METHODOLOGY FOR ASSESSING THE OPPORTUNITY OF FLOODING OF FORMER OPEN-PITS IN THE CONTEXT OF LAND RECLAMATION

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Abstract

As a result of open-pit mining exploitations, impressive size gaps occur in the landscape. Their flooding leads to the occurrence of so-called open-pit lakes and represents an interesting way to reclaim the degraded land. Because there is still no way to evaluate the opportunity of flooding the open pits, a methodology for assessing this opportunity was developed in order to identify the open-pits that are suitable for flooding. For this purpose, more criteria have been established that allow a complex assessment of the flooding opportunity. The methodology also aims to ensure maximum safety conditions in the former mining perimeter, the socio-economic and cultural requirements of local communities and the harmonization of the land in accordance with adjacent ecosystems.

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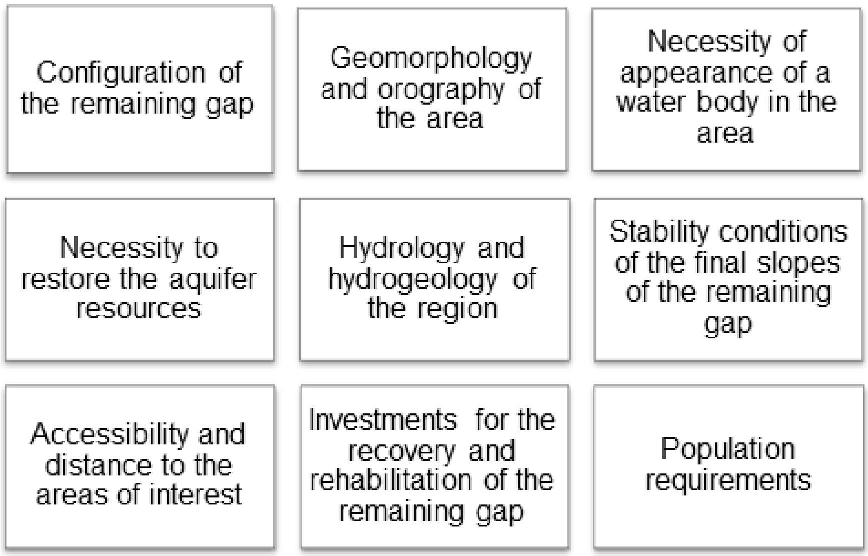


