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Research Article

CONTRIBUTION OF THE LANDSCAPE EVALUATION IN THE STUDY OF THE IMPACT ON ENVIRONMENT: APPLICATION OF THE HYDRO-QUÉBEC METHOD ON THE TECHNICAL LANDFILL CENTER OF HAMICI, TIPAZA (ALGERIA)

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ABSTRACT

The development and operation of Technical Landfill Centers (TLC) for urban solid waste lead to significant landscape alterations and have a negative impact on its overall image. However, the Environmental Impact Assessment (EIA) conducted for these TLCs in Algeria do not currently consider the impact of this activity on the landscape as a determining factor for validating the implementation of the landfill site. It is limited, instead, to some mitigation measures.

This work addresses the importance of taking into account the impact of TLCs on the visible landscape through EIAs. In this context, the planned landscape integration measures within the scope of the EIA conducted by the Ministry of Environment for the urban solid waste landfill site of Hamici, situated 29 *km* from the capital Algiers, were examined. In addition, an evaluation the TLC's impact on the visible landscape after its construction and operation was implemented using the Hydro-Québec method.

The results show a high visual impact of the TLC on the landscape unit receiving the landfill cells, a moderate impact on the unit receiving the TLC buildings, and a minor impact on the unit hosting the human settlement, which has the largest number of potential observers in the area. In the light of these findings, it is imperative to integrate landscape evaluation as an operational phase through EIAs before making decisions regarding the siting of landfill sites. This is essential for the purpose of preserving the image of the environment conveyed by the visible landscape.

Keywords: *Environmental Impact Assessment (EIA), Landscape evaluation, Hydro-Québec method, Technical Landfill Center of Hamici, Visible landscape*

Introduction

To address the environmental damage caused by uncontrolled landfills, the Algerian State has been committed since 2001 to a national waste management program dedicated to the construction of Technical Landfills

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Centers (TLC) for the disposal of urban solid waste. However, the environmental impact studies conducted for these TLCs are not exhaustive. The impact on the landscape is not taken into account in the project validation. This observation encourages us to reconsider the landscape issue and its operationality.

In the light of the new knowledge and skills that are emerging in the field of territorial planning (Paquette *et al.,* 2008), any environmental modification requires the consideration of the visual landscape (Jessel, 2006). This is why it becomes crucial to include Landscape Assessment in the Environmental Impact Assessment (EIA). In the case of TLCs, the importance of landscape evaluations to supplement EIAs, can probably be explained by the potential threats that may rise from the development of this type of facility, affecting all the components of the landscape. This implies the need to acquire approaches, methods and tools that enable its effective management and protection.

The Hamici TLC was built to receive solid urban waste from municipalities of the Tipaza province and those from western municipalities of Algiers. It is located in an agricultural landscape. In general, this type of landscape is often referred to as an "ordinary landscape" (Dewarrat *et al.,* 2003) or a "common landscape". There is no broad consensus regarding its quality and value when compared to the so-called exceptional landscapes. However, its evolution needs to be accompanied, including for agricultural landscapes, whose function is also the production of landscape (Deffontaines, 2001). In fact, the traditional discourse associated with the agricultural sector is confronted with the rise of aspirations that claim a greater attention to changes threatening the environment and rural heritage (Koohafkan and Altieri, 2011). The increasing social demands to improve the quality of the living environment of ordinary landscapes are launching new challenges in terms of land-use planning (Vouligny, Domon & Ruiz, 2009).

The Environmental Impact Assessment is an instrument for preventing the nuisance and pollution that can affect the environment because of man-made projects and developments. Land use is a key human activity that not only shapes socio-economic development but modifies, but also, environmental structures and processes (Mander & Uuemaa, 2010).

