SOLID WASTE FROM OIL PIPELINE TRANSPORTATION: IN THE CONTEXT OF ENVIRONMENTAL IMPACT

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ABSTRACT

In the contemporary energy industry, oil pipelines are extensively used; presentation of various effect on environment is might be caused in course to their transportation. Pipeline construction, operation and maintenance are majorly generated solid waste. Such waste can range from metal scraps, plastic materials and grounds with opaque plant covers. The wastes produced are, additionally, environmental contaminations which is a detrimental recipe to local ecosystems. Soil and water sources pollution is one of the most serious problems in Azerbaijan. The management strategies through remedial techniques are developed to minimize the environmental impact of waste generation. Management and disposal of solid waste take place at the environmental protection.

Keywords: Solid Waste, Pipeline Transportation, Environmental Impact, Problems

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INTRODUCTION

Pipeline supplies are part of the global energy configuration and provide stable sources for timely delivery of raw materials needed to produce fuel, which is used by enterprises manufacturing petroleum products. However, while this step provides huge economic profits from it what is more urgent to the world has become a problem of safety and sustainable development for environment. There is some actually big point that has to be highlighted in disposal of solid waste produced by the transportation oil through pipelines.

Examples of solid waste created from oil pipeline operations include sand, sediment, and rust; chemicals used to clean or service pipelines. Accumulation of these wastes inside the pipeline will not only reduce its throughput but also degrade quality of oil transported over time. Moreover, uncontrolled disposal or removal of those will lead to environmental pollution including soil and water resources.

Solid waste has a complex and multifaceted impact on the environment. It can enable direct contamination of soil and waterways as a result of accidental leakage or spillage, together with the bio-accumulation (in ecosystems) trees. In fact, excess waste after cleaning pipes can be highly contaminated with heavy metals and other toxic materials that human beings or wildlife are used to consume.

As care for sustainability and the environment grows, mankind must accept a greater challenge of mitigating oil industry deleterious impacts on our planet. This entails creating and introducing efficient technologies for the treatment of solid waste from oil logistics, control over compliance with environmental standards and regulations. In this light, technical processes related to the transport and cleaning of pipelines should integrate social as well as socioeconomic implications associated with potential environmental hazards.

Therefore, the study of environmental hazards caused by solid waste released from oil pipelines is relevant task in modern science as well an important step to a safe and ecological energy system.

LITERATURE REVIEW

Below is basic reference information about the main information that we have obtained from various academic projects...

In the scientific research conducted by **Gurbanova Fidan in 2017**, the effects of global environmental problems on the development of civilization and their solutions are discussed. First, the effects of environmental problems on human society on a global scale are emphasized, and it is noted that these problems slow down the development of civilization and hinder socio-economic progress. It is emphasized that there is a need for joint action of economy, nature, technology and social spheres to solve ecological problems.

In the second part of the study, specific tasks are presented to determine the role and place of environmental problems in the era of globalization. Important issues such as optimizing mutual relations between society and nature, revealing ideological aspects of environmental problems are touched upon.

Monitoring of sustainable development trends, state environmental expertise, environmental payments and the functioning of environmental-economic mechanisms such as tax incentives are discussed. Various measures and policies are proposed to protect ecological balance and ensure sustainable development in Azerbaijan. The effects of oil refineries located in Baku on the environment and the efficiency of their placement are discussed, it is noted that it would be more appropriate to place these plants in areas outside of Baku.

SOCAR's environmental policy emphasizes the importance of waste-free production and environmental safety issues. Information is provided on the participation of the Azerbaijani state and private companies in Clean Development Mechanism (CDM) projects and environmental safety measures in oil and gas operations.

As a result, it is emphasized the need to take measures at the global and national level in order to ensure sustainable development, solve environmental problems and establish social justice (Qurbanova, 2017).