FIGURE 1 Assessing criteria

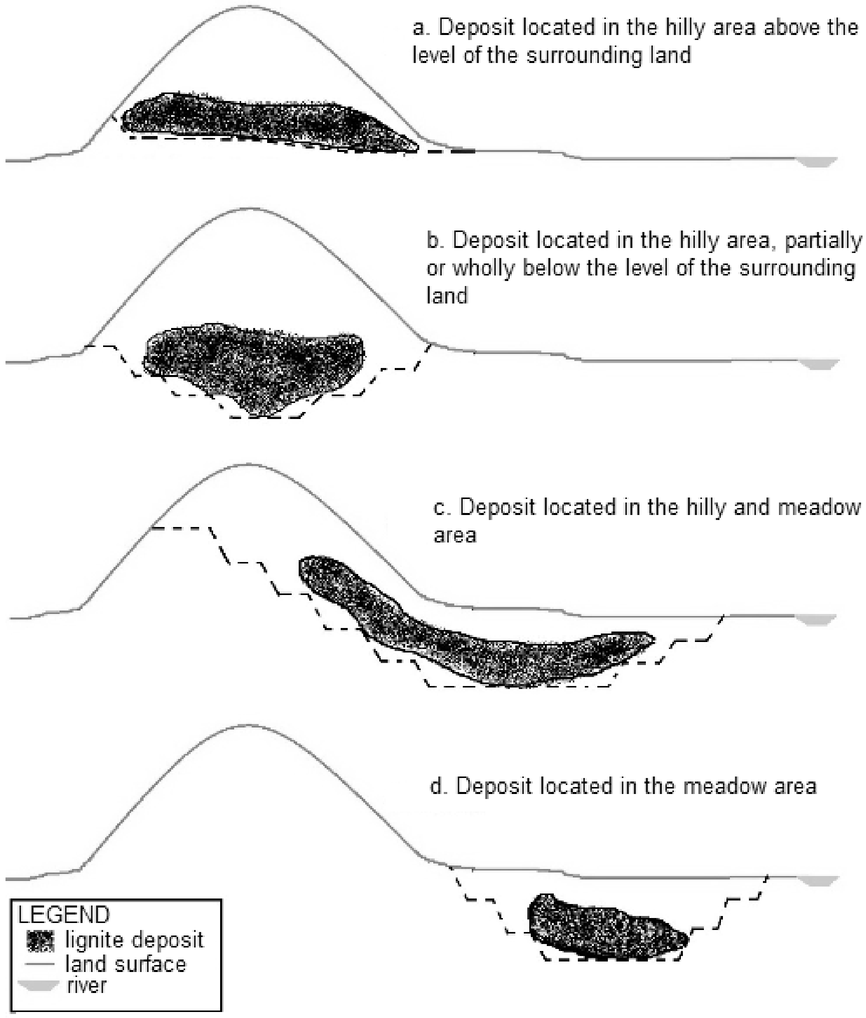


FIGURE 2 The shape of the open-pit according to the location of the deposit in relation to the forms of relief

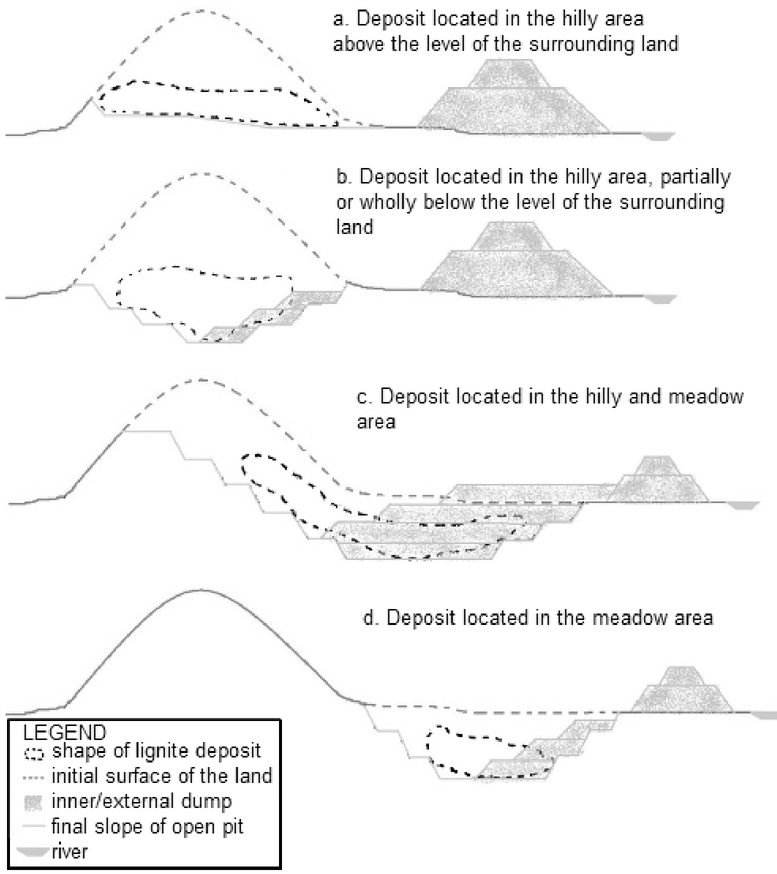


FIGURE 3 The shape of the remaining gaps according to the location of the deposit and the way of construction of the inner and external dumps

