

Environmental Auditing of the Solid Waste Sanitary Landfills in Palestine

Yousrea Ramadan and Yasumasa Tojo

Abstract - Currently sanitary landfills are considered as the only legal disposal methods of municipal waste in Palestine, its number and capacities are limited due to many constrains, that created a strong need for more control over such facilities in order to maintain them functioning properly and mitigate its impact on human beings and environment. Environmental auditing has been introduced in Palestine as a management tool that instruct the operators on how properly manage and operate the landfills to avoid any negative impact on natural resources, human health and surrounding environment. Literature review, visits and onsite evaluation has been conducted to the sanitary landfills in Palestine, in order to be used as a basis for developing “Environmental Auditing Guidelines on Sanitary Landfills in Palestine”, and consequently it has become possible to manage solid waste landfills more effectively and efficiently.

Keywords - landfill, environmental auditing, waste management

I. Introduction

Solid Waste Management Sector in Palestine is considered as a significant and important sector, due to its impact either on human health or surrounding environment. Currently in Palestine about 4,356 tons/day (2018) is generated, where (94%) is collected by Joint Service Councils (JSCs), Municipalities, and private sector. 65-70% of the collected municipal waste is disposed in the six operational landfills in Palestine, where the remaining quantity (30-35%) is disposed in illegal dumpsites [1]. In the same context the Sanitary Landfills operators unfortunately still lacking any confirmation scheme on appropriateness of the design, planning, operation, management, and monitoring of the landfills, accordingly more follow-up and control on these sites is recommended [2] and addressed by “Environmental Auditing” that is for the impact of the industries and their products on natural resources and environmental quality. ‘Environmental Audit’ is considered as important tool to ensure sustainable industrial developments, through verifying its compliance with environmental requirements, and evaluating the effectiveness of the environmental management system, assessing risks and to identify and correct environmental hazards [3].

The concept of environmental auditing came into being in industrialized countries such as Canada, USA, UK and Netherland during early 1970’s under a different number of approaches and names depending on the company concerned such as Environmental review, Environmental performance appraisal, Quality approach, etc. In 1972, British Petroleum (B.P.) International group first used this concept. The United States Environmental Protection Agency published their environmental policy in 1986 followed by International Chamber of Commerce book let on environmental auditing in the year 1988 [3].

TABLE 1. Currently Operating Sanitary Landfills in Palestine [3]

| Sanitary Landfill | Location | Targeted Area | Receiv. Quantity (t/day) | Managing Responsibility |
|------------------------------|-----------------------|-----------------------------------|--------------------------|-----------------------------------|
| Zahret Al Fenjan | Jenin Governorate | North of West Bank | 1,200 | Jenin JSC |
| Jericho | Jericho Governorate | Jericho Jordan Rift Valley | 55 | Jericho JSC |
| Al Menya | Bethlehem Governorate | South of West Bank | 1,000 | Hebron & Bethlehem Higher Council |
| Biet Anan ⁽¹⁾ | Jerusalem Governorate | North and North west Jerusalem | 90 | N&NW Jerusalem JSC |
| Deir Al-balah ⁽²⁾ | Deir Albalah | Middle area, Khan Yunis | 450 | JSC-KRM |
| Juhr Eldik | Gaza Governorate | Gaza & North Governorates | 700 | Gaza Municipality |
| New Sofa (Alfukhari) | Khan Yunis | Middle area, Khan Yunis and Rafah | 450 | JSC South Gaza |

(1): Beit Anan is considered as controlled landfill, (2) Deir Al-balah landfill is currently closed.



Yousrea Ramadan
 Directorate of Joint Service Council, Ministry of Local Government
 State of Palestine

Yasumasa Tojo
 Laboratory of Solid Waste Disposal Engineering, Graduate School of
 Engineering, Hokkaido University, Sapporo
 Japan

Figure 1. Location map for existing landfill sites in West Bank and Gaza Strip, Palestine

The main purpose of the auditing process is to provide detailed information about the standard sanitary landfills structure and management in order to realize consistent evaluation of these landfills. There are currently operating sanitary/controlled landfills which are in operation in Palestine as shown in Fig. 1 and Table 1. The responsible operator is using their own standards/criteria for design and operation.