EIA is a procedure regulated by environmental protection laws. The Algerian legislative framework dates back to 1983, with the adoption of framework law 83-03 of February 5 on environmental protection which was followed by Executive Decree 90-78 on February 27, 1990. In 2003, a new environmental law was promulgated, Law 03-10 of July 19, 2003, which defines the regulations for environmental protection in the context of sustainable development and specifies the content of EIAs. In 2007, Executive Decree number 07-145 highlights the projects subject to EIA. The reading of these texts reveals an ongoing and increasingly demanding concern on the part of the Algerian government, for environmental protection. Nevertheless, landscape as an important component of the environment was not mentioned in these texts. This concept is still absent from our legislation and is not integrated into land-use planning operations. The current EIAs carried out for the TLCs in Algeria, do not take into account their impact on the landscape, except for some mitigation measures. However, the Environmental Impact Assessment should not be a post-justification of the project, but should be taken in consideration from the very beginning (Chaib, 1996). This is exactly what can be observed in southern countries. Except for the material dimension, the social representations of the landscape have been much less studied, while landscape policies are either non-existent or, at best, in a preliminary stage of development. In contrast, research on landscape in the Western countries is extensive and covers various aspects including its materiality, representations, and public policies (Gauché, 2015).

The expert approach to landscape evaluation originally developed in North America during the 1970s is still widely used in planning. It has demonstrated its effectiveness in the protection and management of landscapes (Vouligny, Domon, & Ruiz, 2009). This involves assessing the impacts of developments and projects on the landscape with the aim of achieving integration and harmonization. Canadian approaches are very similar to those applied in the United States. These functionalist approaches to landscape that emphasize the

notion of visual absorption capacity of the project.

In Québec, several landscape evaluation methods have been developed, including the Hydro-Québec method which has been specifically designed for electric line and transformer substation projects. However, this method can be applied to broader contexts beyond electricity, allowing the consideration of landscape characteristics as well as the identification of their level of sensitivity and resistance to the installation of proposed facility.

Presentation of the Case Study (TLC OF Hamici)

Hamici TLC is a class II technical landfill facility (for urban solid waste), with a total capacity of 10 million tons of municipal solid waste. It is designed for a lifespan of approximately 20 years. It covers an area of more than 80 ha, including 45 ha dedicated to waste disposal (MATE, 2007). The TLC is located east Douaouda town in the Tipasa province, 29 km from Algiers, in an agricultural region. Since 2014, it has been receiving urban solid waste from the western municipalities of the of Algiers province and those of the municipalities of the Tipaza province.

The selection of the TLC site was essentially based on economic feasibility due to its relatively low cost given the rural character of the region and the availability of land with impermeable soil. In terms of topography, it is characterized by valleys and gentle slopes (MATE, 2007). Regarding land use, it can be divided into four landscape entities, an agricultural zone, an inhabited agricultural zone, a wooded zone, and a human settlement represented by the Douar Bourahmoun.

Material and Method

Landscape serves as a moderate between society and nature (Bertrand, 1978). It is evaluated using three approaches. The first one is objective and employs quantitative methods (Ohta, 2001), to analyze of the physical elements of landscape (fauna, flora, landforms, geology, hydrology, etc.). This analysis help define its characteristics and potential by using cartography. The second approach is subjective includes the observer's perspective. This observer may be an expert, generally, architects and landscape architects, who study on the relationship between man or the landscape user and the landscape (Beaudet, 1999). The third approach postulates the complementarity between the two previous approaches. It adopts a complete and exhaustive characterization of the landscape and a cross-viewpoint that expands the objective of the analysis. It aims to connect the physical structures to the visual perception of landscape (Rivard, 2008).

This latter approach is materialized in the operational approach developed by Hydro-Québec, which assesses the capacity of landscape to absorb the transformations caused by the project and the impact of these transformations on the perception of the landscape through exploratory cartographic analysis, field observations, and a photographic report considered as a valid substitute for the real landscape (Steen Jacobsen, 2007).

The Hydro-Québec method

In response to the absence of approaches and indicators for monitoring the visible landscape in the context of land use planning and landscape management (Jessel, 2006), the Hydro-Québec method introduces an approach that aims to the overall integration of infrastructure into the receiving environment. This approach encourages the consideration of all the structuring and dynamic components of the environment (concrete landscape), the potential visibility of the infrastructure (visible landscape) and the level of appreciation attributed to the landscape (symbolic landscape) (Hydro-Québec, 2013).

The Hydro-Québec method, first published in 1992, was designed for the implementation of electrical line and substations projects. It is the result of accumulated experience, conclusions from follow-up studies and extensive research relating to the various aspects of landscape visual analysis (Hydro-Québec, 2013). This method is an integral part of a broader environmental evaluation framework. It presents an approach based on knowledge and assessment of the landscape and its visual quality to ensure an optimal integration and insertion of the infrastructure within the landscape.

