

REVIEW / ARTÍCULO DE REVISIÓN

The future threat of desertification in Iraq

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DOI. 10.21931/RB/2023.08.02.85

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Abstract: Desertification worldwide has increased dramatically since the middle of the last century. This is also a dangerous threat to Iraq, primarily due to years of neglecting this issue. The areas affected by desertification vary from one country to another in the Arab region, which is about (40) million hectares in Iraq. The problem has mainly spread in Iraq due to military operations that have destroyed soil quality since 1980. This has led to other serious consequences: turning productive land into barren land, increased dunes, and increased pressure on groundwater to threaten food and water security. This study will discuss options to address the desertification problem in Iraq for now and how this will progress in 5 years. It will first identify the key issues of desertification in Iraq before evaluating the current and future problem environment. It will also provide potential solutions and a problem cluster now and in 5 years. It is essential to discuss how these will progress into the future, especially in Iraq's unstable political environment with an ongoing war. It will suggest some viable options for the country when political stability is achieved and outline how evaluation criteria can be applied to the possible solutions.

Key words: Desertification, Management, Iraq.

Introduction

Desertification worldwide has increased dramatically since the middle of the last century. Losing more than 40 % of the planet's land is degenerate, affecting half of humanity directly and threatening nearly half of the global GDP (US\$44 trillion)¹. According to United Nations reports, by 2050, the rate of land degradation is expected to reach 16 million square kilometers. This is also a dangerous threat to Iraq, mainly due to years of neglecting this issue. The areas affected by desertification vary from one country to another in the Arab region, as this area amounts to about (31) million hectares in Yemen, about (40) million hectares in Iraq, (93) million hectares in Sudan and (14) million hectares in Algeria². The problem has spread in Iraq due to military operations that have destroyed soil quality erosion since 1980³⁻⁵; This has led to other serious consequences: a turning of productive land to barred land, increased dunes and their adverse effects, declining forms of biota, increased air pollution and sand movement, increased pressure on groundwater, threats on food, drought and water security^{6,7}. This study discusses options to address the desertification problem in Iraq for now and how this will progress in 5 years. It will first identify the critical issues of desertification in Iraq before evaluating the current and future problem environment. It will also provide potential solutions and a problem cluster now and in 5 years. It is essential to discuss how these will progress into the future, especially in Iraq's unstable political environment with an ongoing war. It will suggest some viable options for the country when political stability is achieved and outline how evaluation criteria can be applied to the possible solutions.

Background of desertification in Iraq

The problem of desertification in Iraq began in 1970, and the major contributors include war, political stability, water scarcity, land clearing and degradation and climate

change^{8,9}. Desertification affected "69 % of Iraq's agricultural lands," according to Sarmad Kamel, the Director of the Planning Department in the Directorate of Combating Agricultural Desertification^{9,10}. Between 1970 and 2010, projected planted lands reduced from 12.2% to 8.3% of Iraq's total area¹¹.

War

Military operations, in particular, have caused significant damage, with heavy machinery breaking down surface soil and damaging desert vegetation. This increases the amount of minute suspended in the air, which impedes plant growth^{12,13}. The use of weapons by US forces in Kuwait and Iraq has spread toxic materials, and the burning of oil wells has also destroyed land through black and acid rain¹⁴. Not only did the activities and the severe economic embargo spread toxic material, the destruction of palm trees during the Iraq-Iran war (the 1980s) and destroyed soil, but unprecedented sandstorms across the country contributed to desertification^{15,16}.

Political instability

Due to years of war, the unstable government in Iraq continues to suffer and struggle for stability after the US occupation⁸. The conflict between Iran and Iraq also prevented the Ministries of Agriculture and Irrigation activities for land conservation and development due to directing those two ministries' capabilities to support that war from the former regime. The unjust siege in the nineties of the last century and the occupation of most areas by ISIS (2014-2017) in Iraq led to the reluctance of many projects related to combating desertification¹⁷.