In the Project of “ Technical Assistance in Solid Waste Management In Palestine (Phase-II; 2015-2019) [6] implemented by Ministry of Local Government (MoLG) and financed by Japanese International Cooperation Agency (JICA), one of its main objectives was to introduce a Landfill Environmental Auditing according to the conditions of Palestine. In this paper, we report on the process of introducing Landfill Environmental Auditing system through the formulation of a Guidelines, and report on the results of actual application of the Auditing process for three landfills in West Bank, Palestine.

II. Scope of Landfill Environmental Auditing

The environmental auditing process for any sanitary landfill is a kind of checking up on the functionality of the landfill and to secure its soundness from all aspects, such as design, operation, management, inspection, maintenance, and safety, which leads to formulate a clear picture for the operation and monitoring about the sanitary landfill status. The environmental auditing is expected to contribute to fix any failure in the landfill operation, and consequently the landfill continues functioning properly. The following items are required to be checked:

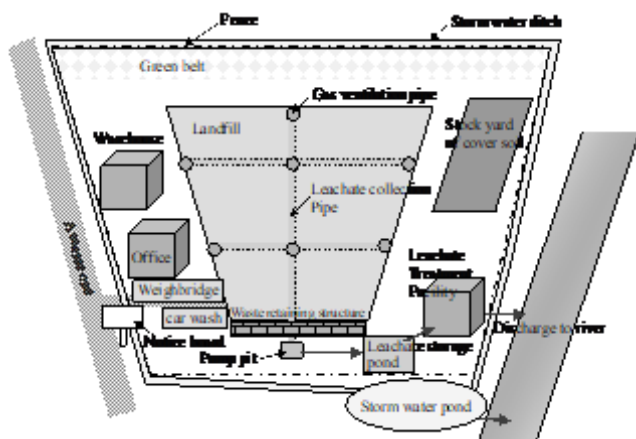


Figure 2. A basic infrastructure of the sanitary landfill. [2]

1. Site selection (proper site must be selected and vulnerable areas must be avoided)
2. Planning: Estimation of the quantity and quality of waste to be disposed of
3. Design: appropriate design and sufficient equipment's must be installed in the site (Fig. 2)
4. Construction: enough quality control of construction procedure

5. Operation: operation follows the standard procedure applied commonly
6. Management: proper management and maintenance of the facility
7. Monitoring: Every environmental component is monitored appropriately

III. Formulation of the Landfill Environmental Auditing Guideline

In Palestine, making environmental auditing of sanitary landfills was never being done before 2015, what was conducted an internal auditing only, as the responsible authorities of auditing process ; MoLG and Environmental Quality Authority (EQA), didn't have any clear approach to conduct an external auditing.

A joint work between MoLG, EQA and JICA had been started in 2015 in order to investigate the sanitary landfill's operations and current situation and make some analysis toward developing a management tool mentioned later "Guidelines on the Environmental Auditing of Solid Waste Sanitary landfills in Palestine" (Auditing Guideline).

The field work started in 2015, under the support of the MoLG-JICA Project for Technical Assistance in solid waste management in Palestine. MoLG as implementing and leading institution formulated a technical committee composed of MoLG, EQA, and Technical Directors from JSCs currently operating the sanitary landfills in West Bank, Zahret Al Fenjan, Al Menya and Jericho landfills supported by Japanese Expert who is delegated by the project.

The field work has been divided into three study phases covering over the period of the MoLG-JICA Project for Technical Assistance in Solid Waste Management in Palestine (Phase-I and II; 2015-2019). In each phase, many samples were taken and subjected to on-site experiments and measurements were taken of different factors and parameters that control the landfill's function. Based on the field study, various discussions about landfill environmental auditing were made.

