Impact du Dérèglement climatique sur les maladies à transmission vectorielle: l'exemple des leishmanioses

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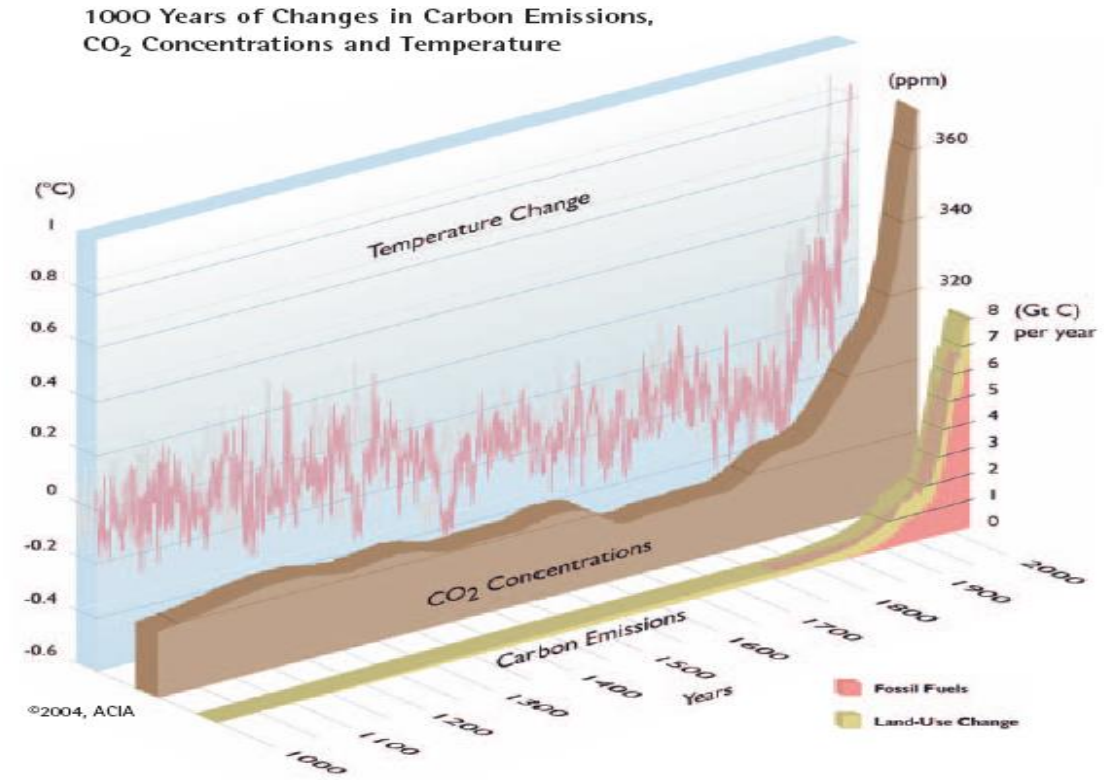
Membre fondateur de l'Académie Algérienne des Sciences et des Technologies

1st Congress in MENA Region on clinial Microbiology and Infectious diseases-

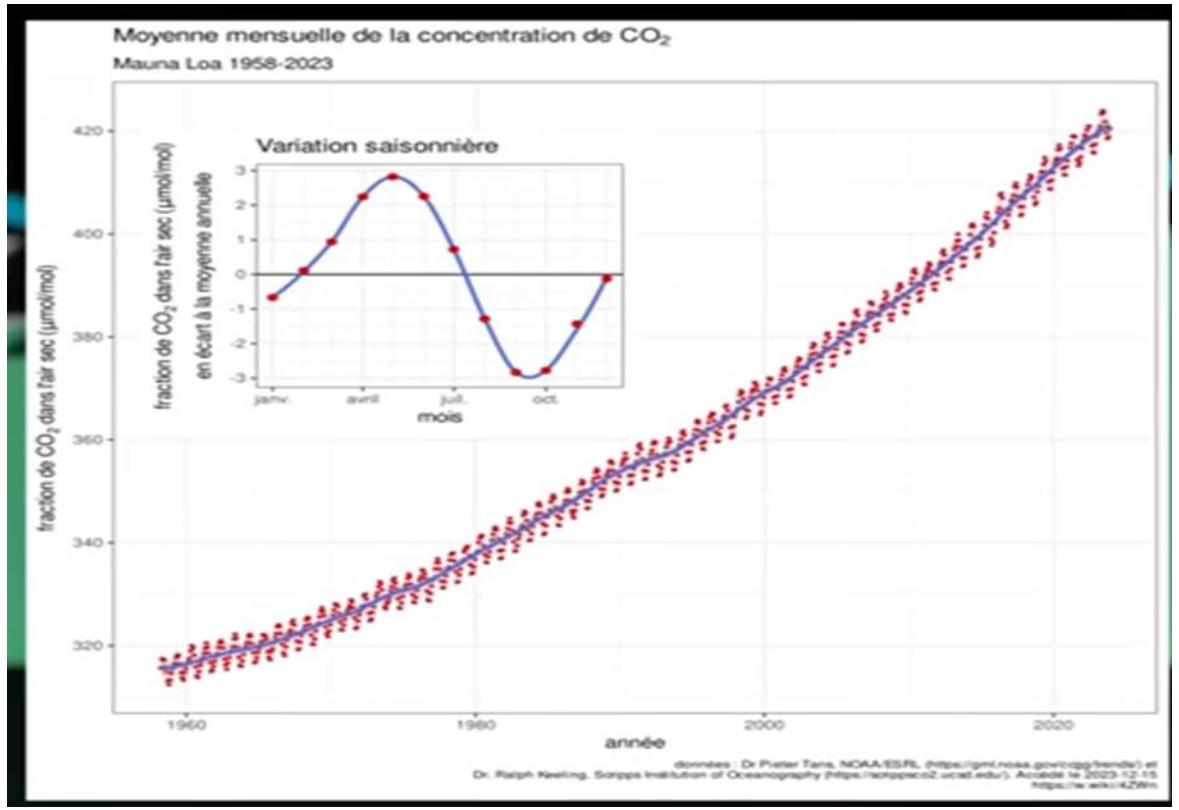
34th National Congress of Tunisian Society of Infectious Diseases. 23-23 Mai 2025 – Hammamet -Tunisie

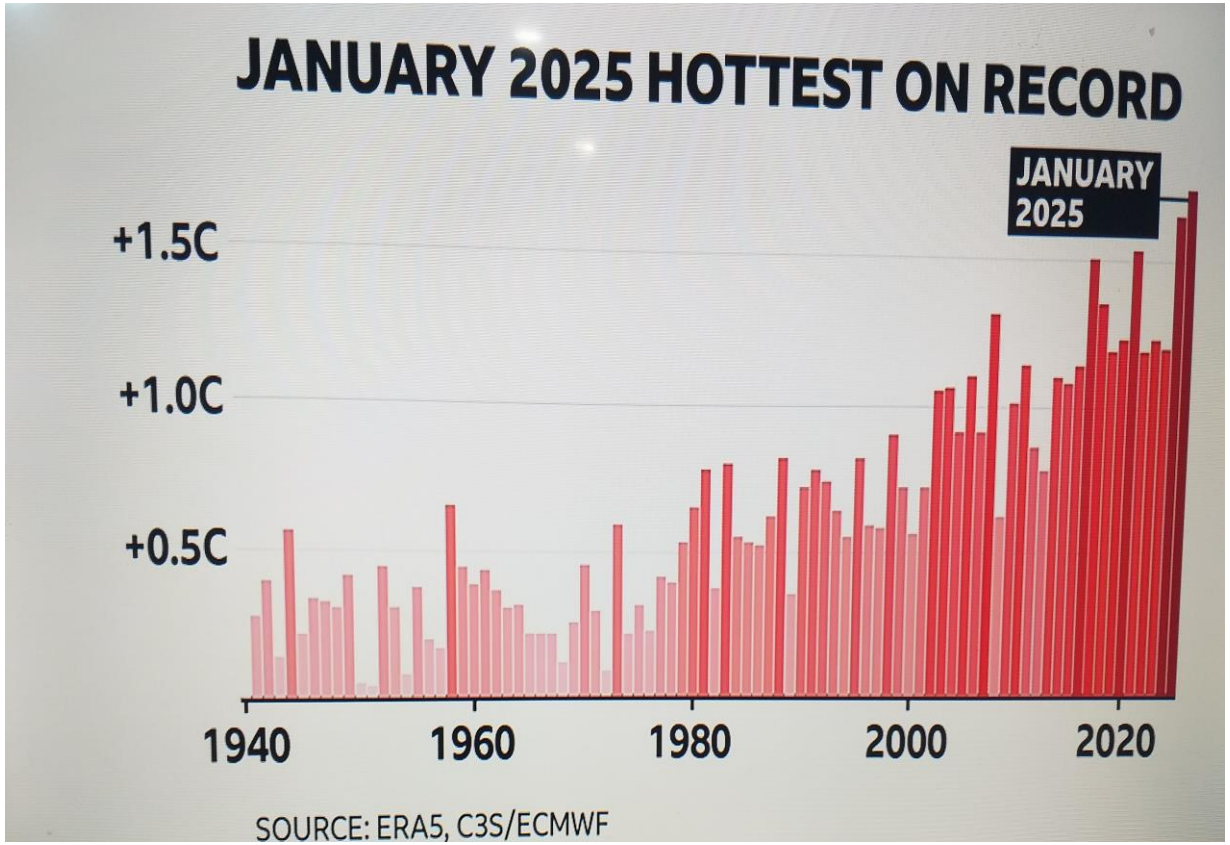
Le dérèglement climatique

Le changement climatique fait référence à l'ensemble des déséquilibres environnementaux qui se produisent dans le monde à cause, principalement, des activités humaines et qui pourraient interagir avec l'émergence ou la réémergence de maladies à transmission vectorielle .



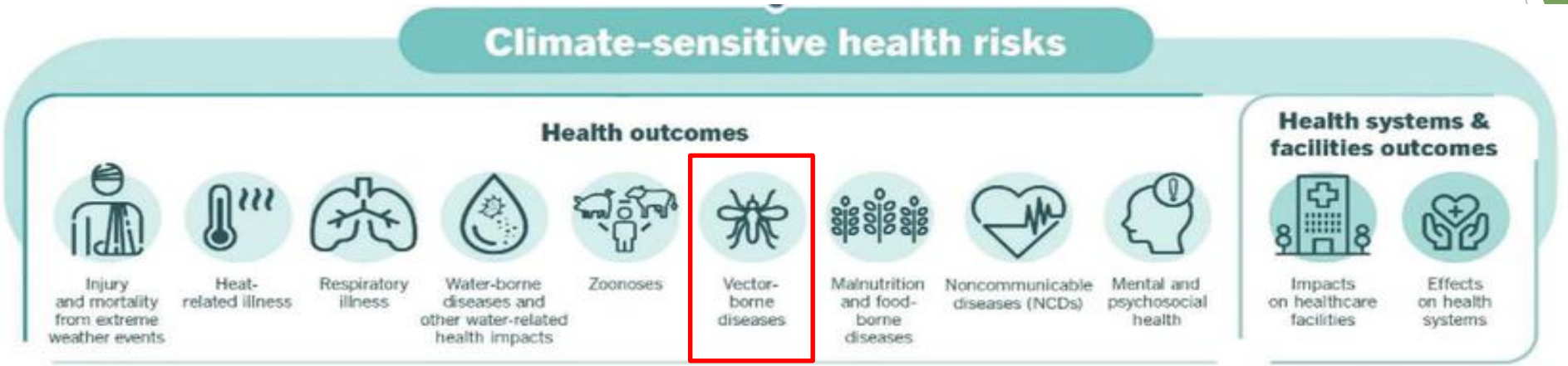
1000 ans de Changement en Emission de Carbone, Concentration CO_2 et Température



