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Discovering agricultural fires and role of the various actors in the South-East of Algerian Sahara: the case of Berriane oasis. A descoberta dos incêndios agrícolas e do papel dos vários intervenientes no Sudeste do Sahara Argelino: o caso do oásis de Berriane.

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Abstract

This research aims to identify the various actors and their missions to fire management in Berriane oasis; a south-east region of Algeria known for its challenging environment and dense oases. The research is conducted in three main steps respectively involving the characterization of oases fires in the Berriane region, analysis of the spatial variability of fire in relation to the human and environmental factors, and finally, role of the different actors by the MACTOR method. The analysis of structured games between actors allowed assessing their influences and dependencies. Results confirm the role of actors of agricultural fires management the protection of the oasis ecosystem.
Keywords: Fire. Management. Environment. Oases fires. Games. Agricultural fires.

Resumo

Esta pesquisa visa identificar os vários atores e suas missões para o manejo do fogo no oásis de Berriane; uma região sudeste da Argélia conhecida por seu ambiente desafiador e oásis densos. A pesquisa é conduzida em três etapas principais, envolvendo respectivamente a caracterização de oásis de incêndios na região de Berriane, análise da variabilidade espacial do fogo em relação aos fatores humanos e ambientais e, finalmente, o papel dos diferentes atores pelo método MACTOR. A análise de jogos estruturados entre atores permitiu avaliar suas influências e dependências. Os resultados confirmam o papel dos atores do manejo de queimadas agrícolas na proteção do ecossistema oásis.
Palavras-chave: Incêndios. Gestão. Ambiente. Incêndios de oásis. Jogos. Incêndios agrícolas.

1. Introduction

The Oasis Algerian has a rich of the palm trees groves and various ecosystems, but the vegetation coverage accounts for only a small part of Algeria's vast territory, due to the inexorable advance of the Sahara and dry environment.

Berriane is one of the thirteen oases that encompass the region of Ghardaia (Algerian Sahara); it is part of the territory of the territory of the Mzab, one of the Algerian Oasis that faces a rapid regressive forest dynamic in the north-central Algerian Sahara. Located in the bioclimatic arid region of Sahara, this region is affected by sand encroachment and degradation of the ecosystem, on more than 2 million hectares of soils and rangeland (Bouarfa et al., 2020; Bouarfa; Bellal, 2018) under the effect of a particular climate (Missoumi et al., 2002).

Saharan and arid areas in Algeria are characterized by the ecosystem fragility of oasis. They are the first zones subject to degradation of the plant cover forest is particularly sensitive, because it is dominated by date palm trees. Furthermore, due to the chronic drought that has become a structural phenomenon, the forest systems are permanently disturbed by the negative effect of humans, animals in this fragile ecosystem area.

In oasis ecosystems, agricultural fires are mainly caused by human activities due to negligence (for example, fires from agricultural burns). In general the country is characterized by 80% of unknown fires and a very low percentage of natural fires, as elsewhere, makes it difficult to set up a prevention policy focused on social groups or specific activities (Meddour-Sahar, 2015). In Sahara region, malicious fires rarely occur in oasis ecosystems when compared to northern regions of country. More than dozens palms trees recorded as material losses in Berriane oasis, according to data announced by the Civil Protection in 2021. Also this oasis affected by the various fire, since it experienced more than 172 various episodes between 2008 and 2018 (DPSB, 2018).

This paper is an explorative essay of the main causes and the effects of oases fires on the various oasis ecosystem particularly in the oasis of Berriane in the northern Algerian Sahara which are, essentially the most affected by the fire, although there is a tangible local effort to reduce it. Also, with the purpose of understanding the role of actors of fires management and protect the oasis ecosystem.

The research objectives identify actors participated in reducing the spread of agricultural fires and analyze the potential for alliances or conflicts in achieving the goals. Also, with the purpose of understanding the role of actors in fires management and protect the oasis ecosystem.

2. Material and methods

2.1. Approach and methods

In this paper, in order to decipher the role of actors against agricultural fires in the Berriane region, we will analyze the actors' games using the MACTOR method, Mactor (Matrix of Alliances and Conflicts Tactics, Objectives, and Recommendations) method is a technique and software is developed by Michel Godet (Godet, 2001). The working theory of MACTOR is to perform a matrix analysis based on the relationship of control between actors in the form of a matrix, which is referred to as Matrix of Alliance, Conflict, Strategy, Goal, and Recommendations by its abbreviation. To analyze actions system in agricultural fires management of oasis areas and protect the oasis

ecosystem. From using this method of analysis, we propose to estimate the balance of power between the actors, the convergences and divergences of the objectives.