Next study conducted by **Nuraliyeva N.R in 2010** examines the reforms carried out by the state of Azerbaijan to develop the national economy and the effects of this development on the environment. In particular, the negative effects of the observed development in the fields of industry, agriculture and transport, starting from the 60s of the last centuries, on the ecological situation of the country and the Caspian Sea are noted. As a result of extensive economic development and irrational use of natural resources, harmful substances and solid wastes released into the air and water bodies have increased, and this has aggravated the ecological situation. The research, based on the data of the State Statistics Committee, emphasizes that the amount of harmful substances released into the atmosphere in the central and large industrial cities of the country is much higher than the current norms. Assessment of the ecological situation and analysis of the impact of economic activity on the environment are indicated as the main goals (Nurəliyeva, 2010).

The article written by **Shadlinskaya G.V., Gasimova G.E. in 2017** provides information about the negative effects of pollutants on the environment and the measures taken to prevent these effects. The purpose of the article is to explain to students the effect of oil pollutants on water, soil and other areas, to familiarize them with the methods of prevention, as well as to provide scientific knowledge about the environmental hazards caused by oil pollution. The main goal is to form environmental culture in students through this knowledge.

In the article, the main directions of scientific and technical development carried out to solve environmental problems in the oil refining industry are listed. These directions include measures such as modernization of technological facilities, refining of crude oil, improvement of energy efficiency, waste treatment and neutralization, improvement of anti-corrosion and cooling technologies.

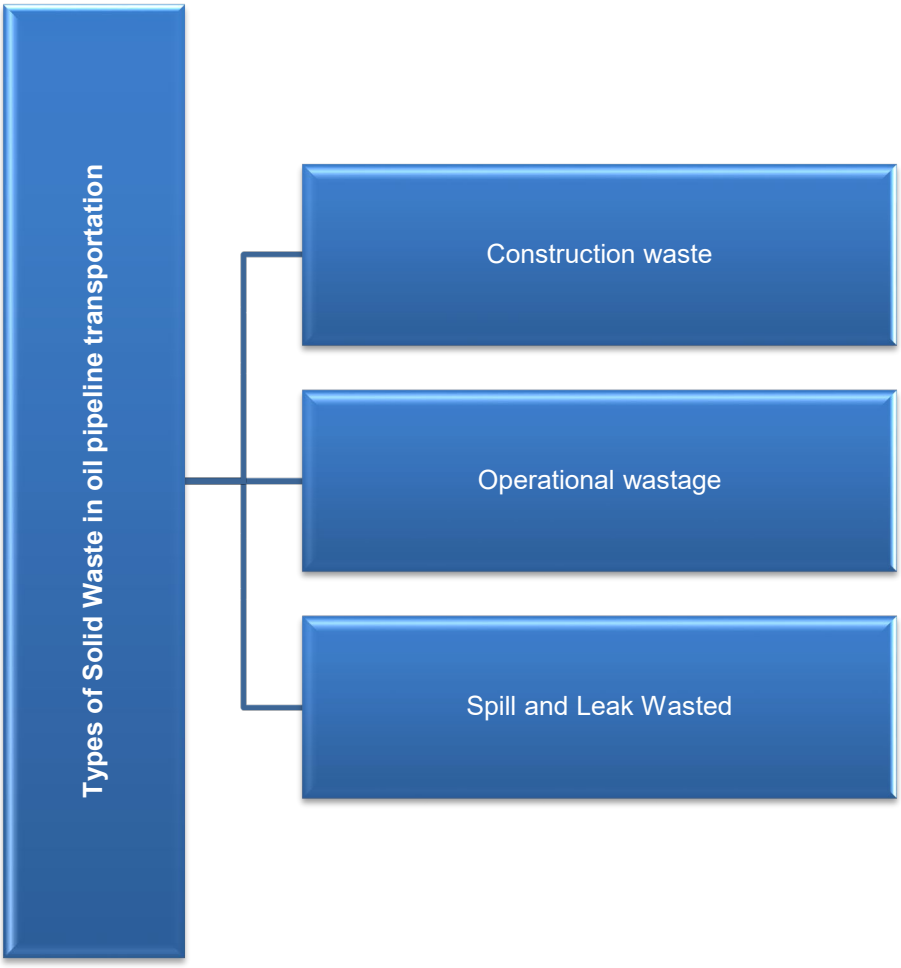
The teacher asks students questions based on the article and tests their knowledge about oil refining processes and the environmental problems that arise during these processes. The task calls for research on the development of oil production, chemical processing methods, the nature of recycling and mineral fertilizers obtained during the processing process.