Water scarcity

Desertification has largely been impacted by water

Citation: Alkhulaifi M. The future threat of desertification in Iraq. *Revis Bionatura* 2023;8(2) 84. <http://dx.doi.org/10.21931/RB/2023.08.02.84>

Received: 15 May 2023 / **Accepted:** 10 June 2023 / **Published:** 15 June 2023

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scarcity, and the most significant areas affected are in the south, center and west of Iraq¹⁸. There are several reasons for Iraq's problem with water scarcity. Firstly, despite the lack of research available on the impact of climate change in Iraq, water supplies in Jordan, Syria and Egypt have been affected by an increase in average temperatures¹⁹⁻²¹. Secondly, most of Iraq's water resource comes from neighboring countries such as Iran, Turkey and Syria^{22,23}. Also, Iraq's water supply decreased by 98%, whereas the Tigris and Euphrates decreased by 30% in the 1980s and is expected to drop to 50% by 2030²⁴. An increase in the demand for water and the construction of dams in these countries has resulted in a diminishing supply reaching Iraq. In addition to the large depressions in Lake Hamrin, the Iraqi Marshes, Dukan Lake, and Darbandikhan Lake²⁵.

Furthermore, the operation of hydroelectric power stations on its dams, and for this effect, this decrease may be important for generating energy used to support electricity needs²⁶. Since the 1960s, dams have been built in Syria (Bath and Tabqa dams) and Turkey (Karakaya, Keban and Ataturk dams). Thirdly is the ineffective management of water resources. Political instability and lack of knowledge, especially on barriers, have had a detrimental impact on Iraq's water resources management. In the 1970s, the canal Thartar was built for flood controls, and in 1985, the Haditha Dam was constructed to produce electricity; however, these dams have not saved sufficient water to meet the country's demands²⁸.

In addition, the difficulties imposed by the drought led many farmers to lose their work and leave their lands. Three thousand three hundred fifty-eight families were displaced due to climatic effects that led to desertification^{29,30}. Moreover, it ignited many social conflicts due to drought in the center and south (Planetary Security Initiative, 2020). The decrease in rainfall caused the returnees to their lands in Nineveh Governorate after ISIS displaced them to migrate again. The Iraqi president has sounded the alarm about climate change and water scarcity. Therefore, Iraq's existence is threatened, leading to the threat of 40 % of the area of Iraq to desertification³².

Climate change

Desertification has been affected by high average temperatures and lack of rain^{33,34}. The annual rainfall is less than 100mm in more than 72% of Iraq's area, causing severe movements in dunes leading to more excellent desert land^{35,36}. The lack of rainfall for the 2020-2021 season is the second driest in the past 40 years, which caused a decrease in water flow in the Tigris and Euphrates by 29% and 73%, respectively. Salinity has been another threat to land and the flows of the water of Tigris and Euphrates³⁸. A lack of awareness by farmers and insufficient drainage^{39,40} has caused this. Iraq is affected by drought, climate change and desertification, which in turn leads to soil erosion and a decrease in the productivity of a dunum^{41,42}. The loss of one centimeter of the surface layer of the soil leads to a reduction in the yield of crops by more than 2%. This soil erosion is due to weather factors and the failure to use sustainable methods to preserve soils from erosion⁴³.

Human activity

This relates to the misuse of natural resources and erroneous practices by humans, including land clearing⁴⁴. This has become a concern after 2003 due to war and the lack of strong laws and enforcement. An increase in urban

population from 35% in 1950 to 75% in 1995 in particular, and the Iraqi president indicated that the people of Iraq in 2022 will rise from forty-one million to fifty-two million after ten years, has led to the clearing of forests to meet the demand of overpopulated cities and lack of vertical housing. There is no central plan for implementing housing projects, leading to the encroachment of cities horizontally and the abuse of arable land.

