Design Project ENAC-SSIE 2017

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Use of GIS to plan waste management in Albania

INTRODUCTION

Prior to the 2014 territorial reform, municipalities in Albania had grown increasingly fragmented such that the cost of service provision in the local government units (counties) hampered the development of democratic local governments[1]. With 70% of communes being unserved or underserved, waste management services were among the most important aspects that the reform sought to improve. The establishment of a local solid waste management plan in the different administrative units of Shkodër county necessitates that service be extended into previously unserviced rural areas. Different routes can be implemented to satisfy this need, but the associated costs and service levels must be evaluated.

OBJECTIVE

Development of a GIS-based methodology and tool, that considers local-scale features, to **facilitate the decision-making process** and **calculate the cost and service levels** for waste management planning in Shkodër, Albania.

METHODOLOGY

1. Estimating population size & waste production

➔ No official records exist that georeference the population at a local scale
- ◆ Population distributions were estimated as a function of a regional scale population census, a population registry and building density

➔ Waste production distribution = *Est. building occupancy* × *waste production rate*

2. Routing plan

➔ Developed with the goals of (1) minimizing collection frequency, and (2) maximizing truck capacity between trips to the landfill

➔ Number of bins assigned based on waste production rate and routing plan

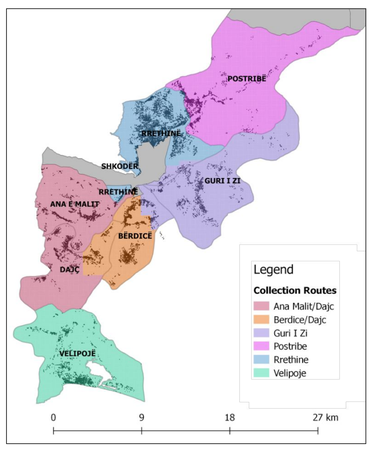

Figure 1 (left): Boundaries of each routing plan (collection zone).

Table 1: Proposed weekly schedule based on the six defined routing plans, with an indication of the estimated population served, waste collected, and trucks used.

Proposed Weekly Schedule	Route						Est. population served	Waste collected (t)	Trucks used
	1	2	3	4	5	6			
	Ana E Malit + Dajc (partial)	Berdice + Dajc (partial)	Guri I Zi	Postribe	Rrethine	Velipoje			
Mon	x	-	x	x	x	x	54426	40.6	5
Tue	-	x	-	-	x	-	28056	15.1	2
Wed	-	-	x	-	x	x	37921	23.2	3
Thu	x	-	-	x	x	-	37081	24.5	3
Fri	-	x	x	-	x	x	45401	31.1	4
Sat	-	-	-	-	x	x	26948	15.6	2
Sun	-	-	-	-	-	-	0	0	0
Bins required	86	80	78	90	73	85			

3. Waste collection point placement and bin allocation

➔ Determined based on building density within each of the six collection routes: 500m by 500m grid was used

➔ More bins will be placed in high density zones

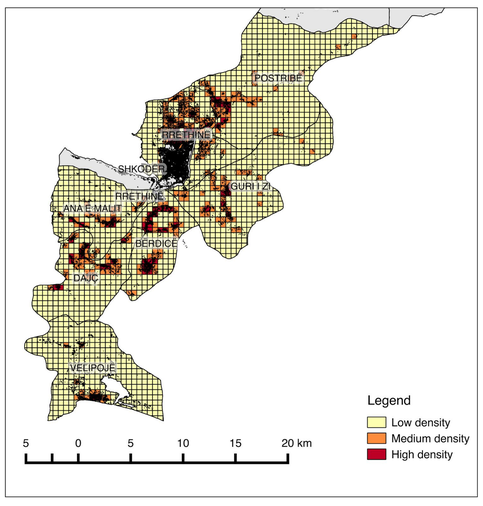

Figure 2 (right): Map of density zones produced in QGIS using a regular 500m by 500m grid.