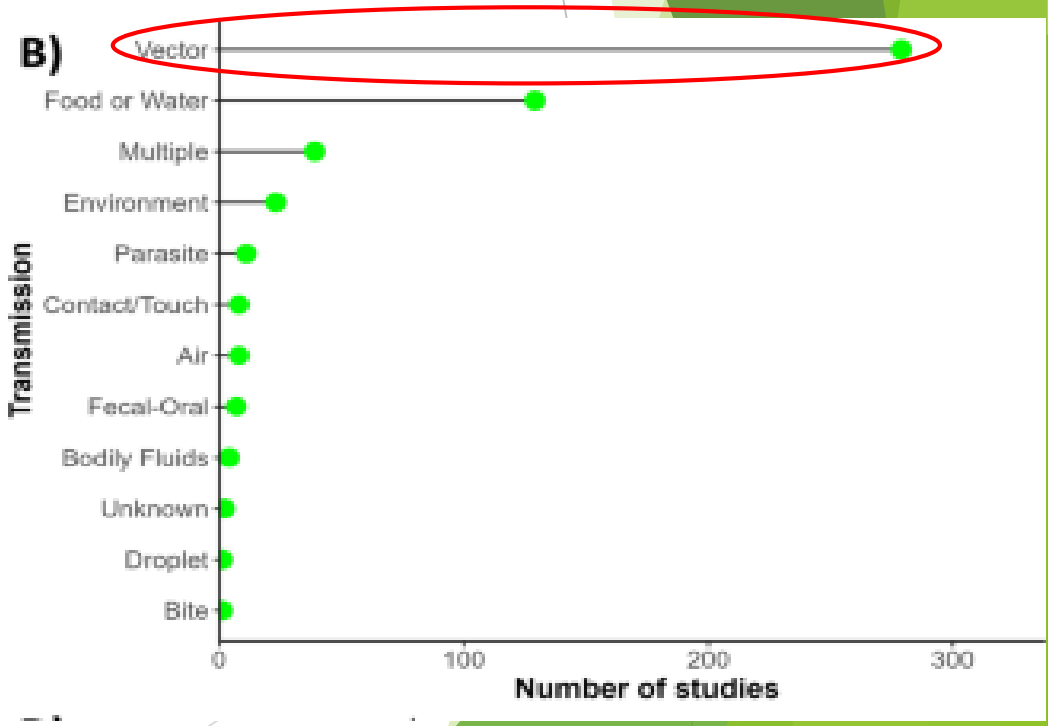


La courbe de Keeling :concentration de CO2 dans l'atmosphère(1958-2020

Effets du changement climatique sur la santé



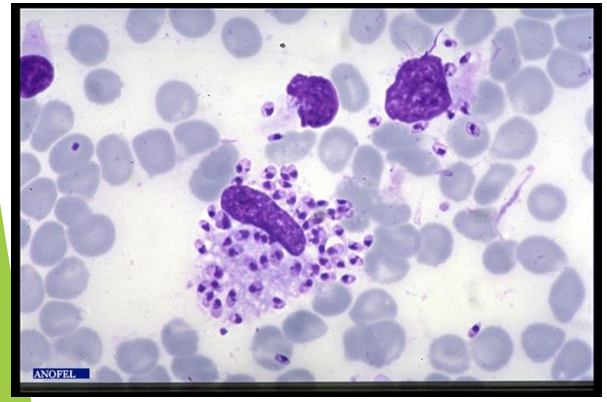
D'après l'OMS : les maladies sensibles aux variations climatiques tuent environ 700 000 personnes chaque année. Une revue systématique sur le changement climatique et santé a mis en évidence que les MTV occupent la 1ère place. Particulièrement celles transmises par les moustiques



Van de Vuurst & Escobar. (2023) Climate change and infectious disease: a review of evidence and research trends. Infectious Diseases of Poverty 12:51

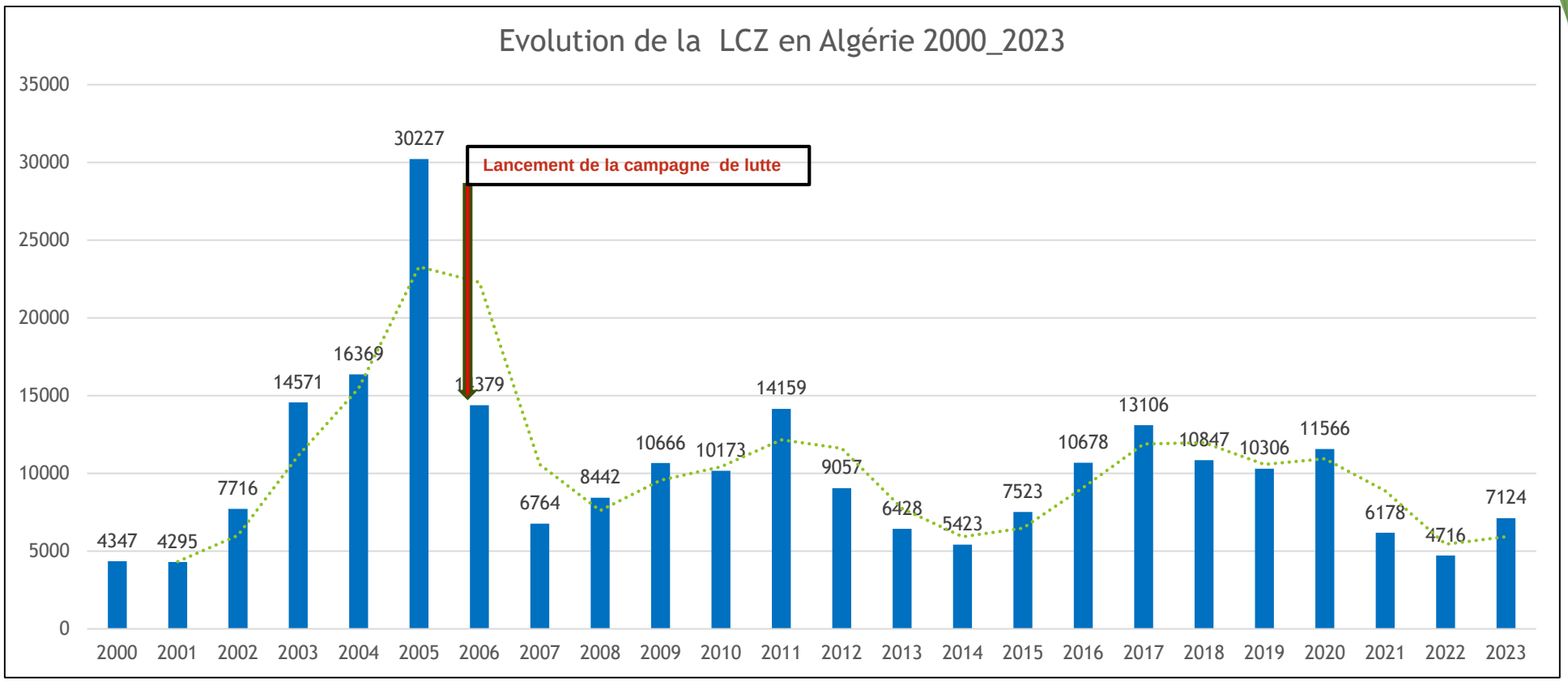
Maladies transmises par les phlébotomes : la Leishmaniose cutanée

Leishmania major (Parasite)



P. papatasi (vecteur)

P. obesus et M shawi hôtes réservoirs


Evolution de la LCZ en Algérie 2000_2023
35000
30000
25000
20000
15000
10000
5000
0
Lancement de la campagne de lutte
4347
4295
7716
14571
16369
30227
14379
6764
8442
10666
10173
14159
9057
6428
5423
7523
10678
13106
10847
10306
11566
6178
4716
7124
2000
2001
2002
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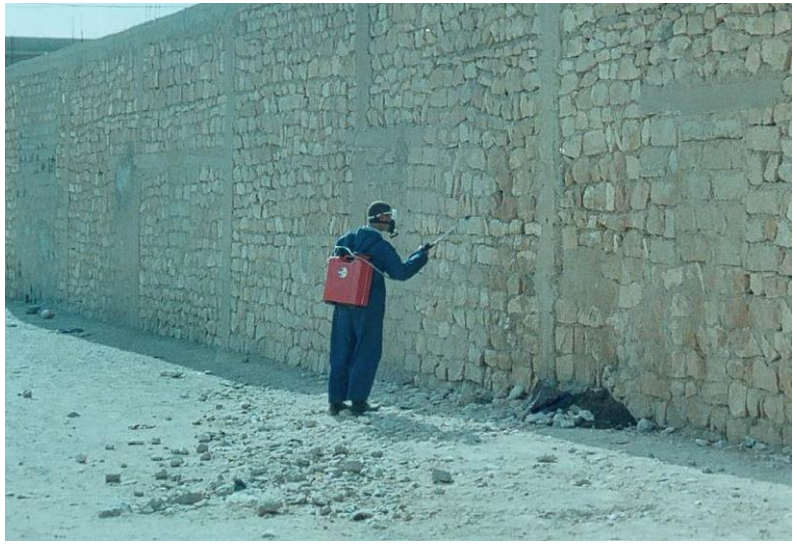
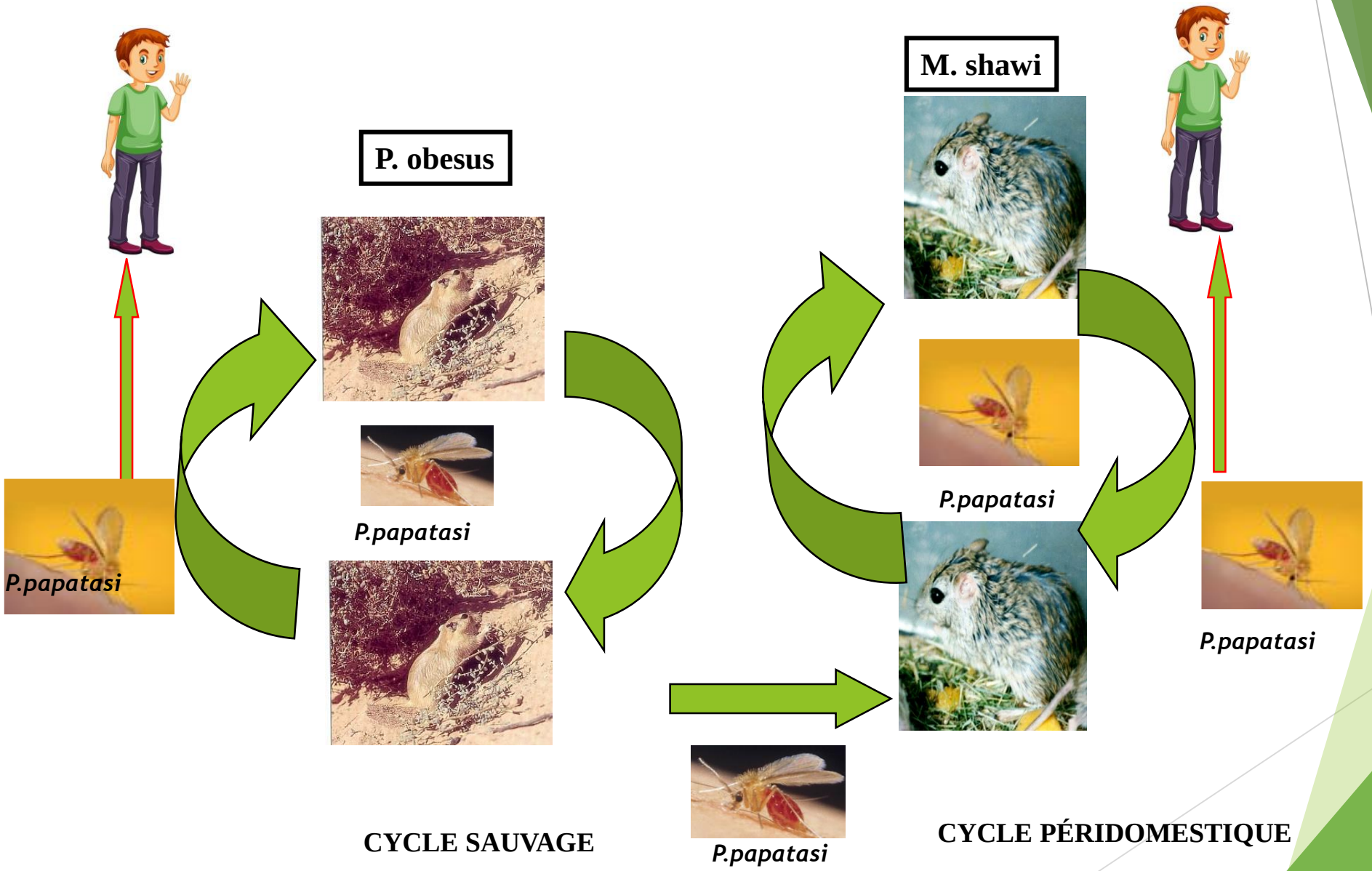
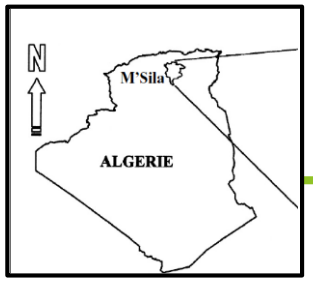


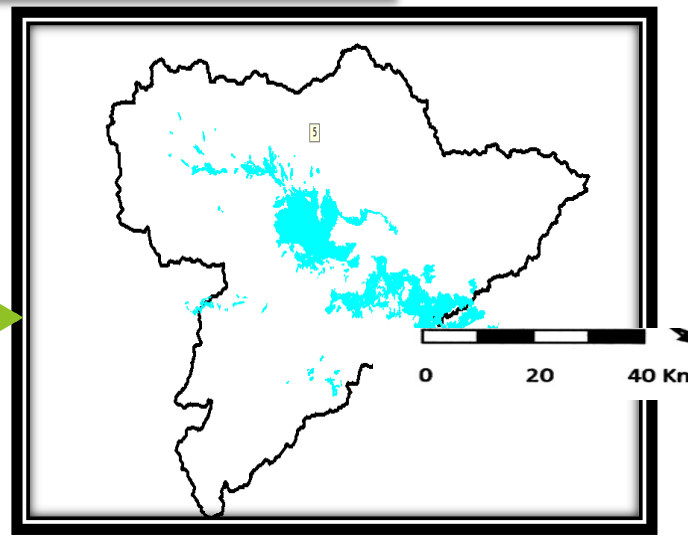
cycles de transmission de la LCZ à L major en Algérie



Habitats of *P obesus*, primary reservoir host of *L. major*.