Evaluation of the current management environment

The management of the Directorate of Combating Agricultural Desertification (DCAD) in Iraq now includes 3 central departments: the technical section (Department of Planning, Department of Investment of Western Sahara (Iraq), Department of rangeland management, Department of Water wells), the administrative section and the department of the project that some small department in states primarily in the southwest of Iraq (Draft desert oases Draft dunes (Dhi Qar and Baiji), Draft development of natural vegetation, Draft drilling water wells, Hammad Basin Development Project).

Current actions

The Directorate of Combating Agricultural Desertification (DCAD) is one of the Ministry of Agriculture formations that has fought against desertification due to its threat to food security and long-term environmental damage. Some activities by the DCAD and its state departments were undertaken before the war in 2003 and have now slowed down or ceased. The projects are outlined as follows:

The dune stabilization project

Desertification is devouring, along with salinization, about 200,000 dunums of arable land annually in the current situation for two reasons: the first is the scarcity of water from its sources outside the borders and poorly quality infrastructure in the water sector⁴⁶ and the second is the weakness of sustainable plans to combat desertification and build green areas which depend on irrigation and traditional practice in agriculture^{47,48}. It extends from the Diwaniyah desert in central and southern Iraq and the Al-Baaj deserts in northwest Iraq^{9,49}. To address these shifts, some sand dunes have been installed in Dhi Qar and Baiji. Table 1 shows these activities in 2005-2006, further outlined below.

Mechanical methods (mud coverage)

The sand dune is covered with a layer of heavy soil about 15 to 20cm in thickness. After rainfall, it helps prevent movement of the sand and gives the opportunity to plant seeds for natural growth.

Biological methods

This occurs after the coverage of the mud, where trees and shrubs that are tolerant of salinity and drought are planted in the form of green belts and windbreaks.

Dry Farming

The sands of the central region (state of Salah al-Din and Baiji) have the ability to retain moisture. To take advantage of the humidity, the plan (humid farming) has long roots and is planted at a soil depth suitable for after being soaked in water for 24 hours.

Production of seedlings

Seedling production of oasis and desert plants tolerant

	2005			2006		
	Planning	Implementation	Proportion of implementation	Planning	Implementation	Proportion of implementation
Mud coverage	5000 Donum	600 Donum	12%	1000 Donum	1098 Donum	101%
Seeding production	2 million seedlings	750 seedlings	0.0375%	Million seedlings	417500 seedlings	42%
Tree planting	500000 trees	172,400 trees	35%	Million trees	477650 trees	45%
Seed collection	50 tonnes	16.250 tonnes	32%	-----	-----	-----

Table 1. Dune protection in Dhi Qar and Baiji. to drought and salinity is needed to install sand dunes.

Project desert oases

Creating oases in the desert in the west of Iraq to encourage investment in the desert, relying on groundwater to provide water for sheep farmers and planting natural vegetation to enhance the environment. Table 2 shows these activities.

Hammad Basin Development Project

Basin in Hammad, located in western Iraq, is part of a joint venture with neighboring countries (Saudi Arabia, Jordan, and Syria) and extends over 32,500 km², about 13 million acres. This is equivalent to about 7.4% of the area of the country. The main beneficiaries of this project are the nomadic people, and pastoral plants are considered the most essential sources in the provision of food for animals. The region, in recent years, has been affected by overgrazing and degradation by human and animal activity.

Establishment of model farms

These farms grow with crops that are resistant to salinity and drought. This project aimed to create farms that use sprinkler irrigation to grow plants in appropriate environmental conditions, such as palm, olive and other trees in the states of Anbar, Najaf, and Karbala.

Project drilling water wells

This project involved drilling wells to provide water for modern irrigation technologies in Kirkuk, Nineveh, Salahuddin, and Anbar. This project ceased after 2003 because of the deteriorating security situation and damage to big rigs. Table 4 illustrates the number of water wells completed in Nineveh.

