8TH Seminar For Homogeinization And Quality Control In C limatological Databases

Homogenization of rainfall series and climate variability in the North-eastern Algeria

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PLAN

- Presentation of the study area.
- Homogenization of data.
- Checking homogeneity of reference stations
- Break detection at different stations.
- Validation breaks.
- Correction series.
- Validation adjusted series.
- Analyze Tendencies of the Rains

PRESENTATION OF THE ALGERIAN MET OFFICE

Organization of National Meteorological Office 1

To ensure its missions, the Algerian met-office employs a manpower of 1198 agents among which, 64% represents the technical body.

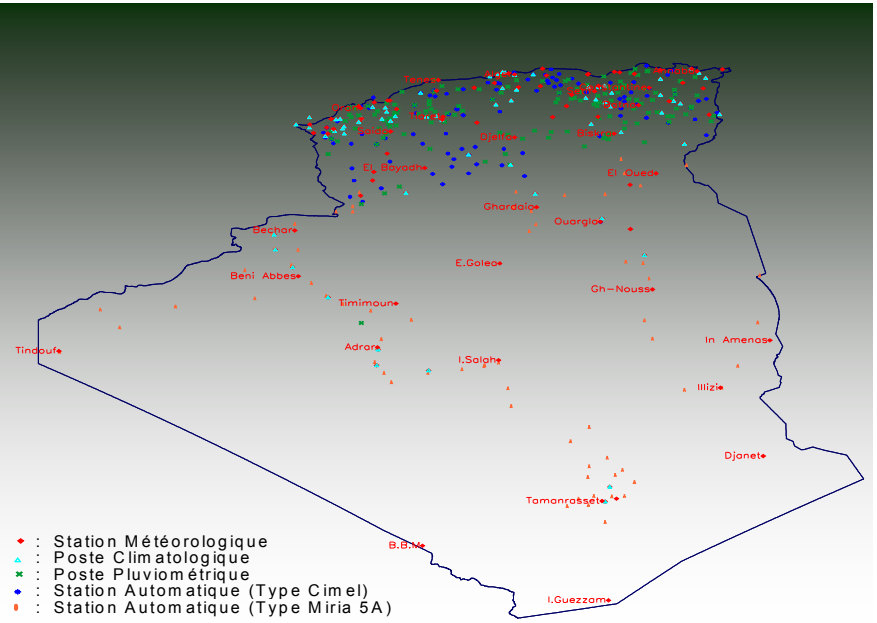
The Algerian territrory (2,3millions Km2 is covered by a network of observational stations

- **84 observation stations surface and 05 altitude**
- **300 climatological stations, 100 Automaticly sations**
- **40 SMA DCP (locust invasion), 10 SMA (Local area , Algiers)**
- **3 radar centers (Setif, Seraidi, D.E.Beida)**
- **2 special Research stations, dedicated to specific observation**

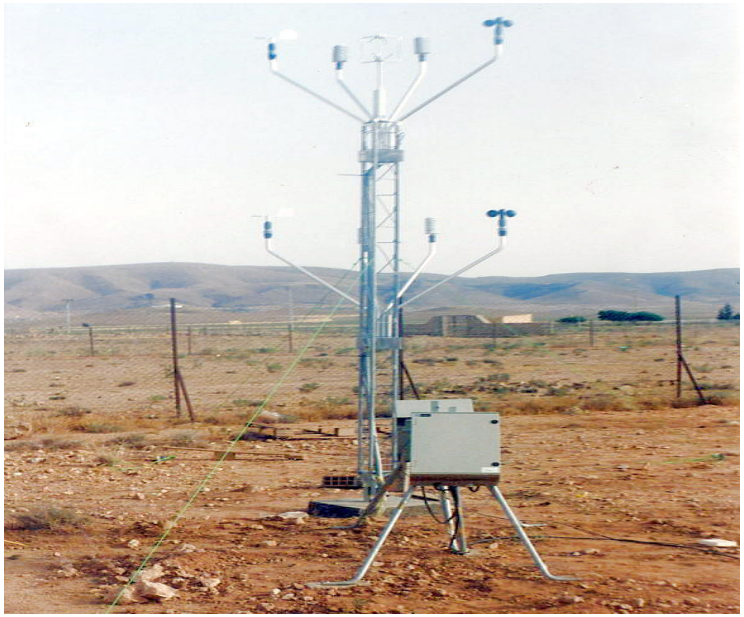
Concerning the structures :

- **4 Functional directions and 4 Operational ones at the central level.**
- **6 Directions at the regional level, in charge of the observational**

