

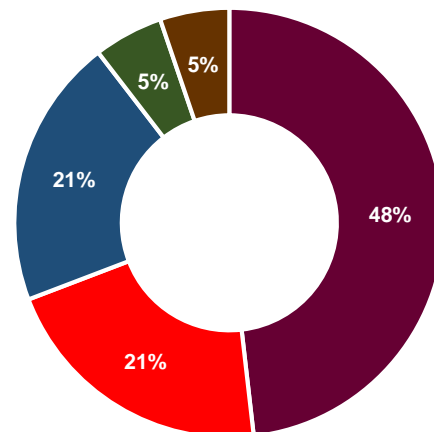
Určenie parametra DOC pre skládkované odpady



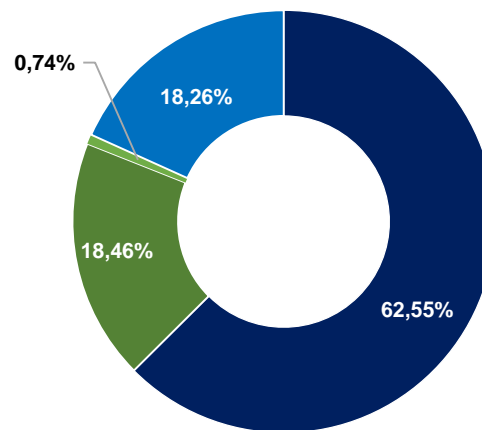
ODBOR
EMISIE
A BIOPALIVÁ

Janka Szemesová
Marek Hrabčák

SKLÁDKY NA SLOVENSKU = ZDROJ EMISIÍ JE LFG

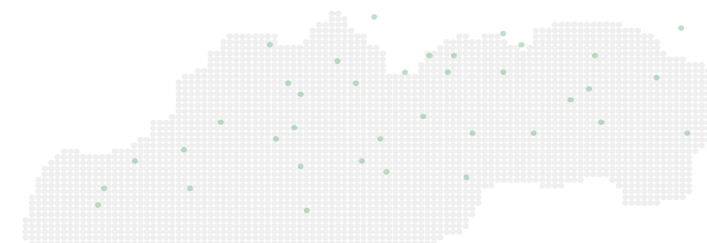


- 1. Energy without transport
- 1.3 Transport
- 2. IPPU
- 3. Agriculture
- 5. Waste



