

CARBON AND NITROGEN MASS BALANCE IN SOME LANDFILL MODELS FOR SUSTAINABILITY ASSESSMENT

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“Sustainability” idea is present in the history of the humanity since its origin. In 1987 World Commission on Environment and Development defined “Sustainable Development” as a development “which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Waste and landfill problems should be managed keeping in mind this concept.

Current regulations in Europe set in at least 30 years the duration of the aftercare of a municipal solid waste landfill. But actual sequences of operative management of a landfill and waterproof coverage commanded by the same regulations do not guarantee to reach limits fixed by the law regarding environmental emissions within this period of time. Concept of “sustainability” of a landfill concerns exactly this subject: it’s not morally acceptable to leave to future generations a high pollution potential site, without economic coverage to manage it. Therefore we need to reach acceptable impact within the period of assured economic coverage. A landfill has an acceptable impact if emissions that come from it don’t change in a considerable way quality of the surrounding air, ground and underground waters; therefore emissions that don’t cause significant modifications in the surrounding environment can be considered as negligible. Once established the acceptable risk value, we can decide the best techniques to reach it and the needed time.

Current lawmaker approach fixes aftercare period length instead, ignoring that actually used management techniques don’t guarantee at all that this period is enough, with the consequence to leave a contaminated soil to the future generations.

In this point of view, mass balance can be a suitable tool for studying long term emissions. It can be applied in small scale to different landfill models, then obtained results can be used in real scale evaluations.

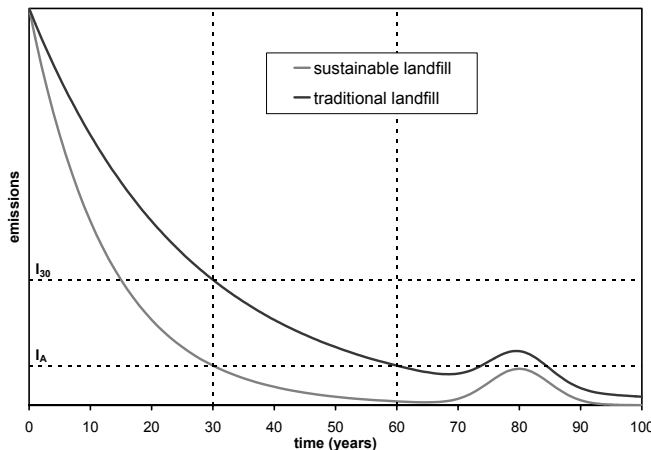


Figure 1. Comparison between the sustainable landfill model (tolerable emission within 30 years) and a traditional landfill scenario (figure’s legend must be written under the figure)

Indent as here shown

Day	0	9	21	71	146	160	
COL1	ANAEROBIC			SEMIAEROBIC			
COL2	AER.	ANAEROBIC			SEMIAEROBIC		FLUSH.
COL3	AEROBIC	ANAEROBIC			AER.	FLUSH.	
COL4	ANAEROBIC						

Figure 2. Columns' management scheme used for model application – 174 days overall

in the IMAGE department, University of Padova, some tests have been planned to apply a mass balance model in a small scale. Four Plexiglas columns have been filled with mechanically pretreated waste, coming from Legnago (VR) landfill. Each column contained about 27 kg of waste, and was kept at a controlled temperature of 35°C, to simulate in a better way a real landfill situation. System allows to confer distilled water to simulate rainfall, and to extract produced leachate. It's also possible to introduce external air, with monitored capacity, and to measure composition and volume of output gas, collected by specific envelopes. Collecting efficiency of leachate and landfill gas can be considered of 100%.

Entire duration of tests was 174 days. Columns were managed according to four different landfill scenarios, reported in Figure 2.

Aerobic phase was simulated through continuous input of external air of 5 NI/h; for the semiaerobic phase the air introduced is 1 NI/h. To simulate the average rainfall in Padova, 800 ml of water a week were introduced into each column.

Mass balance seems to be a very useful tool to evaluate long term impact of a waste landfill. Together we tabbed removal and transformation percentages concerning carbon and nitrogen in the four columns used for the tests.

Table 1. Carbon removal and transformation percentages among beginning TOC (table's legend must be written on the top of the table)

	COL 1	COL 2	COL 3	COL 4
C leachate (%)	9,1	6,5	4,2	9,1
C landfill gas (%)	8,6	17,5	8,7	1,0
C transformed (%)	6,2	12,5	43,2	2,5
Total C (%)	24,0	36,5	56,1	12,6

Table 2. Nitrogen removal and transformation percentages among beginning TKN

	COL 1	COL 2	COL 3	COL 4
N leachate (%)	19,7	19,4	16,3	19,0
N transformed (%)	4,3	6,0	13,4	0,4
Total N (%)	24,0	25,4	29,7	19,3