National Networ



Station of KSAR CHELLALA
Arid and semi-arid Zones



Stations dedicated to specific observations

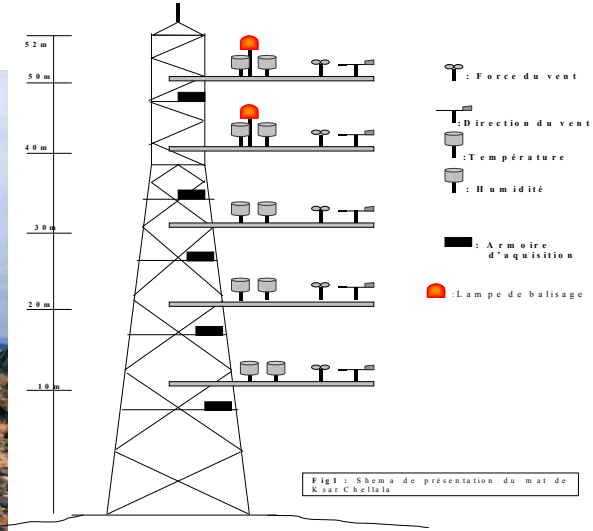


Fig1 : Shema de présentation du mat de Ksar Chellala

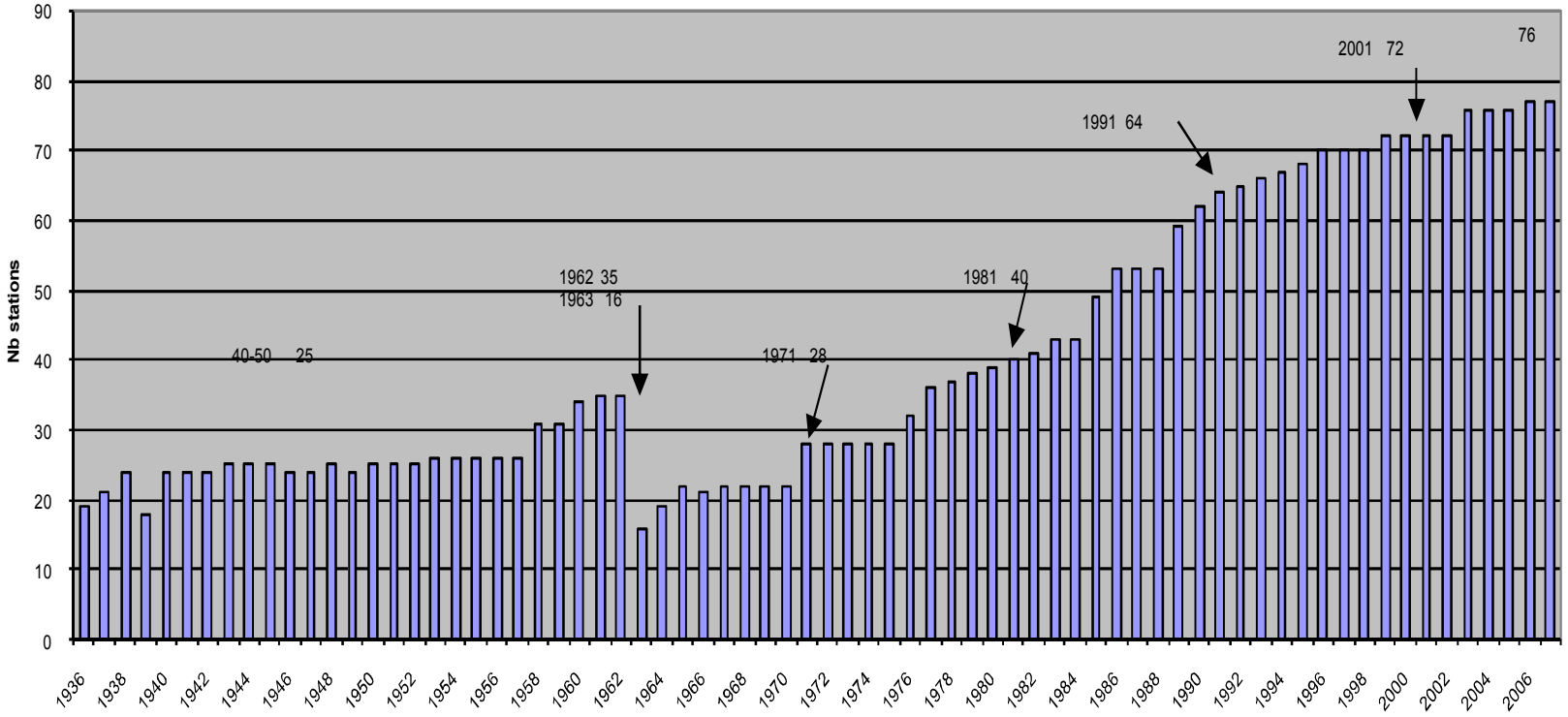
Station of ASSEKREM (2710 m)
Global atmosphere Watch

National Network

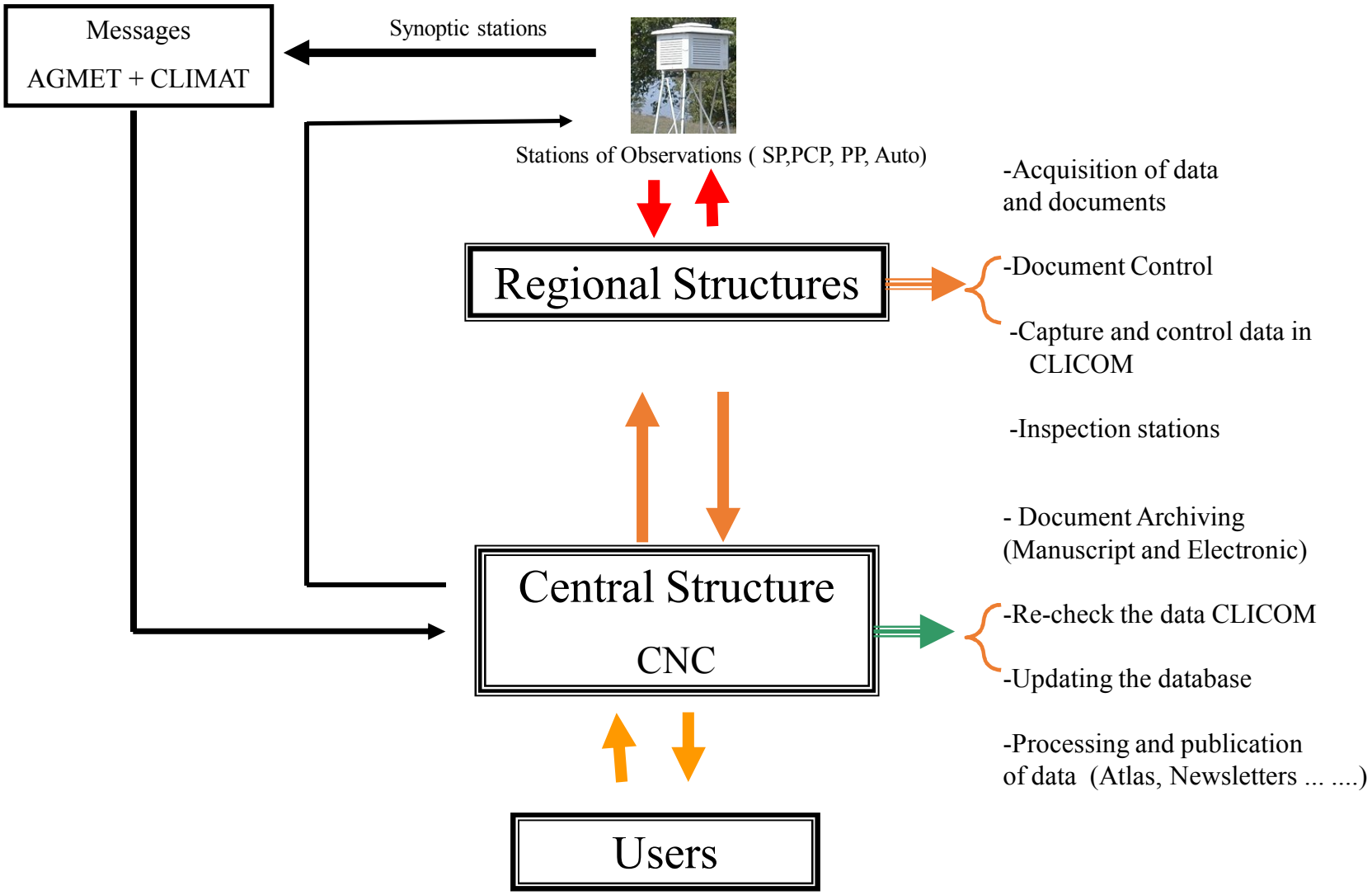
EVOLUTION OF the SYNOPTIC NETWORK 1936-2013