A. The First Study Phase

During the first phase in 2015, the technical committee had visited three functioning sanitary landfills in West Bank, discussing with the operators about the landfill conditions in general, and introducing them the purpose of the visits and the expected results of the auditing process, and how they can utilize the auditing results and findings as a tool to seek for improvements through responsible authorities. Table 2 is summarizing the main observed parameters and the results collected during these visits.

the Japanese expert introduced a draft Guidelines of environmental auditing for landfills, to be discussed, and modified according to Palestinian conditions. The proposed guidelines contents covered all issue related to Landfills constructions, operation, management and monitoring.

TABLE 2. Observation results collected through the first phase of field work in 2015.

| Parameters | Zahret Al Fenjan landfill | Al Menya Landfill | Jericho Landfill |
|-------------------------------------|---|--|---|
| Waste acceptance | Quantity of waste is measured by track scale (weighing bridge), but it is exceeding the planned received quantity | Waste acceptance is well managed. Quantity of waste is measured by track scale (weighing bridge) and the data treatment is automated. Vehicle washing is provided, waste inspection area is there. | Quantity of waste is measured by track scale (weighing bridge) and the data treatment is automated. The system seems to become a little bit old. |
| Waste filling operation | Daily soil cover was not implemented strictly. huge waste quantities were exposed to the atmosphere. | Waste disposal is well managed and working face (waste dumping place) is minimized. Daily cover soil is done strictly. The filling operation is done according to cell method. Recyclable materials were separated in the site (manual separation line). | Due to the delay of construction of new landfill, they face serious problem on lack of space, that forced the operator to avoid adding soil cover as requested. since Implementation of soil cover consumes the precious space remaining in landfill. |
| Odor | Odor was noticeable and this was due to leachate pond. the operator decided to use deodorants (according to the complaint they received, in order to solve this issue). | Odor from leachate storage pond is not serious than expected. However, actually there is a smell which is probably come from leachate pond, or from the surface at where leachate spraying is performed. | Odor issue is serious because waste is exposed to the atmosphere and no cover soil was done. Reduction of odor at the site boundary is necessary as the basic function of the landfill. |
| Leachate management | Leachate is stored at the pond, then after being aerated, it is sent back to the landfill as leachate recirculation. (according to the world bank who designed the system) | Used leachate treatment system is composed of a sequence of aeration lagoon and reverse osmosis. But since operation of reverse osmosis is costly, it is not functionalized. | No leachate is generated. However, at least, confirmation of leachate head inside landfill is necessary. |
| Monitoring | Various monitoring has been conducted. It is documented by the operator that leachate, air, soil, insect, etc. are sampled and analyzed periodically. | Monitoring is conducted for air, leachate, groundwater, etc. | Some investigation was conducted to the close groundwater resources before the site construction and it was again investigated five year after the operation commenced. There was no indication of any groundwater contamination. |
| Guideline, manuals, criteria | The used manual, is the operation manual which has been developed in the landfill construction phase by the donor. | The operators had guidelines and operation manuals set by the private operating company who we operating this landfill in 2013. | Operation manuals are existing. |
| Over all comments | The landfill is suffering from hard situation that is not expected, due to excess quantity of the waste delivery, but If the waste delivered as planned, the landfill is expected to operate appropriately. | The landfill is well managed. The condition of the landfill and maintenance currently performed is similar to that in developed countries. | The landfill is facing serious problem on the shortage of the space. Most effective measure is the soil cover. Separation of recyclable-material before dumping for reducing the amount of waste, shredding the waste to create more uniform waste may be used. |

B. *The Second Study Phase*

The second phase took place in 2016, the main goals of this phase were to:

- continue working in developing the draft guidelines based on meeting and discussions held with local Palestinian experts.
- define concrete environmental monitoring items and their criteria
- conduct auditing survey and develop auditing reports for the Zahret Al Fenjan Landfill.

In this phase an environmental auditing scheme was developed and proposed to the relevant authorities as shown in Fig. 3.

During the second phase, the draft guidelines was subjected to deep discussions and modifications by auditing committee, in order to make it applicable for the country.