Prediction of management environment in the future

If the war continues (now with ISIS) and political instability remains, developing the (DCAD) will be difficult. However, if the conflict is resolved, the management environment in the future should improve and open more pro-

Activities	2005			2006		
	Plan-ning	Implementa-tion	Proportion of implementation	Plan-ning	Implementa-tion	Proportion of im-plementation
Establishment Oases	6 Oases	-----	-----	2 Oa-ses	1 oasis	50%
Plantation	500000 Tress	65000 Tress	13%	-----	-----	-----

Table 2. The Desert Oases project.

Activities	2006		
	Planning	Implementation	Proportion of implementation
Establishment of pasture plants (farms)	2	1	50%
Production of seedling	9000 Seedling	80000	89%

Table 3. Development project of vegetation (natural pasture).

Current options	Estimated progress in 5 years
<p>There are some options now, but they are limited due to the war.</p> <ul style="list-style-type: none"> • Stop all military operations and remove landmines and explosives in the ground (requires the support of international organizations). • Resume all projects of DCAD <ul style="list-style-type: none"> - Sand dune stabilisation - Development of natural pastures by increasing agricultural and grazing stations in various parts of Iraq - Increasing green areas in the desert through the development of natural grass - Creating oases • Provide sufficient funds and increase activities by government for the DCAD projects 	<ul style="list-style-type: none"> • Some areas are free from landmines and explosives (if military operations stop) • If funding is provided, there is potential for projects to reach completion in 5 years and increase the breadth of activities across Iraq (depends largely on access to areas and security)

Table 4. Project drilling water wells in Nineveh. Projects in all areas, particularly in the southwest states. The DCAD's management in the future includes the technical section(Department of Planning, Department of Investment of Western Sahara (Iraq), Department of Rangeland Management, Department of Water wells), the administrative section and the Department of Project that some small departments in states primarily in the southwest of Iraq (Draft desert oases(Anbar, Najaf, Karbala, and Muthana) Draft dunes (Dhi Qar, Anbar, Najaf, Karbala, and Muthana and Biji), Draft development of natural vegetation(in all states of the southwest of Iraq), Draft drilling water wells(Nineveh, Kirkuk, Anbar), Hammad Basin Development Project)

If the current status of the situation continues into five years later, it will get worse. Much of Iraqi land and environment is likely to become desert by 2020, putting Iraq's food and water security at significant risk. However, suppose the war resolves and a more stable political environment is achieved. In that case, there is potential to treat this problem with specialists and experts in the field of desertification and apply modern technology to address this problem. Additionally, the enforcement of strict laws to stop the logging and removal of vegetation for various purposes, including residential and agricultural purposes and, particularly, for growing wheat and barley in western Iraq because these crops only depend on rain for irrigation. Preventing overgrazing by the owners of the animals is another factor that has affected the land severely.

It is also essential to address water to combat desertification in Iraq and water and food security in the future. There are two possible solutions to this problem. Firstly, the government should implement sustainable management plans and focus attention on the Tigris River because it has several tributaries in the mountains of Iraq⁵⁰. Building dams in this area can provide water catchment in spring and summer when the snow melts from the north of the Iraq Mountains. Also, the government should focus on improving resources from the Tigris River as it directly enters Iraq, which

differs from the Euphrates that entered Syria before Iraq⁵⁰. The government should also build a strong relationship with neighboring countries, especially Turkey, to improve access to the Tigris and the Euphrates. Although the government can improve water management through better use of technology, such as adopting modern irrigation techniques, improving the successful water management practice would be much more effective in the long-term water supply⁵⁰.

Problem clusters

The current situation

The problem of desertification in Iraq can be further investigated according to its clusters, shown in Figure 1. All collections have played a significant role in the worsening of desertification; however, Iraq's ongoing war, political stability, and water scarcity are considered the most critical factors that have heavily contributed to this problem.

The future situation

If the war and political environment continues, the problem will grow. The priority is security for people, but if the political situation improves, the future of desertification in Iraq can be determined according to its clusters in Figure 2.