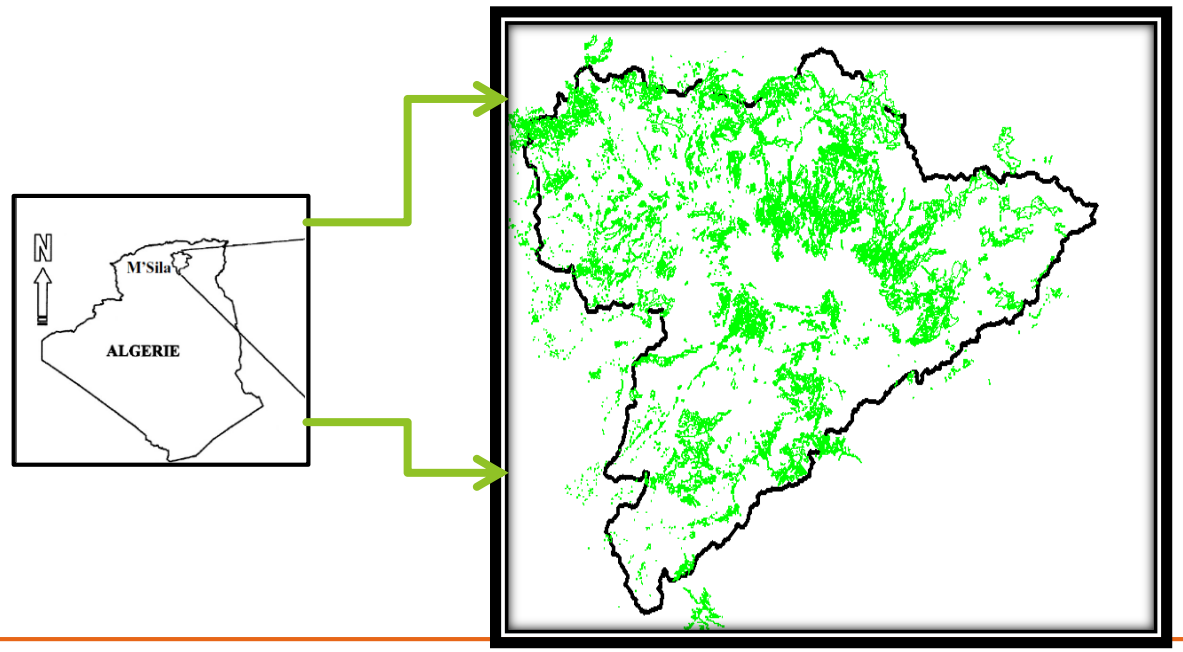
Plantes and areas of Chenopodiaceae , natural habitat of *P obesus* colonies in the extended ZCL focus of the basin of Hodna, North east of Algeria (Map : Kamel Cherif Université de M'sila)





Basin of Hodna-M'sila Algeria

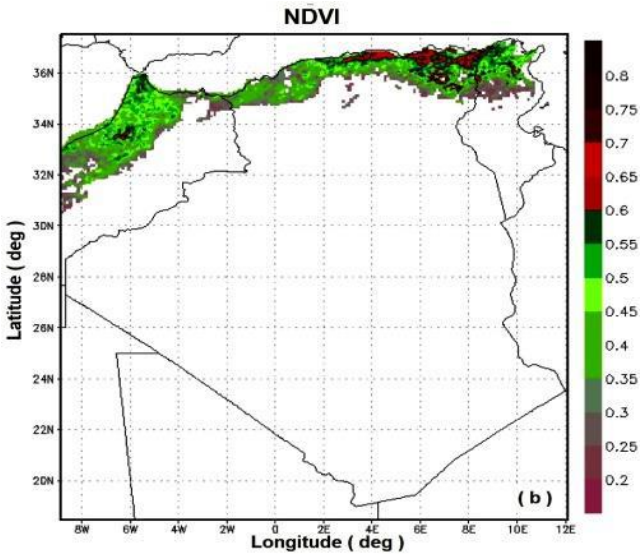
Habitats of *Meriones shawi* **, Secondary reservoir host of** *L. major*.

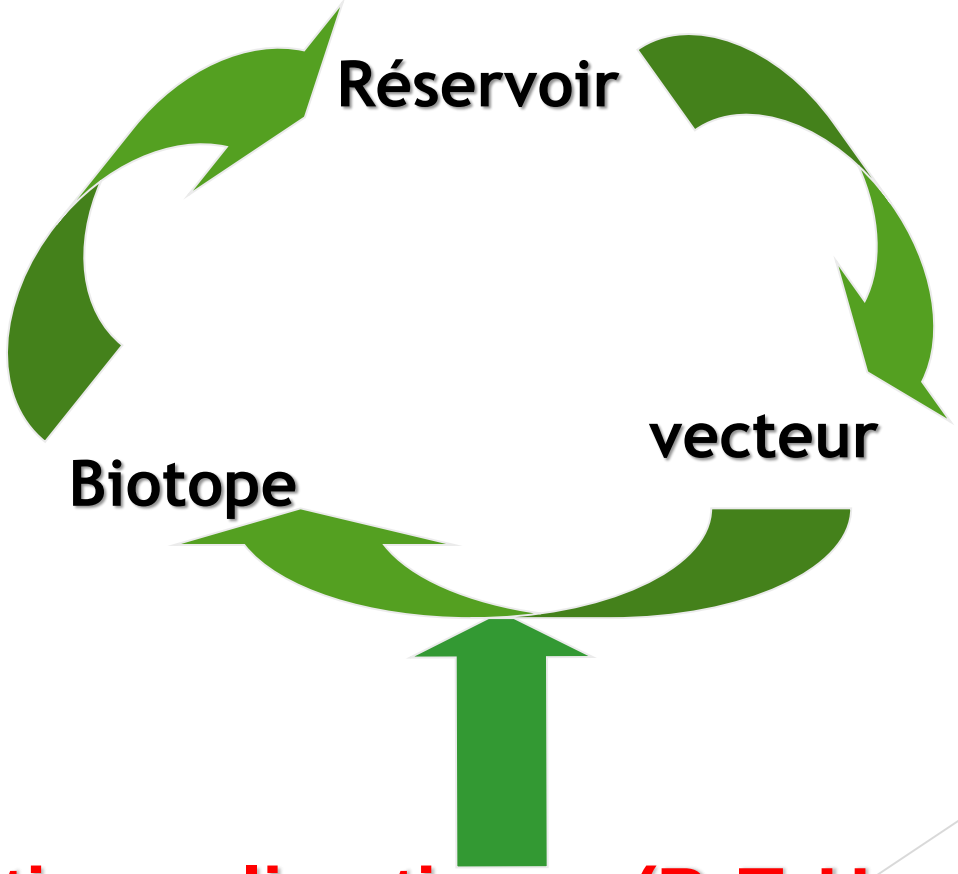


Spatial distribution of the gerbil *M shawi* in the basin of Hodna M'sila -Algeria: endemic area of ZCL

(Map : Kamel Cherif Université de M'sila)

Interférence Climat et Leishmaniose cutanée





Variations climatiques (P, T, Hum)

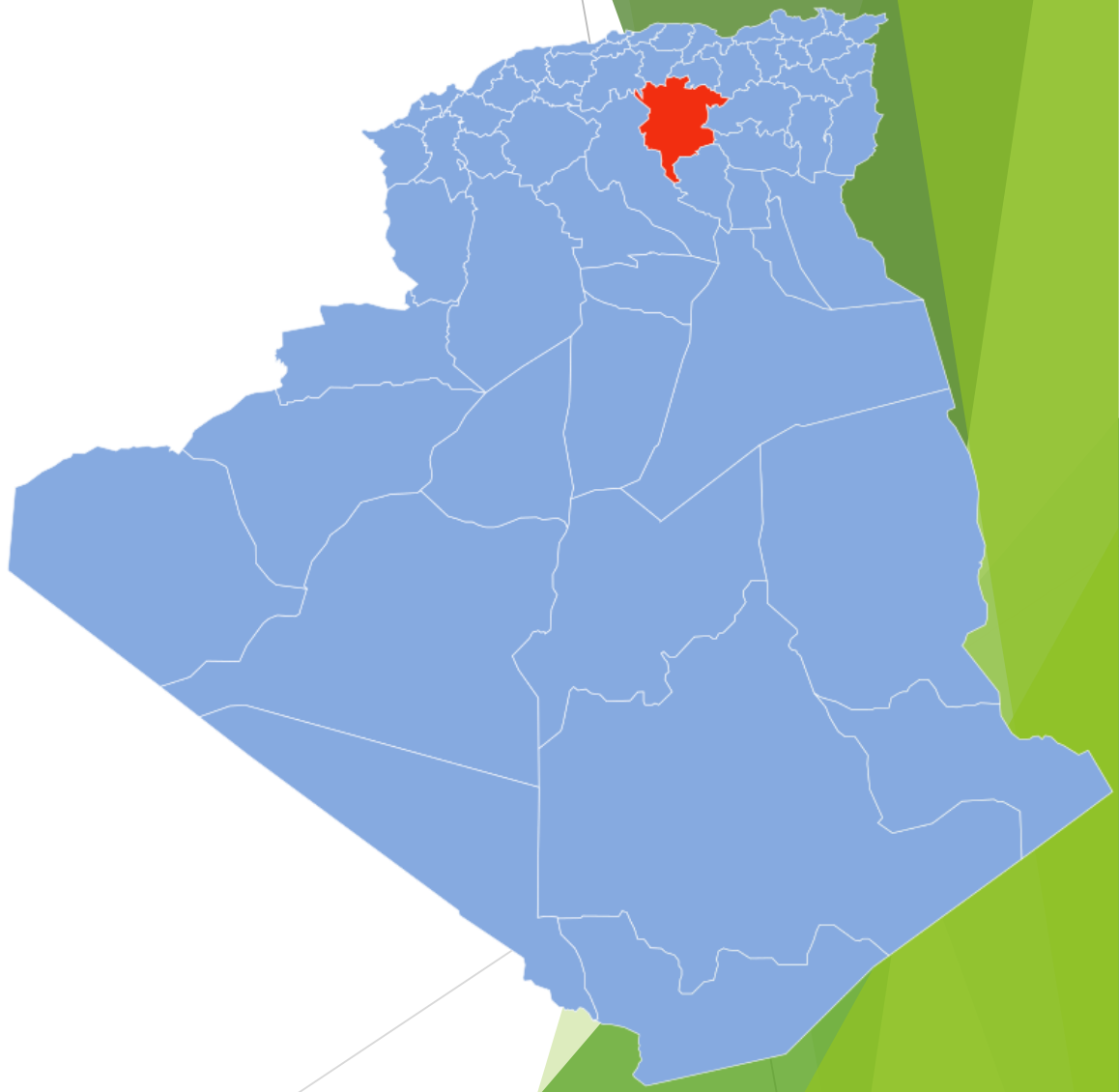
Facteurs favorisants à l'émergence des foyers de LCZ : projets agricoles .

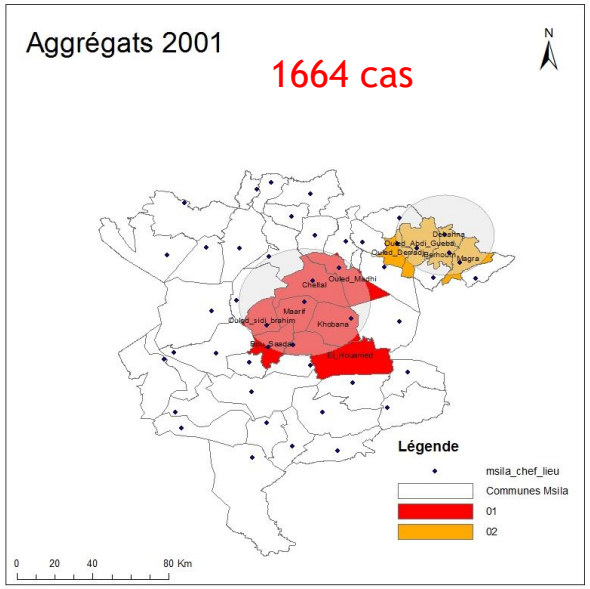
Dégradation du tissu urbain et mauvaise hygiène du milieu

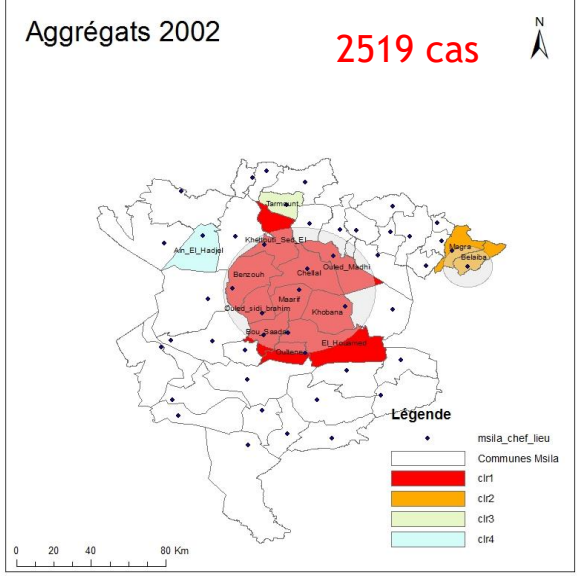
Facteurs favorisant l'émergence de la LC : urbanisation non contrôlée