2022

- SWDS
- Composting
- Incineration
- Wastewater



VZNIK SKLÁDKOVÉHO PLYNU - LFG

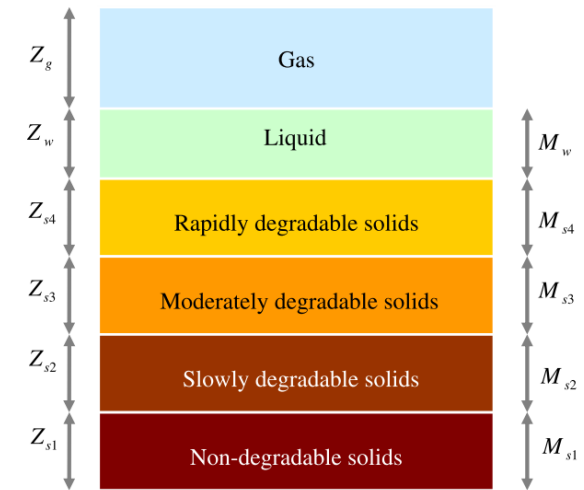
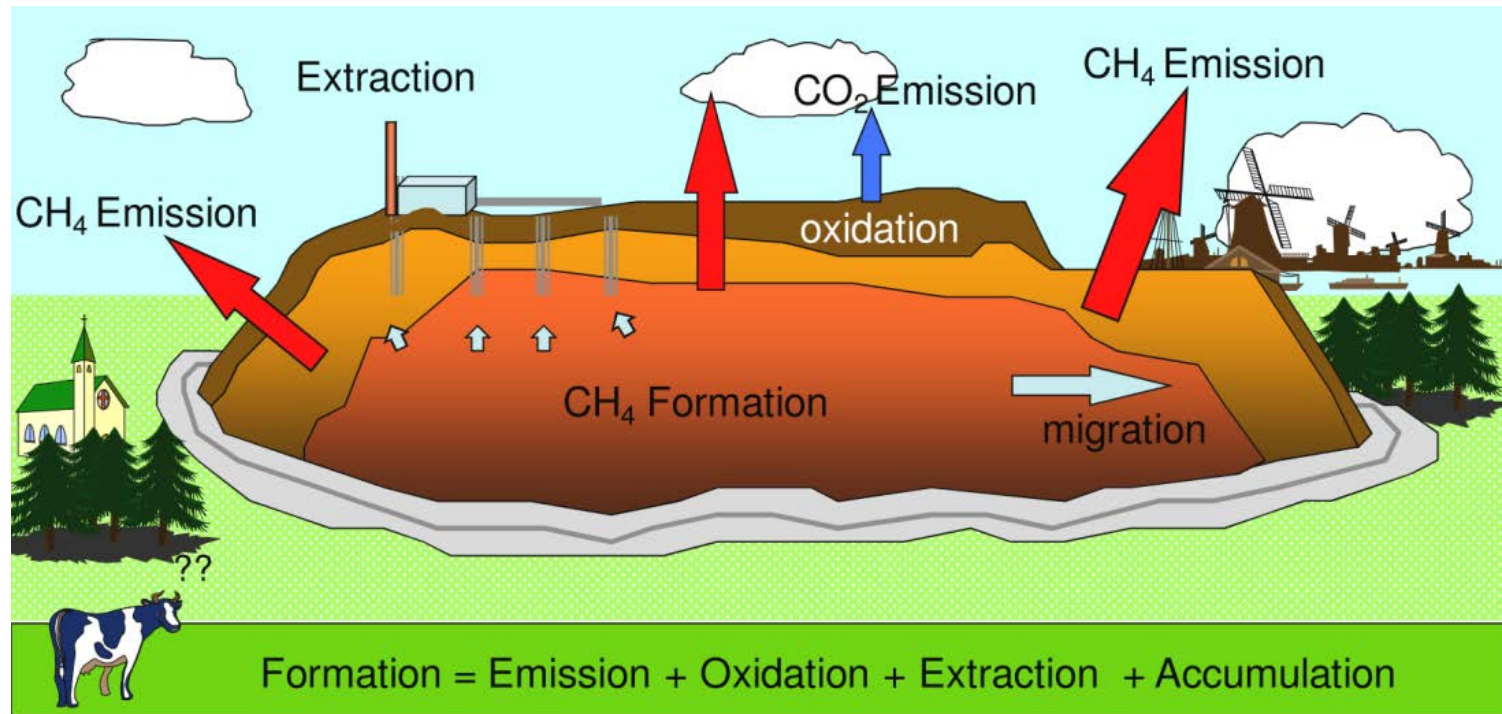