8 stations with continuous observations from 1936 till 2013

Stations principales de 1936 à 2011



Channel acquisition and processing of climatologically data

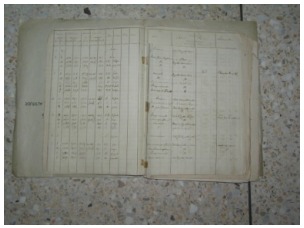


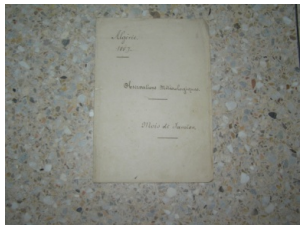
Base of climatological data 1

Handwritten archived on two sites ORAN before 2003, ALGIERS since 2003

The oldest climatologically document Algiers city 1856

ORAN





Base of climatological data 2

Seized - control data

Volume of the bank data

- **4000 years of synoptic data**
- **10 000 years of daily data (precipitation, temperatures)**
- **1000 years of (automatic) hourly data**
- **22 years of data VAG**

Climate Products 1

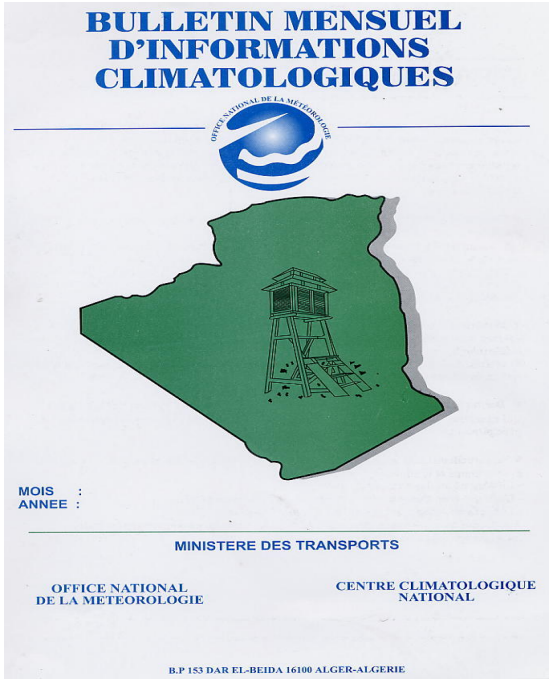
Routinely collected meteorological data from meteorological stations has to:

Observations :
Medium,
Normal,
Return periods …
From series homogenized
Generator series:
Probabilities,
Case studies.

Seasonal forecast :
Anomalies of precipitation and temperatures of 1, 2 and 3 months

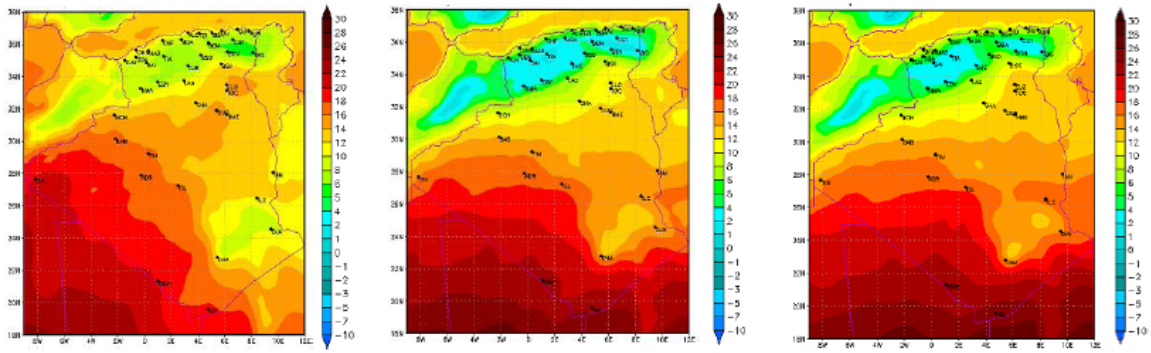
Statistical adjustments:
Correlation between observations and model outputs

Product Produced 2:



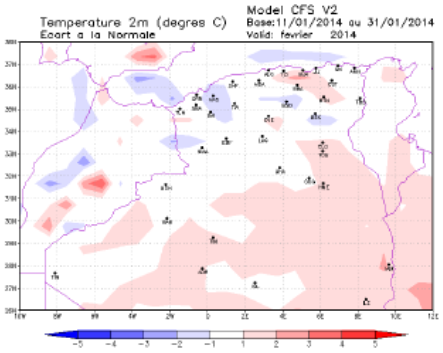
Climate Publications

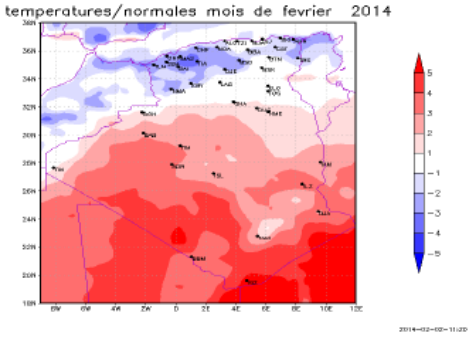
- Newsletter of decadal climate and agro meteorological information.
- Monthly newsletter of climate information.
- Annual Summary of weather in Algeria.
- Newsletter of the seasonal forecast

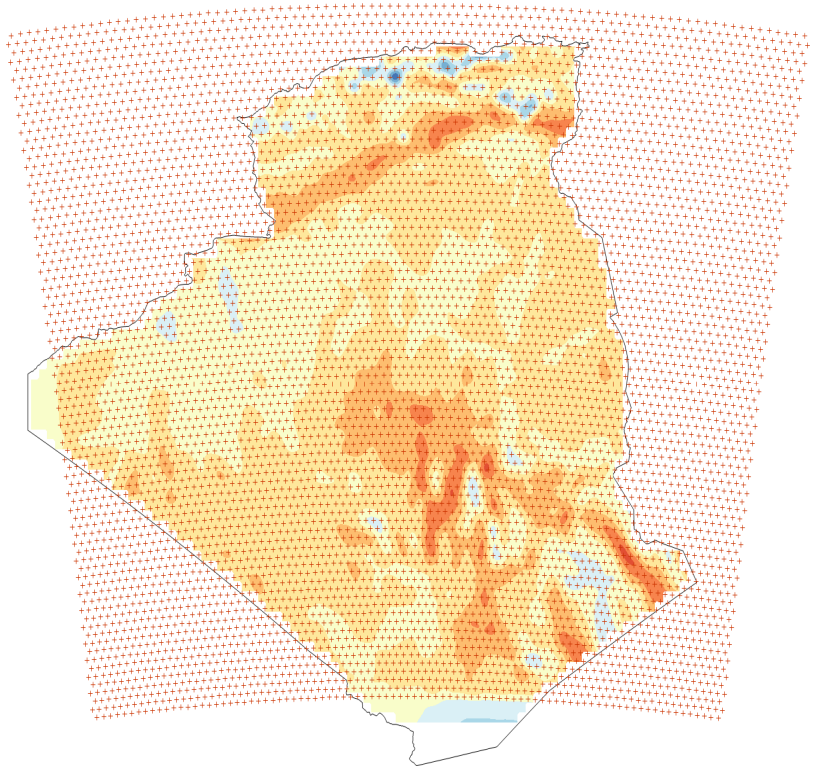


En haut on a représenté la Température prévue par le modèle CFS en réalisant un Downscalling de 40Km résolution pour la 1er, 2ème et 3ème Décade mois de Février 2014.

