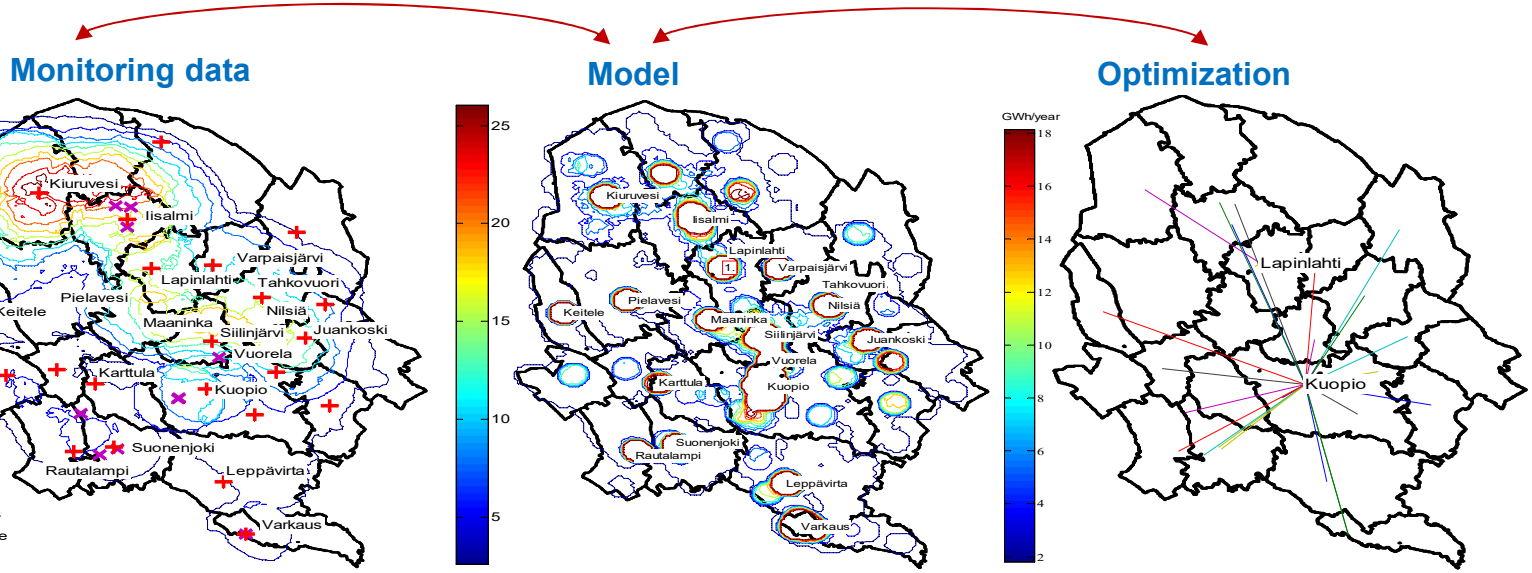
Other spatial modelling

Example: **biogas production modelling**

Combining spatial waste monitoring data with energy and emission balance calculations (e.g. Huopana et al. 2013)

Enables the finding of optimal production sites (in terms of costs, emissions, energy efficiency)
Can be used to define most feasible local waste management operations



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Monitoring utilities for stakeholders

Utilities for waste producers

- **New monitoring information improves sorting by producers.**
- Optimizes right container size and emptying schedule in apartment houses.
- Peaks in the produced waste can be followed per real estate.
- Cost visibility encourages to plan more efficient waste points.
- Lost food in biowaste will degree 15 percent with monitoring feedback (Lisa Dahlén et.al 2010).

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Utilities for waste collection and transportation

- **Evaluates tranportation cost per kg, km, day and route.**
- Helps to plan pick-up and transport routes
- Reports number of emptied / not emptied containers in routes
- Reports average weights of routing area
- It is easier to forecast the number of trucks needed during the seasons
- Applicates weight based billing
- Evaluates fuel consumption and emissions in routes and seasons

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Utilities of spatial analysis for decision makers

- **Identifies housing companies, housing estates and regions, where waste amount are different compared to other estates.**

- Identifies explanatory factors, which cause differences (e.g. building type, socioeconomic status, waste management services, etc.)

- Points out environmental effects spatially (driving kilometers compared to produced energy versus emissions; smell of landfill spatially; effluent of polluted water or soil)

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“Measured waste is recycled knowledge”

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