The evaluation addresses the intensity of the visual impact, which is determined by two parameters. The first parameter is landscape's absorption capacity which influenced by the topographic characteristics, vegetation density and land use allowing the landscape to visually absorb the project. The second parameter is the ability of the infrastructure itself to be visually integrated into the landscape. This depends on the height of the buildings and their location regarding to the observer (Hydro-Québec 2013).

Therefore, the evaluation of visual impact intensity is carried out in two phases:

Phase 1: Landscape inventory

A landscape inventory is carried out by characterizing the territory to identify the issues arising from the presence of the project in landscape. This step is followed by the validating the perimeter of the study area and subsequently to identify the landscape elements to be inventoried.

Based on maps and field observation a delimitation of the landscape units within the study area is established. These units serve as the basic divisions of the territory and are determined by considering the physical characteristics of territory, the functional relationship expressed by land use, and the visual characteristics of the landscape (Tricaud *et al.,* 2010). Afterward, the characterization of these units is conducted using information collected from natural and human environments studies including aspects such as landform, vegetation, hydrography and land use patterns.

Phase 2: Evaluation of the importance of visual impact

Landscape evaluation aims to improve our understanding of human-landscape interactions (Zube, 1980). In the Hydro-Québec method, the importance of the visual impact is assessed by combining two evaluations to determine the project's impact on the visible landscape (Figure 1):

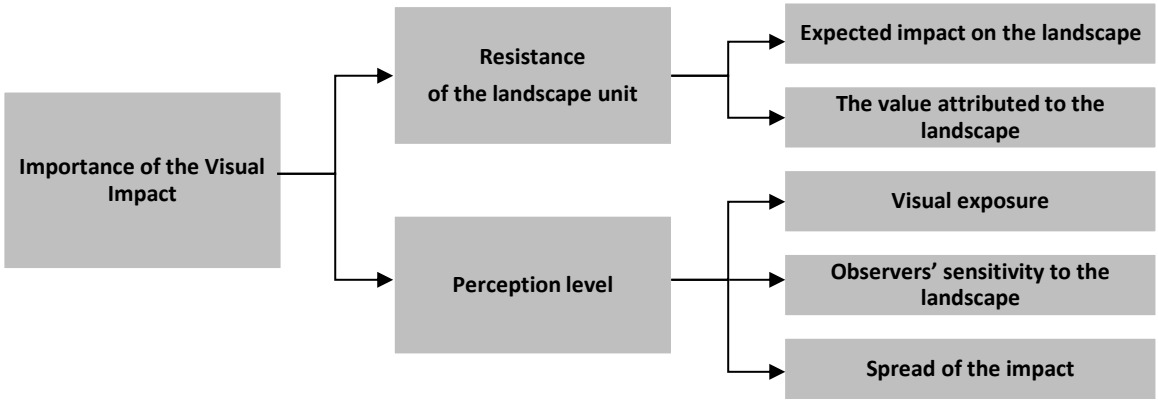

Figure 1. Parameters for assessing the importance of visual impact the method Hydro-Québec (Hydro-Quebec, 2013)

- ***Resistance of landscape units to the implementation of projected infrastructure***

The evaluation of landscape units' resistance involves assessing both the perceived impact on the landscape and the intensity of the associated value. Both are evaluated using a three-point scale (High, moderate, low) (Table A1) (see Appendix):

- *The significance of the potential impact on landscape* is determined by the landscape's capacity to accommodate a new facility. This assessment is evaluated according to two interdependent parameters: the absorption capacity which refers to the capacity to hide or blend in the projected facility) and insertion capacity (compatibility of the project physical components with the influential landscape features);
- *The value attributed to the landscape* is determined by the inherent qualities as well as the interest expressed by its users. Moreover, the environmental purpose and the activities of the observer also reveal the level of interest in the landscape.

- ***Perception levels***

This evaluation takes into account the extent of alteration generated by the facility within the observers' field of view. The perception level is determined through the analysis of three parameters:

- The level of visual exposure of the project;
- The sensitivity of observers towards the landscape;
- The radiation of the impact.