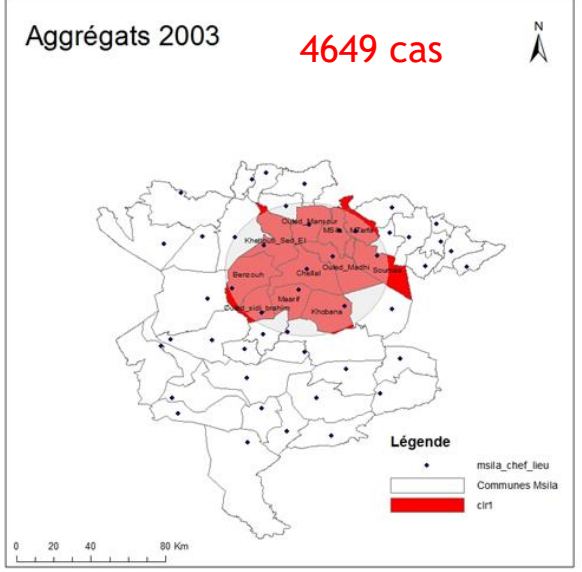
LCZ et climat : l’exemple du foyer de M’sila

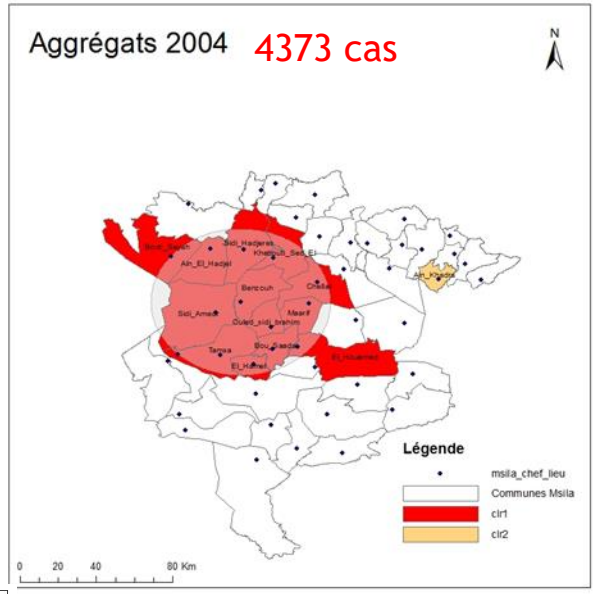
superficie de 18 175 km^2 :
prédominance de la steppe qui couvre 1 200 000 ha (soit 63 % de la superficie totale) de la wilaya.
La superficie affectée à l’agriculture représente 20 % de la surface totale, consacrées essentiellement à la céréaliculture et au cultures maraichères .
population est de 1 029 447 habitants.
Le climat à M'Sila, est semi-aride froid, La température moyenne est de 18,6 °C et la moyenne des précipitations annuelles ne dépasse pas les 250 mm.
1981-82 : Première épidémie de la LCZ

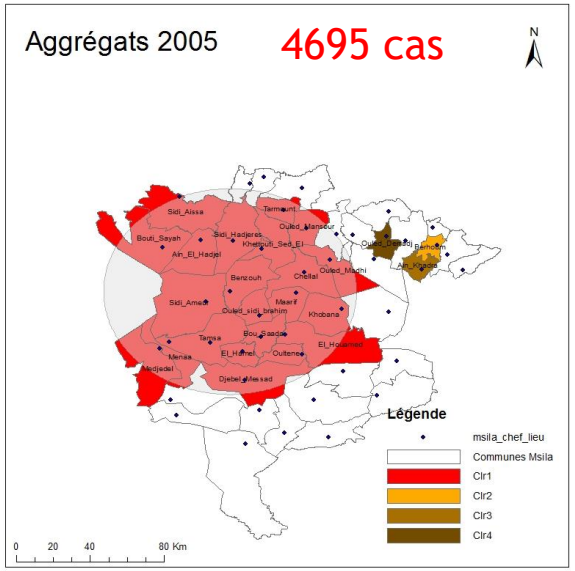


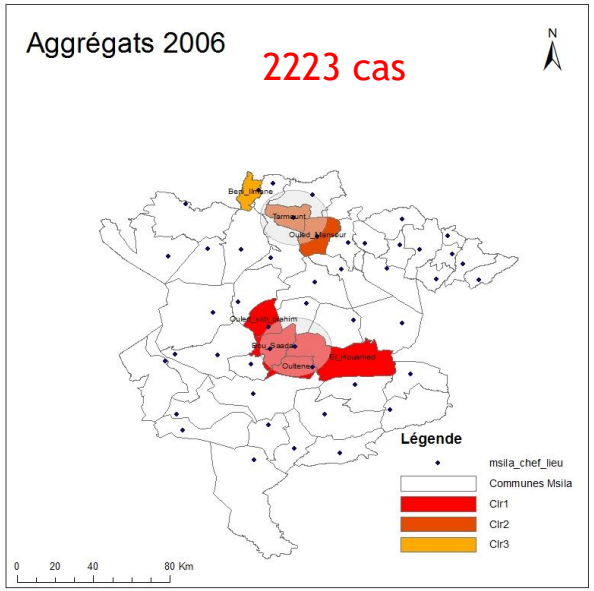


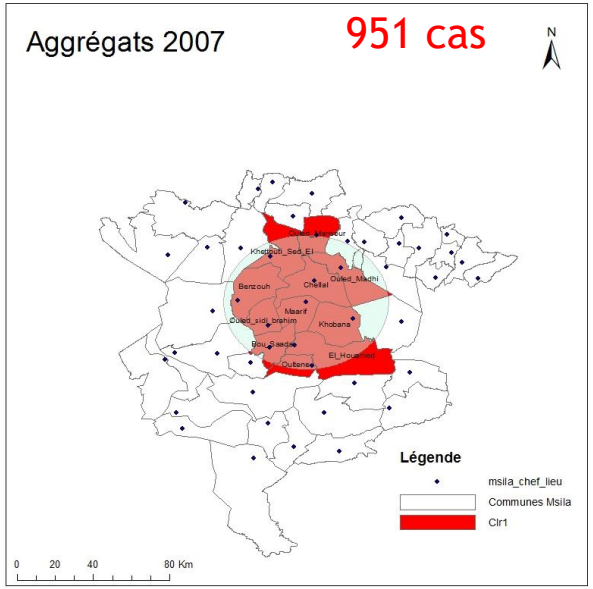


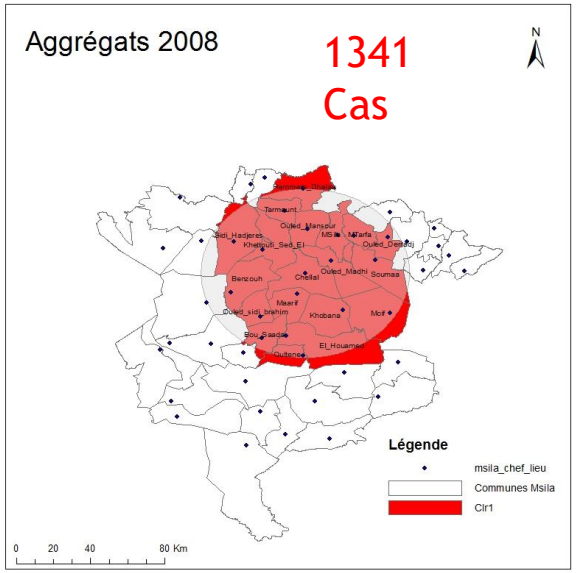




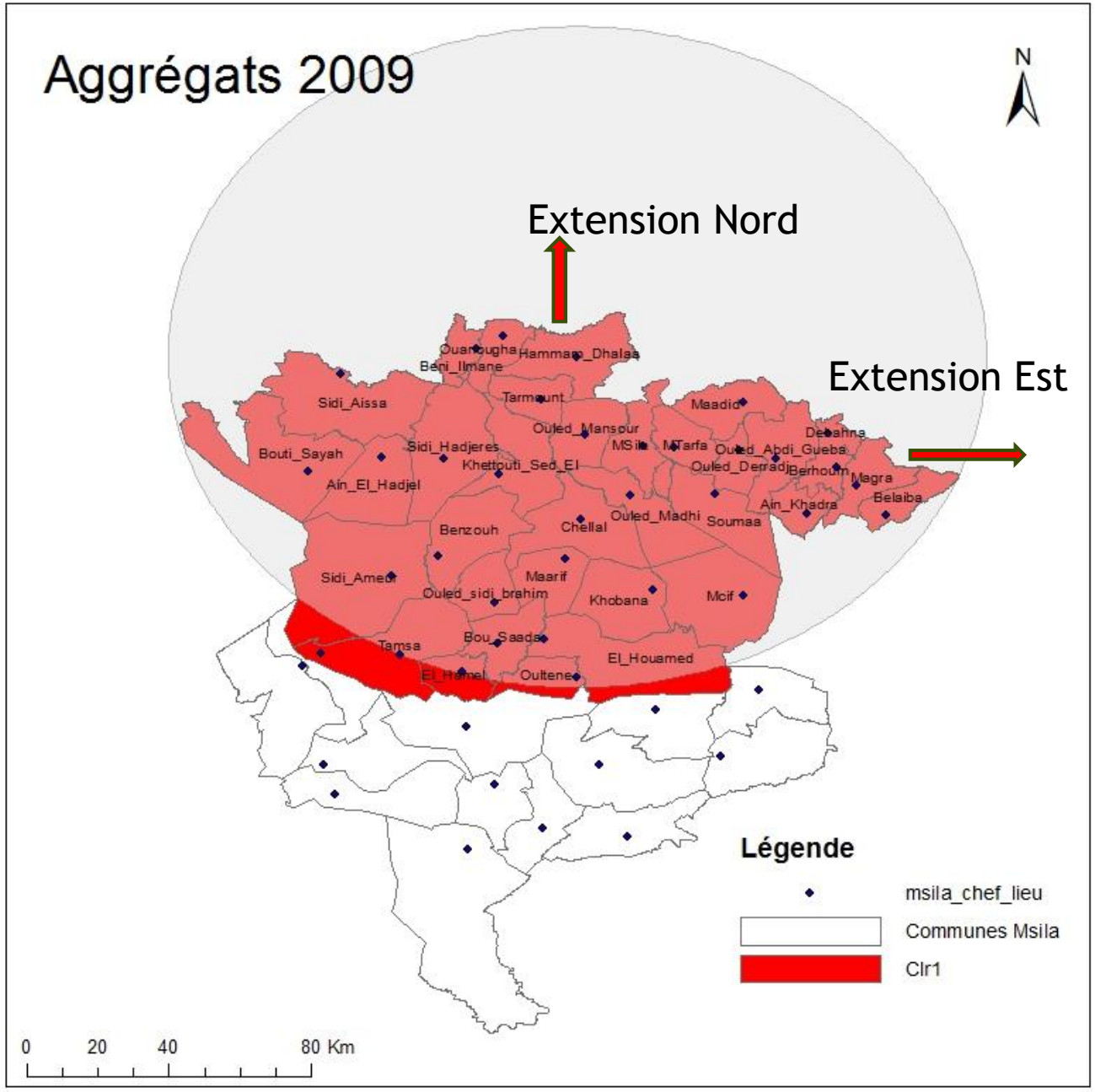








Evolution temporo-spatiale des clusters des cas de LCZ à M'sila de 2001à 2009



2009: Reconstitution d'un grand cluster dans le nord de la wilaya >> extension du foyer au nord vers la commune d'El Mhir (BBA) et à l'est vers la commune de Barika (Batna)