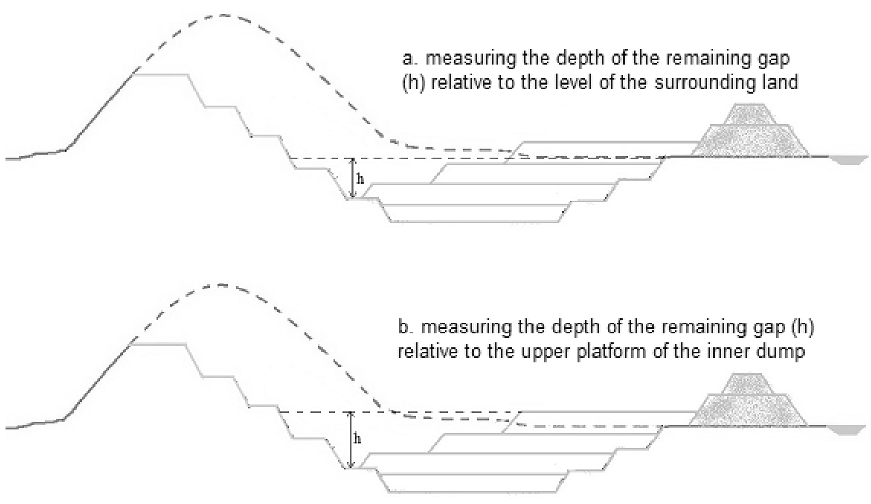


FIGURE 4 Measuring the depth of a remaining gap

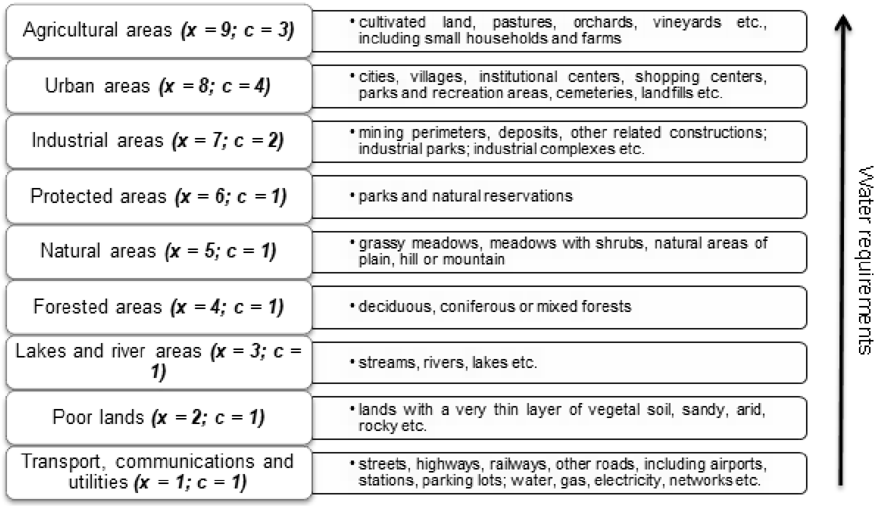


FIGURE 5 Types of land uses

FIGURE 6 Water requirements according to specific areas of activity

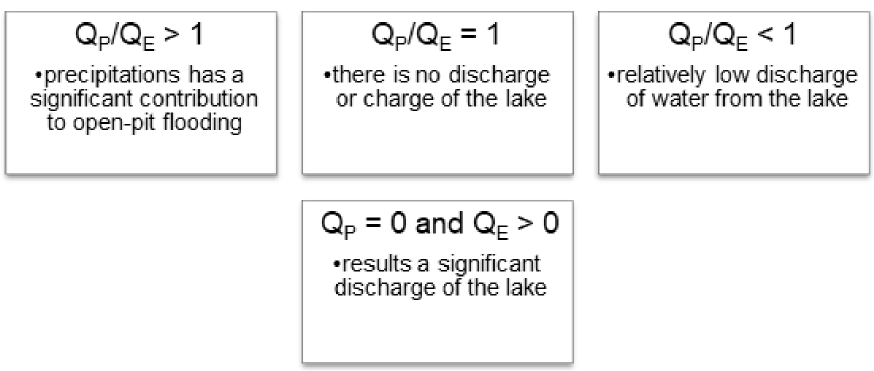


FIGURE 7 The amount of water contributing to the flooding

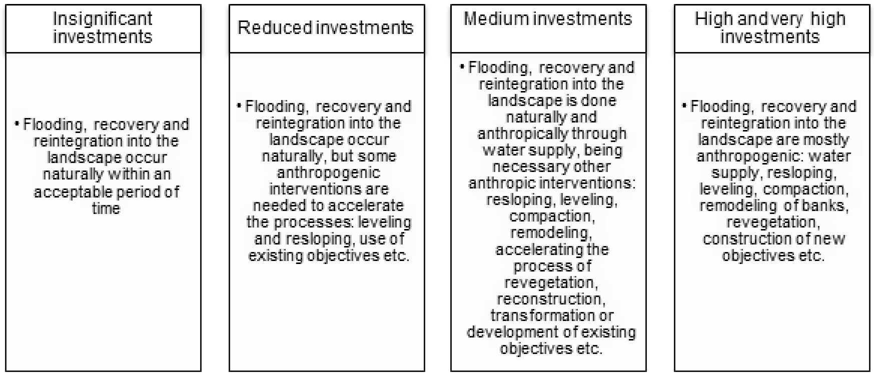


FIGURE 8 Classification and quantification of investments according to the nature of the necessary works