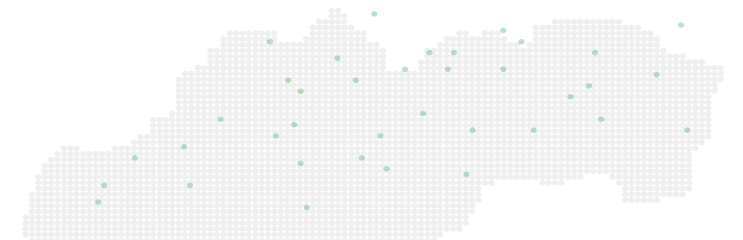
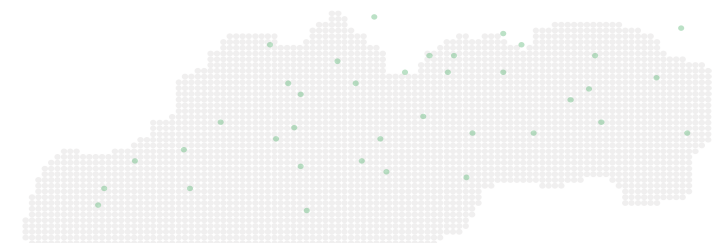
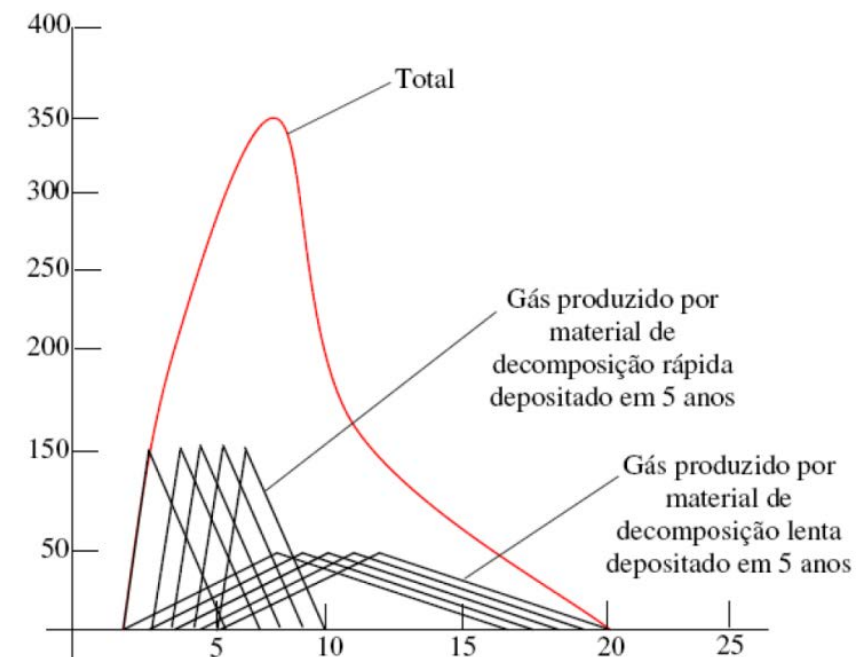
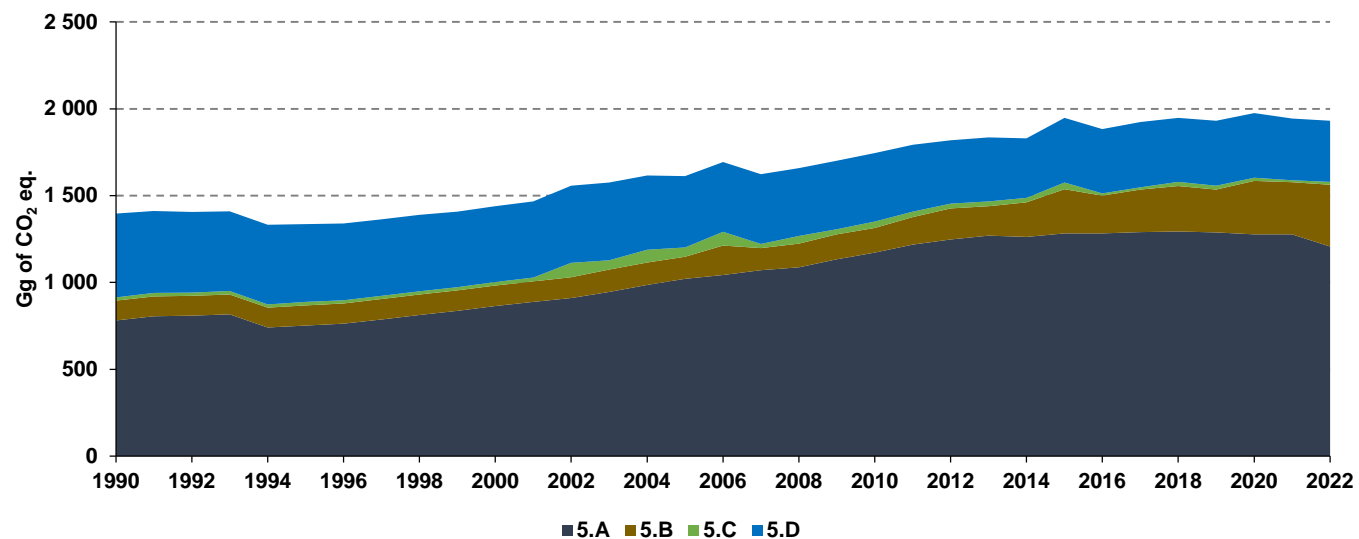