The analysis of MACTOR provides an analysis of relationships directly and indirectly, in which the actor's position, convergence, divergence, and mobility from actor to actor are analyzed. Several articles science determine different influence patterns not only relying on power also demonstrate whom actors can influence other actors (Rees et al., 2017), who are key players (Mangifera; Isa, 2019), and who can evaluate the balance of power between actors in the chain supply was carried out (Elmsalmi; Hachicha, 2014), and encouraging the various actors involved in the technology transfer system in the Agricultural (Andrianyta et al., 2022).

Data were obtained through interviews with actor representatives following the Godet technique (Godet, 2007). There are several interview phases that are passed to be able to analyze the relationship between actors and MACTOR analysts, as shown in Table 1.

Table 1 - summarizes the main steps and tools of the MACTOR model

Stages	Inputs	Tools	Outputs
1	Create the table of actor's strategies (Identify Actors)	Key variables of the analysis	Structuring of the actors involved (Table listing actors and actor strategies)
2	Objectives. Challenges, threats and opportunities	Triangulation	Table issues objectives
3	Motivations, constraints, and means of action	Describe approaches • Focus groups • Survey	Table of actors
4	Actor positions x objectives	Matrix "actors x objectives" 1MAO	Identifying convergences and divergences simple averaging the two stamped
5	Actors x actors influence and dependence	Matrix Direct Influences MID	•MIDI: Matrix of direct and indirect influences • Global influence (I) and dependence (D) coefficients • Power of actors: relative strength standardized coefficient Ri (scale ranging from 0 to 4)
6	2MAO, MIDI	Factorial analysis	Obtaining: tables and graphs

2.2. Study area characteristics

The study area is the oasis of Berriane, in the south-east of Algerian Sahara, part of the northern Algerian Sahara (Figure 1), where it forms a crossroads that links the four regions of Algeria (south, east, west and north); located about 600 km southwest of Algiers.

To date, this oasis has evolved into city in the part north of M’zab Valley which is classified as a town according to the administrative division from 1984. It is a distance of 40 km far from the capital of the wilaya. The area of this town is mostly occupied by oasis agriculture and palm trees groves, are increasingly threatened, facing serious degradation constant (Addoun; Hadeid, 2022).

The Oasis of Berriane is the subject of our study (Figure 2). They are characterized by a dry to hyper dry climate, intra-annual variability of temperature. The maximum temperature can reach

50°C during the summer season. Weather changes and rainfall show up mainly in late fall and winter: with a mild winter, and an average annual rainfall is around 48 mm/year (ONM, 2019).

However, thanks to the existence of large palm areas, the temperature in the middle of a huge palm forest can go down to 14°C. During the winter period, the temperature drops to 4°C. So, high temperature in summer causes sudden fires, due to unknown causes in the oases are related indirectly with a human activity; we label them anthropogenic (e. g. stubble burning...). People still well remember the last conflict of the group social (Rouibi, 2016; Oussedik, 2015). It caused material and other damage; and conflict over socio-economic conditions, also the fires in the old palm grove.

