DEFINING THE NEEDS AND DEVELOPING AN INFORMATIONAL SYSTEM FOR THE MONITORING AND REPORTING OF LANDFIL GAS FOR MUNICIPAL LANDFILS

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Municipal waste in Serbia

- 2.5 million tons of municipal waste produced in Serbia every year
- Around 50% biodegradable waste?
  - Separation?
  - Recycling?
- Waste disposed off on a large number of dumpsites, legal and illegal (unsanitary) landfills around the country
- Most landfills not built according to national and international standards

The „new“ landfilling system

- New system of regional landfills proposed
  - Includes 25-30 big, sanitary, regional landfills built by highest standards
- Transition from small quantities of municipal solid waste spread around the country to large quantities (volume – height of landfill)

No.	Regional landfill	Population (1000s)	MSW (2015) (t)
1.	Beograd	1,500.0	558,060
2.	Subotica	286.1	75,067
3.	Kragujevac	219.0	59,641
4.	Zajecar	236.4	87,139
5.	Uzice	346.7	76,100
6.	Nis	324.1	82,322
7.	Krusevac	317.8	100,752
8.	Novi Sad	370.0	142,988
9.	Zrenjanin	193.3	49,123
10.	Loznica	138.7	34,120
11.	Leskovac	296.3	75,273
12.	Vranje	216.1	85,090
13.	Pancevo	138.1	55,103
14.	Lapovo	150.0	38,106
15.	Sombor	164.1	41,675
16.	Kikinda	143.2	36,368
17.	Vrsac	111.0	28,215
18.	Indjija	250.0	63,510
19.	Smederevo	147.6	37,492
20.	Sabac	201.9	51,297
21.	Jagodina	160.0	40,646
22.	Nova Varos	107.2	27,239
23.	Pirot	106.5	27,055
24.	Ub	362.0	91,962

Biodegradable waste = landfill gas

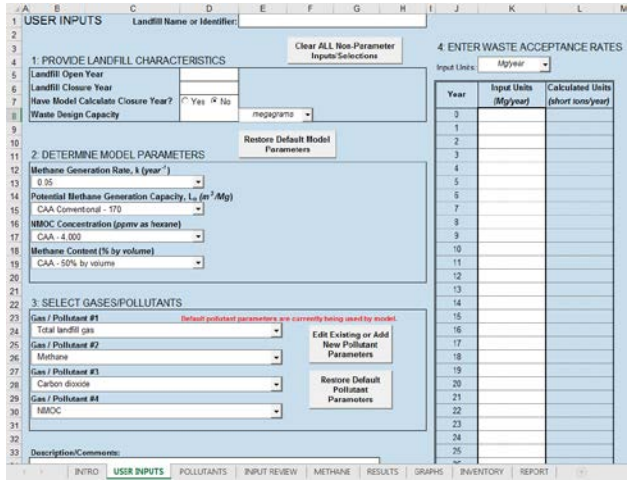
- Microbial population mediates transformation of carbon to CH_4 and CO_2
  - On small landfills – aerobic transformation – more CO_2
  - On big (regional) landfills – anaerobic transformation – more CH_4
- Methane – Global Warming Potential 25 times higher than CO_2 (Intergovernmental Panel on Climate Change, 2014)
- Landfills contribute 5-10% to global methane emissions

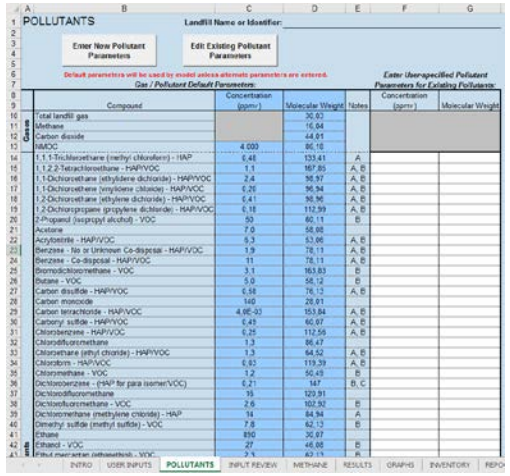
Landfill gas monitoring and reporting

- In the EU: Monitoring Mechanism Regulation (MMR) – regulates monitoring and reporting of all anthropogenic greenhouse gas emissions
- Serbia is a member of the UN Framework Convention on Climate Change
- Serbian legislation is being harmonized to the EU legislation
- Integrated cadastre of pollution – provides a starting point for identifying and monitoring sources of pollution