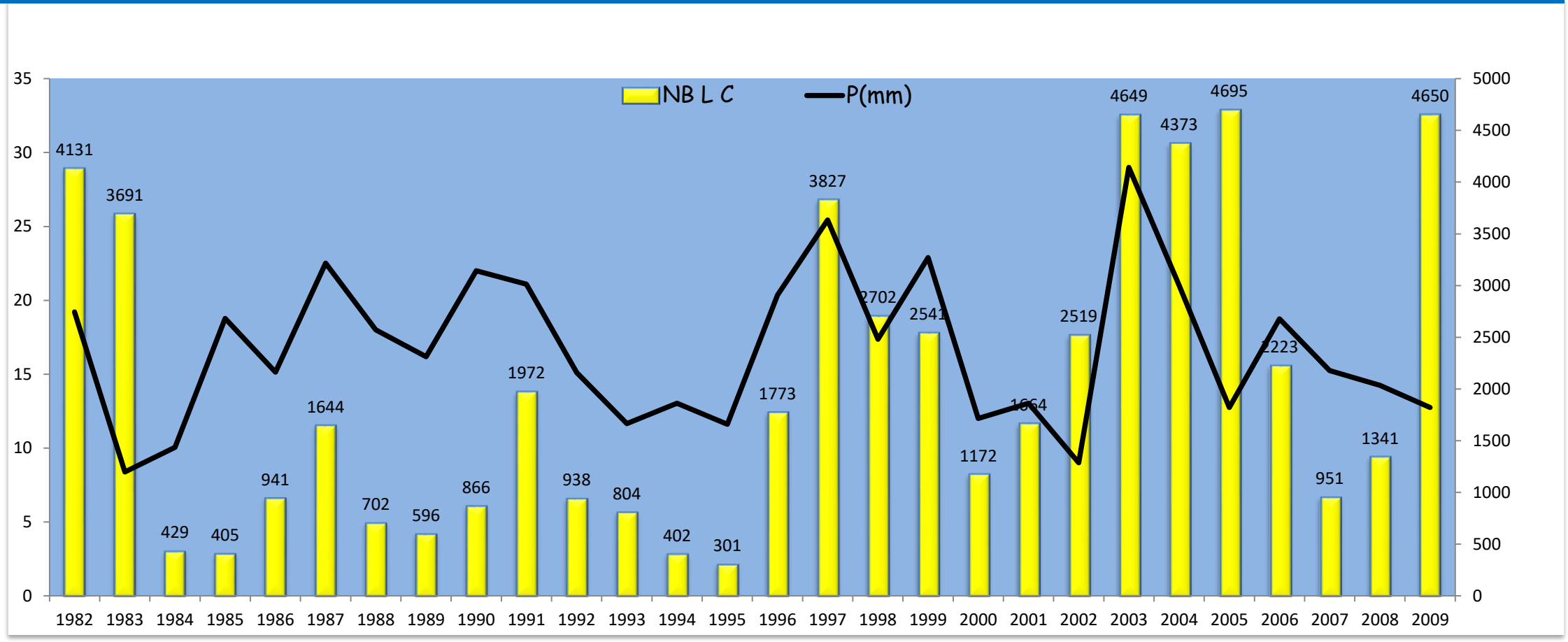
Extension de *Leishmania major* au nord de l'Algérie

Spread of *Leishmania major* to the north of Algeria

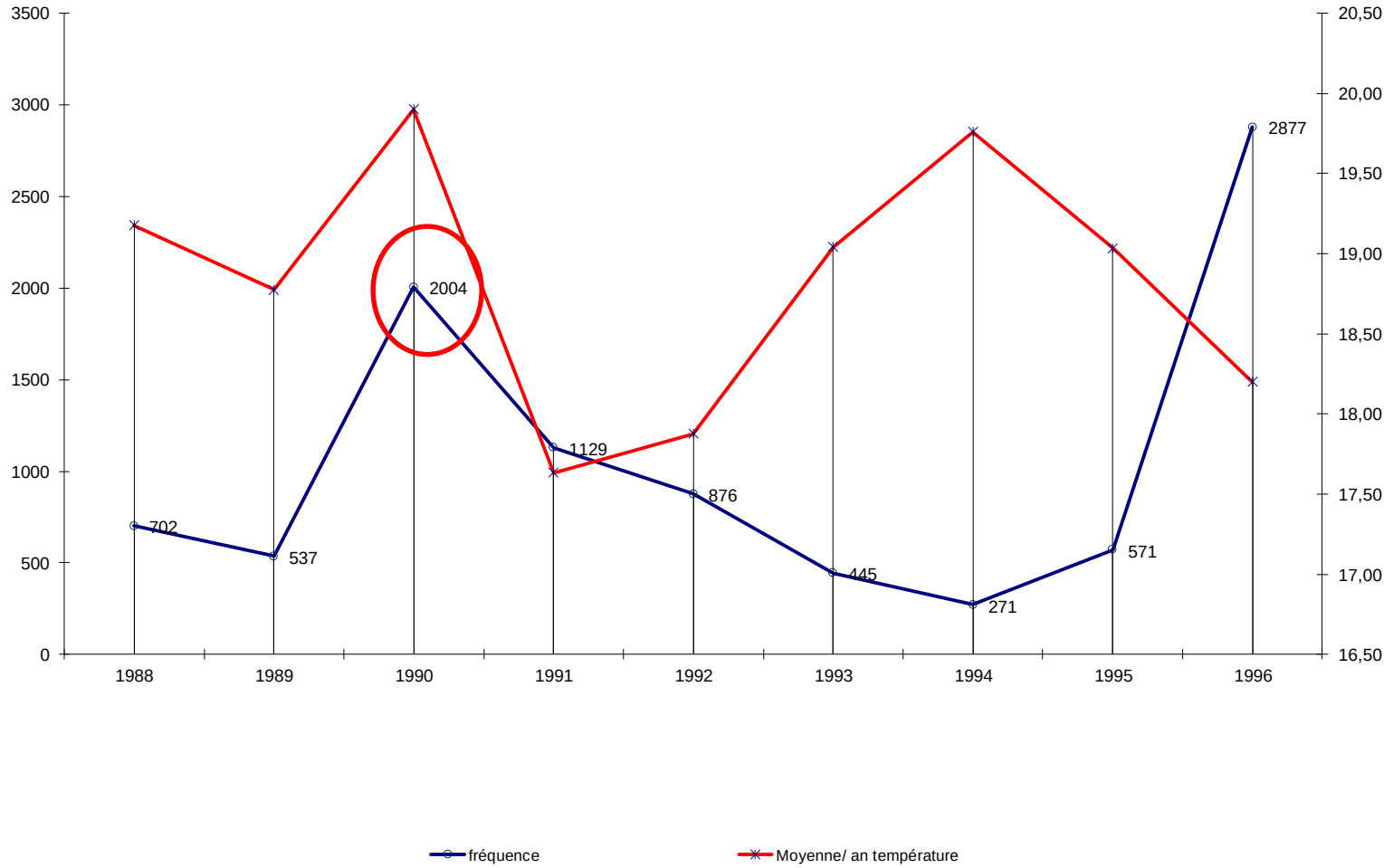
A. Boudrissa · K. Cherif · I. Kherrachi · S. Benbetka · L. Bouiba · S.C. Boubidi · R. Benikhlef · L. Arrar · B. Hamrioui · Z. Harrat

Reçu le 24 mai 2011 ; accepté le 23 août 2011

Leishmaniose Cutanée et précipitations dans la wilaya de M’sila



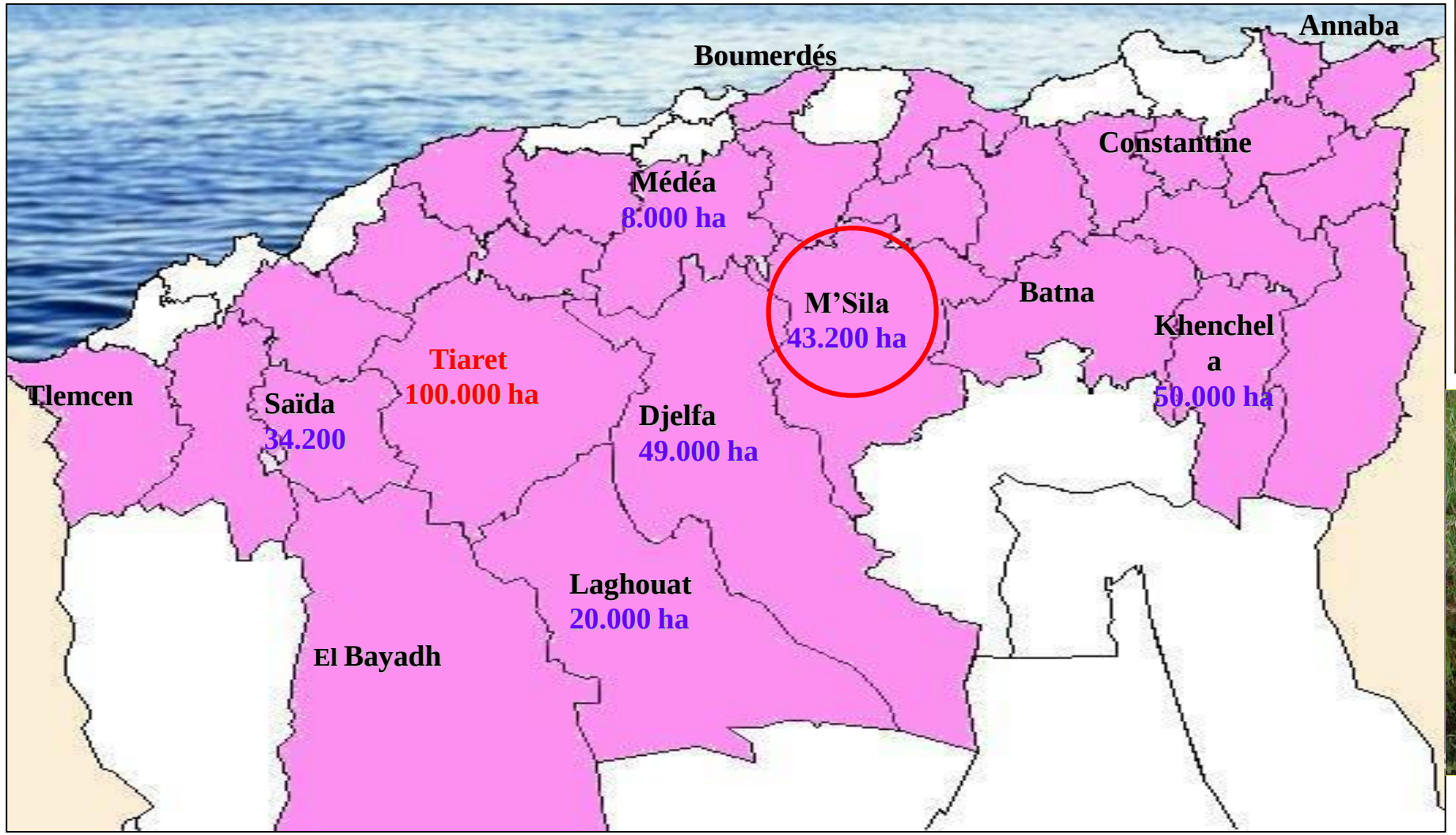
Les épidémies cycliques de LC sont fortement liées à la moyenne des précipitations annuelles.
Ex: Relation entre les précipitations (Trait noir) et cas de leishmaniose cutanée (barres jaunes) dans la wilaya de M’sila durant la période 1982-2009