The evaluation conducted by assessing the level of the facility's visual exposure, the sensitivity levels of the observers toward the landscape, and the extent of the impact range. These three parameters are rated on a three-point scale (High, moderate, low) (Table A2) (see Appendix).

The assessment then proceeds by evaluating the significance of the visual impact of the project on four levels of importance (Table A3) (see Appendix): major, moderate, minor, and none. This scale corresponds to four levels of landscape modification: significant, partial, minor, and negligible modifications (Table 1).This grid, inspired by the H.Q method grid, has been slightly adapted to better align with the objectives of this study.

Table 1. Levels of visual impact importance (Hydro-Quebec, 2013)

Visual Impact Importance /Intensity	Landscape Modification Level
Major	Significant modification
Moderate	Partial modification
Minor	Slight modification
None	Negligible modification

Results and Discussions

Evaluation of the impact study on the TLC environment of Hamici

Technical landfills are subject to an Environmental Impact Assessment. The study conducted by the Ministry of Territorial Planning and Environment (MTPE) for the TLC of Hamici, in 2007 recommends some measures to integrate the landfill cells into the site. To reduce the project's impact on the landscape, these measures include the implementation of grass-covered peripheral dikes and a limitation of the area under operation. The same study considers the impact of the TLC to be insignificant except in the final phase, before the redevelopment works. However, on-site, we observed the absence of these dikes, where the agricultural landscape merges with the waste (Table 2). The residents of the farms north of the TLC are affected by the smoke emitted from the landfill operation. The same goes for farmers cultivating the lands west TLC, who are permanently facing the burial cells. As for the Douar Bou Rahmoun located less than 2km from the TLC, the impact on the inhabitants cannot be negligible, with the daily passage of loaded trucks that access the road to the TLC, which is adjacent to the Douar (Table 2).

Evaluation of visual impact significance of Hamici TLC using the Hydro-Québec method

Landscape inventory

The landscape inventory is an essential preliminary step prior to assessing visual impacts. Initially, we started by characterizing the landscape enabling us to devise the study area into landscape units. After that, on-site investigations, we proceed with mapping some specific elements, such as wooded areas and two plant screens (Figure 2). The first screen runs alongside the Oued while the second borders the CW 112 road. In addition, we collected data on land use, such as cultivated land surrounding the landfills, the presence of agricultural farms and two residential areas. The first residential zone, Douar Bourahmoun is located less than 2km from the cells, while the second consisted of collective housing, in which, we observed, during our site visit, that there were no visual openings due to the vegetal screen that borders the CW 112 road.

Table 2. Evaluation of landscape integration measures proposed by the Environmental Impact Assessment, (MTPE) (2007)

	Landscape integration measures proposed by the EIA	Estimation of the visual impacts of landfill sites by the EIA	On-site observations	
At the landscape scale	-Perimeter embankments with a minimum height of 1.50 meters, covered with grass, for the landfill site.		-The absence of perimeter embankments results in the integration of the agricultural landscape with the waste materials -A height of 1.50 meters is insufficient for a waste height of 30 meters at the end of operation.	
	-Limitation of the area under operation to reduce the project's impact on the landscape. -Progressive landscape rehabilitation for soil restoration after operation.		-In 2014, only one landfill cell was put into operation. In 2023, two cells are in the closure phase, one cell is currently in operation, and the fourth cell is under construction	
At the scale of landscape users		-The visual impact of the landfill site on the population is mitigated by the implementation of artificial visual screens (hedges, tall trees) around the site perimeter	-The absence of visual screens around the site perimeter. - Significant visual impact for residents of farms located 300 and 600 meters away from the landfill cells, as well as for farmers cultivating the surrounding lands who are constantly exposed to the landfill cells enveloped in smoke.	
		-The visual impact of the landfill site is negligible, except during the final phase before redevelopment works.	- The nearest human settlement to the landfill site is Douar Bou Rahmoun, located less than 2km away. The visual impact on the residents cannot be overlooked, especially with the smoke emitted from the site and the daily passage of waste-laden trucks through the access road of the landfill site, which borders the Douar	

Vegetative screen along the river (Oued)

Vegetative screen along CW 112 road

Figure 2. Vegetative screens

Each landscape possesses a unique character, distinguished by its prominent features, which were utilized as the basis for identifying and categorizing landscape units. Therefore, four units were defined (Figure 3):

- Inhabited Agricultural Landscape Unit (IAL);
- Agricultural Landscape Unit (AL);
- Residential Landscape Unit (RL): Douar Bourahmoun;
- Wooded Landscape Unit (WL).