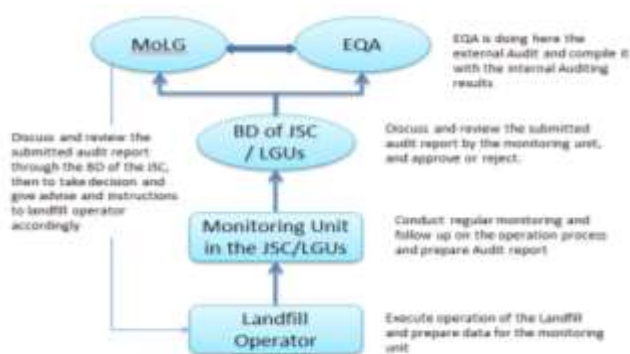


Figure 3. Proposed Environmental Auditing Scheme

The content of the guidelines included the items listed below, and each item is summarized in an auditing checklist that describe in specific what each item should cover:

- Basic infrastructure (Liner, retaining dam, leachate collection, gas management, etc.)
- Operation (waste acceptance, waste filling, compaction, etc.)
- Leachate management (quantity, head, quality)
- Gas management (monitoring & control)
- Routine inspection & maintenance
- Safety (Labors safe)
- Littering and vector (dispersion, birds, insect, etc.)
- Environmental monitoring (groundwater, surface water, air, odor)

C. The Third Study Phase

The main objectives of this phase was to finalize the first draft Auditing Guidelines which was reviewed and modified during the second phase, based on Zahret Al Fenjan landfill auditing process as a case study of verifying these Guideline.

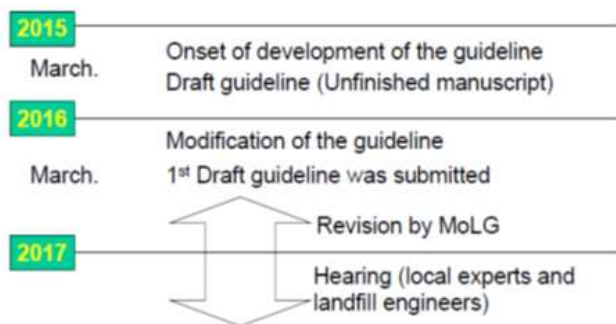


Figure 4. Auditing Guidelines development and verification progress

In the auditing visit, following items had been checked according to the tables and checking lists of the draft Auditing Guidelines:

- Odor at the boarder of the site by Odor sensor

- Determination of major odor components (High sensitivity gas detection tube)
- Average odor concentration around the pond (Passive dosi-tube)
- Soil sampling in wadi (for evaluating emission incident)
- Leachate quality in the leachate pond (pH, ORP, EC, COD, NH⁴⁺, NO³⁻)
- Existence of nitrification bacteria
- Aeration experiment and trace NH₄ concentration
- Examination on the effect of Ferric Chloride (FeCl₃.6H₂O) and Poly ferric Sulfate Solution (Fe₂(OH)_n(SO₄)_{3-n/2}]m) on the purification and reduction of odor .

TABLE 3. Summary of the Main Auditing Items and Findings

| Auditing Issue | Results |
|--------------------------------------|--|
| Fundamental Requirements of landfill | Most of the structures and equipment's are designed and constructed so as to comply with the international standards. |
| Management of landfill operation | Waste acceptance procedure are performed satisfactorily, but there are some issues on the waste filling operation |
| Leachate management | Prediction of Leachate quantity done (the climate data and landfill specification), it is recommended to estimate the leachate quantity with time series, regarding the leachate quality: the landfill is examining the optimal leachate treatment process, whereas at the moment no treatment is conducted. |
| Landfill Gas management | Control of gas pressure: Gas collection and energy recovery are planned after the completion of entire cell. But, during the filling operation, no gas management is performed. Regarding the toxic gas: There is a gas detector to monitor such gases. And the workers are informed about these gases such as H ₂ S. The working face is flat, and accumulation is not expected. About Explosive gas monitoring: it is Not performed. |
| Routine inspection and maintenance | Necessary inspections and maintenances are performed appropriately. At present, it seems there are no document regarding routine inspection and monitoring. Thus, preparation of the manual of them are recommendable. |
| Safety | Most of necessary safety measures are adopted. But the detection system concerning gas for safety seems to be insufficient. Introduction of a gas detection system to prevent accidents related to explosion and life of workers is recommendable. |
| Littering and Vector | Littering is noticeable is the site, where most of dispersed waste is blocked at the fence mostly, due to insufficient cover soil. Regarding Vector: Many birds flying over the landfill can be identified. This is also caused by insufficient soil cover. As for pests, it is dealt with by using insecticide in the summer. |
| Environmental monitoring | Various monitoring for gas (including odor), leachate, surface water, and groundwater has been conducted voluntarily. Accordingly, conduction of monitoring activity should be better done on a regular basis. |