Fig. 1. Phase diagram for solid MSW.

Emisie metánu zo skládky (zdroj: Scharff, H. / Kjeldsen, P.)



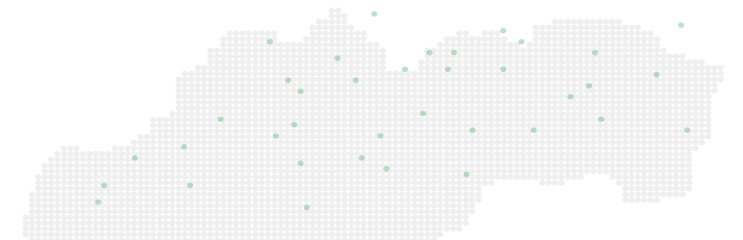
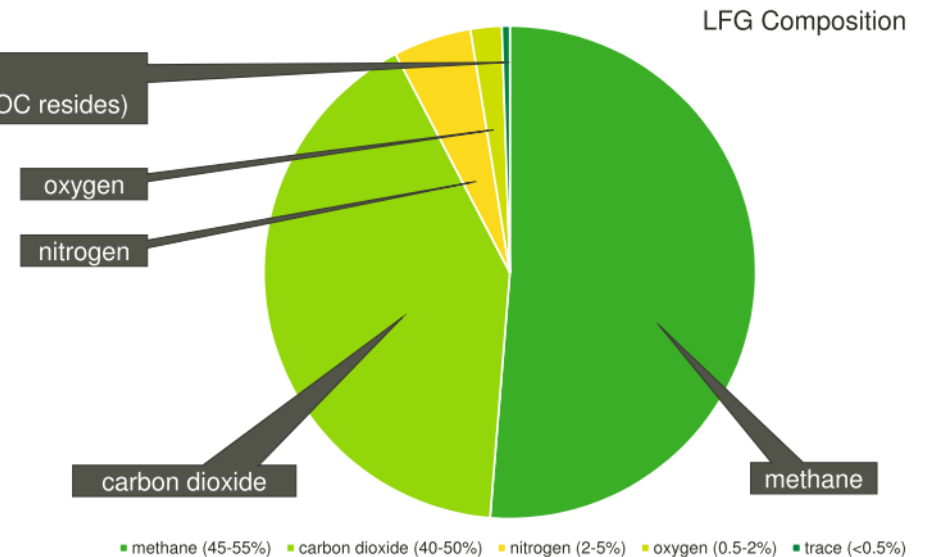
VZNIK SKLÁDKOVÉHO PLYNU JE KUMULATÍVNY (od roku 1950)