Current options to alleviate desertification and their progress in the next 5 years

After 2003, many businesses and infrastructure has been affected by military operations and the security situation faced in Iraq. This has also led to the termination of environmental projects, including plans to address desertification. If the war continues, the problem is likely to increase, but Iraq has options if the war resolves. Figure 3 shows how the desert is expanding in Iraq. Iraq is located between six countries, and the government needs to build strong relationships with these countries, especially with Turkey, Syria

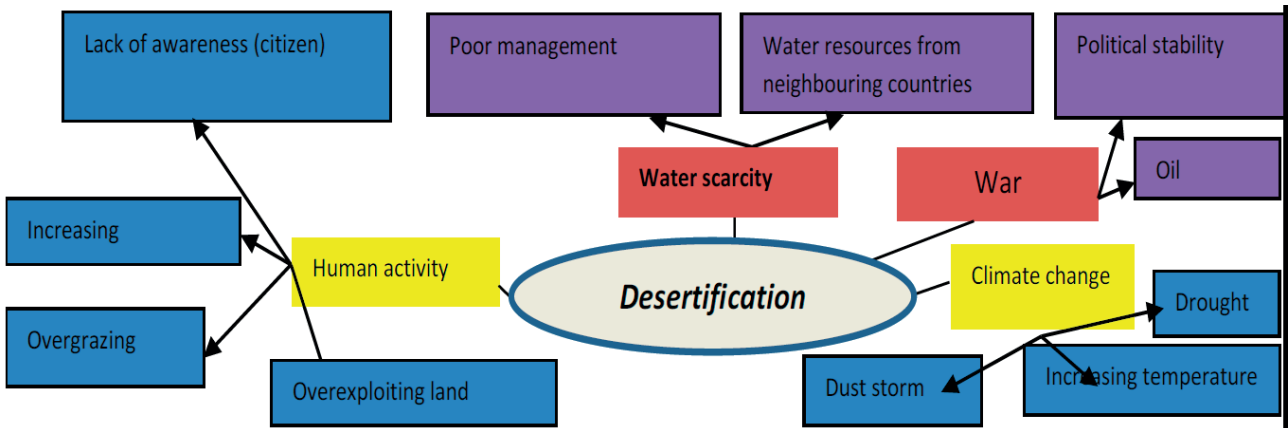


Figure 1. The major problem clusters contributing to desertification now.