In general, as you can see the third phase's results and proposed mitigation measures were not that much differs

from the previous phase, but some additional measures were proposed to mitigate the problem in leachate management such as :

- 1) Add emergency ponds with leak proof,
- 2) Construct a leachate treatment process intended to release the treated leachate
- 3) Introduce a pump to enhance leachate aeration
- 4) Recirculation seems to be necessary

By the end of this phase, the environmental auditing was ready to be published and applied by the Auditing Team formulated later from MoLG and EQA.

D. Applying the Auditing Guideline

The published version of these guidelines (Fig.5) is composed of 8 chapters, in each chapter a detailed description of the auditing issue is made, based on the literature review, standard and criteria used globally, more discussion and modifications made over these criteria in order to be more consistent with Palestinian conditions and environment.

Each chapter includes in its end a checklist that lists all items and sub-items which should be monitored and evaluated during the auditing process, then to documents the results in a report to be submitted to the authorities who are in-charge of monitoring the landfill operation as illustrated in Fig. 3.



Figure 5. Landfill Environmental Auditing Guideline (2019) [2]

The Ministry of Local Government decided to apply these guidelines on the currently functioning landfills twice a year (one during summer season and the second during Winter season), in order to have more control on these landfills, and consequently go forward improving the situation where is requested, which comes under the main strategic goals of the national strategy of solid waste management in Palestine (2017-2020), the Goal No.1 “An effective legal and organizational framework for SWM” and

the Goal No.3 “Effective and environmentally-safe management of SW services in Palestine” [5] .

During 2019 and before the pandemic COVID 19 appears, the auditing team member of MoLG and EQA, have conducted the auditing for the three-functioning landfill in West Bank, and the main findings can be summarized as follows:

(1) Zahret Al Fenjan Landfill (Jenin)

The main serious problems occurring in the site included:

1. A huge amount of waste is received to the landfill about 3 times the planned amount is carried in everyday, so the landfill working face has to be widened, and sufficient covered soil cannot be implemented for such wide working face properly. As a result, the problem of nuisance on the surface becomes extremely serious, as well as Odor problems. Accordingly, thorough soil covering is the most fundamental exercise of sanitary landfill. As a solution the operator used limestone collected from the surrounding ground as covering material but unfortunately, it can be hardly expecting the reduction effect of odor. Thus, it is desirable to adopt soil covering that is more likely to have a deodorizing effect. However, additional costs will also be incurred for the introduction of such alternative coverings, which exceeds the operator financial capacity, as a more economical solution the operator currently is using tree branches to reduce odor, this scenario was effective, but they couldn't depend on as long-term solution.

Finally, as an alternative, the operator used 130L of odor reduction substance by spraying it over the leachate pond as daily solution of odor problem, and according to their records it is efficient method as no more complaints were received. It was noted by the operator that a feasibility study is conducted by MDLF in order to select the most appropriate leachate treatment technology in Palestine.