Cas de LC et Température annuelle moyenne dans la wilaya de M’sila

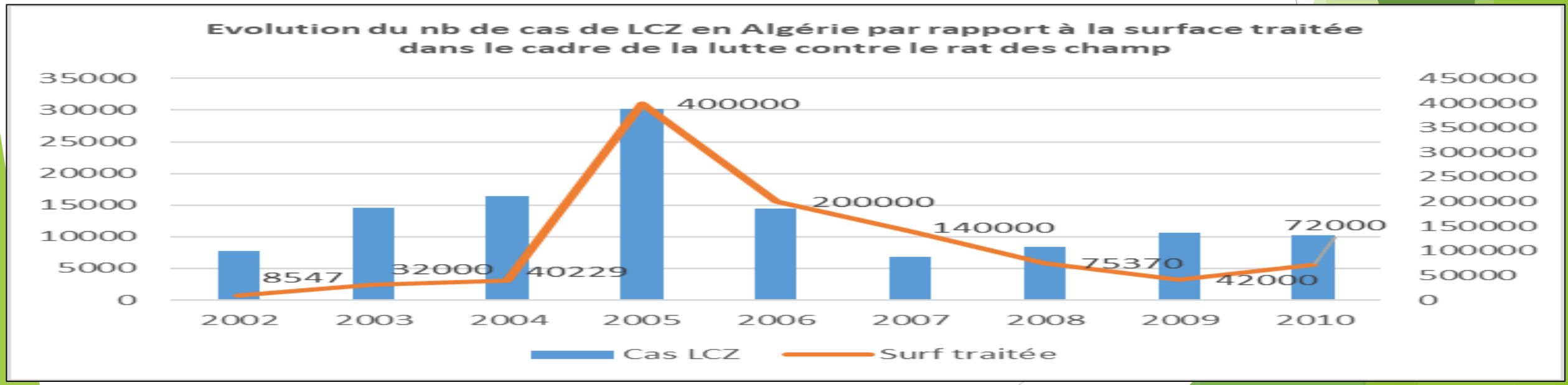
2005

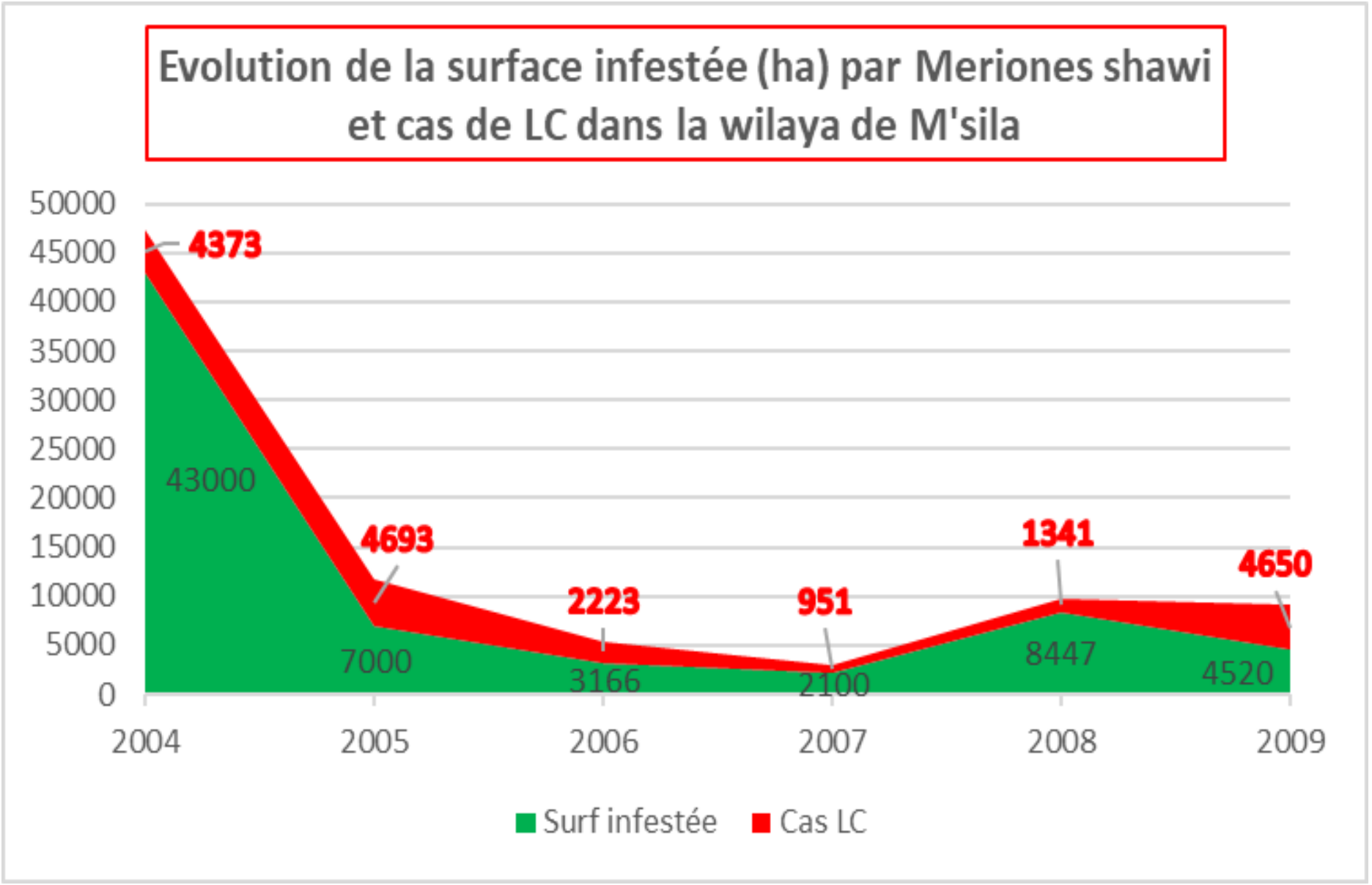
Superficie infestée par les rats des champs: 500.000 ha –Surface traitée 400000 ha



Campagne de lutte contre *M shawi* (2006) : Moyens mobilisés

- Rodenticides :10 tonnes
- Encadrement : 240 agents : (DSA, INPV, Ch.agric.)
- 70 véhicules VTT
- **Superficie totale traitée : 400.000**
- **Coût financier : ≈ 500.000 US$**

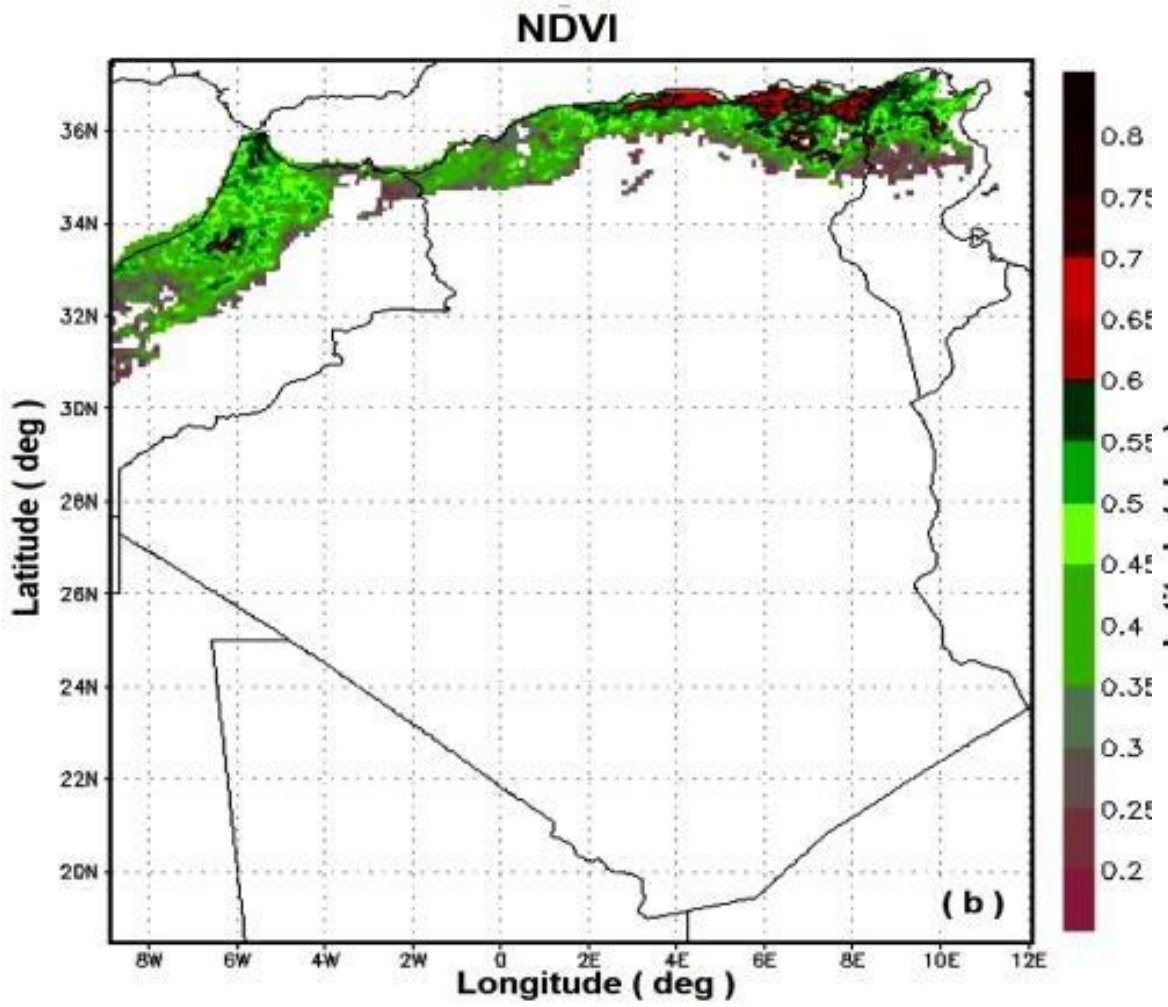




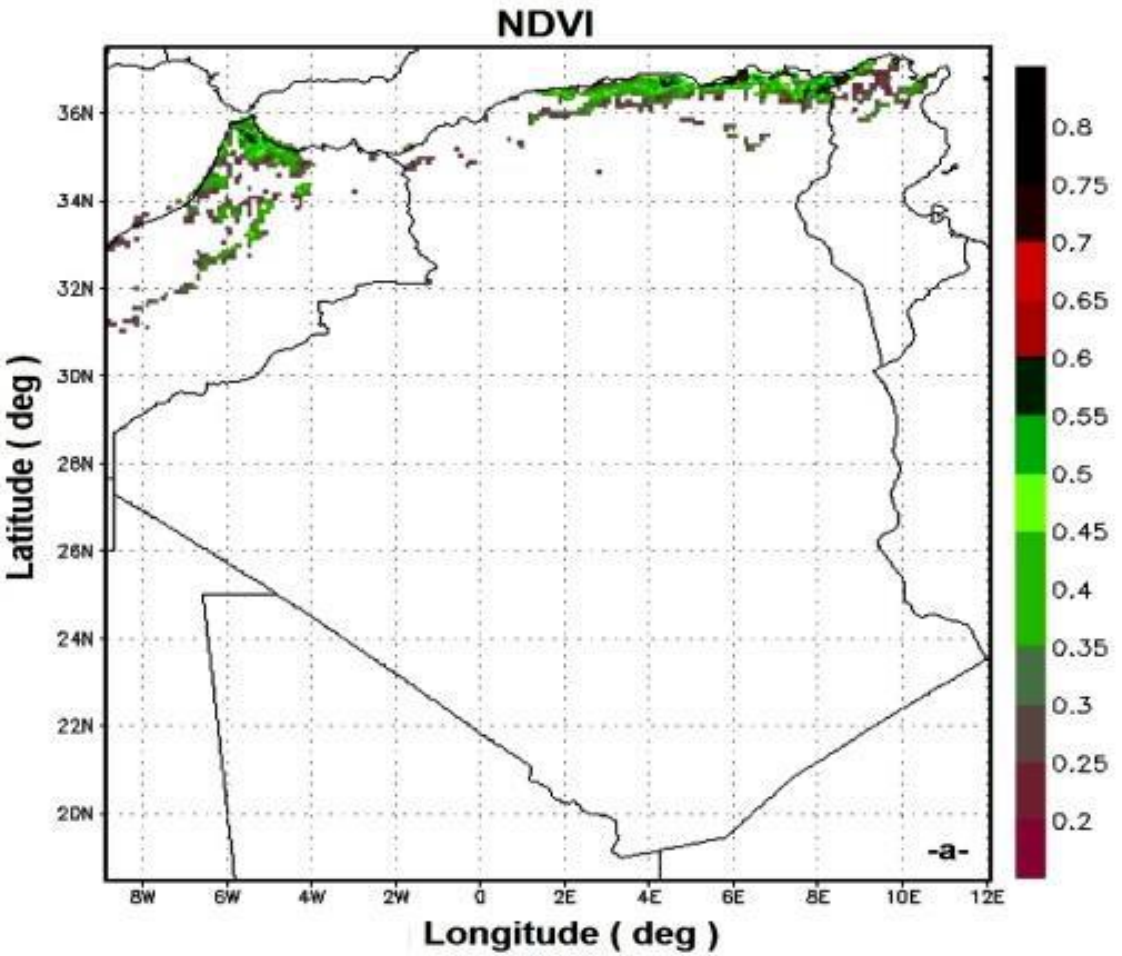
Source : Institut National de la Protection des Végétaux. Direction de la santé wilaya de M’sila

Rat des sables :Espèce protégée!!

Couverture végétale déterminée par les indices de végétation: Le NDVI semble être un facteur important représentant les interactions environnementales et les conditions climatiques. La dynamique de la population de rongeurs réservoirs et vecteurs de CL semble liée à la densité de la végétation et à l'humidité.



April 2003



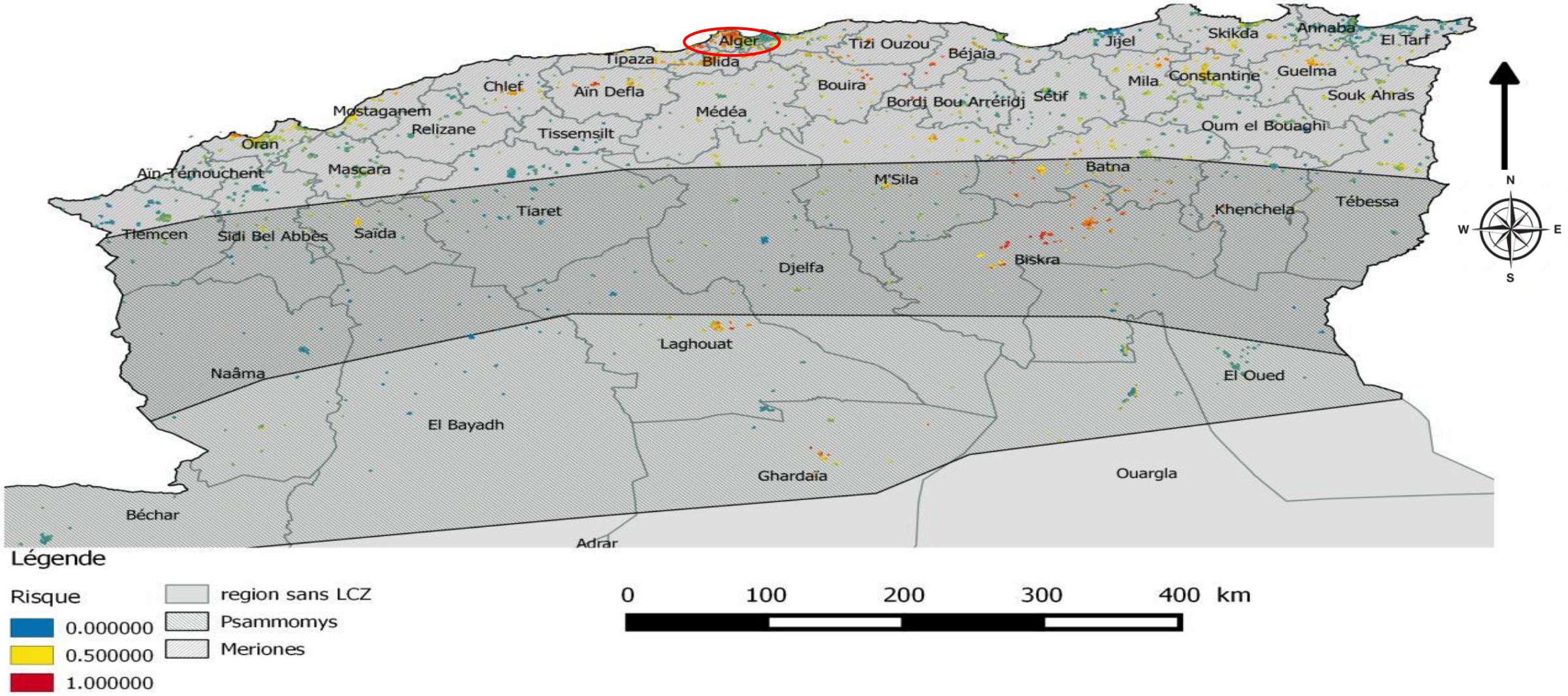
July 2003

Ref : Razagui A & Bachar NEI . *Revue des Energies Renouvelables Vol. 17 N°3 (2014) 497 – 506*