As a result, the article discusses the impact of technological processes that cause environmental problems in the oil refining industry and measures designed to prevent these problems. These measures are aimed at making the industry operate in a more environmentally efficient and safe manner (Shadlinskaya, Gasimova, 2017).

METHODOLOGY

Pipelines are a critical component of the global energy supply chain; they facilitate oil transport. Although pipelines have been found to be safer and more efficient than alternative methods of oil transportation, including via truck or ship; they can impact the environment. A particularly critical issue addresses the production and disposal of solid waste from pipe activities.

There are fundamentally divided into three types of Solid Waste in oil pipeline transportation: Construction waste, Operational wastage, Spill and Leak Wasted.



Schema 1: Types of Solid Waste in oil pipeline transportation

Source: prepared by author

During the construction of oil pipelines, large quantities of solid waste are generated. Such as excess soil, rocks and vegetation along with inorganics like steel, concrete and plastic. When these materials are dumped, they can disturb local ecosystem function; cause soil erosion or habitat destruction.

In the course of oil-pipeline operations, several kinds of solid waste are produced. This includes waste from maintaining its integrity - such as spent filters, contaminated rags and cleaning materials. Corrosion control procedures, such as protective coatings use creates waste (old paint and blasting abrasives).

While pipeline spills and leaks are infrequent events, they can produce large quantities of solid waste. Examples of solid waste include contaminated soil, vegetation, and equipment related to the spill response (Alpaslan, 2006).