The landscape units receiving the landfill are as follows:

- Inhabited Agricultural Landscape (IAL) which hosts the landfill cells and the settling pond;
- Agricultural Landscape (AL) incorporates the TLC access road, the sorting center and the administration building.

The TLC is perceived from the Residential Landscape (RL) unit of Douar Bourahmoun. On the other hand, nobody lives in the Wooded Landscape Unit (WL), so there are no users. Therefore, it will not be included in the evaluation process. Nevertheless it represents an important plant cover that requires preservation and safeguarding.

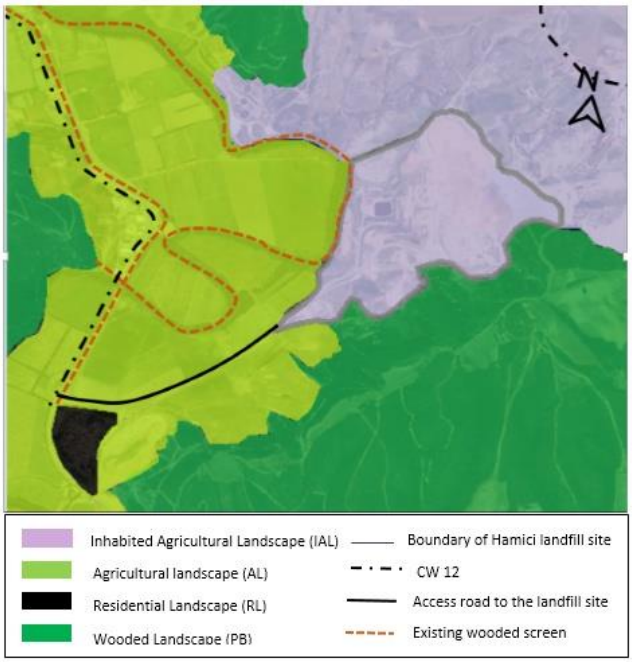

Figure 3. Division of landscape units in the study area

Based on the aesthetic approach, we assessed the two landscape units hosting the TLC namely the Inhabited Agricultural Landscape unit (IAL) and of the Agricultural Landscape unit (AL). We conducted an evaluation of the landscape's quality in terms of visual effects. The landscape offers expansive visual vistas and a heightened sense of depth, which is accentuated by its predominantly flat landform with occasional gentle slopes that widen the visual field towards the agricultural lands, offering a variety of textures and colors. Therefore, farmers in both landscape units have direct views of the landfill cell. This latter is also subject to the daily passage of transport trucks carrying urban solid waste. The inconvenience is not only visual but also acoustic and olfactory. By understanding these perceptions we gain insight into the sensitivities experienced by both farmers and residents living in these landscape units.

Intensity of the visual impact of Hamici TLC on landscape units

a) Inhabited Agricultural Landscape Unit (IAL)

The unit comprises hilly agricultural land. At the beginning of its operation in 2014, it received a single cell and the settling tank. Over time the number of cells gradually increased. As of 2023, two cells are in the process of being closed, one is currently in use, and the fourth cell is under construction. The unit serves an agricultural purpose and hosts both farms and residences.

- ***Evaluation of the resistance level***

  The evaluation of resistance level was based on evaluating the perceived significance of the impact on the landscape resulting from landfill development, taking into account the value attributed to this landscape given its agricultural vocation. The observers are primarily represented by the farmers who occupy the farms and cultivate the land surrounding the cells.

- Significance of the apprehended impact on the landscape.

  The unit has a low capacity for absorbing landfill cells due to:

  - The waste height reaching up to 30 m by the end of operation, making it impossible to conceal the waste from the farms' residents located in the north and east of the cells.
  - The lack of physical compatibility between the agricultural vocation and the waste storage. The landfill cells are easily distinguishable from the other natural elements within the landscape modifying its overall perception, and thereby compromising its aesthetics.