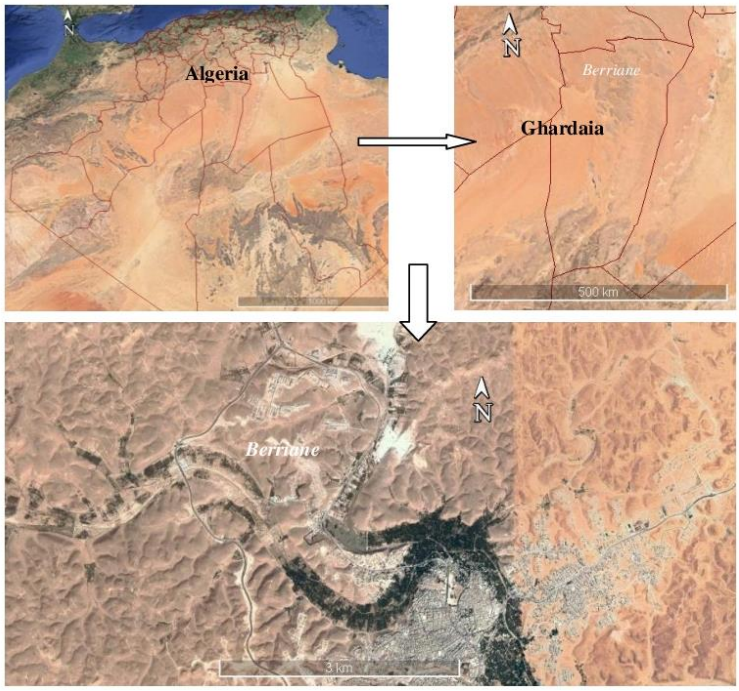


Figure 1 - Study area location (source: author's own elaboration, 2022)

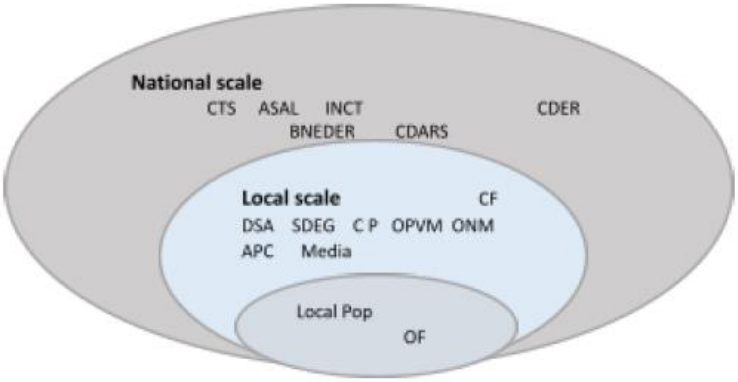


Figure 2 - Relevant agricultural fires management stakeholders in the study area (Source: Author's own elaboration)

- **National scale actors:**
  CTS: The Space Technology Center
  ASAL: Algerian Space Agency
  INCT: National Institute of Cartography
  CDER: Research Center in Renewable Energy
  BNEDER: National Office for Rural Development Studies
  CDARS: Commission for the Development of Agriculture in the Saharan Regions

- **Local scale actors:**
  CF: Forest conservation of the wilaya of Ghardaïa
  DSA: Directorate of Agricultural Services
  SDEG: Algerian Company for Electricity and Gas Distribution
  C P: Civil Protection
  OPVM: Office the protection and promotion of M'zab Valley
  ONM: National Office Meteorological of Ghardaïa Station
  APC: Municipal People's Assembly
  Media: Media (Radio Ghardaïa)
- **Local representatives:**
  Local Pop: Local population (palm grove owner)
  OF: Oasis farmers

3. Data collection and analysis

Strategic analysis includes an analysis of the strategies of different actors involved. In the first phase, focus groups and series of interviews with potential key informants have allowed us to select main actors (Table 2). Sixteen key actors are considered to play a central role in the reduction of agricultural fires in the Berriane oasis.

As can be seen from Table 3, the main objectives of the different actors operating within the territory of Berriane are related to local fires. We have finalized a list of 13 objectives that are considered to be pursued by the main actors identified in key areas that determine the future Heritage of the palm forest in the region of Berriane (Table 2).

Table 2 - List of major actors of reduce fires in the local system

	Actor	Description
1	CF	Local responsible for Forest management
2	DSA	Responsible for Agricultural Services in local scale
3	CDARS	Institutions that are partners of Development agriculture in the Saharan Regions
4	SDEG	Is a state-owned utility in charge of electricity and natural gas distribution in Algeria
5	C P	Civil security is the set of means implemented by a State to protect its citizens
6	O F	Individuals in the palm grove
7	CDER	Institutions that are partners of research Development in the field of renewable energy
8	BNEDER	Plan Rural development in the fields of rural Development, rural economy, rural social, and agricultural
9	OPVM	A public institution concerned with the protection and promotion of M'zab Valley
10	ONM	Climate data sources
11	APC	Responsible for local government structures.
12	Local Pop	Groups or individuals who represented by local farmers in the palm grove
13	Media	Means of communication and dissemination of information
14	CTS	Researchers and extension agents from Research and Development institutions
15	ASAL	Is a national public institution with a specific character,
16	INCT	Institutions that are partners of research Development as sources of knowledge

Source: author's own elaboration, 2022

In the second phase, face-to-face interviews have been conducted with each actor in agricultural fires of oasis, in order to identify issues and objectives (Table 3). Having based the list

of actors and associated objectives, a detailed survey was conducted with a sample composed of 40 farmers in the region of Berriane.