Score / Criterion	P = 0 - inopportune	P = 1 – reduced opportunity	P = 2 – average opportunity	P = 3 – high opportunity
C1	hilly or mountain area, the deposit is above the level of the surrounding land, practically does not result in a gap	hilly (or hilly and meadow area with extension to the hilly area) or mountain area, the deposit is partially or completely below the level of the surrounding land, reduced probability of occurrence of a remaining gap (it is likely to result in a remaining gap, but its dimensions are usually small)	hilly or hilly and meadow area, relatively high probability of occurrence of a remaining gap	meadow area, high probability of occurrence of a remaining gap
C2	practically does not result in a gap, h = 0 m	shallow depth of the remaining gap, h = 0 - 10 m	medium depth of the remaining gap, h = 10 - 30 m	high depth of the remaining gap, h > 30 m
C3	$M_b \leq 2$; predominates lands without special water requirements and for which water supply is not a priority; it is not necessary to restore the aquifer resources;	$2 < M_b \leq 5$; predominates lands with low water requirements, for which water supply is not a priority; average need for restoration of aquifer resources;	$5 < M_b \leq 7,5$; predominates lands with average water requirements, for which water supply is a priority; high need for restoration of aquifer resources;	$7,5 < M_b \leq 9$; predominates lands with high water requirements, for which water supply is a priority; major need for restoration of aquifer resources.
C4	for domain of activity that do not have water requirements (D0), there is no need of creating a lake	for domain of activity that have low water requirements (D1), reduced need of creating a lake	for domain of activity that have average water requirements (D2), the average necessity of creating a lake	for domain of activity that have high demands on water (D3), a major need of creating a lake
C5	- $Q_P = 0$, $Q_E = +$, it results in a significant discharge of the lake - 1st class, mining perimeter with reduced possibility of flooding from aquifer formations; - mixture of aquifer rocks (sands, gravels, etc.)	- $Q_P/Q_E < 1$, results in a relatively small discharge of the lake, but that can be covered by the influx of water from the aquifer formations - class II, mining perimeter with average possibility of flooding from aquifer formations; - mixture of predominantly aquiferous rocks	- $Q_P/Q_E = 1$, results that rainfall does not contribute to the flooding of the remaining gap, but there is no loss of water from the lake - class III, mining perimeter with high possibility of flooding from aquifer formations; - mixture of predominantly aquiclude rocks	- $Q_P/Q_E > 1$, results that rainfall has a significant contribution to flooding the remaining gap - class IV, mining perimeter with major possibility of flooding from aquifer formations. - mixture of aquiclude rocks (marls, clays, etc.)
C6	4th class of stability, Fs <1, unstable slopes, with active displacements;	3rd class of stability, slopes with reduced stability / at the limit of stability, Fs ≈ 1, slopes that can enter dangerous movement even as a result of the individual action of some triggering factors (such as the presence of water in the body of the slope as a result of heavy rainfall, explosions, earthquakes, vibrations from the vehicles of high tonnage machines or overloads given by overloading the berms / platforms, etc.);	2nd class of stability, slopes with high stability, Fs = 1.25 ÷ 1.5, slopes at which possible displacements can be recorded in case of concomitant or individual action of some triggering factors, but which can be limited by arrangements;	1st class of stability, Fs> 1.5, slopes with high stability reserve, at which the probability of sliding is very low or even zero (only in case of the simultaneous action of several triggering factors can slip phenomena).
C7	- dirt roads improved or unimproved, temporary, strictly for driving vehicles, closed to public traffic, hardly accessible - very long distance from the areas of interest (>50 km)	- paved roads, opened or closed to public traffic, accessible, very low traffic - relatively large distance from the areas of interest (10 - 50 km)	- semi-permanent roads, opened to public circulation, easily accessible, low traffic or medium - medium distance from the areas of interest (1 - 10 km);	- permanent roads, opened to public traffic, easy access, heavy or very intense traffic - low distance from the areas of interest (0 - 1 km)
C8	high or very high investments	average investments	reduced investments	does not require investment or involves very small, insignificant investments
C9	$P_f = (n_{var} - p_{lake}) \cdot c$ equation 3			

FIGURE 9 The matrix of evaluation of the opportunity of flooding of former open-pits