Available solutions for estimating landfill gas emissions

- Developed to: organize the emission inventory, collect and verify waste data, produce emission estimates, help monitor emissions, and comply with local regulations in this area
- US Environmental Protection Agency: Land Gem

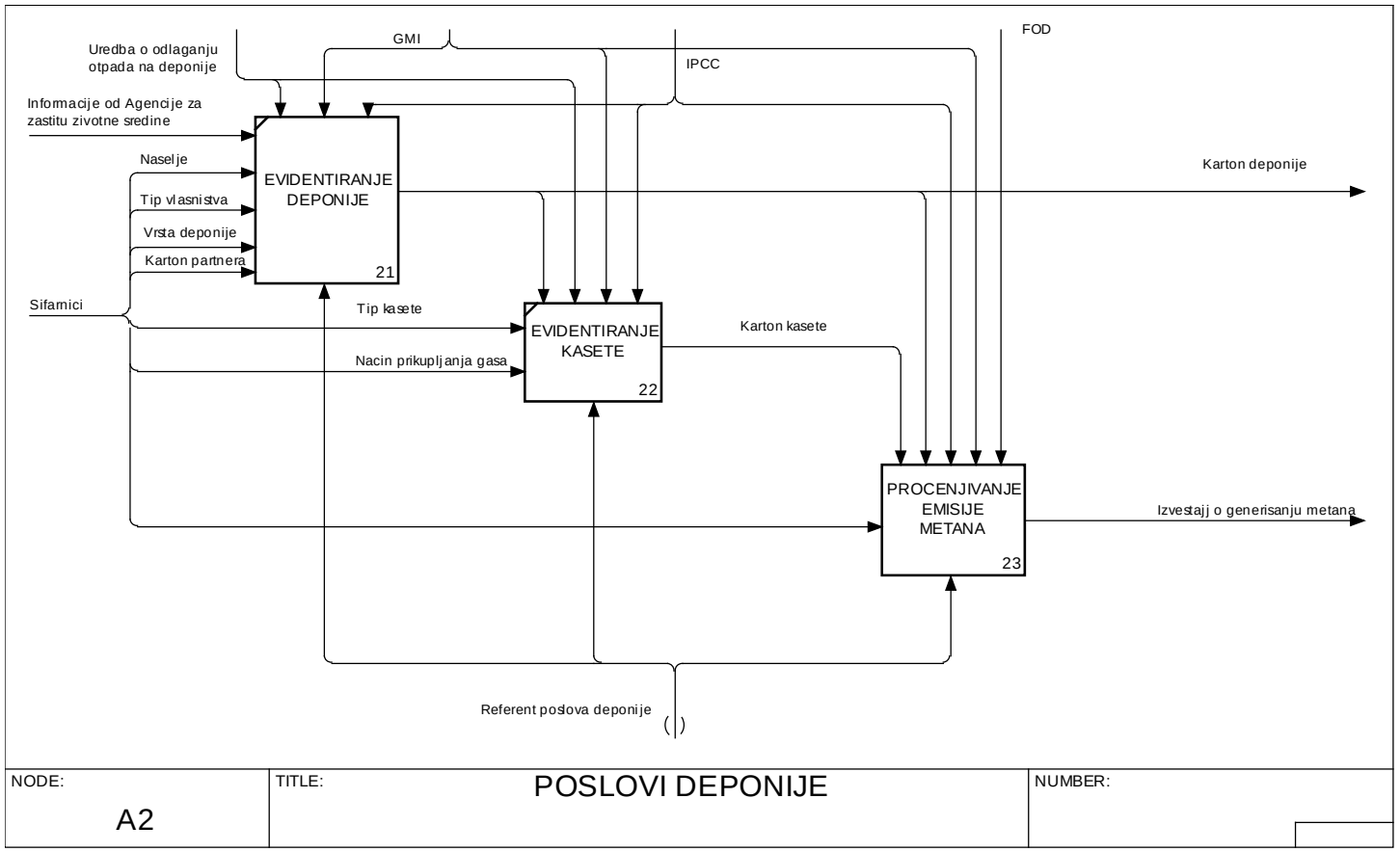




Development of an informational system

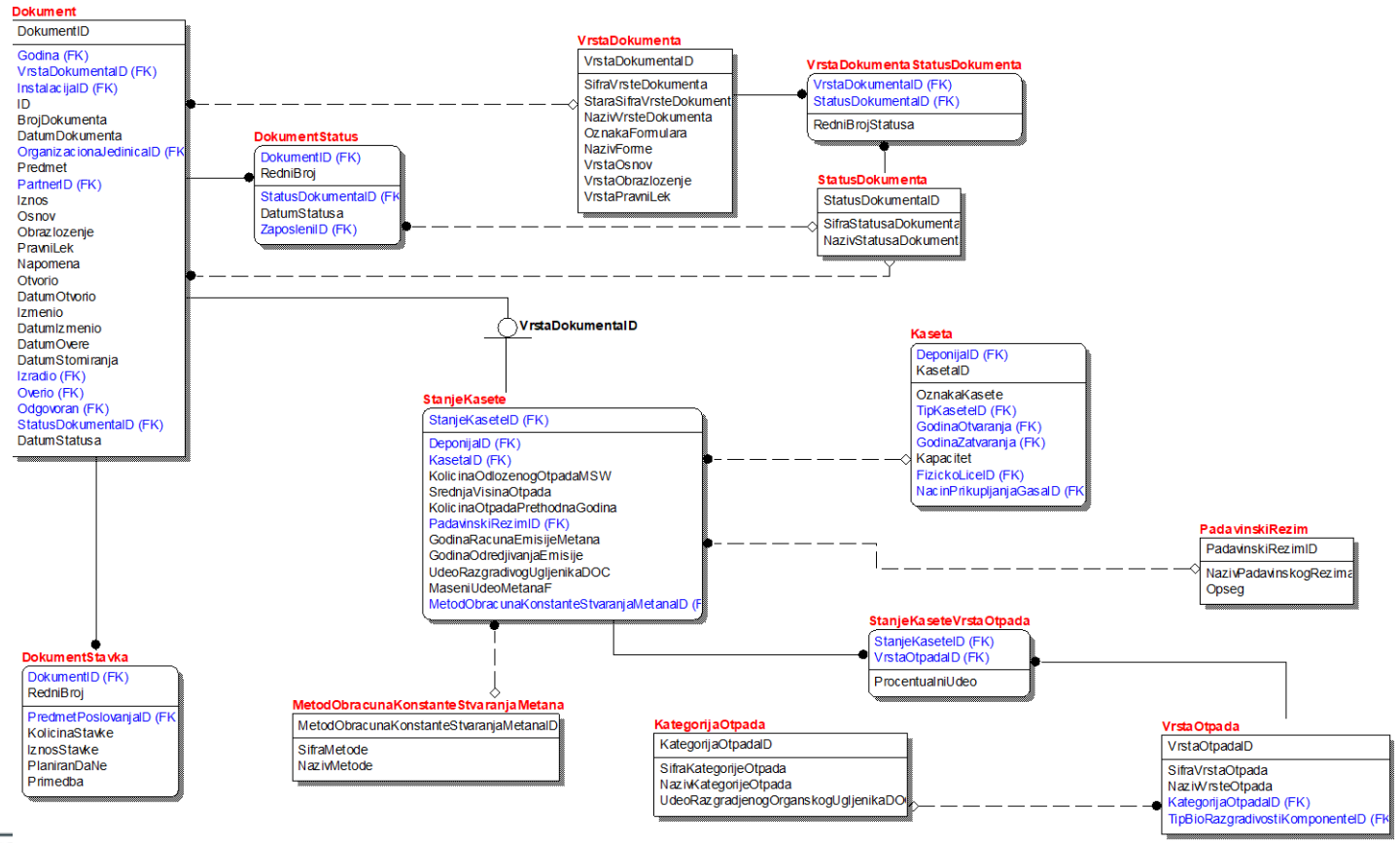
- Begins by modelling the process and necessary data
- Process modelling:
  - Decomposition of a complex system into more simple components
  - Methodology: Top-Down
  - Result: series of simple processes which can easily be solved
- IDEF0 standard, implemented in Bpwin Process Modeler
  - Process decomposition: series of diagrams using standard syntax and semantics, connected in a way to describe the heirarchal system