To a large extent, these goals can play a role in the development of the oases heritage, and Exploring agricultural fires, the pursuit help helps to knowing more about the motives underlying agricultural fires and arson, and ways of managing in Sahara region.

Table 3 - List of major objectives used in the empirical analysis

	Objectives	Abbreviation
1	Sensitize the population to the importance of the forest	Sen. Pop. for
2	Open the rural tracks in oases and forests	Op. Rur. Tra
3	Monitoring of forest areas	Mon. for. area
4	Monitoring and alert system	Mon. aler. area
5	Prevention and fight against forest fires	Pre. for. fir
6	Monitor and assessment of forest cover	Mon. ass. cov
7	Forecasting of the meteorological risk and the water status of the vegetation	Fo. Mete. veg
8	Participation in reducing the fires in the old palm grove.	Par. re. oasi
9	Rural electricity connection	Rur. Elec
10	Control forest cover assessment	Con. for. cov
11	Encouraging the afforestation and reforestation	Enc. aff. ref
12	Fire fighting, and fire prevention	Fir. figh
13	Protection of Ecosystem	Pro. Eco

Source: author's own elaboration, 2022

4. Results and discussion

4.1. Agricultural fires in the oasis of Berriane

Preliminary results through field observations, permitted to identify two types of fires, which are included in agricultural fires, which can be the result of the extreme thermal phenomena during the summer period and its interaction with other plant factor such as the spread of grassy, and dry plants (Krimi, 2022).Or a human factor as a result of neglecting palm nests and reckless use of fire within the forest field (Krimi, 2022).

As follow:

- Agricultural fires or fires in the old palm grove system, which is witnessing a major degradation today by anthropogenic pressure;
- Stubble burning is a practice of removing paddy crop residues from the field for sowing (Saini et al., 2019). Farmers in the perimeter of Berriane burn their field after the crop harvest, considering stubble burning as a low-cost disposal practice and preparing land for next seeding operations.

Figure 3 - Stubble burning (elimination of cereal residues) in the irrigated perimeter outside the oasis of Berriane (phot. T. Addoun, 2022)

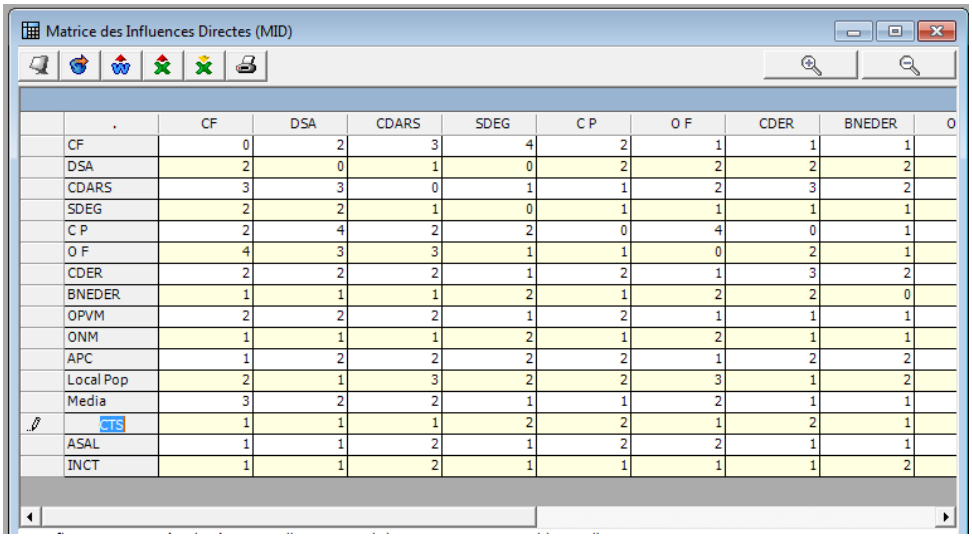
Figure 4 - This is a Fire "palm grove" in the oasis of Berriane (phot. Civil Protection, 2022)