En bas on donne la sortie pour la Température mensuelle (mois de Février 2014) du Modèle CFS 100Km résolution pour 24 membres et Downscalling de 40Km résolution.





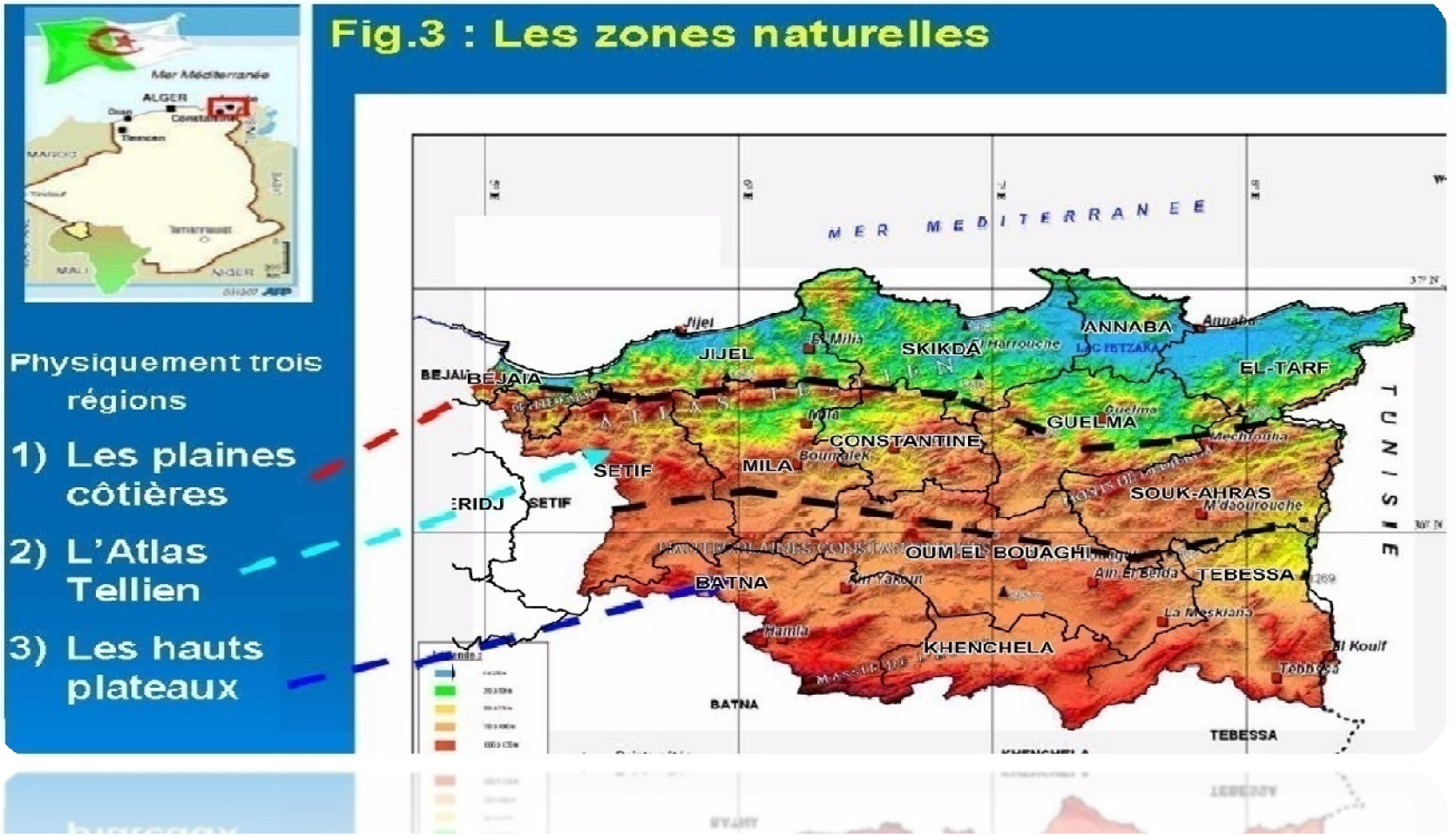


Homogenization of rainfall series

Presentation of the region of study

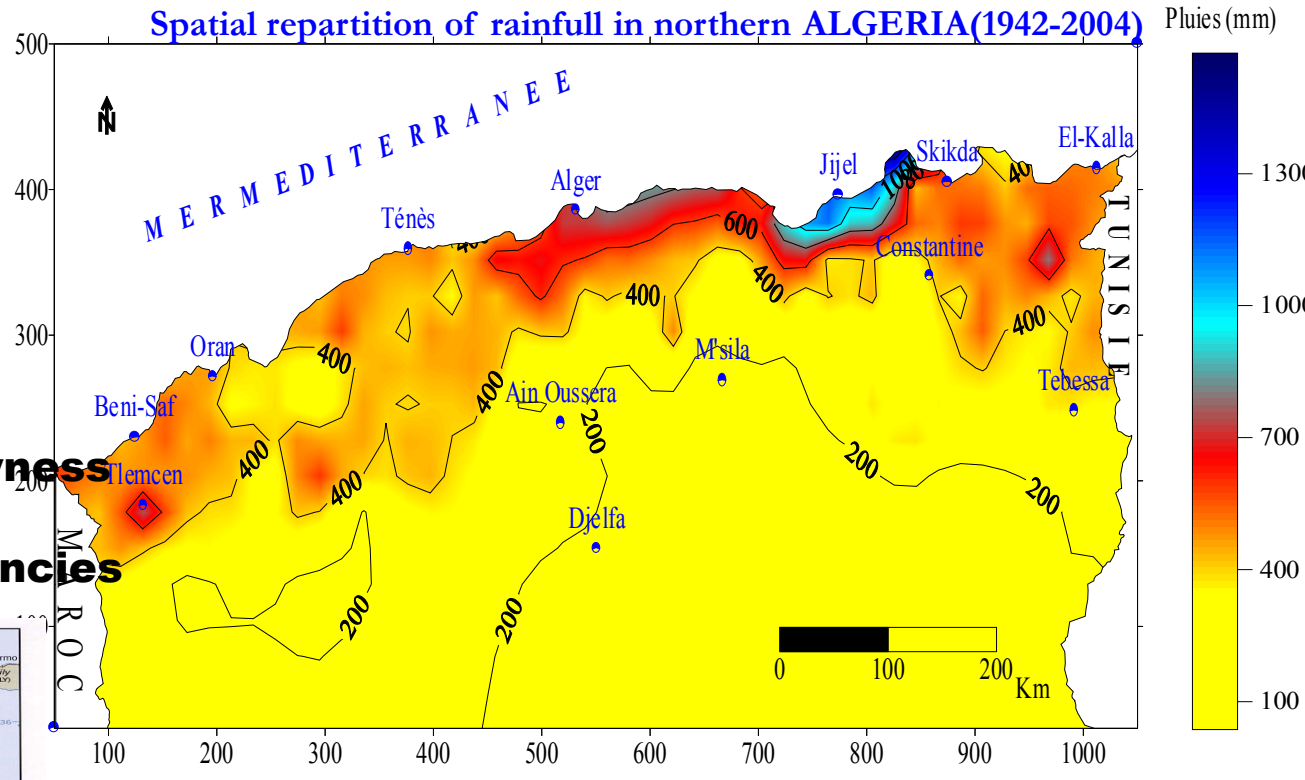
We thus have 18 weather stations including 03 series of reference: Annaba, Constantine, Tébessa.