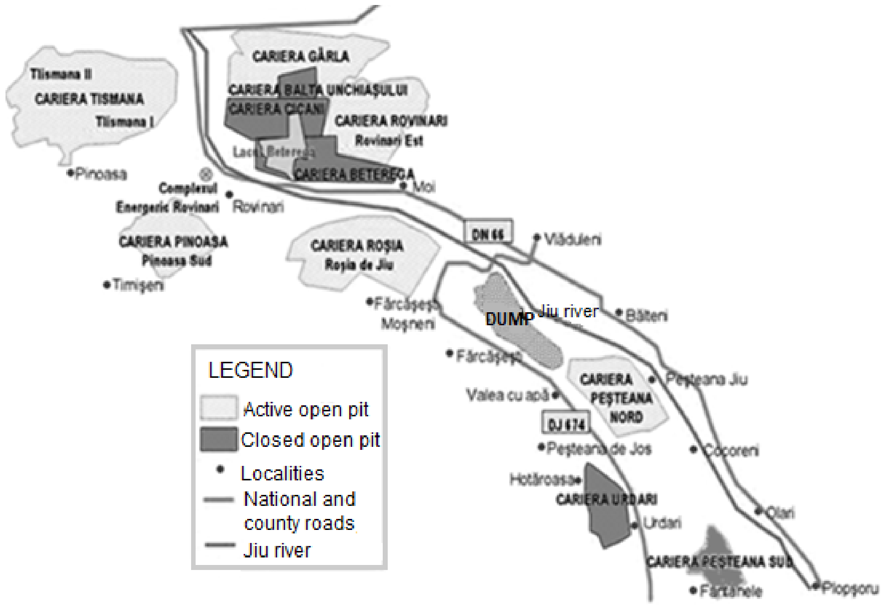
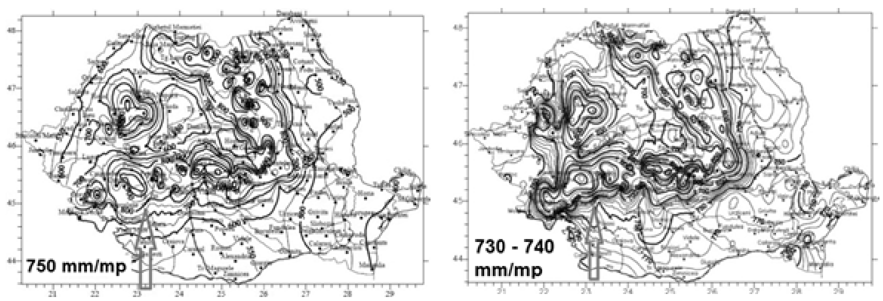


Figure 10 Rovinari Mining Basin (***, 2016-2019)



mm/mp = milimeters per square meter

FIGURE 11 Average annual rainfall (left), potential evapotranspiration (right) (Păltineanu, Mihăilescu, Seceleanu, Dragotă, & Vasenciuc, 2007)

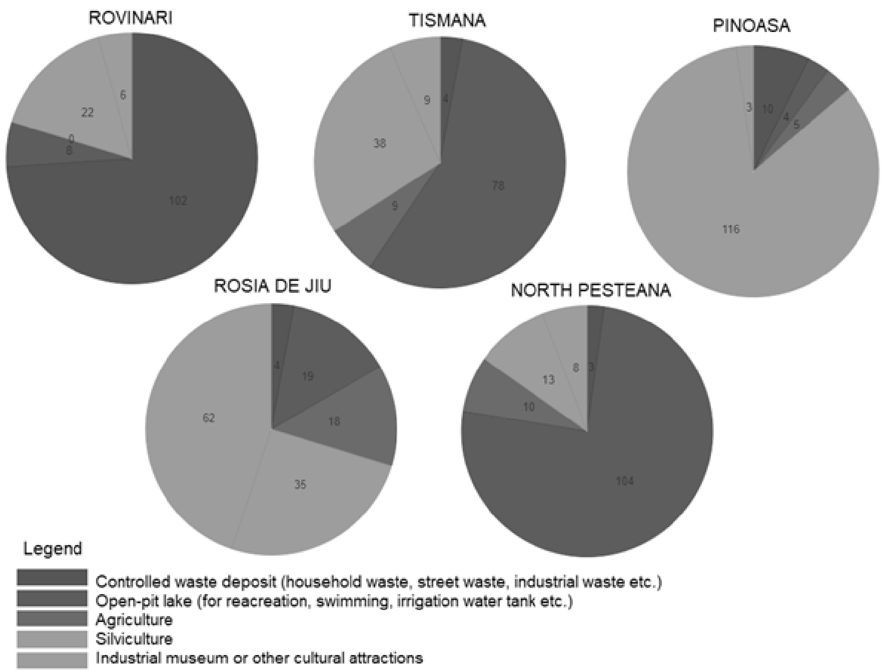


FIGURE 12 Partial survey results