Application of agrotechnical techniques in the reclamation of a solid waste landfill

A A Bulekova[1], *A E* Gabdullina[2], *T K* Murzashev[1], *T A* Bulekov[3], and *Zh M* Gumarova[1*]

[1]West Kazakhstan Agrarian-Technical University named after Zhangir Khan, 51, Zhangir Khan St., Uralsk, 090009, Kazakhstan
[2]Kazakhstan University of Innovation and Telecommunication Systems, 81, M. Mametov St., Uralsk, 090000, Kazakhstan
[3]LLP "Ural Agricultural Experimental Station", 6/1a, Baraeva St., Uralsk, 090010, Kazakhstan

Abstract. The work examined the existing solid waste landfill in the city of Uralsk with a total area of 36 hectares. In 2020-2022, a project for a new landfill was developed. Thus, our research proposed alternative solutions for the use of reclamation of the old solid waste landfill using technologies for cultivating perennial grasses. In the experiments, 100% (option 1) and 50% of the landfill body + 50% soil (option 2) were selected. The results of the experiment showed that in option 2, from the landfill body and soil (1:1), seed germination was higher than on samples from 100% of the landfill body. Among the components of perennial herbs, it is recommended to use a grass mixture (wheatgrass, hair grass and sainfoin).

1 Introduction

Waste production per person is estimated at 1.5 to 1.8 kg per person per day. With around 75% of the population concentrated in urban areas, it is imperative that the government takes steps to speed up the recycling and waste management scenario in the country [1]. Landfill reclamation works limit its negative impact on the environment, for example, they reduce the spread of pollutants into the soil and water, protect slopes from erosion, reduce dust, and allow the creation of new vegetation cover. and improving the visual quality of the landscape. [2-3] . Landfill remediation is practiced to a limited extent at a number of landfills throughout the United States and is of growing interest worldwide. The main factors for landfill remediation are: solving problems of groundwater pollution caused by waste in old, unlined landfills by eliminating the source of pollution; create new capacity for future landfill activities and reduce closure costs by reducing landfill area [4-5]. Increased global production leads to the continued generation of waste, some of which still ends its life cycle in landfills and landfills. Despite efforts to reuse and recycle waste and self-degrade waste, existing and old landfills and landfills remain a huge challenge for the future [6]. To facilitate the management of closed landfills and the search for adequate remediation methods, ex-post monitoring, impact assessment and the necessary cost-benefit analysis must be carried out, taking into account the appropriate type of remediation and

* Corresponding author: aina_zhg@mail.ru

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local conditions. Waste management is a challenge in all countries, with important implications for human health, the environment, sustainability and the circular economy [7-9]. Municipal solid waste (MSW) is a reflection of the culture that produces it and has negative impacts on human health and the environment. In a global context, people are discarding increasing amounts of waste, and the composition of this waste is becoming more complex than ever with the proliferation of plastic and electronic consumer products. New pollutants enter the environment from various anthropogenic sources and are distributed among environmental components. [10-13]. New pollutants enter the environment from various anthropogenic sources and are distributed among environmental components, turning into municipal solid waste, so recycling is one of the main problems that require environmentally friendly recycling methods [14-15].

2 Materials and methods

2.1 Object of study

The object of the study is a solid waste landfill located in the West Kazakhstan region on the north-western outskirts of the regional center of Uralsk, at a distance of 3.5 kilometers from the village of Zachagansk, 4.5 km from the village of Derkul and 2 km from the Uralsk highway -Saratov. The location of the object was determined in the following coordinates: 51°12'26.5" N 51°12'51.5" E.

2.2 Research methods

During the research, samples were taken from the landfill body of the solid waste landfill in the city of Uralsk and the lands adjacent to the landfill. The experimental scheme consisted of sowing perennial grasses - Taipaksky wheatgrass in its pure form, Bozoisky volosnets in its pure form and a grass mixture that included Taipaksky wheatgrass, Bozoisky volosnets and Pink sainfoin 89. The control option in the experiment was clean soil. Perennial grasses were sown according to the “Field Experiment Methodology” of B. A. Dospehova with the following rates: wheat grass - 25 kg/ha; volosnets – 35 kg/ha; grass mixture – 40 kg/ha. The depth of seeding of wheatgrass seeds was 2-3 cm, volosnets - 2-3 cm, grass mixture - 3-5 cm. Sowing was followed by care and monitoring of growth.

3 Results

The landfill was put into operation in 1975 for a period of 25 years. In 2000, the period was extended until 2025. Currently, a new project for a solid waste landfill is being prepared, since the old landfill is overcrowded and obsolete.