Our area is composed by three natural environments



why the choice of this region?

- **it is the most rainy region**
- **A very great variability of the rains**
- **Confronted with the problem of the dryness**
-
- **Detection of break point and the tendencies**



(Medjrab. A, 2005)

Our work consists in studying climatic changes observed on the North-eastern area of Algeria, while being based on the analysis of its annual, monthly and daily distributions of pluviometry.

the data climatic monthly and annual require their preliminary homogenisation what was the subject of our first part.

The detection of the climatic change: Several approaches are proposed with an aim of analyzing the behavior and the tendency of annual precipitations of our area of study

The first database consists of precipitation measurements of monthly and annual rainfall to eighteen (18) weather stations in the region "North-eastern Algeria" during the period 1936 to 2004

Homogenisation of the data

Most of the time, the artificial ruptures of the basic series (that which one wants to study) refers using the series, the latter must be homogeneous, if not inhomogeneousness in one of them could be allotted to the basic Series. Therefore before studying the homogeneity of the basic series and applying the tests of detection of breaks, it should initially be checked that our series of references are homogeneous.

Checking of homogeneity of the stations of references

•Adjustemnt test of Kolmogorov- Smirnov:

Assumption of the test:

H_0 : « F=F_0 » VS H_1 : « F ≠F_0 » ou F_0 law continues on R

Application of the test of Kolmogorov Smirnov:

We apply the differnt tests of the homogeneity to the annual quantity of precipitation for the different series of the study.

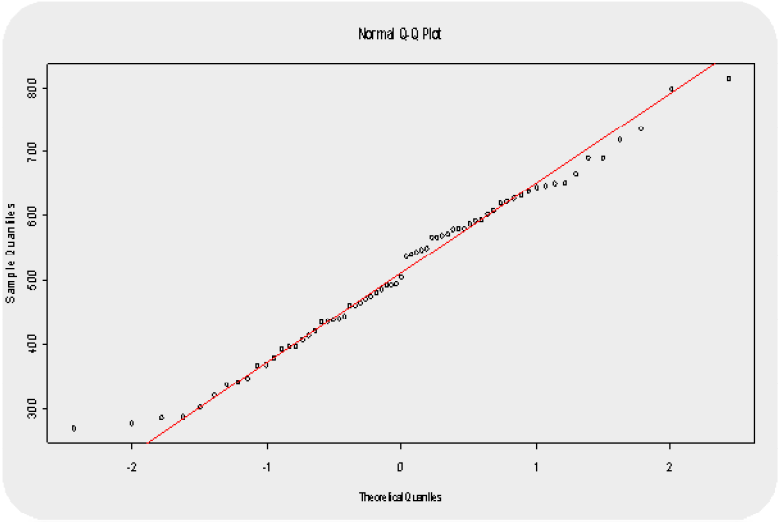
Series of Constantine

Assumptions of the test:

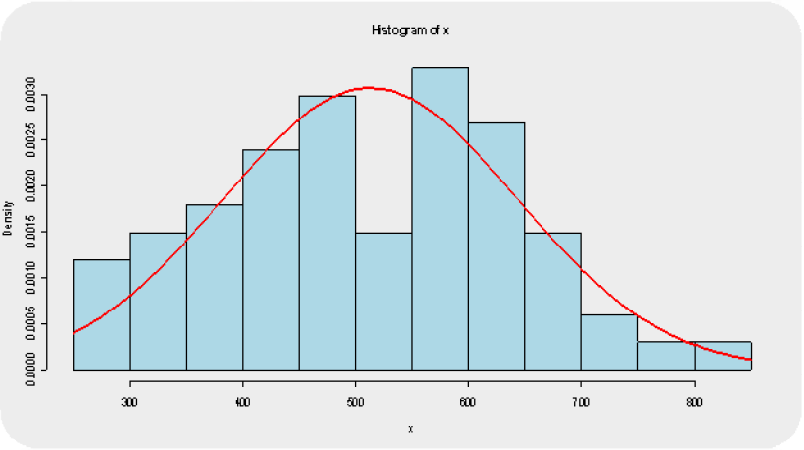
$H_{0\ the}$ sample follows a normal law.
$H_{1\ the}$ sample does not follow a normal law.
Law of probability adjusted with the data: Normal NR (μ = 512.797, Sigma² = 16926.115),
One rejects H_0 if p- value is lower strictly has 0,05.

Test de Kolmogorov-Smirnov / test bilatéral :

D	0.078
p-value bilatérale	0.813
Alpha	0.05



" the purpose of QQ-Stud " is to examine the line of Henry and the variations of the observations on this line, and allows us to give representations visually very instructive of the distribution of our observations compared to the Distribution of " Normal " reference, we see that all the points are around the right-hand side, which enables us to say that our data are well adjusted.