2. The amount of leachate exceeds the planned value, making it impossible to control as the daily received amount of waste exceeds the predicted value at the design stage, and hence the moisture derived from the waste is increased and consequently more leachate is generated. As well as covering of the received waste quantity by soil became insufficient so that eventually it allows rainwater to infiltrate to the waste layer, especially in winter, making leachate quantities more and more. At the time of designing, it was estimated that only a single pond is needed and furthermore it was judged that the leachate can be managed by evaporation. This judgment in design unfortunately resulted in the current condition in which a part of leachate overflows the site. So, in order to overcome such problem, the operator prepared a design to construct a new leachate pond, and started construction works in the beginning of 2019, the expected capacity of this pond is 15000m³ and supposed to be put into operation by April 2019, while the leakage from old leachate pond still there and must be evaluated and mitigated in order to keep the surrounding environment from any expected pollution in future.

Finally, what can be recommended here, a financial support for the implementation of soil covering and leachate treatment should be provided sufficiently, as it is difficult to reduce the amount of waste to be delivered at this landfill, unexpected situations different from the design stage are occurring, so it is normal that the site becomes to be struggling to respond it. Since the essential cause is overwhelming quantity of daily waste, generators (i.e., general public) should also be responsible together for this situation and should pay a reasonable cost.

(2) Al Menya Landfill (Bethlehem)

The general situation of the landfill according to auditing team can be described as satisfactory except for the following issues which need more attention from the Operators and more support from the government:

1. Emphasis on applying the environmental monitoring plan is strongly advised.
2. Making a clear inspection protocol for accepting waste in the landfill site, and to focus on the importance of making composition analysis more frequently, in order to seek for the efficient technology for reduction and recycling.
3. Current waste sorting line and composting present in the site is excellent investment opportunity, but unfortunately, the sorting process was terminated due to financial and technical problems. consequently, more efforts are requested at all levels to re-operate the sorting line in this landfill, toward reducing the waste quantities, which disposed in the landfill, and consequently reduce the leachate quantity.
4. landfill gases should be collected and utilized in energy production, so more financial support is requested here, since the gas collection system is already installed in the site.
5. Appropriate Leachate treatment technology is recommended in the site, to solve the currently produced leachate as a quantity and quality which is categorized as high in BOD and COD concentrations.
6. Regarding littering issue, appropriate implementation of daily soil cover is recommended, even there is a specific hired staff for this task, a lot of waste were dispersed along the surrounding fence.

(3) Jericho Landfill (Jericho)

In this landfill, the auditing team clarified the following problems:

1. Daily cover soil is not enough as per standard. Consequently, many associated problems occurred, and the operator justified this "if soil cover quantity is added as per standards, the available space in the landfill become very limited" so this is more important than decreasing the quantity in order to keep the landfill working longer.
2. In order to solve the wild animal's presence in the site, more restrictions on slaughterhouses waste were enforced, by the operator. During the visit the slaughterhouses waste was disposed of in the cell as is and left without any cover.

This condition makes the site more attractive for dogs which were noticed.

3. The operator had to be supplied with monitoring devices/apparatus that make him able to monitor the process in the landfill properly.
4. More efforts needed to be paid toward operating the separation and recycling facility in the site. Since the waste separation and recycling would significantly contribute to reduce the waste quantity dumped in the landfill.

E. Summary of Landfill Environmental Auditing in Palestine

Based on the results of the auditing process, many actions were taken accordingly, to name a few; for example, at Zahret Al Finjan landfill.