The following main operations are used at the landfill: waste reception, storage, compaction and isolation. Waste is accepted in an uncompacted state. The waste storage method used is “pushing”. With this method, waste is stacked in layers, the height of waste storage should not exceed 2 m. Shifting and compaction of waste is carried out by a heavy bulldozer weighing 12-16 tons. Compaction of waste is carried out in layers of 0.5 m and is achieved by passing the bulldozer two or four times over one place, i.e. each subsequent track of the caterpillar overlaps the previous one by ¾ of the width of the track. The compacted layer of waste must be isolated with a layer of soil 0.25 m high.

Soil cover within the sanitary protection zone of the landfill: wormwood-turfgrass and grass-wormwood steppes. The soil-vegetative layer is heavy loam. Sampling was carried

out at a depth of 0-20 cm. Table 3 shows the coordinates of sampling points determined using the GPS navigation system.

Table 1. Coordinates of sampling points.

Try	Coordinates
Sample from the landfill body	51°12′07″N 51°13′01″E
The soil	51°11′48″N 51°13′02″E

In the West Kazakhstan region there are two solid waste disposal sites, these are the solid waste landfills in Uralsk and Aksay and 206 village landfills. The issue of village spontaneous landfills is especially acute, since the requirements for the disposal of solid waste are not met here (Figure 1).

Fig. 1. The actual state of natural landfills.

In 1975, when the landfill was put into operation, the population of Uralsk was about 154 thousand people. At that time, the capacity of the landfill was calculated taking into account the actual population of the city for a period of operation of 25 years. However, after 48 years, the city's population increased to 236 thousand. Based on the above, population growth since 1975 has been 53.5%.

A reclamation project has been prepared for the existing Uralsk landfill. In this case, general reclamation is 45 months, technical reclamation is 19 months, biological reclamation is 24 months.

Based on the above, our research was aimed at monitoring the germination of seeds of the following perennial grasses: wheatgrass, volosin and grass mixtures (wheatgrass, volosny, sainfoin) with further obtaining yield in the form of green mass.

A two-factor experiment was laid down:

Factor 1. Sample from 100% of the landfill body (option 1).

Sample from 50% of the landfill body + 50% soil (1:1) (option 2).

Factor 2. Perennial herbs: wheatgrass, wheatgrass, grass mixture (hairgrass, wheatgrass, sainfoin).

In control samples (100% soil), 100% germination of seedlings of all studied perennial grasses was observed, which confirms the germination of crop seeds.

In option 1, wheatgrass sprouted by only 10%, volosnets - by 80%, and the grass mixture sprouted by 70%. In the second option, wheatgrass seedlings were 20%, and hair grass and grass mixture showed 100% seed germination and gave good green mass (Figure 2).

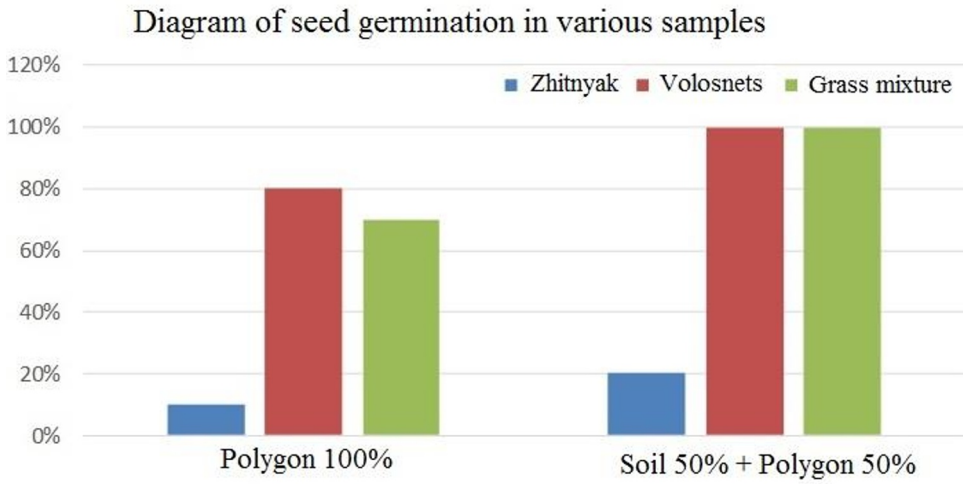

Fig. 2. Growth dynamics of perennial grasses.

According to the data, in samples from the landfill body (100%), seed germination is inferior to the sample from the landfill body and soil (1:1) for all considered perennial grasses. According to the data obtained, wheatgrass showed poor results of germination and germination in both samples, but hair grass and grass mixture showed quite high results. Based on the above, it follows that the germination rate of hair grass and grass mixture is high in two variants of the experiment.