ZLOŽENIE LFG

Table 1: Typical Gas Compositions on Landfill Sites

Gas Component	Air (%)	In-Waste Landfill Gas Composition (%)	Landfill Gas in the Gas Collection System (%)	Landfill Gas in Perimeter Borehole (%)	Landfill Gas Surface Emissions (%)
Nitrogen	78	0	<20 N ₂ +O ₂	78	78
Oxygen	21	0	<7	21	21
Methane	0.0002 (2 ppm)	50 - 60	40 - 60	<1	0.0002 - >1
Carbon Dioxide	0.03	40 - 50	30 - 50	<1.5	
Hydrogen Sulphide	0	0.0001 - 5 (1 - 50,000 ppm)	0.0001 - 5 (1 - 50,000 ppm)	<.05 (0.001 - ppm)	
Total NMVOCs	<0.0001 (<1 ppm)	0 - >0.1 (0 - >1000 ppm)	0 - >0.01 (0 - >100 ppm)	<1	



BILANICIA EMISIÍ METÁNU ZO SKLÁDOK PODĽA IPCC

$$G_{CH_4} = \sum_{x=S}^{T-1} \left\{ W_x \times MCF \times DOC \times DOC_F \times F \times \frac{16}{12} \times (e^{-k(T-x-1)} - e^{-k(T-x)}) \right\}$$

where:

- G_{CH_4} = Modeled methane generation rate in reporting year T (metric tons CH₄).
- x = Year in which waste was disposed.
- S = Start year of calculation.
- T = Reporting year for which emissions are calculated.
- W_x = Quantity of waste disposed in the landfill in year x (metric tons).
- MCF = Methane correction factor; default value = 1.
- DOC = Degradable organic carbon (metric tons C/metric ton waste).
- DOC_F = Fraction of DOC dissimilated; default value = 0.5.
- F = Fraction by volume of CH₄ in landfill gas; default is 0.5.
- k = Rate constant.

$$A = \left[\sum_{x=S}^{T-1} \left\{ W_x L'_x (e^{-k(T-x-1)} - e^{-k(T-x)}) \right\} \right]$$

where

- A = CH₄ generation (Mg/yr)
- x = Year in which waste was disposed
- S = Start year of inventory calculation
- T = Inventory year for which emissions are calculated
- W_x = the quantity of waste disposed at the solid waste disposal site (Mg)
- L'_x = CH₄ generation potential (Mg CH₄/Mg waste)
= $MCF \times DOC \times DOC_F \times F \times 16 / 12$ [IPCC nomenclature]
= $L_0 \times 16/0.02367 \times 10^{-6}$
- L_0 = CH₄ generation potential (m³ CH₄/Mg waste) [AP-42 nomenclature]
- MCF = CH₄ correction factor (fraction), typically 1 for managed landfills
- DOC = degradable organic carbon [fraction (Mg C in waste/Mg waste)]
- DOC_F = fraction of DOC decomposed (fraction), generally assumed to be 0.5
- F = fraction by volume of CH₄ in landfill gas, generally assumed to be 0.5
- k = decay rate constant (yr⁻¹).

Table 4-1 Three Tiers of Method to Estimate CH₄ Emissions from SWDS [20]

Tier	Method	Activity Data	Parameters
Tier 1	IPCC FOD method	default	default
Tier 2	IPCC FOD method	good quality country-specific activity data on current and historical waste disposal at SWDS ^a	default (some)
Tier 3	1) IPCC FOD method, or 2) country specific methods	good quality country-specific activity data on current and historical waste disposal at SWDS ^a	1) nationally developed key parameters ^b , or 2) measurement derived country-specific parameters ^b

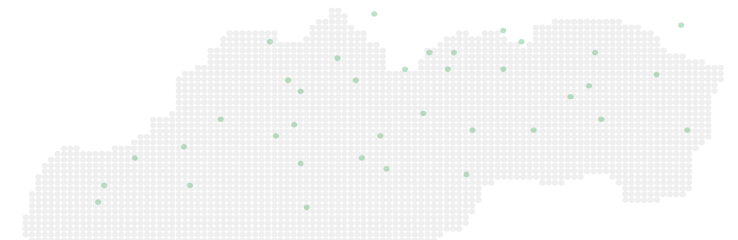
a. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. Data are needed on amounts disposed at the SWDS.

b. Key parameters should include the half-life, and either methane generation potential (L_0) or DOC content in waste and the fraction of DOC which decomposes (DOC_c).

Pozn.:

L_0 = metánový potenciál na tonu odpadu

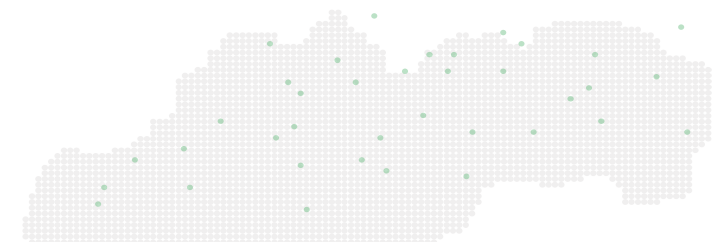
K = rýchlosť rozkladu bio-degradovateľného odpadu