Results:

It is noticed that the normal law adjusts the series of reference well: Annaba, Constantine and Tébessa, therefore one can suppose that those are homogeneous

Detection of the breaks in the different stations:

1) Method of Jaruskova:

This method consists has to build a series of differences between the basic series and the reference series.
And relaying on a statistical test of change of average.
The hypotheses of the test:
H0: " the series is homogeneous "
Vs
H1: " there is a break on average in the series »

$$Q_i = \sqrt{\frac{(n-i)i}{n}} \frac{(\bar{d}_{1:i} - \bar{d}_{i+1:n})}{s_i} \quad ,i=1,\dots n-1 \quad ;$$

$$s_i^2 = \frac{1}{n-2}\left[\sum_{j=1}^{i}(d_j - \bar{d}_{1:i})^2 + \sum_{j=i+1}^{n}(d_j - \bar{d}_{i+1:n})^2\right]$$

$$W = \{Q_p / Q_p > Q_\alpha\} \qquad Q_p = max_{i=1,\dots n-1}\{|Q_i|\}$$

$$Q_\alpha = F^{-1}{}_{Qi}[½ + ½\sqrt[n-1]{0.95})\,]$$

In the threshold a=0.05, the zone of rejection

results of the test of Jaruskova

The basic series	the Series of reference	Results applied to the series of comparison
Hamla	Tébessa	$Q_{p\ (observée)} = 2.24$ $Q_{p\ (observée)} < Q_{\alpha}$, on accepte H_0 pas de rupture.
Jijel	Annaba	$Q_{p\ (observée)} = 3.93$ $Q_{p\ (observée)} > Q_{\alpha}$, on rejette H_0 Il existe une rupture en moyenne à l'année (1974-1975)
La Meskiana	Tébessa	$Q_{p\ (observée)} = 2.84$ $Q_{p(observée)} < Q_{\alpha}$, on accepte H_0 pas de rupture.
Ain Yagout	Tébessa	$Q_{p\ (observée)} = 2.51$ $Q_{p\ (observée)} < Q_{\alpha}$, on accepte H_0 pas de rupture.
El kouif	Tébessa	$Q_{p\ (observée)} = 4.546$ $Q_{p\ (observée)} > Q_{\alpha}$, on rejette H_0 Il existe une rupture en moyenne à l'année (1953-1954)
Boumalek	Constantine	$Q_{p\ (observée)} = 5.51$ $Q_{p\ (observée)} > Q_{\alpha}$, on rejette H_0 Il existe une rupture en moyenne à l'année (1991-1992)

2) Method of sequential Wilcoxon:

This method consists has to build a series of report between the basic series and the reference series.

The hypotheses of the test:

H0: " the series is homogeneous "

Vs

H1: " there is a break on average in the series "

The statistics for i fixed is:

$$Z_i = \frac{R_i - [\frac{i(n+1)}{2}]}{\sqrt{i(n-i)(n+1)/12}}$$

i=11…….n-9

In the threshold has 0.05 the zone of rejection(dischaW $= \{Z_p / Z_p > Z_\alpha\}$ $Z_p = \max |Z_i|$

$$z_\alpha = \emptyset^{-1}\left(\frac{1}{2}\sqrt[n-19]{1-\alpha}\right) + \frac{1}{2}$$

Results of the test of sequential Wilcoxon

La série de base	La série de référence	Résultats appliquée sur la station de comparaison
La Meskiana	Tébessa	$Z_{p\ (observée)} = 3.8227$ $Z_{p\ (observée)} > Z_{\alpha}$, on rejette H_0 Il existe une rupture en moyenne à l'année (1983-1984)
El kouif	Tébessa	1ere détection : $Z_{p\ (observée)} = 4.7679$ $Z_{p\ (observée)} > Z_{\alpha}$, on rejette H_0 Il existe une rupture en moyenne à l'année (1963-1964) 2eme détection : $(Z_{pobservée)} = 2.816$ $Z_{p\ (observée)} < Z_{\alpha}$, on accepte H_0 pas de rupture
Boumalek	Constantine	first detection $Z_{p\ (observée)} = 5.35$ $Z_{p\ (observée)} > Z_{\alpha}$, on rejette H_0

According to the results obtained by both tests, we recorded breaks at the level:

The meskiana in 1983-84.

Jijel in 1974-1975.

Me daourouche 1966-1967.

El kouif in 1953-1954, in 1963-1964.

Oum el bouaghi in 1947-1948, in 1949/1950.

Boumalek: in 1991-1992, in 1987-1988.

Validation of the breaks:

Test of translation of Wilcoxon:

The hypotheses of the test:

H_0 : «F x=F y »
Vs
H_1 : « $F_{Xi} = F_{Yi+e}$ si e>0 » soit H_1 : « $F_{Xi} = F_{Yi+e}$ si e<0 »

The zone of rejection spells: $W=\{w/w_x < W_\alpha\}$

or $Wx = \sum_{j=1}^{i} R\,xj$

The sum of the rows(ranks) of the observations of X.

Such as Wa is read on the table of Wilcoxon to the threshold has.

The test of translation of wilcoxon will allow us to compare two periods:

- The first period: $X = (X_1 \ldots\ldots X_i)$

- The second period : $X = (X_{i+1} \ldots\ldots X_n)$

$$\underbrace{X}_{1 \quad i} \qquad \underbrace{Y}_{i+1 \quad n}$$

- I: The year of break.
- **The hypothesis made out a will(tested):**

H0: " X and Y have the same distribution " (H=H0)

VS

H1: " X and Y have no same distribution " (H=H1)

Zone of rejection:

We reject H0 if p - been worth is lower strictly has 0,05.

Results:

The table this below summarizes the results of stations presenting breaks close or situated in extremes, and the check of the first break detected at the level of El kouif (1953/1954).

	El kouif
P-value	0,52
conclusions	H_0

	Oum El Bouaghi	Boumalek	Mila
Années	**$P_{1=}$ 47/48 P_2 =49/50**	**P_1 =88/87 P_2=91/92**	**P_1= 2000/01**
commentaires	**P_1 et P_2 Rupture très proche**	**P_1 et P_2 Rupture très Proche**	**Rupture située aux extrêmes**

Every obtained break is controlled annually and monthly
Station Boumalek

Check break (1991-1992)

	Annuel	sept	Oct	nov	dec	janv	fev	mars	avril	mai	juin	Juillet	Aout
p-Value	0 ,05	0,14	0,01	0,03	0,02	0,08	0,02	0,01	2,8e-07	0,04	0,08	0,2	0,090
Conclusions	H_1	H_0	H_1	H_1	H_1	H_0	H_1	H_1	H_1	H_1	H_1	H_0	H_1