4 Discussion

During the study, the current state of the solid waste landfill in Uralsk was studied. According to the analysis, over the entire period of time, the region has accumulated 6.4 million tons of solid waste on an area of more than 550 hectares. About 108 thousand tons of solid waste are generated annually in the region. According to the satellite image, the landfill body is completely filled and requires reclamation.

For the biological stage of reclamation, we proposed agrotechnical measures. Thus, the conclusion follows that the actual state of the landfill body requires reclamation work.

5 Conclusion

Based on the above, it follows that the actual state of the landfill body of the old landfill requires reclamation work. Based on the research conducted, it is recommended:

- At the biological stage of reclamation of the old landfill, mix the landfill body with soil in a 1:1 ratio.
- Use perennial grasses for sowing, since perennial grasses are not only a source of feed, but also improve soil structure and increase crop yields.
- We recommend using for sowing the components of a grass mixture of perennial grasses, consisting of one legume and two cereals.

References

1. N. Radwan, N. A. Khan, Elmanfaloti, RAG Optimizing solid waste collection using the RSM approach and Strategies to Achieve the Sustainable Development Goals (SDGs) in Jeddah, Saudi Arabia. Scientific Group, **11**, 16612 (2021) https://doi.org/10.1038/s41598-021-96210-0
2. K.R. Vanapalli, B.K. Dubey, A.K. Sarma, J. Bhattacharya, Assessment of microplastic pollution of aquatic ecosystems - an Indian perspective. Case Study. Than. Environ. Eng., 3, 100071 (2021)
3. E. Koda, P. Osinsky, A. Podlesok, A. Markevich, J. Winkler, M.D. Waverkova, Geoecological approaches in the process of reclamation of an old landfill of household waste: expectations and reality. Soils and foundations , **63**, **1** (2023) https://doi.org/10.1016/j.sandf.2023.101273
4. Z. Zhang, X. Wang, Stimulating the separation of household waste sources: mechanisms and side effects. Resource. Conserv. Recycle., **162**, 1054 (2020)
5. P. Jain, T.G. Townsend, P. Johnson, An example of landfill remediation at a landfill in Florida, Waste Management, **33**, **1**, 109-116 (2013) https://doi.org/10.1016/j.wasman.2012.09.011
6. Z. Vintsevitsa-Gale, S.J. Burlakov, M. Fontaine-Kazeka, M. Vdovin, E. Hans, V. Radovitsa, M. Zahur, A comprehensive assessment based on a case study of former landfills converted into green areas, from the point of view of ecosystem services and restoration of land assets. Sustainable Development (Switzerland), **15**, **4** (2023) https://doi.org/10.3390/su15043256
7. S.M. Al-Salem, P. Lettieri, J. Bayens, Ways of recycling and recovery of solid plastic waste (PSW): an overview. Waste Manag., **29**, 2625–2643 (2009)
8. M.D. Waverkova, The impact of landfills on the environment – an overview. Geosciences (Switzerland) . MP And AK. (2019) https://doi.org/10.3390/geosciences9100431
9. L. Giusti, Review of waste management practices and their impact on human health. Waste management (2009) https://doi.org/10.1016/j.wasman.2009.03.028
10. S. Khan, R. Anjum, S.T. Raza, N. Ahmed Baza, M. Ihtisham, Solid waste management technologies: current state, problems and prospects for the future, Chemosphere, 288 (2022) https://doi.org/10.1016/j.chemSphere.2021.132403
11. A. Siddiqua, J.N. Khakhladakis, Al-Attiyah WAKA, Review of environmental pollution and health effects associated with waste disposal and open burial sites, Environmental science and pollution research . Springer Science and Business Media Deutschland GmbH (2022) https://doi.org/10.1007/s11356-022-21578-z
12. The World Economic Forum, the Ellen MacArthur Foundation and McKinsey. The New Plastics Economy - Rethinking the Future of Plastics, World Economic Forum (2016)
13. E. MacArthur, In addition to plastic waste. Science, **358**, 843-843 (2017)
14. A.A. Bulekova, T.K. Murzashev, B.E. Gubasheva, S.M. Gabdullina, Solid waste disposal in Uralsk, IOP Conference Series: Earth and Environmental Science, **723**, 042072 (2021) doi:10.1088/1755-1315/723/4/042072
15. M. Gavrilescu, K. Demirova, J. Aamand, S. Agatos, F. Fava, New environmental pollutants: current and future problems of biomonitoring, environmental risks and bioremediation, New Biotechnology, **32**, **1**, 147-156 (2015) https://doi.org/10.1016/j.nbt.2014.01.001