1. The Operator used to cover the waste by 15 cm thickness daily cover, supported by spraying some deodorant material in the site, which positively minimize the odor problem, and this indicated by decrease in the number of received complaints from the community.
2. Regarding leachate management, the JSC took many measures to mitigate the problem through constructing new additional leachate pond and install rainwater drainage system to divert rainwater and avoid mixing it with leachate during winter season. In addition, JSC constructed soil retaining wall that prevent waste collapse, which positively impact the situation in the landfill and make preventive plan for 2020-2021 winter season effective.
3. Recently the operator had received a financial support through Palestinian government, to insert the lining system to the new leachate pond and to make a feasibility study of selecting most appropriate technology of leachate treatment in the site.
4. As a continuous support from JICA toward enhancing the Solid Waste Management Sector in Palestine, the operator is supposed to receive a financial support to start a pilot project in waste reduction through composting.
5. In Jericho Landfill, the main action which recently took place is the rehabilitation of one of the old cells with area up to 12,000 m², in order to get more apace, as well as bring the opportunity to extract and ventilate the accumulated gases in order to get rid of the flaring and explosion problems. So, the JSC of solid waste management in Jericho has received a financial support from government and partially from UNRWA to cover the associated cost of this activity. Additionally, another support is supposed to be received from JICA to help the JSC to start implementing a pilot project that aims at reducing the generated waste (In-organic fraction; mainly plastic, glass, cardboard and paper) through recycling, which seems to be more feasible in comparison with organic waste recycling in Jericho Governorate.
6. At Al Menya landfill, according to the requested measures in the auditing results, nothing is made, except more control over the littering and waste burning in the site.

Based on the auditing implemented work and achieved results, MoLG in cooperation with EQA decided to expand the auditing process as a significant management tool to cover the transfer stations as well, so a new set of auditing checklists had been developed and applied in the current running transfer stations in West Bank.

iv. Conclusions and Recommendations

(1) To conduct the landfill auditing process in each sanitary landfill is particularly important as a management tool to find out the current issue on landfill management and to share the information regarding the status of the site among the stakeholders and decision makers, so it is not performed only to check and evaluate the activity of the site.

(2) The results of auditing should not be considered as atoold to solve the failure there only, but also should focus the target toward introducing a new management technology in the field, as the landfill must not be the only method to get rid of the generated waste, since Palestine is facing many challenges to construct new landfills from different aspects; financial, technical and political level.

(3) At technical level, accurate devices and experimental apparatus are crucial in order to examine appropriate treatment technology, in addition to the strong need of some experts who can conduct this kind of examination, especially at current situation, where two landfills (Zahret Al Fenjan and Al Menya landfills) are trying to construct leachate treatment facilities. In the same context, cooperation of local experts (such as university or some institute) who can do this kind of experiments and analysis is quite important.

(4) At governmental level, the decision makers should take serious actions toward solving any failure at the site, either through financial subsidies, incentives or through adapting laws and legislations that impose more control over waste generation and following 3Rs practices.

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References

- [1] Valerie Thoni and Samir K.I. Matar, 2019. Overview report, SOLID WASTE MANAGEMENT IN THE OCCUPIED PALESTINIAN TERRITORY, West Bank including East Jerusalem & Gaza Stripent in the occupied Palestinian territory.
- [2] MoLG-JICA Project, 2019. Environmental auditing guidelines on sanitary landfills in palestine. Japan International Cooperation Agency.
- [3] Sangita Pradeep Ingole, 2012. Environmental Auditing: Its Benefits and Counterance. International Journal of Science Innovations and Discoveries, 2 (5), p.152-156.
- [4] MoLG-JICA Project, 2019. Data Book, Solid Waste Management of Joint Service Councils West Bank Palestine. Ministry of Local Government, Palestine.
- [5] MoLG 2017. National Strategy of Solid Waste Management in Palestine (2017-2022)
- [6] MoLG-JICA Project, 2019. Final Report of the Project for Technical Assistance in Solid Waste Management in Palestine.

About Authors:



Eng. Yousrea Ramadan is the Environmental Officer of the Directorate of Joint Service Councils, Ministry of Local Government, State of Palestine. She is also the Project Member of the MoLG-JICA Project for Technical Assistance in Solid Waste Management in Palestine Phase-II (2015-19) as well as MoLG-JICA Project for Capacity Development in SWM in Palestine Phase-III (2020-).



Dr. Yasumasa Tojo is Associate Professor, Laboratory of Solid Waste Disposal Engineering, Graduate School of Engineering, Hokkaido University, Sapporo, Japan. He was collaborated with the MoLG-JICA Project for Technical Assistance in Solid Waste Management in Palestine (Phase-II) as a JICA Expert on Landfill Environmental Auditing (2015-2018).