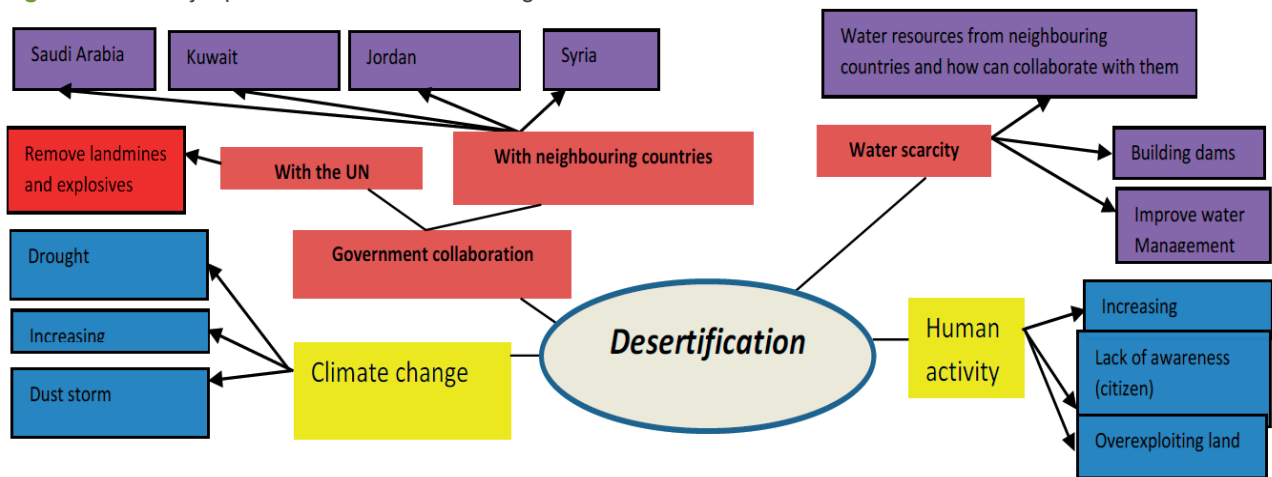


Figure 2. The major problem clusters contributing to desertification in 5 year

and Iran, which holds many of Iraq's water sources. The Tigris River is a precious resource that can be utilized with careful water management and the construction of dams.

Additionally, the desert in western and southern Iraq extends into neighboring countries (Syria, Jordan, Saudi Arabia and Kuwait) and will, therefore, need cooperation to address the problem. Table 5 shows options for addressing the issue of desertification now and in the next 5 years. This shows how the southwest of Iraq is at most significant risk of desertification. It is predicted that if the current spread of the desert continues.

Future options and the best time for a problem resolution

The ideal time to act on Iraq's desertification problem is when the war concludes, and political stability is achieved. However, Iraq is at risk of a significant environmental disaster due to neglect of the environment and attempts to turn Iraq into a country of consumers. In the near future, options must be made to accommodate the unpredictable political situation. Table 6 shows future opportunities with a more excellent guarantee of success.

Table 9 shows the actions to combat desertification if the war stops. Removing all the landmines and explosives in the ground with the support of international organizations is the most essential action. Many states have no plans to combat desertification, so it is necessary to increase the number of state departments, particularly in the southwest of Iraq. This is followed by building solid relationships with neighboring countries to manage desertification and water scarcity through joint projects to build dams and improve water management. Also, there needs to be better policies

on land and water use and enforcement of laws. The government also needs to be restructured so the local governments can decentralize power to monitor the progress and evaluate the success of these actions.

Conclusions

Desertification in Iraq has become a severe threat, especially to arable land and food and water security. The country has attempted to address this issue, particularly with the initiation of the DCAD desertification projects, but the wars in Iraq and political instability have hindered further development. This report has examined the problem according to its environment and clusters, discussed how the current options will progress, and suggested other options for the future. Overall, solutions need to cope with the economic, institutional and technical resources available and the unpredictable political situation.

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Current options	Estimated progress in 5 years
<p>There are some options now, but they are limited due to the war.</p> <ul style="list-style-type: none"> • Stop all military operations and remove landmines and explosives in the ground (requires the support of international organizations). • Resume all projects of DCAD <ul style="list-style-type: none"> - Sand dune stabilisation - Development of natural pastures by increasing agricultural and grazing stations in various parts of Iraq - Increasing green areas in the desert through the development of natural grass - Creating oases • Provide sufficient funds and increase activities by government for the DCAD projects 	<ul style="list-style-type: none"> • Some areas are free from landmines and explosives (if military operations stop) • If funding is provided, there is potential for projects to reach completion in 5 years and increase the breadth of activities across Iraq (depends largely on access to areas and security)

Table 5. Options to address desertification and their progress in the next 5 years.

Option	Description
Development of standards and indicators	To monitor the progress of activities and areas protected from desertification
Securing land area to access for environmental activities	Removing all the landmines and explosives on the ground in cooperation with international organizations
Enforce laws and appropriate policy.	Mainly to control land clearing for the growth of wheat and barley by Bedouin Tribes.
Improve cooperation between all stakeholders and government states	Increase the autonomy of local governments in the decision-making process
An increasing number of DCAD departments, especially in the western and south of Iraq	As many states do not have an institutional structure to address desertification,
Improving and developing water management and building dams	Utilise water resources, especially in the north of Iraq, which is important to address water scarcity in the long term
Building strong relationships and cooperation with neighboring countries	Collaborative effort to address desertification and improve access to water
Improve dissemination of knowledge, skills and tools	Important for the long-term sustainability of efforts

Table 6. Future options (ideally after the war).