- Given value

  The evaluation of the unit's intrinsic quality takes into account the notions of uniqueness, harmony and integrity. However, in this case, uniqueness and storing waste in an agricultural landscape are two incompatible terms. The primary observers who contribute to the landscape's appreciation are the farmers, as they have a direct and permanent relationship to the site through their work and their residences.

  Therefore, a strong importance of the apprehended impact on the landscape combined with a great value corresponds to a strong resistance of the unit. This suggests that the landscape unit is not well suited for the integration of the project.

- ***Evaluation of the perception level***

  The TLC was established within a landscape unit and benefit from an agricultural vocation. The storage of waste alters the landscape in a significant way.

  - The level of exposure for farmers and farms' occupants is quite high, as they have an open and direct views of the waste stored in the cells;
  - The sensitivity of the inhabitants and farmers is significant due to their permanent and stationary presence in the landscape. These areas serve simultaneously as both their places of residence and work at the same time;
  - The impact of waste storage cells is localized affecting the immediate surroundings of the site, including the farmers and the inhabitants who live in the vicinity.

With a high exposure and sensitivity of the observers combined with a localized impact, the level of the observers' perception is strong.

Therefore, due to the unit's strong resistance and the significant level of perception, the impact is evaluated as major (table 3). Consequently, highly recommended mitigation measures include the restoration of landscape elements to the original condition after the two filled cells have ceased operation. Additionally we suggest creating a dense vegetative boundary around the site to limit the visual exposure to the landfill cells.

Table 3. Intensity of visual impact on the Inhabited Agricultural Landscape unit (IAL)

Landscape Unit	Indicators					Intensity of visual impact
	Resistance level of the landscape unit		Perception level of the development			
	Importance of the expected impact on the landscape	Attributed value to the landscape	Exposure Level	Sensitivity Level	Radiation of the impact	
Inhabited Agricultural Landscape unit (PAH)	**Major**	**High**	**High**	**High**	**Local**	**Major**
	High		**High**			
						
						

b) Agricultural Landscape Unit (AL)

- ***Evaluation of the unit resistance level***

This unit possesses an agricultural vocation; it is located west of the study area, but this time the lands are flat and faces the landfills, which are slightly elevated. The unit hosts the access road, the gates, the TLC administration, the maintenance workshop and the sorting center.

- Significance of the apprehended impact on the landscape

This parameter is evaluated as moderate due to the height of the TLC buildings (administration, maintenance workshop and sorting center) not exceeding one level, measured in the middle of the flat land.

- Given value

The intrinsic quality of the unit was assessed based on the integration level of the access road and the TLC buildings. However, these buildings successfully integrate into the site, considering their height, which does not exceed that of the neighboring farms. As for the access road to the TLC located amidst agricultural lands, its impact on farmers is significant. This impact is not caused by its mere presence, but rather due to the large number of waste–laden trucks that utilize this road on a daily basis, emitting smoke and generating noise.

Consequently, with a moderate importance of the apprehended impact on the landscape coupled with a high value, the resistance of the Agricultural Landscape unit is estimated to be moderate (Table 4).

- ***Evaluation of the perception level***
  - The exposure level of the TLC buildings and the stored waste is important for farmers who cultivate the lands bordering the TLC access road. Conversely, the cells are hidden from users of CW 112 road, which traverses the unit and are only visible from specific point of view where the road is not lined with trees (plant screen).
  - The sensitivity of the moving observer passing by the CW 112 road is not significant due to the presence of two plant screens; the first is formed by the vegetation bordering the Oued, while the second one consists of tall trees bordering the CW 112 road (Figure 3). On the other hand, the sensitivity of farmers cultivating the land along the access road of the TLC is significant, primarily due to the waste-laden trucks and the visibility of the waste cells which open up their visual field.
  - The range of the visual impact caused by waste storage cells, as well as the TLC buildings is point-specific. Landscape modification only affects specific viewpoint for the farmers.

Therefore, with high visual exposure, high sensitivity of the observers and a point-specific visual impact, the perception level of the observer is considered average.

To conclude, with a moderate resistance of the unit and a moderate level of perception, a moderate the impact is generated (Table 4). Therefore, it is recommended to create a visual plant screen along the entire TLC access road, which passes through agricultural land.