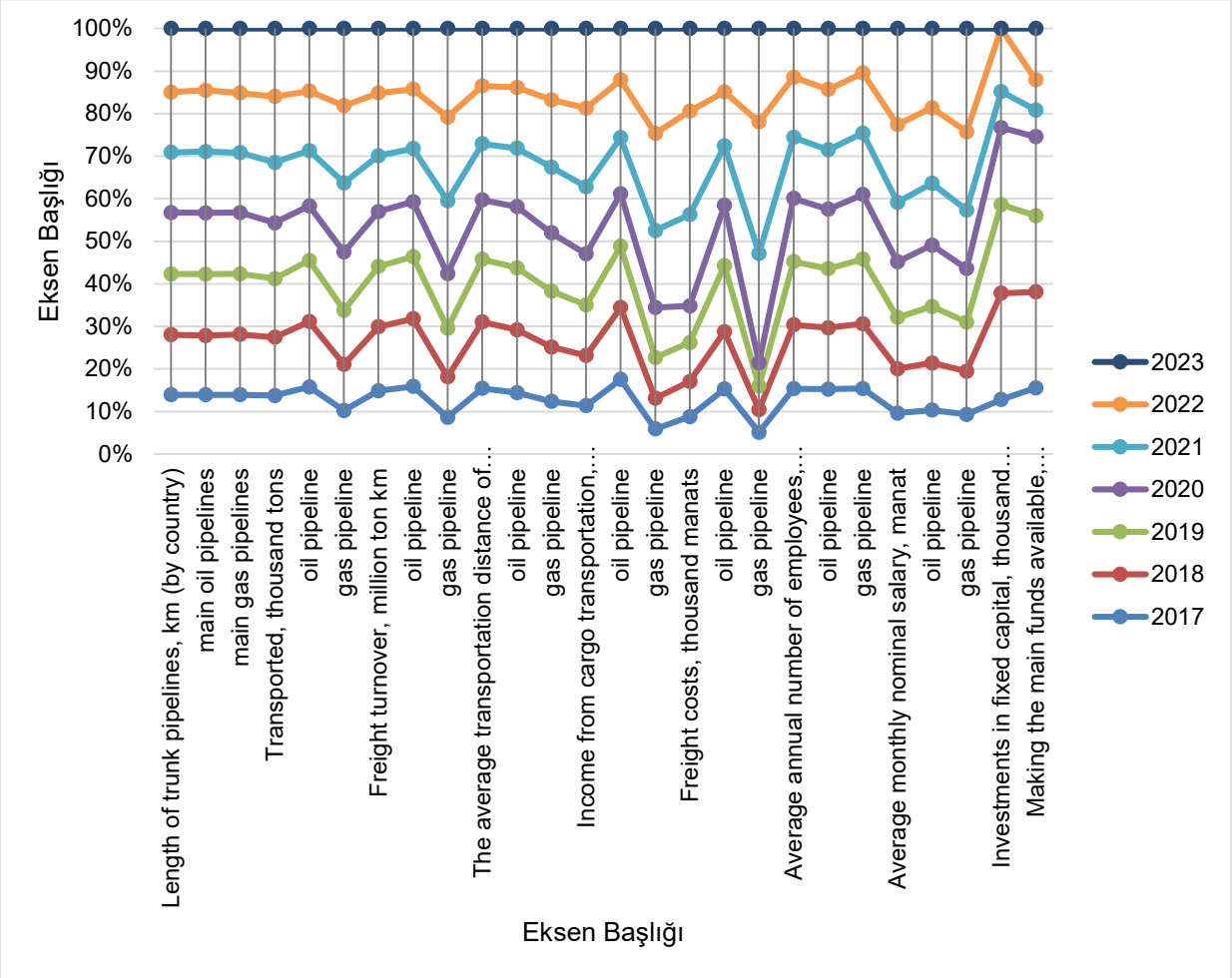


Chart 1: Pipeline transport in Azerbaijan

Source: Dövlət Statistika Komitəsi. Azərbaycanda nəqliyyat, 2024

	2017	2018	2019	2020	2021	2022	2023
Length of trunk pipelines, km (by country)	5,376	5,438	5,506	5,556	5,458	5,454	5,772
main oil pipelines	1,523	1,523	1,576	1,576	1,576	1,577	1,588
main gas pipelines	3,853	3,915	3,930	3,980	3,882	3,877	4,184
Transported, thousand tons	58,490	58,402	58,596	56,040	60,298	66,035	68,037
oil pipeline	42,559	41,491	38,787	34,720	35,018	37,782	39,753
gas pipeline	15,931	16,911	19,809	21,320	25,280	28,253	28,284
Freight turnover, million t km	65,879	66,452	62,768	57,065	58,018	65,333	67,014
oil pipeline	60,616	60,658	55,798	49,271	47,585	53,364	54,325

gas pipeline	5,263	5,794	6,970	7,794	10,433	11,969	12,689
The average transportation distance of one ton of cargo, km	1,126.3	1,137.8	1,071.2	1,018.3	962.2	989.4	985
oil pipeline	1,424.3	1,462.0	1,438.6	1,419.1	1,358.9	1,412.4	1,367
gas pipeline	330.4	342.6	351.9	365.6	412.7	423.6	449
Income from cargo transportation, thousand manats	2,203,546	2,272,532	2,292,011	2,323,741	3,049,506	3,567,157	3,617,825
oil pipeline	1,599,097	1,539,697	1,313,258	1,127,013	1,197,650	1,238,914	1,101,742
gas pipeline	604,449	732,835	978,753	1,196,728	1,851,856	2,328,243	2,516,083
Freight costs, thousand manats	418,547	393,426	436,830	411,830	1,021,213	1,158,408	925,185
oil pipeline	263,263	232,316	267,603	243,661	240,720	218,571	256,391
gas pipeline	155,284	161,110	169,227	168,169	780,493	939,837	668,794
Average annual number of employees, people	3,184	3,110	3,082	3,079	2,969	2,932	2,367
oil pipeline	805	762	737	737	737	749	758
gas pipeline	2,379	2,348	2,345	2,342	2,232	2,183	1,609
Average monthly nominal salary, manat	828.6	896.7	1,036.2	1,124.2	1,206.9	1,572.4	1,944
oil pipeline	984.3	1,053.4	1,265.9	1,369.4	1,384.5	1,688.6	1,776.0
gas pipeline	776.0	845.7	964.0	1,046.7	1,148.5	1,532.6	2,023.7
Investments in fixed capital, thousand manats	86,488	168,301	140,487	121,823	57,334	99,834	119 165
Making the main funds available, thousand manats	116,155	168,450	133,904	138,702	46,893	52,825	90,306

Table 1: Pipeline transport in Azerbaijan

Source: Dövlət Statistika Komitəsi. Azərbaycanda nəqliyyat, 2024

This table gets pipeline infrastructure and related economic indicators for the years 2017 to 2023. Key observations include:

The total length of trunk pipelines increased with a substantial increase in 2023. Long-distance oil and gas pipelines also increased slowly, but the latter saw a sharp increase in 2023.