4.2. Actor’s strategies

4.2.1. Analysis of actors strategic

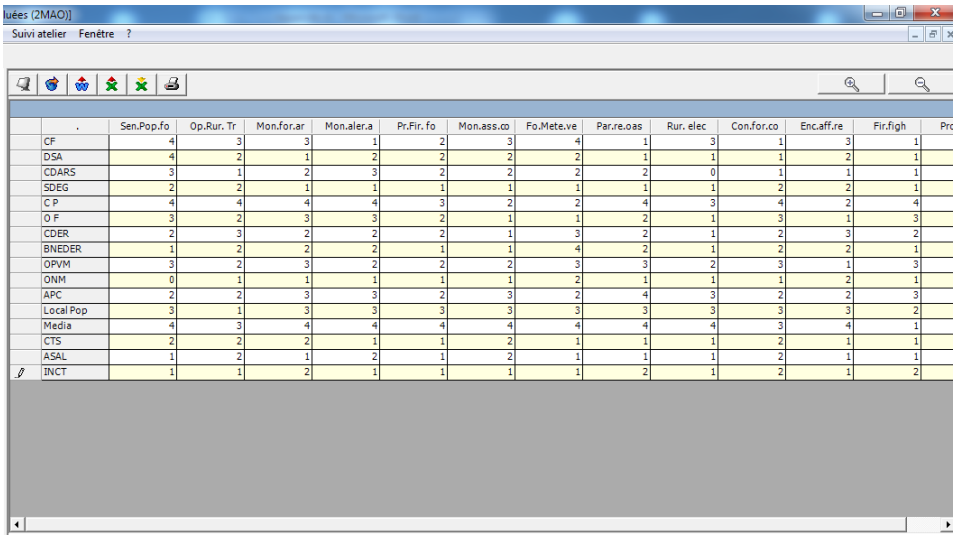
MACTOR method offers several graphic representations and aggregate coefficients to help to understand the relationship between main actors in the interpretation of model results.

The Mactor method produced the initial matrix from the Mactor Analysis in the form of the direct influence matrices (Actors / actors matrix) Matrix (MDI) in Figure 5 and the Valued of Position Matrix (2MAO) in Figure 6.


Matrice des Influences Directes (MID)

.	CF	DSA	CDARS	SDEG	C P	O F	CDER	BNEDER	O
CF	0	2	3	4	2	1	1	1	
DSA	2	0	1	0	2	2	2	2	
CDARS	3	3	0	1	1	2	3	2	
SDEG	2	2	1	0	1	1	1	1	
C P	2	4	2	2	0	4	0	1	
O F	4	3	3	1	1	0	2	1	
CDER	2	2	2	1	2	1	3	2	
BNEDER	1	1	1	2	1	2	2	0	
OPVM	2	2	2	1	2	1	1	1	
ONM	1	1	1	2	1	2	1	1	
APC	1	2	2	2	2	1	2	2	
Local Pop	2	1	3	2	2	3	1	2	
Media	3	2	2	1	1	2	1	1	
CTS	1	1	1	2	2	1	2	1	
ASAL	1	1	2	1	2	2	1	1	
INCT	1	1	2	1	1	1	1	2	

Figure 5 - Direct Influence Matrix


Suivi atelier Fenêtre ?

.	Sen.Pop.fo	Op.Rur. Tr	Mon.for.ar	Mon.aler.a	Pr.Fir. fo	Mon.ass.co	Fo.Mete.ve	Par.re.oas	Rur. elec	Con.for.co	Enc.aff.re	Fir.figh	Pr
CF	4	3	3	1	2	3	4	1	3	1	3	1	
DSA	4	2	1	2	2	2	2	1	1	1	2	1	
CDARS	3	1	2	3	2	2	2	2	0	1	1	1	
SDEG	2	2	1	1	1	1	1	1	1	2	2	1	
C P	4	4	4	4	3	2	2	4	3	4	2	4	
O F	3	2	3	3	2	1	1	2	1	3	1	3	
CDER	2	3	2	2	2	1	3	2	1	2	3	2	
BNEDER	1	2	2	2	1	1	4	2	1	2	2	1	
OPVM	3	2	3	2	2	2	3	3	2	3	1	3	
ONM	0	1	1	1	1	1	2	1	1	1	2	1	
APC	2	2	3	3	2	3	2	4	3	2	2	3	
Local Pop	3	1	3	3	3	3	3	3	3	3	3	2	
Media	4	3	4	4	4	4	4	4	4	3	4	1	
CTS	2	2	2	1	1	2	1	1	1	2	1	1	
ASAL	1	2	1	2	1	2	1	1	1	2	1	1	
INCT	1	1	2	1	1	1	1	2	1	2	1	2	

Figure 6 - Valued of Position Matrix

The Mactor program then processes Figure 5 and Figure 6, the results as follows.