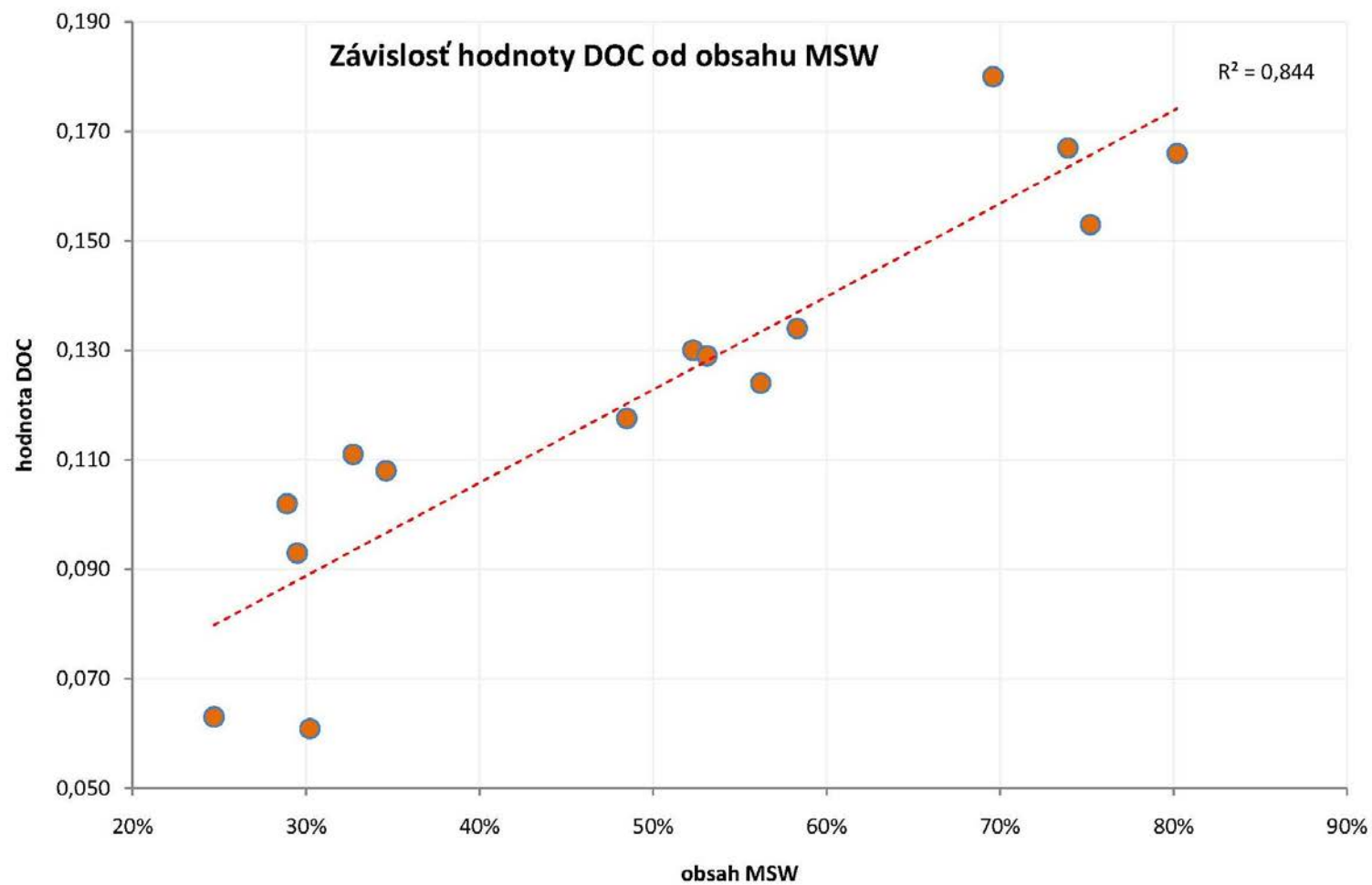
URČENIE ZLOŽENIA ODPADU NA SKLÁDKE

Table 2-1. Recommended DOC (Degradable Organic Carbon) and Decay Rate Values for Landfills^a

Waste Model/Waste Type	DOC (weight fraction, wet basis)	k [dry climate ^b] (yr ⁻¹)	k [moderate climate ^b] (yr ⁻¹)	k [wet climate ^b] (yr ⁻¹)
MSW Landfills—Bulk Waste Option				
All waste materials	0.2028	0.02	0.038	0.057
MSW Landfills—Bulk MSW Option				
Bulk MSW	0.30	0.02	0.038	0.057
Construction and demolition waste	0.08	0.02	0.03	0.04
Inert waste (glass, metal, plastic)	0.0	0.0	0.0	0.0
MSW Landfills—Waste-Specific Option				
Food waste	0.15	0.06 ^c	— ^c	0.185 ^c
Garden waste	0.20	0.05 ^c	— ^c	0.10 ^c
Paper waste	0.40	0.04 ^c	— ^c	0.06 ^c
Wood and straw waste	0.43	0.02 ^c	— ^c	0.03 ^c
Textile waste	0.24	0.04 ^c	— ^c	0.06 ^c
Diapers	0.24	0.05 ^c	— ^c	0.10 ^c
Sewage sludge	0.05	0.06 ^c	— ^c	0.185 ^c
Inert waste (glass, metal, plastic)	0.0	0.0	0.0	0.0
Industrial Waste Landfills				
Food processing industry	0.22	0.06	0.12	0.18
Pulp and paper industry	0.20	0.02	0.03	0.04
Wood and wood products	0.43	0.02	0.03	0.04
Construction and demolition waste	0.08	0.02	0.03	0.04
Inert waste (glass, metal, plastic)	0	0	0	0
Other industrial solid waste (not otherwise listed)	0.20	0.02	0.04	0.06