Million ton-kilometers of Freight turnover, aviated to a decline till 2020 and then increased in terms showing its best number at 42569756(Sept-23). Turnover of oil pipelines has risen slightly since falling after a push upwards and pipeline turnover for gas continued to increase.

Income from cargo transportation has steadily increased, with gas pipelines taking the lead over oil pipelines by 2023.

Freight costs surged in 2021, especially for gas pipelines, but fell back to lower levels by 2023.

Average number of employees fell, but gas pipeline jobs dropped more sharply over the next ensuing five years.

The average monthly nominal salary was gradually increasing, and in 2023 the wage growth of gas pipeline employees had increased significantly.

Investments in fixed capital were increasing, unsteady during the period due to main fund availability fluctuations with a peak at 2018 and flushness of ascension into regional market.

In general, the table reflects a growth in pipeline infrastructure and economic expansion—especially apparent on gas side—and increases in transportation income versus oscillation of freight prices.

In 2023, 4086.1 thousand tons of waste were generated in the country, and 66.6 percent of them were solid domestic waste, and 33.4 percent were various types of waste generated as a result of the production activities of enterprises.

79.4 percent of the 2719.6 thousand tons of solid household waste generated last year were transported to landfills for disposal, 19.5 percent were used for energy production, and 1.1 percent were sold within the country. 223.0 million kWh or 8.6 percent more electricity than in 2022 was produced due to the use of household waste.

Last year, 22.9 percent of production waste was used as raw material in enterprises, 19.9 percent was sold domestically, 1.6 percent was exported, 8.5 percent was transported to landfills for disposal, including residues generated in industry and other areas of the economy in previous years. 47.1 percent remained in institutions.

As a result of the production activity of enterprises, 232.9 thousand tons of hazardous waste was generated in 2023, or 30.9 percent less than the previous year, and their share in the total amount of waste was 5.7 percent. 67.4 percent of the waste was generated in the mining industry enterprises, most of which fall to the enterprises located in Baku. Last year, 60.1 thousand tons of hazardous waste were completely neutralized, including residues from previous years.

Category	Total (Thousand Tons)	Percentage	Details
Total Waste Generated	4086.1	100%	
Solid Domestic Waste	2719.6	66.6%	
Production Waste	1366.5	33.4%	
Solid Domestic Waste Breakdown			
- Landfilled	-	79.4%	2154.4 (Thousand Tons)
- Used for Energy Production	-	19.5%	530.3 (Thousand Tons)
- Sold Within the Country	-	1.1%	29.9 (Thousand Tons)
Electricity Produced from Waste	223.0 million kWh	8.6% increase	
Production Waste Breakdown			
- Used as Raw Material	-	22.9%	313.6 (Thousand Tons)
- Sold Domestically	-	19.9%	272.8 (Thousand Tons)
- Exported	-	1.6%	21.9 (Thousand Tons)
- Landfilled	-	8.5%	116.1 (Thousand Tons)
- Remaining in Institutions	-	47.1%	643.0 (Thousand Tons)
Hazardous Waste Generated	232.9	5.7%	30.9% decrease from previous year
Hazardous Waste Breakdown			

- Neutralized	60.1	Includes residues from previous years
- Mining Industry Share	67.4%	Majorly from Baku

Table 2: Waste movement in 2023

Source: Dövlət Statistika Komitəsi. 2023-cü ildə tullantıların hərəkəti haqqında, 2024