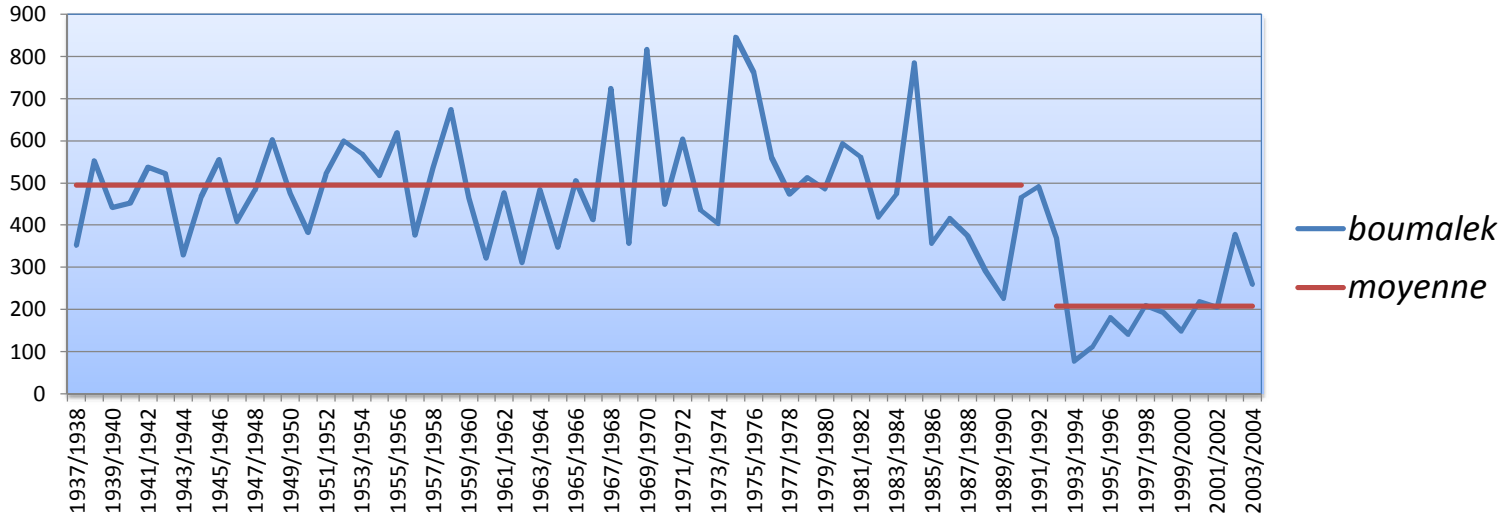
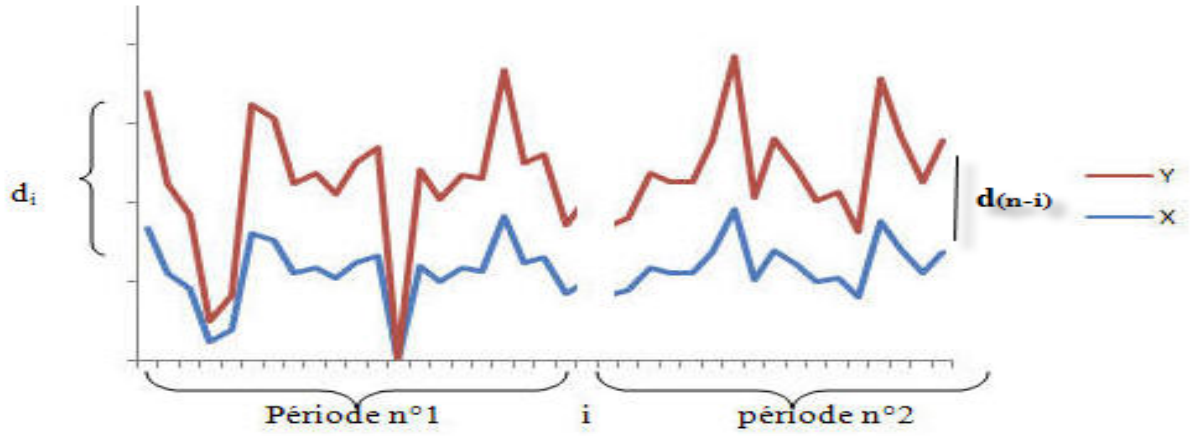


Figure IV: the evolution of the quantities of rain in the station of BOUMALEK

Correction of the series of the study

Method of correction :

The Correction statistique : The objectif of this correction is to find the evolution former to the break, i.e. to return the variation dn-i of the second period equal to the variation di of the first period.



$\widehat{d_{n-i}} = \bar{d_i}$) $(\widehat{x_{n-i}})_j = (x_{n-i})_j + (\bar{d_i} - \overline{d_{n-i}})$,

Où $(\widehat{x_{n-i}})_j$: L'estimation de la j^eme observation de la deuxième période,

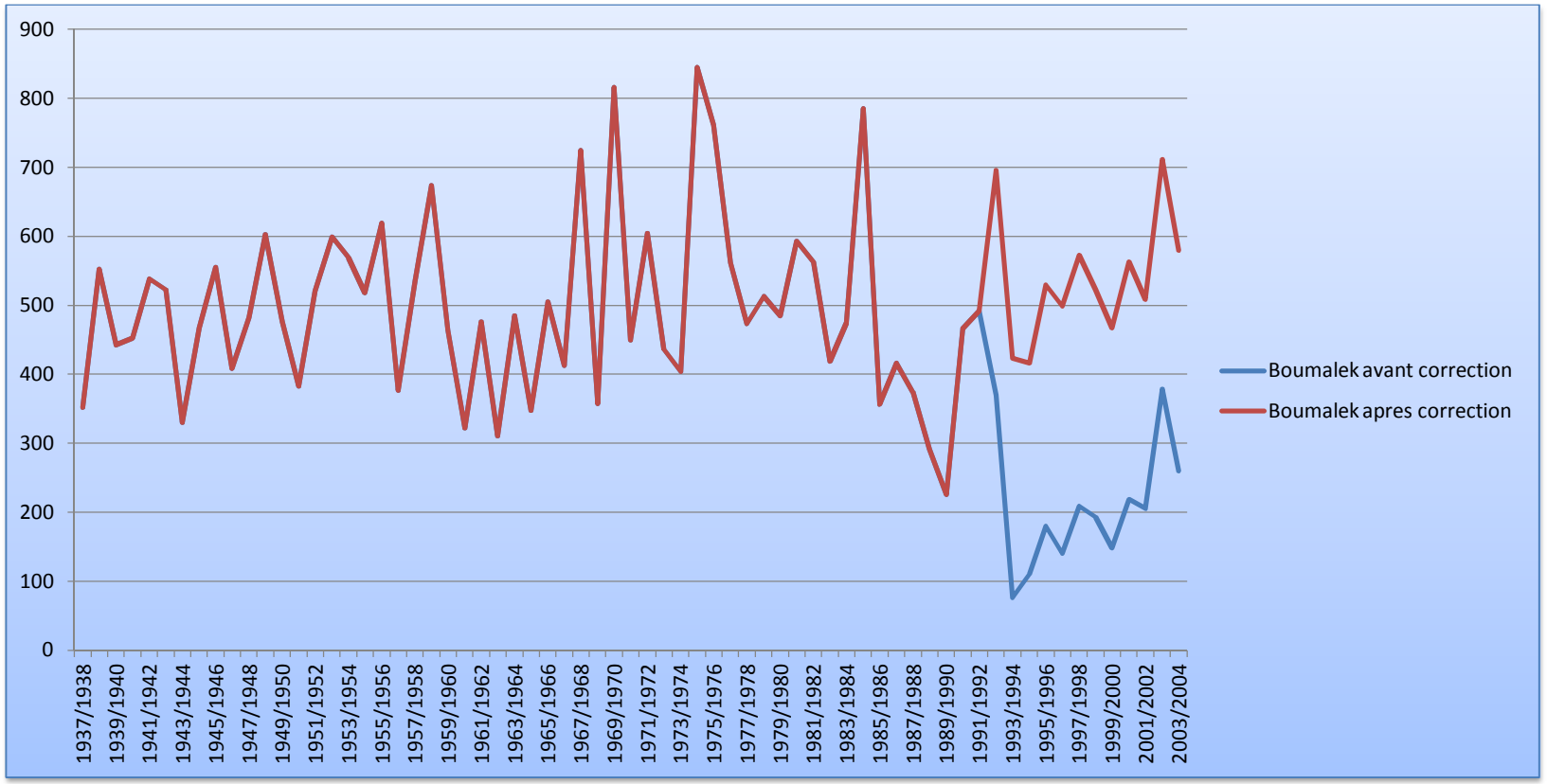
$(x_{n-i})_j$: La j^eme observation de la deuxième période,