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8. NRC. (2021b). Iraq's drought crisis and the damaging effects on communities.

Criteria	Important Questions for Today	Important Questions for the Future
Political appraisal	<ul style="list-style-type: none"> • Is the political environment stable enough? • Is the area secure enough for activities? • Consider the military operations against ISIS • Consider access to land • Can Iraq be responsible for this issue alone? (or requires the support of other countries) • Are existing institutional structures adequate for the solution? • Does the solution consider the possibility of corruption? • Are the policies in place adequate and address the key issues? 	<ul style="list-style-type: none"> • Does it consider the different outcomes of the war (if the conflict continues or resolves)? • Does it consider changes in political sectors and organization? • Consider corruption in the government. • Consider changes in authority. • Are policies and laws effective?
Social appraisal	<ul style="list-style-type: none"> • Does it consider the needs of Bedouin tribes that live in the desert? 	<ul style="list-style-type: none"> • Are the needs of the Bedouin tribes protected?
Economic appraisal	<ul style="list-style-type: none"> • Does it address the needs of the agricultural sector? • Consider that the costs are financially viable during the war. 	<ul style="list-style-type: none"> • Are projects costs efficient? • Has it benefited the agricultural sector? • Evaluated according to the costs and benefits?
Technical appraisal	<ul style="list-style-type: none"> • Is training required? • Are all technical needs sustainable? • Will the resources be available when needed? 	<ul style="list-style-type: none"> • Is training valuable in the long term? • Can the solution be successful without certain resources?
Sustainability appraisal	<ul style="list-style-type: none"> • Can the solution be sustained over the projected timeline? • Can the solution handle sudden changes (particularly during war)? • Will all stakeholders support the solution? 	<ul style="list-style-type: none"> • How has war affected the solution's sustainability? • Does the solution require the commitment of all stakeholders?

Table 7. Criteria for selecting solutions to desertification in Iraq.

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Option	Criteria					
	Political appraisal	Social appraisal	Economic appraisal	Technical appraisal	Sustainability appraisal	Total Score
Development of standards and indicators	4	4	4	5	4	21
Cessation of Military operations and political stability	5	5	4	5	5	24
Strict law and appropriate policy	5	4	5	4	4	22
Improve cooperation between all stakeholders and government states	4	4	5	4	5	22
Complete all projects of DCAD	5	4	5	5	4	23
Improving and developing water management	5	4	5	5	4	23
Building strong relationships and cooperation with neighboring countries	5	4	5	5	4	23
Improve dissemination of knowledge, skills and tools	4	5	4	5	4	22

Ordinal level: A-Excellent =5, B- Very good =4, C- Good= 3, D-Fair = 2, E- Poor =1

Table 8. Option evaluation at the operational level now.

Option	Criteria					
	Political appraisal	Social appraisal	Economic appraisal	Technical appraisal	Sustainability appraisal	Total Scores
Development of standards and indicators	4	4	4	4	4	20
removing all the landmines and explosives on the ground in cooperation with international organizations	5	5	4	5	5	24
Strict law and planning appropriate policy	5	4	4	4	4	21
Improve cooperation between all stakeholders and governments' states	4	4	4	4	5	21
An increasing number of DCAD departments, especially in the western and south of Iraq	4	5	5	5	4	23
Improving and developing water management and building dams	4	4	5	4	4	21
Building strong relationships and cooperation with neighboring countries	5	4	4	4	5	22
Improve dissemination of knowledge, skills and tools	4	4	4	4	4	20

Ordinal level: A-Excellent =5 B- Very good =4 C- Good= 3 D-Fair = 2 E- Poor =1

Table 9. Option evaluation at the operational level if the war stops.

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