Table 4. Intensity of impact on the Agricultural Landscape unit (AL)

Landscape Unit	**Indicators**					**Impact Intensity**
	Resistance level of the landscape unit		Perception level of the development			
	Importance of the expected impact on the landscape	Attributed value to the landscape	Importance of the expected impact on the landscape	Value attributed to the landscape	Importance of the expected impact on the landscape	
Unité de Paysage Agricole (PA)	**Moderate**	**High**	**High**	**High**	**Point-specific**	**Moderate**
	Moderate		**Moderate**			
						

c) *Residential Landscape (RL) (Douar Bourahmoun)*

The residential landscape unit will not be subject to a resistance evaluation since it does not accommodate any structure or development related to the TLC. However, it represents the highest concentration of potential observers, particularly the urban solid waste landfills cells. Therefore, the evaluation will focus on the perception level of the TLC by observers from this unit.

- ***Evaluation of the perception level***
  - According to on-site observations, the level of exposure is relatively low due to the significant distance between Douar

and the TLC, despite the elevation of the Douar and the expanded visual field towards the TLC.

- The sensitivity of Douar Bourahmoun observers towards the TLC is considered to be high due to the noise generated by the waste transport trucks, which pass by the Douar on a daily basis with a high traffic flow.
- The impact of the TLC impact is localized. It affects all the inhabitants of the Douar who witness the transformation the surrounding landscape and its vocation.

With low visual exposure, high observer sensitivity and a point-specific impact, the perception level is considered low. Consequently the visual impact is ratedas minor (Table 5). As a result, it is recommended to install a vegetal visual and acoustic screen along the access road of the TLC, which passes through the Douar.

Table 5. Intensity of impact on the Residential Landscape unit (PR)

Landscape Unit	**Indicators**			**Impact Intensity**
Residential Landscape unit (PR)	Perception level of the development			
	Exposure Level	Sensitivity Level	Radiation of the de impact	
	Low	**High**	**Local**	**Minor**
				

Results indicate a major visual impact for the inhabited agricultural landscape unit that receives the landfill cells. Therefore, it is recommend implementing mitigation measures such as landscape rehabilitation after ceasing the operation of the cells, and creating a dense vegetal boundary around the site, in order to minimize the visual exposure of the cells from the nearby houses and farms.

For the agricultural landscape unit, the visual impact was considered to be moderate; As a result, it is recommended to create a vegetal visual screen along the TLC access road which traverses the agricultural lands.

Regarding the residential landscape unit, the visual impact was estimated to be minor. However, it is still recommended to create a visual and acoustic vegetation screen along the TLC access road that passes through the Douar in order to reduce the impact of waste transport trucks (Figure 4).

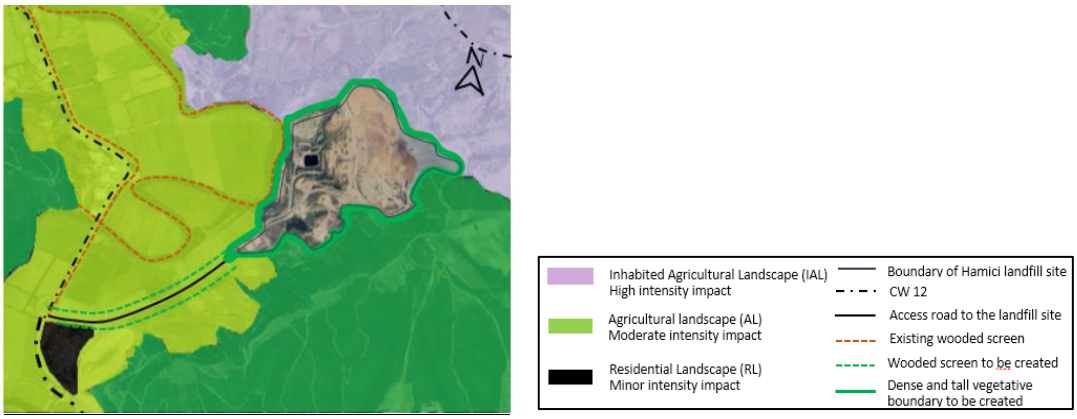

Figure 4. Significance of the impact of the Hamici landfill site on the landscape

Conclusion

According to the results of this study, integrating landscape assessment in the EIA of landfills is crucial to provide decision-makers with valuable insights into the landscape's capacity to accommodate the project. Conversely, omitting this procedure can have a negative impact on the project's visibility. This is particularly relevant for Hamici TLC, located on agricultural lands, similar to the majority of TLCs in Algeria. The agricultural landscape is often approached in a functional perspective, solely as a result of human activities overlooking its inherent perceived values. It is important to recognize that farmers, beyond their traditional role in food production, also contribute to shaping the visible landscape.