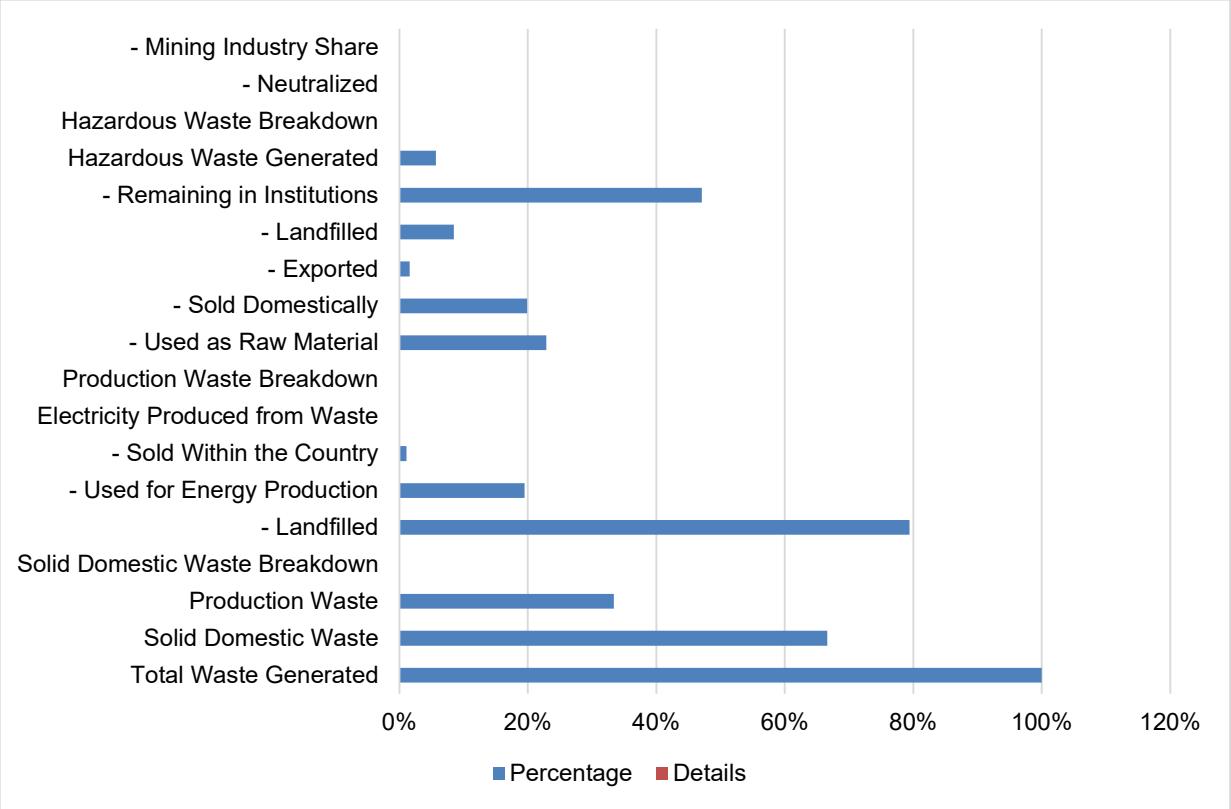


Chart 2: Waste movement in 2023

Source: Dövlət Statistika Komitəsi. 2023-cü ildə tullantıların hərəkəti haqqında, 2024

Solid waste from oil pipeline transportation has diverse environmental impacts:

Disposal of solid waste with a poor foundation, especially oil-contaminated waste causes soil contamination. This is bad for plants, it can sabotage local ecosystems, and impact human health if the contamination reaches farms or water bodies.

Pipeline spills or leaking of solid waste can pollute water. Polluted materials can enter rivers, lakes and groundwater affecting aquatic habitats and degrading water quality for drinking or agricultural use.

The building and upkeep of oil pipelines also destroys the surrounding habitat, which has negative consequences for biodiversity. Moreover, this environment also disrupts local ecosystems further due to the improper disposal solid waste which negatively affect wildlife and reduce natural resilience of such environments (Somuncu, 2013).

Certain solid waste, especially hazardous waste, could need to be incinerated for disposal. This procedure can emit dangerous pollutants into the atmosphere, which will then degrade air quality and pose serious health risks to surrounding communities.