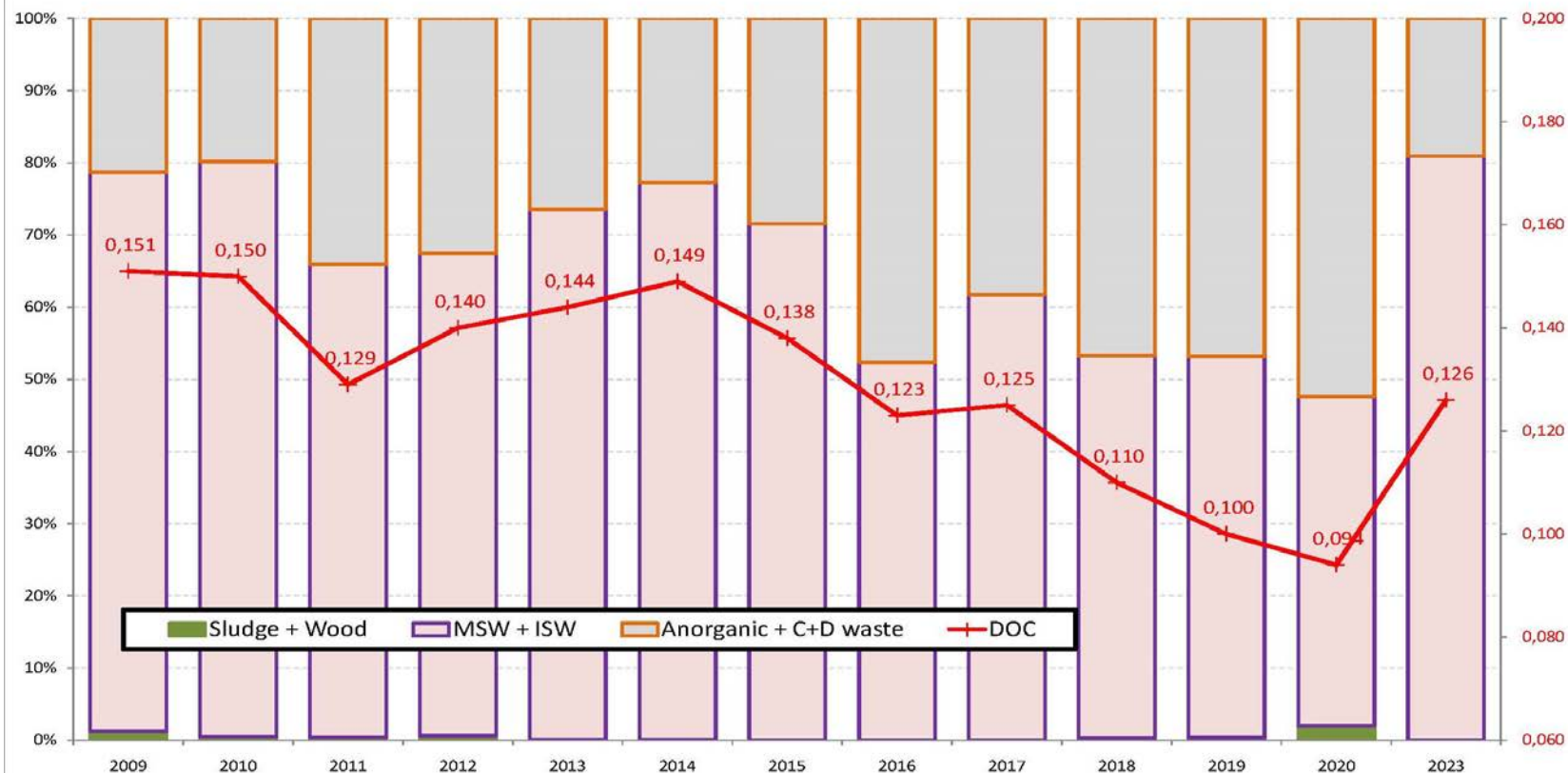


PARAMETER DOC

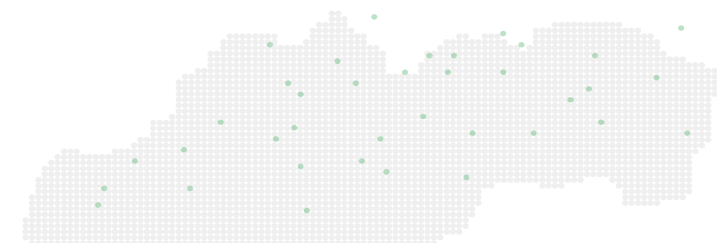
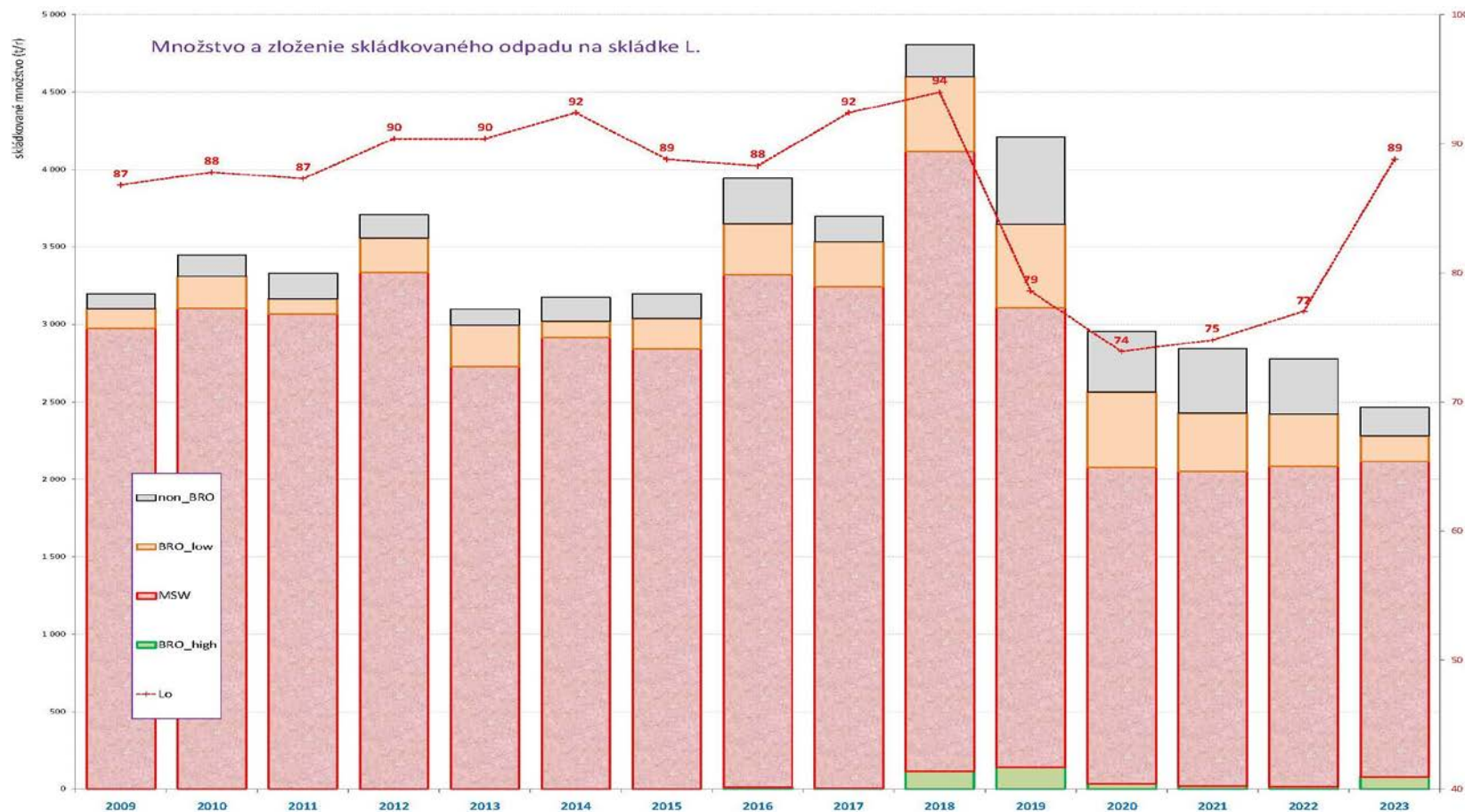