The impact assessment of Hamici TLC on the landscape was based on our on-site observations. Our objective was to consider the sensitivities of farmers and inhabitants of nearby farms, some of whom are located just 300 m away from the landfills. This approach allowed us to combine two types of knowledge, the knowledge related to landscape production and the knowledge pertaining to its perception. It facilitated the integration of objective and subjective perspectives, encompassing both functional and sensitive approaches. This dual perspective is essential for addressing major issues associated with the integration of TLCs into the landscape. In this context, the functional perspective was addressed through the evaluation of landscape units resistance of the study area, while the sensitive perspective was conducted by assessing users perception of the landfill site.

Results indicate a major impact on the landscape unit that receives the landfill cells. The unit has a low capacity to accommodate the waste with heights reaching up to 30 m at the end of operations. Moreover, there is a lack of physical compatibility between the agricultural nature of the environment and the waste storage activity. Consequently, recommended mitigation measures include restoring the landscape elements in the two cells to their original state after ceasing operation. In addition, it is recommended to establish a dense and high plant boundary around the site to limit the visual impacts of the operational and ongoing cells.

Regarding the landscape unit receiving the TLC buildings and access road, which traverses the agricultural land, the impact is moderate. It is recommended to create a visual plant screen along the road to reduce the visual and acoustic disruption of the daily passage of waste-laden trucks on the farmers cultivating the adjacent land.

For the landscape unit where the human settlement is located, hosting a larger number of potential observers, the impact is minor. The installation of a visual plant screen on both sides of the TLC access road can reduce the visual impact of waste trucks transport on the inhabitants of Douar Bourahmoun.

In conclusion, the landscape assessment provided a fresh perspective on the agricultural landscape and allowed for a reevaluation of the visible landscape by considering the sensitive dimensions. These include the affective and identity-based values that connect farmers with nature. The primarily purpose of landscape evaluation is to provide insights into the organization of the landscape and the relationships established between the planned activities and the natural environment. In the case of a technical landfill, the landscape evaluation becomes essential to complement the EIA and validate the selection of the TLC site.

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Appendices

Table A1. Landscape Unit Resistance: Evaluation Grid

Apprehended Impact on landscape	Attributed value to the landscape	Resistance of landscape units
Low	Low	**Low**
	Moderate	**Low**
	High	**Moderate**
Moderate	Low	**Low**
	Moderate	**Moderate**
	High	**Moderate**
High	Low	**Moderate**
	Moderate	**Moderate**
	High	**High**

Source : Hydro-Quebec, 2013

Table A2. Facility perception level: Evaluation Grid

Visual Exposure	Observer sensitivity	Radiation of the impact	**Perception level**
High	High	Regional	**High**
		Local	**High**
		Point-specific	**Moderate**
	Moderate	Regional	**High**
		Local	**Moderate**
		Point-specific	**Moderate**
	Low	Regional	**Moderate**
		Local	**Low**
		Point-specific	**Low**
Moderate	High	Regional	**High**
		Local	**Moderate**
		Point-specific	**Moderate**
	Moderate	Regional	**Moderate**
		Local	**Moderate**
		Point-specific	**Low**
	Low	Regional	**Low**
		Local	
		Point-specific	
Low	High	Regional	Moderate
		Local	Low
		Point-specific	Low
	Moderate Low	Regional	Low
		Local	
		Point-specific	

Source : Hydro-Quebec, 2013

Table A3. Significance of the visual impact: Evaluation Grid

Landscape Unit Resistance	Perception facility level	**Visual impact Significance**
High	High	**High**
	Moderate	**High**
	Low	**Moderate**
Moderate	High	**High**
	Moderate	**Moderate**
	Low	**Low**
Low	High	**Moderate**
	Moderate	**Low**
	Low	**Low**

Source : Hydro-Quebec, 2013