4. Scenario definition

➔ Three scenarios were designed, each with a different collection point placements and truck itinerary but constant number of bins (492)
- ◆ Business-as-usual (BAU): current situation
- ◆ Optimized (OPT): reduced number of collection points to minimize truck stopping frequency
- ◆ Extended (EXT): extension of service to all unserved medium density zones (*Figure 2*)

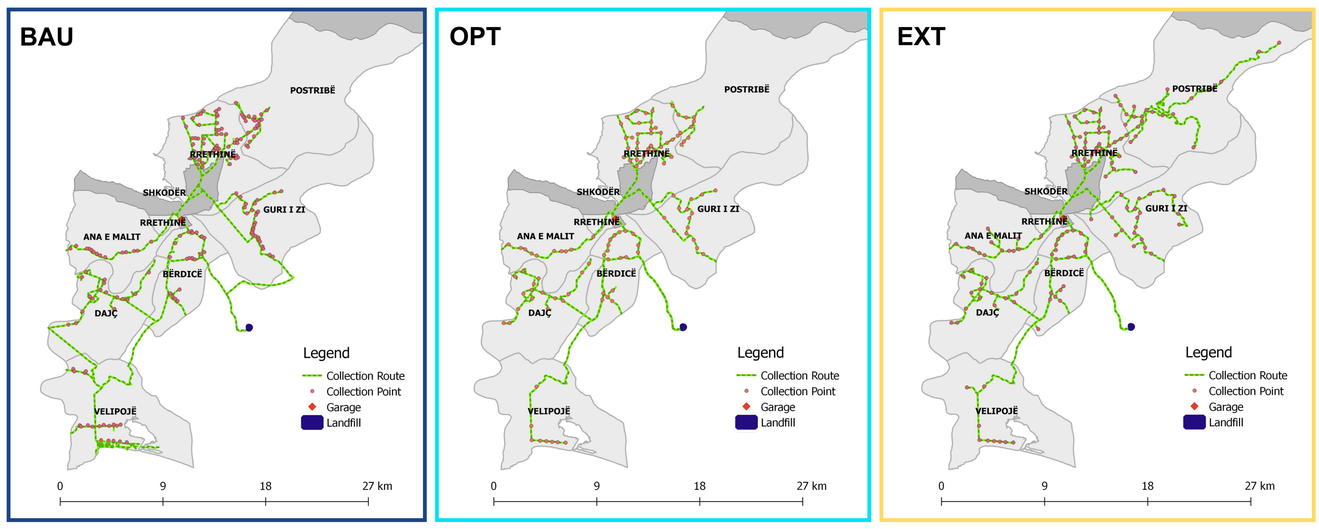

Figure 3: Overview of truck itinerary and placement of collection points in the BAU (left), OPT (middle), and EXT (right) scenarios.

5. Cost & Service level calculation

➔ **Cost calculation** is based on the existing DLDP[2] cost model, with modifications made to the computation of travel and collection distances to calculate costs with greater precision

➔ **Service level** (where 100% is the maximum) is calculated considering:
- ◆ Distance to the nearest collection point (see *Figure 4*), &
- ◆ Frequency of collection (2% penalty for each day of waste accumulation)

➔ Cost and service are calculated using an Excel-based tool developed to automatically generate results

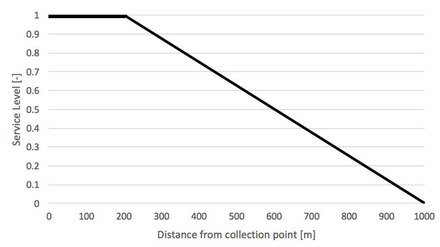

Figure 4: Linear decay function used to calculate base service level.

RESULTS

Cost

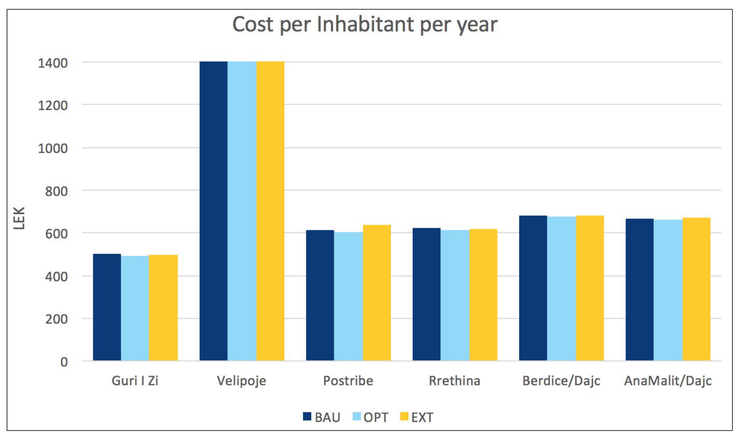

Figure 5: Comparison of annual cost per inhabitant of each collection zone (routing plan) for each of the three considered scenarios.