URČENIE DOC HODNOTY NA SKLÁDKE 1

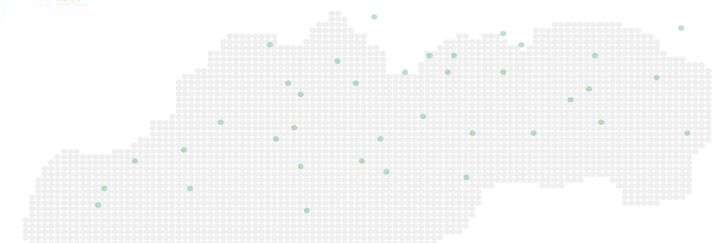
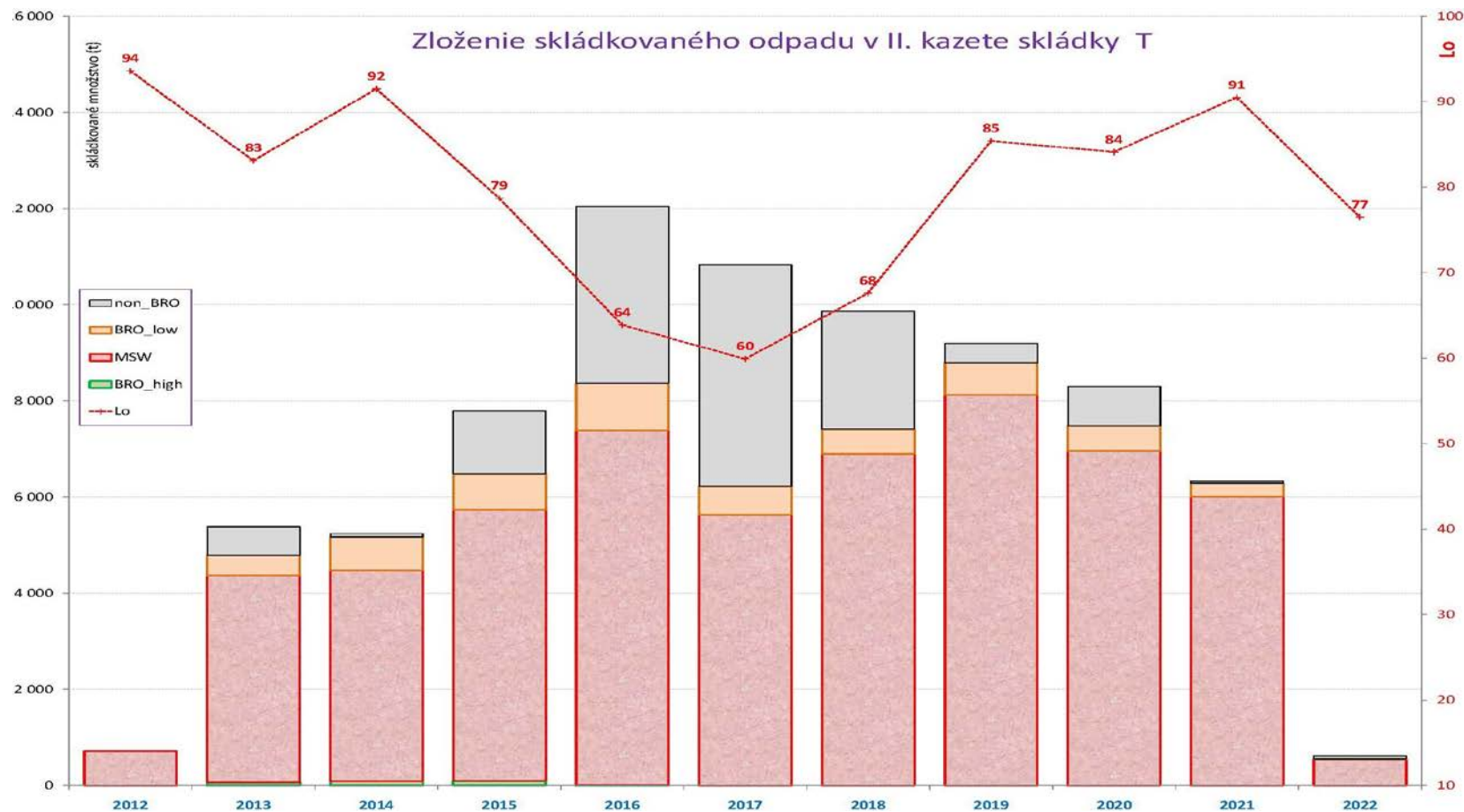
Zloženie skládkovaného odpadu na skládke S. a hodnota DOC.



URČENIE DOC HODNOTY NA SKLÁDKE 2

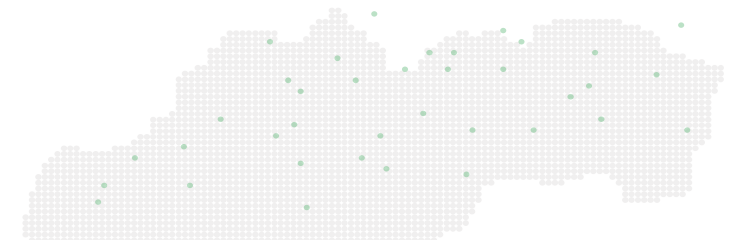


URČENIE DOC HODNOTY NA SKLÁDKE 3



VÝSLEDKY URČENIA HODNOTY DOC PRE SR

- Dopad IPCC default parametrov **DOC = 0,180**, resp. **Lo = 100** pri výpočte generovaného skládkového plynu na slovenských skládkach spôsobuje nadhodnotenie emisií metánu.
- Po spracovaní **15 skládok** sme zistili, že ani pri jednej skládke neboli vypočítané hodnoty DOC alebo Lo na takej vysokej úrovni default údajov.
- Pri menších skládkach, kde prevláda skládkovanie komunálneho odpadu, sú vypočítané hodnoty DOC blízke default hodnote, ale množstvo odpadu je menšie.
- Pri väčších skládkach, kde je podiel anorganických odpadov ($DOC \approx 0$) výrazne vyšší, boli vypočítané hodnoty DOC a Lo výrazne menšie ako default hodnoty.
- Výpočtom určené hodnoty obsahu biologicky degradovateľného uhlíka v závislosti od druhov skládkovaných odpadov pre niektoré skládky klesli až na hodnotu **DOC \leq 0,100 a Lo \leq 70**.
- Korelácia medzi percentuálnym podielom skládkovaných komunálnych odpadov (MSW) a výslednej hodnoty DOC sa preukázala. Nelineárne klesá hodnota DOC s podielom komunálneho odpadu.
- **Zníži sa množstvo emisií metánu zo skládok po implementácii na celé Slovensko.**



Ďakujeme za pozornosť