4.2.2. Map of influences and dependencies among actors

In the field of fires, the forest heritage is subject to continuous degradation of human and natural origins; Soil degradation, fires, overgrazing and fungal diseases are causing considerable areas to disappear (ONS, 2015). Today, deforestation continues to increase due to repeated fires, which are the most devastating factor of degradation oasis ecosystem. The non-renewal of the lands lost following the fires and the non-exploitation of these in an exact way will undoubtedly affect the economic activity linked to agriculture (Bessaoud et al., 2019).

Based on the results of the field study; the results showed that the map of influences and dependencies among actors shows their power relationships (dominant and dominated actors) (Figure 7). This map classifies actors into four groups depending on the combination (dependence, influence): the dominants, the relays, the autonomous, and finally the most responsible parties actors named dominated actors.

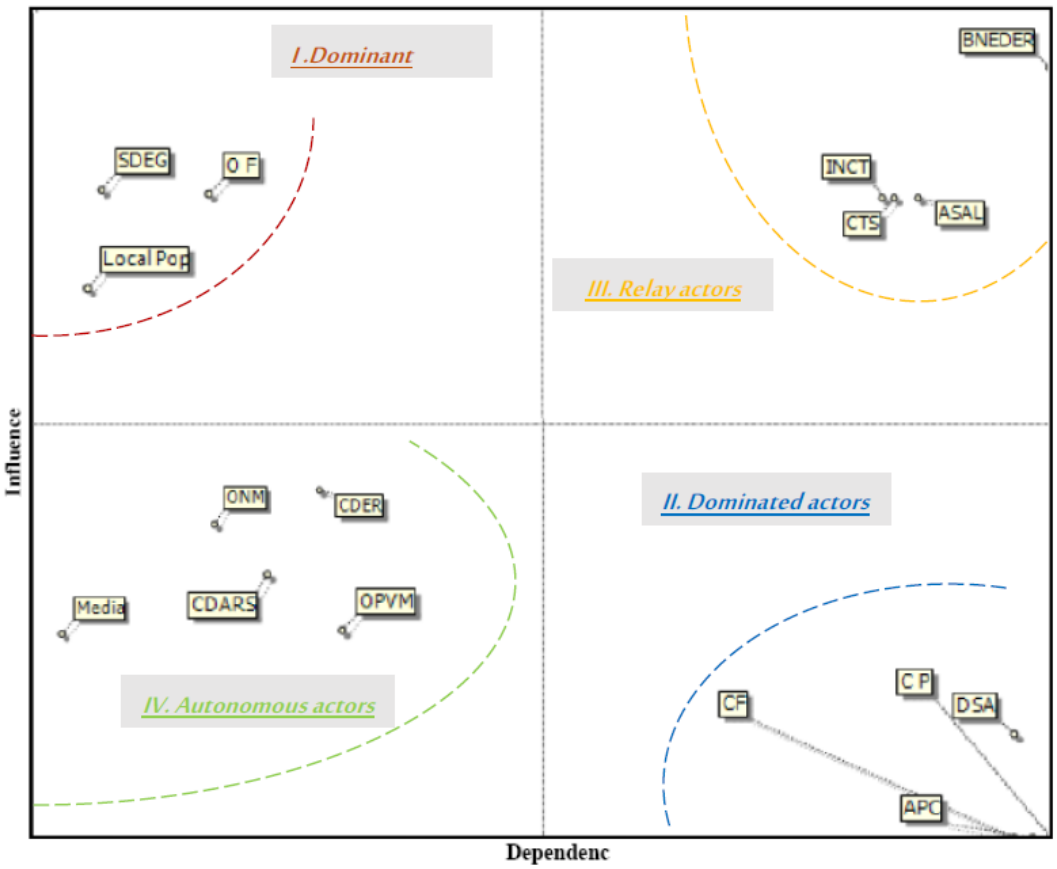


Figure 7 - Map of influence and dependence between actors

1- Four actors are dominated (Southwest): Municipal People's Assembly (APC) and Directorate of Agricultural Services (DSA), Civil Protection (CP) and Forest conservation (CF). These actors are more responsible parties the actions of other actors, which requires their evolution in terms of capacities and means. Note that the power relation among actors is not limited to the simple appreciation of direct capacity of action at the local level.