From *Figure 5 (left)*,

➔ The annual cost per inhabitant is relatively similar across the collection zones, with the exception of Velipoje.

➔ Large per capita costs in Velipoje are attributed to higher waste production rate due to significant tourist influx.
- ◆ A large proportion of this per capita cost will be covered by taxes on local businesses.

Service level

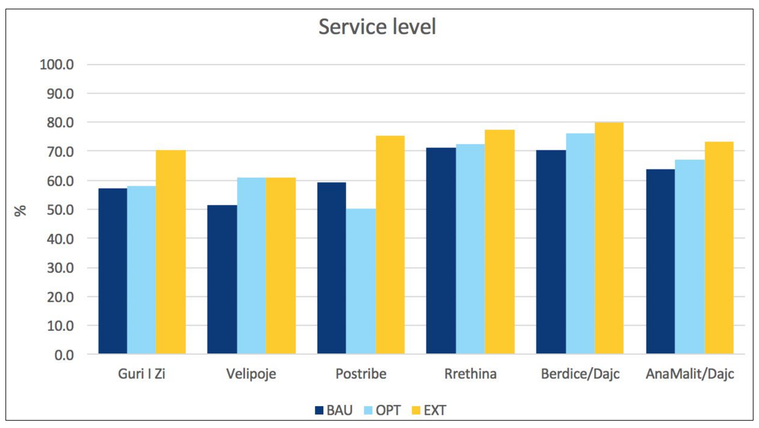

Figure 6: Comparison of the service levels of each service route (routing plan) for each of the three considered scenarios.

From *Figure 6 (left)*,

➔ Extended scenario produces the best results across all service routes.

➔ Postribe has the greatest increase in service level due to the most significant extension of service in the EXT scenario (see *Figure 3*).

Production of calculation tool & User Guide

➔ A user-friendly GIS-based Excel tool is also produced as part of this work.
- ◆ User can input variables extracted from GIS into waste management tool and cost and service level are automatically generated and presented graphically for easy interpretation (*Figures 5* and *6* are generated by the tool).
- ◆ Tool and user manual are delivered to Albanian collaborators so they can easily replicate analysis presented here to guide future waste planning.

KEY LIMITATIONS & FUTURE STEPS

➔ Local scale population data is lacking and estimated population distribution is heavily biased by inability to characterize building types.
- ◆ Future use of waste tool will benefit from local knowledge, integrating client databases with other municipal services, and data from population censuses.

➔ GIS-based tool can be further developed to include other local-scale features like slope and commercial zones that will offer more precise waste management planning.

CONCLUSIONS

➔ **Extended scenario is strongly recommended for implementation**: a significant increase in the service level can be attained with a negligible increase in annual costs.

➔ GIS-based Excel tool and User Guide can be adopted by local actors for **planning, budgeting and tendering waste management** in Shkodër.

Table 2: Summary of costs and service levels for each scenario.

Scenario	Total Ops Cost (per year, million LEK)	Average Service Level (%)
BAU	43.255	62.2
OPT	42.705	64.1
EXT	43.195	72.9

[1] Hoti. E, et al. (2014). Administrative and Territorial Reform: Analysis of the local government situation in Albania (Executive Summary). Minister of State for Local Government (pp. 1-37). Albania.

[2] Decentralization and Local Development Programme (DLDP), (2013). On calculating the costs for Solid Waste Management at Local Government Unit level in Albania. DLDP, Helvetas Swiss Intercoooperation, Albania (pp. 5 – 56). Shkodër: Albania.

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