Modélisation des niches écologiques du vecteur de la LC en Algérie

Variable	Description
Bio01	Annual mean temperature (°C)
Bio02	Mean diurnal temperature range (mean(period max-min)) (°C)
Bio03	Isothermality (Bio02 ÷ Bio07)
Bio04	Temperature seasonality (C of V)
Bio05	Max temperature of warmest week (°C)
Bio06	Min temperature of coldest week (°C)
Bio07	Temperature annual range (Bio05-Bio06) (°C)
Bio08	Mean temperature of wettest quarter (°C)
Bio09	Mean temperature of driest quarter (°C)
Bio10	Mean temperature of warmest quarter (°C)
Bio11	Mean temperature of coldest quarter (°C)
Bio12	Annual precipitation (mm)
Bio13	Precipitation of wettest week (mm)
Bio14	Precipitation of driest week (mm)
Bio15	Precipitation seasonality (C of V)
Bio16	Precipitation of wettest quarter (mm)
Bio17	Precipitation of driest quarter (mm)
Bio18	Precipitation of warmest quarter (mm)
Bio19	Precipitation of coldest quarter (mm)
Bio28	Annual mean moisture index
Bio29	Highest weekly moisture index
Bio30	Lowest weekly moisture index
Bio31	Moisture index seasonality (C of V)
Bio32	Mean moisture index of wettest quarter
Bio33	Mean moisture index of driest quarter
Bio34	Mean moisture index of warmest quarter
Bio35	Mean moisture index of coldest quarter

Carte de probabilité d'occurrence de *P. papatasi* en Algérie. les zones rouges indiquent une forte probabilité de présence du vecteur et les zones jaunes indiquent une faible probabilité de présence du vecteur. **(Garni R : Institut Pasteur d'Algérie)**



Carte de probabilité d'occurrence de LCZ en Algérie en fonction de la présence ou absence des deux rongeurs réservoirs de la maladie *(P obesus et M. shawi)* du vecteur *Ph papatasi* :
Taches orange-rouges forte probabilité d'apparition de la maladie
Taches bleues: faible probabilité d'apparition de la maladie (Garni R : Institut Pasteur d'Algérie)

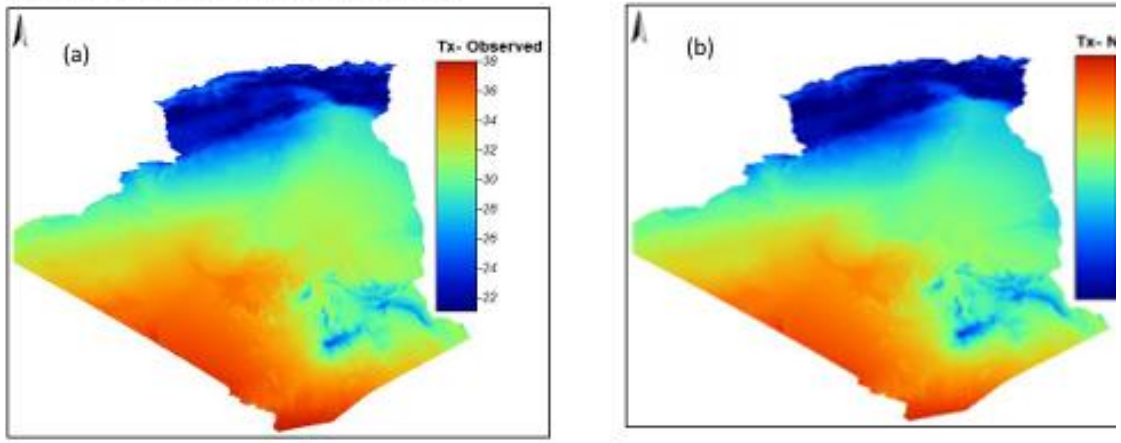


Fig. 3. Spatial variation of T-max (°C) of (a) observed versus (b) simulated, generated by SDSM during the validation period (1991–2005) in Algeria.

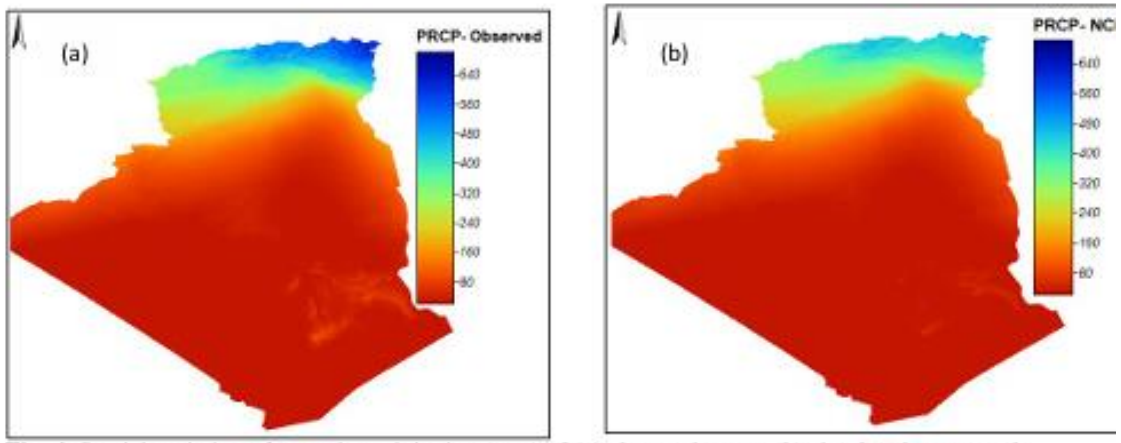


Fig. 4. Spatial variation of annual precipitation (mm) of (a) observed versus (b) simulated, generated by SDSM during the validation period (1991–2005) in Algeria.

Future Climate Projections in Algeria Using Statistical DownScaling Model

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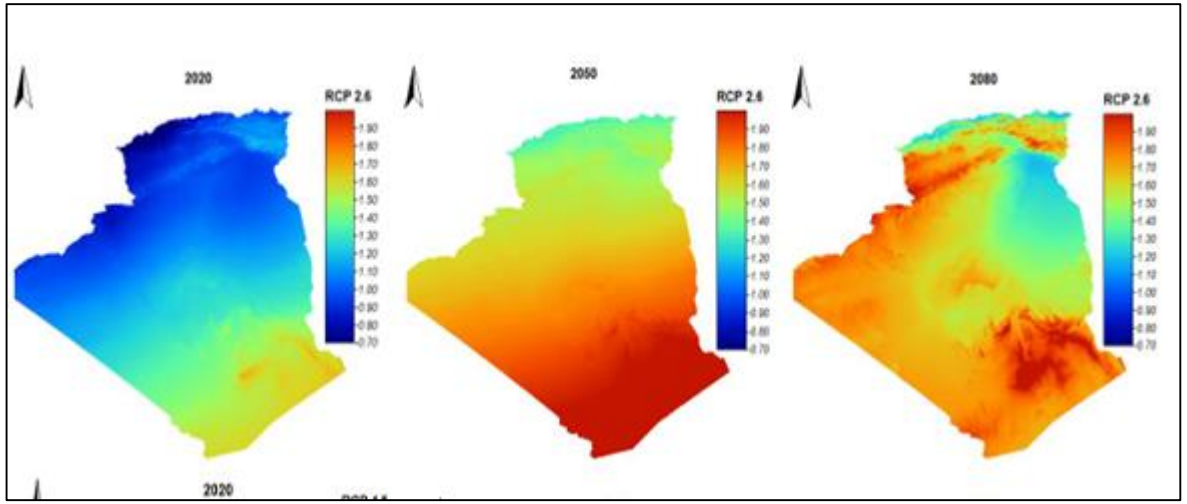
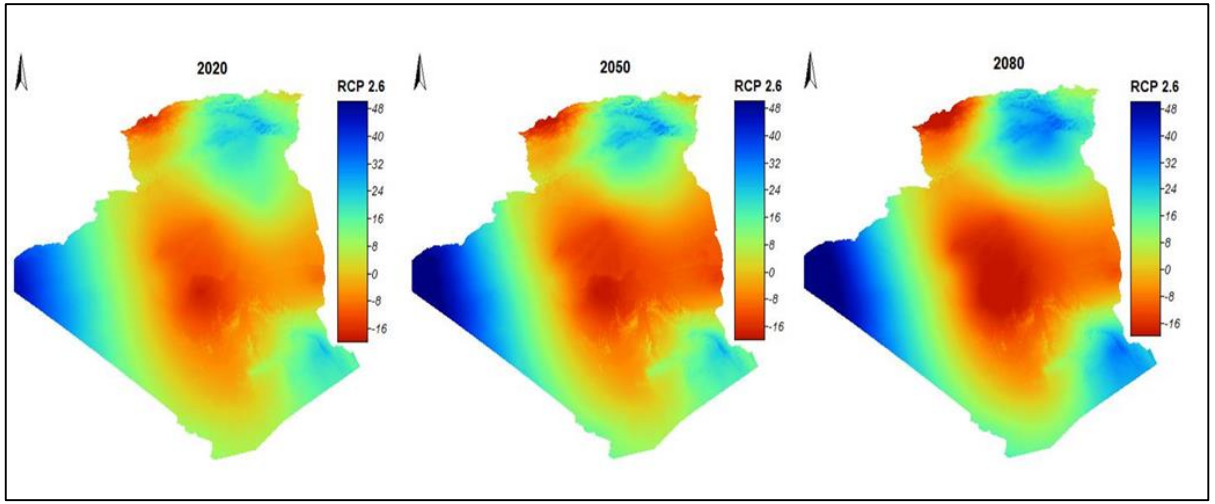


Projected future change of annual mean of T-min (°C) (2020s, 2050s and 2080s) under RCP2.6



Projected future change (%) of annual precipitation (2020s, 2050s and 2080s) under RCP2.6

Prédiction des la survenue de cas de LC dans les pays du Maghreb (Maroc –Algérie-Tunisie) pour les périodes : 2021-2041, 2041-2061, 2061-2081 et 2081-2100., mettant en évidence les variations potentielles de la transmission de la maladie à court, moyen et long terme.

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Spatio-temporal modeling of Cutaneous Leishmaniasis under climate change scenarios in the Maghreb region (2021–2100)☆

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Laboratory of Ecology of Earth and Aquatic Systems, University of Badji Mokhtar, Annaba, Algeria

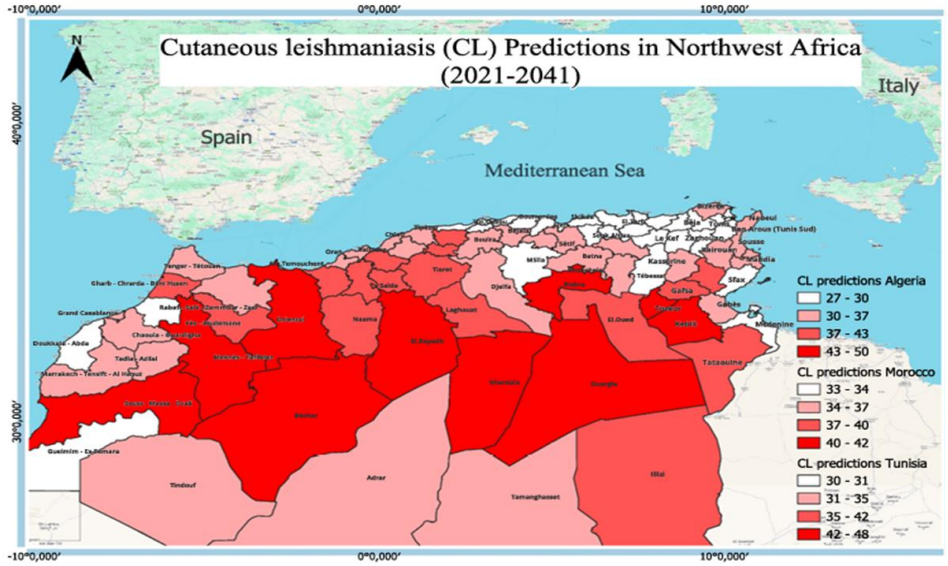

Fig. 6. Prediction of the spatiotemporal evolution of Cutaneous Leishmaniasis in Northwest Africa from 2021 to 2041.