Process modelling



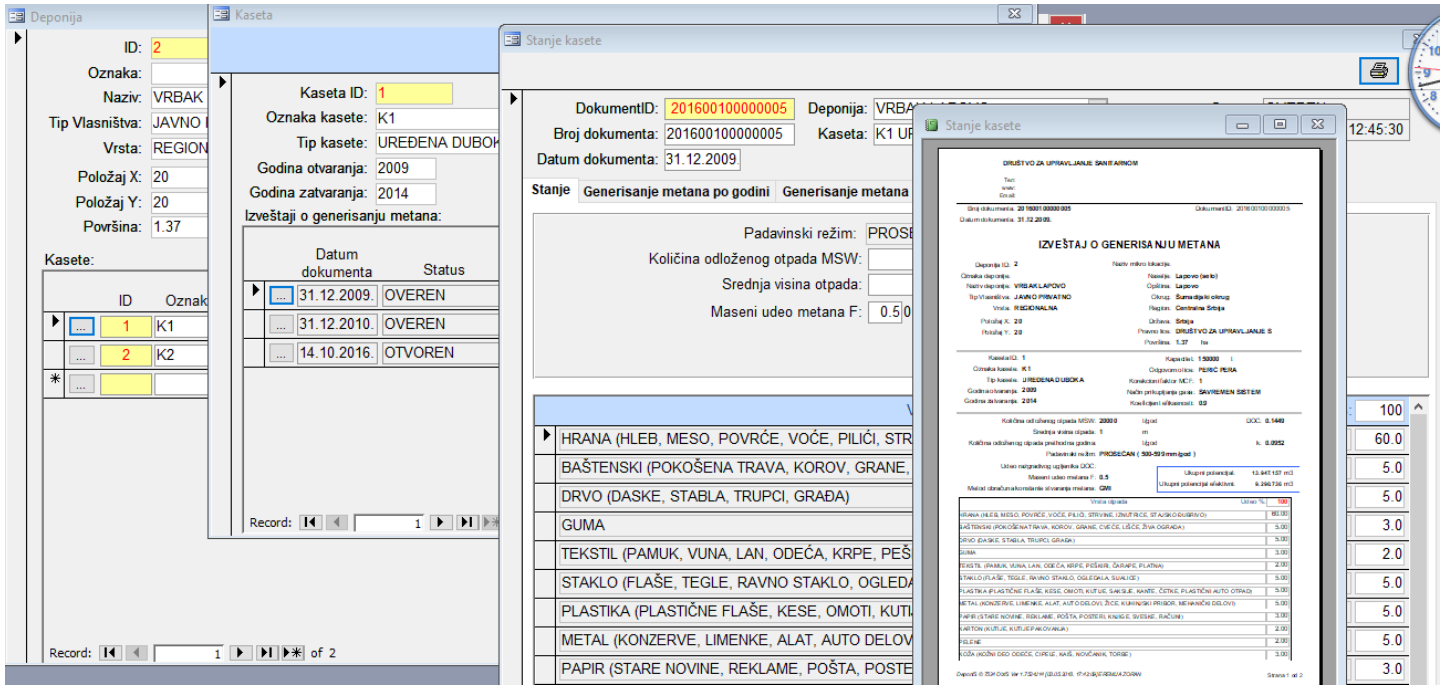
- Rectangles – parts of the complex process
- Arrows: Left – Inputs, Right – Outputs, Top – Controls

Data modelling



- Done using the Bottom-Up methodology
- IDEF1 standard, implemented using Erwin Data Modeler

User interface



- Model – Data – User Interface
- SQL Server is for the server side
- Microsoft Access for the client side
- Enables the use

Potential market

- Serbia and the region (where landfilling is the primary method of municipal waste management)
- Allows for simple, rapid, reliable, scientifically based, reproducible landfill gas quantification, monitoring and reporting
- 25-30 private/public landfill management companies
- Public agencies (Environmental protection agency)

Conclusions

- Municipal waste landfilling: Environmental problem/Renewable energy source
- Available solutions not up to the task (in a simple, rapid, and reliable way)
- A software solution could enable municipal waste management companies to estimate the landfill gas quantities, fulfil reporting requirements, and turn landfill gas into renewable energy

Prospective

- Many/All processes can be modelled using the same methodology
- Software solutions could bring improvements in many fields
- Advanced data analysis tools/systems can help:
  - Protect the environment
  - Reduce the costs/Increase the profit
  - Predict the future and guide investments?

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Thank you for your kind attention

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