According to (Fetoui et al., 2021) the most likely strategy in achieving this objective is to build an alliance. Alliance is a channel for long-term cooperation and empowerment between actors (stakeholders), which is suggested by taking collective action from actors as evidence of commitment (Andrianyta et al., 2022).

As formal institutions they represent the most dominant actors in the local forest system, acting as an intermediary between two categories of actors (dominants and dominated actors).But, their influence on other actors is very weak, and actually they heavily depend on dominant actors depicted in quadrant I (Northwest).

2- Four actors are relay (North-East): These actors have a strong influence and are also very dependent. In our case, it is mainly The Space Technology Center (CTS) and Algerian Space Agency (ASAL), National Institute of Cartography (INCT) and National Office for Rural Development Studies (BNEDER). BNEDER is more influential at the local forest level because of its mission, with its position under the Ministry of Forests and Rural Development. Indeed Algeria – A fire detection and localization system has been set up by the Algerian Space Agency in several wilayas; these uncontrollable fires pushed the Algerian Space Agency to seek a solution. Based on new technologies and satellite images (ASAL, 2022), this establishment intends to contribute to the fight against these flames, which threaten the entire national territory.

ASAL and CTS, although they have the means to carry out their projects or they are supposed to be motivated and inform those in charge of the local fire, remains influenced by other actors in the execution of its projects in the region. Moreover the development of these actors and the expansion of their functions undoubtedly contribute to fire management.

3- On the axis of control, the dominant actors : are Three dominant actors (Northwest): These actors have a strong influence on the others without being themselves strongly influenced: in our study, they are mainly the structures Algerian Company for Electricity and Gas Distribution (SDEG), Oasis farmers (OF) and Local population (palm grove owner) (Local Pop). They influence fires and started of fires, in particular in the fires of the oases and their degradation, indeed they are one of the main actors involved in the occurrence of Agricultural fires.

In fact, we can see that the Algerian Company for Electricity and Gas Distribution (SDEG), is deemed to be influential and dominant players due to its position as a pressure group, despite its limited roles in the initiative and awareness of local fires.

SDEG is in charge of the generalization of access to electricity and the extension of production, and distribution networks of electricity resources. If the projects and objectives of these actors are not realized, or if these actors do not evolve, the water management process will remain blocked which disrupts the access of electricity to agricultural lands.

However, it has been the cause of some unintentional fires (Figure 8), most often caused by discharges or electric arcs from high voltage network and various industrial installations using motorized equipment projecting sparks, etc.

Figure 8 - Unintentional fires in the " palm grove" due to the electric of high voltage network (phot. T. Addoun, 2022)

4- Five autonomous actors (Southwest): They are not very influential and not very dependent actors, they do not have a great power and influence to act on the local fire. In our study, this category includes all economic actors, namely National Office Meteorological of Ghardaïa Station (ONM), Research Center in Renewable Energy (CDER), Office the protection and promotion of M'zab Valley (OPVM), Commission for the Development of Agriculture in the Saharan Regions (CDARS) and Media. . Recently, the CDARS has reforested for the purpose of regenerating land lost by fires and uncontrolled exploitation, protection of watersheds against water erosion, pastoral plantations or development of sustainable forestry economic activity (Bessaoud et al., 2019) within the framework of the protection of natural resources and the fight against desertification. In addition to the autonomous actors, the actors have a weaker role of influence in firefighting. The analysis of the

graph (Figure7) reveals important shortcomings, especially with regard to the weak involvement of these actors at the local level in the development of oases and local activities against the sustainability of the ecosystem.

5. Conclusion

Agricultural fire sensitivity and adaptability of oasis ecosystem in oasis has become the center of sectoral policies and strategic orientations of local and regional economic, but the role of actors and their missions are neglected. It is therefore understandable that the divergence of the objectives of the different actors involved in the oasis ecosystem of the Berriane region has influenced the conservation and development of local resources.

Overall, this study is an essential element for the exploring agricultural fires of oasis ecosystem of the development of Berriane oasis in a sustainable manner with the working together of all stakeholders. The findings of this research can be a first try in part of developing participatory institutions in the Sahara region. The participatory institutional model can take on the role of a "middle way institution" between the different missions of actors and, at the same time, facilitate the involvement of all actors.

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