Waste reduction measures carried out in the construction and operation of pipelines can reduce solid waste produced during its use. Re-used materials (like steel and plastics) can further decrease the thirst for new raw material supply chains, minimizing their impact on nature when building pipelines.

To minimize solid waste management impact on the environment there is a need to put in place some stringent protocols and stick towards implementation of these spells. This means that hazardous waste has to be stored, transported and disposed of properly so it doesn't jeopardize the surrounding soil or water.

Improving the monitoring and maintenance of pipelines reduces spills and leaks, resulting in less spill-related solid waste. Quick and effective response to a spillage is critical in containing waste before it causes severe environmental damage, as discussed earlier.

Carrying out thorough EIAs prior to pipeline construction could highlight potential environmental issues and enable strategies concerning the management of solid waste disposal. Monitoring and assessment for the continued operation of the pipeline can ensure that waste management practices remain effective.

DISCUSSION

Some major trends and areas of concern can be drawn from Azerbaijan data about pipeline transport, waste management:

Pipeline Transport: Compared to the past few decades, there has been substantial growth in pipeline infrastructure and a tremendous increase in trunk pipe length recently. This expansion is part of a strategic plan to increase the ability to transport more oil and gas, which are needed in order to meet increasing demand as well as efficiency. The growth of income from the transit of so-called sunny bread, appearing thanks to pipelines with gas – is a signal about restructuring energy markets towards more competitive types and it still reinforces within economy role which gained natural gases. This increased cost will be short-lived, but the good news is that with much more effective management and deployment of pipeline infrastructure in general leading to improved economic performances.

Waste management Data on waste generation suggests a high level of wastes, with solid domestic produce the major proportion. Some of this waste is being utilized to generate energy or recycled — steps in the right direction toward sustainability. On the plus side, nearly 50% of waste is now recycled or composted and less than a third ends up being landfilled – although that still suggests plenty more to do on both fronts. Although the decreasing trend in hazardous waste generation is encouraging, there remains a significant challenge to managing remaining hazardous materials (e.g., from mining) more effectively. In addition to reducing consumption, it is important that nations have appropriate waste disposal strategies and avoid sanitary disasters.

Overall, trends in pipeline infrastructure and waste management bucked governmental decisions. Although the improvements in pipeline capacity and financial returns are encouraging, much work remains to realize a sustainable development plan that incorporates environmental concerns (e.g. carbon emissions) with waste management issues. More effective waste management systems and a more robust environmental impact assessments will help the communities achieve growth without compromising on ecology.

CONCLUSION AND RECOMMENDATION

Discussing examples of solid waste from oil pipeline transport and general waste management data brings important points to light. Oil pipelines also generate large quantities of solid waste in both organic (soil, vegetation) and inorganic forms (metal, plastics and chemicals). This rubbish can cause serious damage to the environment through things like soil erosion, habitat destruction and spills & leaks causing pollution.

Regarding Azerbaijan, the data show a developing pipeline infrastructure alongside an ever-growing length of pipelines and carried goods. The economic implications of pipeline functioning have been significant as well, income levels from transportation increasing while freight prices vary. Gas pipelines, on the other hand, have experienced massive growth both in terms of transported volume and income (with oil pipeline performance mostly stable).

A large volume of solid domestic and production waste is produced, a significant part being disposed in landfills. A large proportion of domestic waste is recycled or recovered to produce energy but continues to

remain in either institutions, and an even larger fraction generated remains unused. There is less hazardous waste, especially from mines but it still remains a major headache.

The expansion of the pipeline industry and, in turn, its resulting waste generation highlight that there is more work to do on developing enhanced management strategies or sustainable practices. These problems need to be addressed in order to mitigate negative environmental impacts and improve overall sustainability.

Recommendations

1. Improving practices for Implementing Waste Management
2. Advocating for Spill Prevention & Response Plans
3. Improving Recycling and Recovery Projects
4. Improving Regulatory Frameworks and Monitoring
5. Financing climate compatible infrastructure

By following these recommendations, many advances can be made in this sector.

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