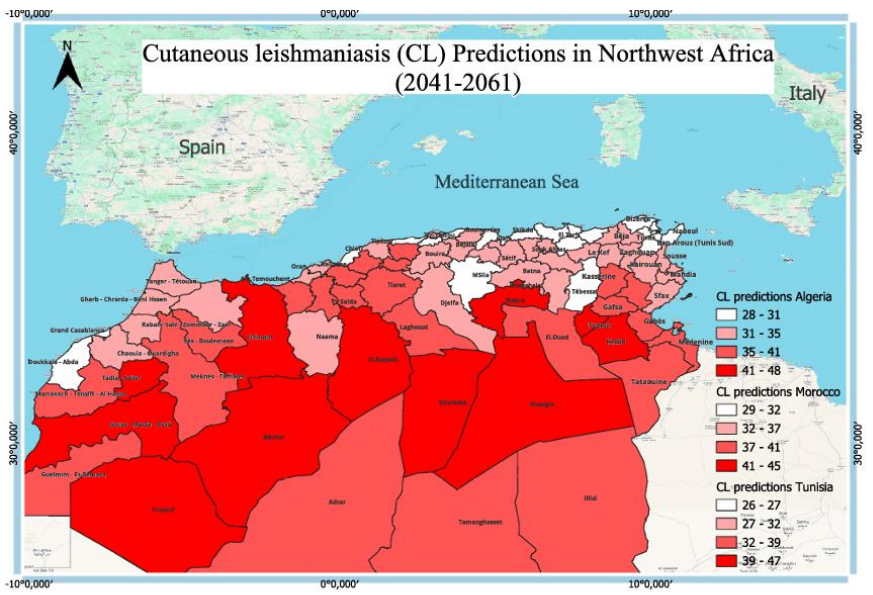

Fig. 7. Prediction of the spatiotemporal evolution of Cutaneous Leishmaniasis in Northwest Africa from 2041 to 2061.

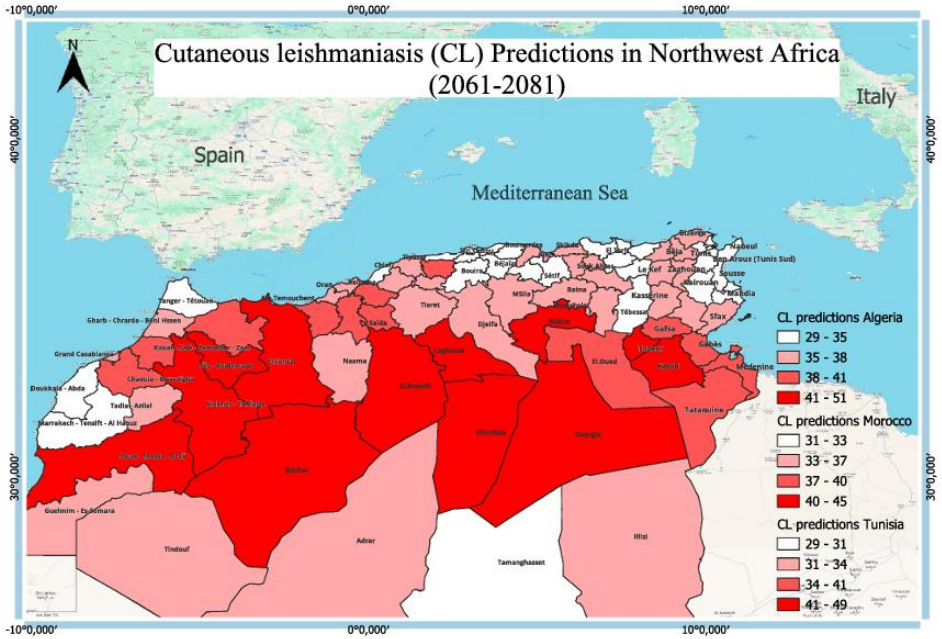

Fig. 8. Prediction of the spatiotemporal evolution of Cutaneous Leishmaniasis in Northwest Africa from 2061 to 2081.

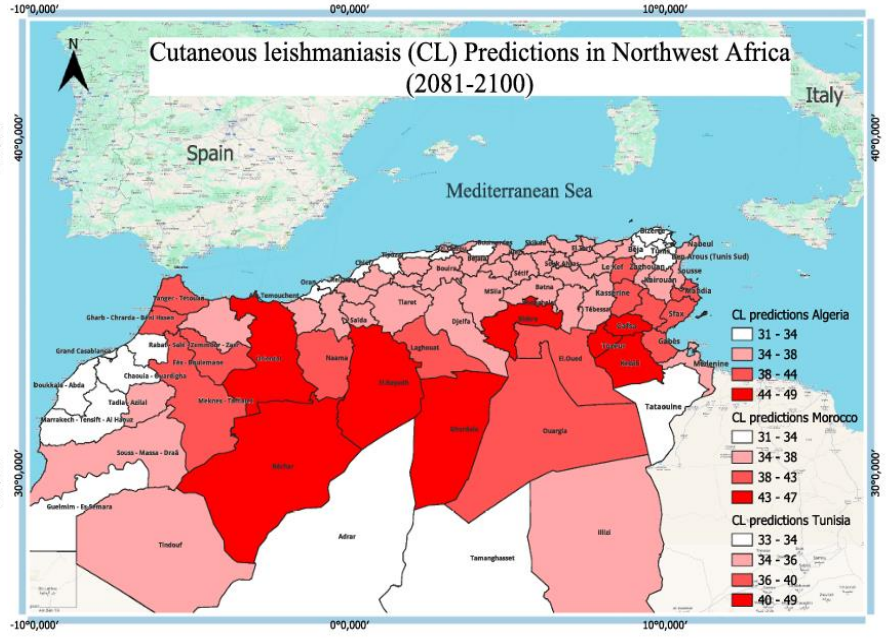

Fig. 9. Prediction of the spatiotemporal evolution of Cutaneous Leishmaniasis in Northwest Africa from 2081 to 2100.

Adaptation to climate change and reduction of public health risks: The case of an endemic vector-borne disease in the wilaya (province) of M'sila (Algeria), the cutaneous Leishmaniasis

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Introduction / Background

Leishmaniasis is a parasitic disease transmitted by sandflies, primarily affecting humans and caused by various Leishmania protozoan species. WHO estimates approximately 1.2 million cases of cutaneous leishmaniasis (CL) globally, with Algeria being the second most affected country. This disease is classified as a neglected tropical disease (NTD) by WHO, presenting significant public health and socio-economic challenges in endemic areas.

In Algeria, zoonotic leishmaniasis, caused by *Leishmania major* and transmitted by sandflies, leads to over 10,000 new cases annually. Wild rodents like sand rats and field rats serve as parasite reservoirs. Cutaneous leishmaniasis typically results in skin lesions, often crusted ulcers, with a significant impact on aesthetics, particularly when it affects the faces of girls and women. Most cases occur in children (60%), and the lesions are often unique (87%) and located on the face (69%). In Algeria, cases peak during winter, with outbreaks occurring every 4 to 6 years, influenced by herd immunity, climate, and environmental changes. The disease's geographical expansion, with new active foci in the Hauts Plateaus provinces, has complicated its epidemiological status in Algeria.

The sandflies' activity and disease transmission period average six months, from April to September. This timeframe allows for preventive measures like insecticide spraying campaigns and non-chemical initiatives to control rodent populations.

Aim and Research Questions

The project aims to explore the complex connection between climate change and the prevalence of cutaneous leishmaniasis in highly affected regions of Algeria. Its key objectives include reducing outbreak occurrences, establishing early detection methods, and implementing adaptation strategies in response to climate change. To achieve these goals, the project will conduct a thorough assessment of the vulnerability of the local population in endemic areas. It will also gauge the perceptions of professionals from sectors like forestry and agriculture regarding climate change's impact on cutaneous leishmaniasis outbreaks.

Furthermore, the project seeks to deepen our understanding of how climate change affects not only cutaneous leishmaniasis but also human health more broadly.

* How does climate change relate to the prevalence of cutaneous leishmaniasis in high-endemic regions of Algeria?
* What are the primary goals of the project?
* What measures are being taken to mitigate the occurrence of cutaneous leishmaniasis outbreaks?
* How will mechanisms for early detection be established in response to climate change?
* How is the vulnerability of the local population in endemic areas being comprehensively examined?
* In what ways does this project seek to enhance our understanding of the broader impact of climate change on cutaneous leishmaniasis and human health?

Methodology

The project involves collecting data over a 40-year period (1982-2020) from various sources to study cutaneous leishmaniasis in Algeria. Data on disease incidence and prevalence will be gathered from government institutions, including the Ministry of Health's Prevention Department and the Health Department of M'sila province. Field surveys and government sources, such as the Ministry of Agriculture and the Institute Pasteur of Algeria, will provide information on sandflies and disease reservoirs, including field rat and sand rat densities and locations.

Meteorological data, such as temperature, precipitation, and relative humidity, spanning the same 1982-2020 period, will be sourced from regional and central weather services. Additional bio-variables datasets will be used to assess the impact of climate change on cutaneous leishmaniasis risk across the country. Predicted data from sources like Worldclim and UC Santa Barbara will be employed to map the future distribution of sandfly vectors and rodent reservoirs.

Master's students, supervised by the project team, will collect and process the data as part of their final dissertations, which will span one year. Senior researchers will assist in data analysis and interpretation. The project also promotes the use of electronic data tools for training stakeholders, including students, health workers, and agronomists, to aid in data collection and real-time monitoring. Electronic forms and data platforms will be created specifically for field investigations, and health professionals will be trained in their use for data collection, early alerts, and electronic surveillance. Additionally, all forms and interviews will be available in both Arabic and French languages to accommodate the region's social context.

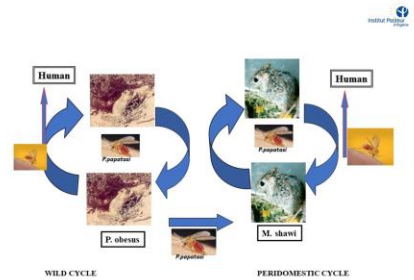

Figure 1: Transmission cycle of Cutaneous leishmaniasis in Algeria including two wild rodents reservoir (Sand rat (*Psammomys obesus* and Field rat (*Meriones shawi*) and the sandfly vector *Phlebotomus papatasi*

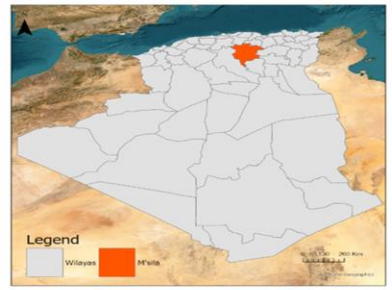

Figure 2: Map of the Wilaya (Province) of M'sila

Figure 3: Lesion and scare on the nose , of CL in the focus of M'sila (Photo from archives of IPA).

Research Progress / Early Insights

The activities accomplished thus far can be summarized in the collection of epidemiological data spanning from 1982 to 2020, the control campaigns already initiated, and the treatment and care of patients. The collection of meteorological data is currently underway. Moreover, the project's coordinator and principal investigator undertook a mission on October 17-18, 2023, during which they engaged with the local team from the University of M'sila. The focus of their discussions centered on strategizing the execution of fieldwork studies pertaining to reservoir hosts, vectors, environmental data, and the planning of meetings involving students and representatives from various sectors associated with the disease.

Conclusion and Next Steps

We've already conducted a comprehensive bibliographic analysis of the epidemiological landscape and future climate change scenarios in countries sharing a similar disease profile. Once the budget transfer is complete, we'll procure the necessary materials and resources for our fieldwork. In the upcoming weeks, we'll be organizing numerous meetings with the general population, stakeholders, and conducting focus group interviews, among other activities, to educate them on methods for adapting to and building resilience against climate change.

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CONCLUSION

- Le changement climatique devrait donc être ressenti plus durement en Algérie, compte tenu de la forte fragilité du pays et de ses faibles capacités d'adaptation.
- Il est important d’avoir une approche multidimensionnelle pour lutter contre les effets du changement climatique sur la santé en particulier les maladies à transmission vectorielle, en mettant l'accent à la fois sur l'atténuation et l'adaptation par les actions prioritaires suivantes :
- Promouvoir les politiques visant à réduire les émissions de carbone
- la mise en place de systèmes de santé résilients.
- Intégration de l'information climatique dans les politiques du développement
- Améliorer les systèmes d'alerte précoce en matière de santé publique pour les conditions météorologiques extrêmes
- Promouvoir l’action intersectorielle, et régionale.

Relance du barrage vert

Le barrage vert : Décrit comme un mégaprojet écologique et agro-économique il a été lancé par le Président Houari Boumediene en 1970.

Il a commencé par les efforts de ses premiers initiateurs et des soldats de l'ANP et il se poursuit, aujourd'hui, avec les scientifiques au moment ou les changements climatiques nous posent de nouveaux défis

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