$\bar{d_i}$: la moyenne des différences d_i de la première période et $d_i = x_i - y_i$,

$\overline{d_{n-i}}$: la moyenne des différences d_{n-i} de la deuxième période et $d_{n-i} = x_{n-i} - y_{n-i}$,

Avec cette correction on aura bien $\widehat{d_{n-i}} = \bar{d}$.

The graph below represents the results obtained by the statistical correction



Evolution of precipitation at the station of BOUMALEK before and after the correction statistical

Validation of the corrected series

After having corrected our series of bases with the statistical method, we will subject these series to a second checking by applying the hypotesis of test of Kolmogorov-Smirnov.

Station of Boumalek

Assumptions of the test:

H_0 sample follows a normal law.
H_1 sample does not follow a normal law.
Law of probability adjusted with the data: Normal NR (μ = 504,812, Sigma² = 15693,177), One rejects H_0 if p-been worth is lower strictly has 0,05.

Test de Kolmogorov-Smirnov / test bilatéral :

D	**0,082**
p-value bilatérale	**0,768**
Alpha	**0.05**

ANALYZE TENDENCIES OF THE RAINS

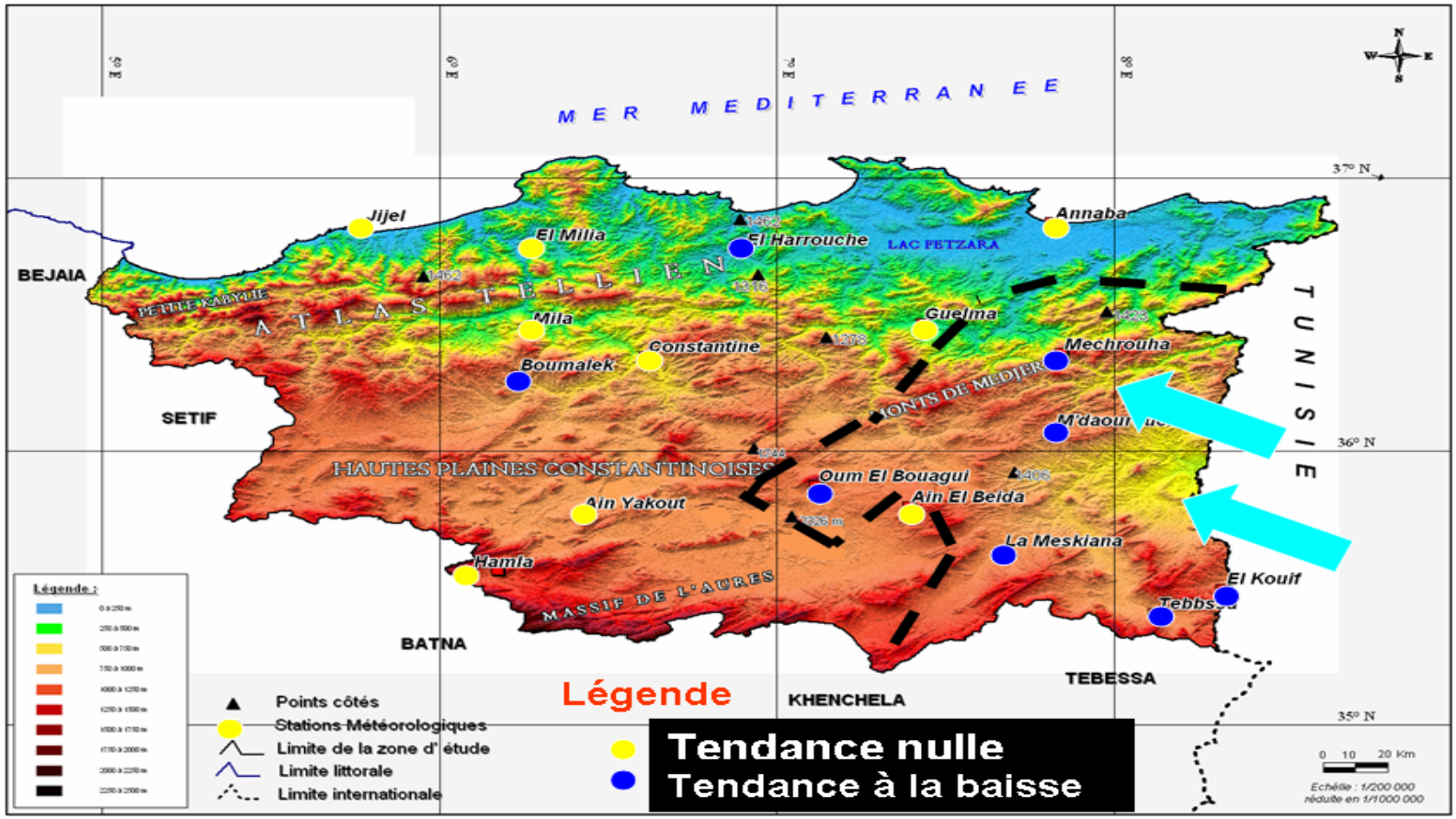
To detect the existence of tendencies in a serie of pluviometric data, different tests can be used. In order to consolidate the results of the tests, we used a nonparametric test, the test of Pettitt, in fact, which has also the effect of locating *the instant of the Break of the average within the series* with a level of significance which translates the real importance of the detected change

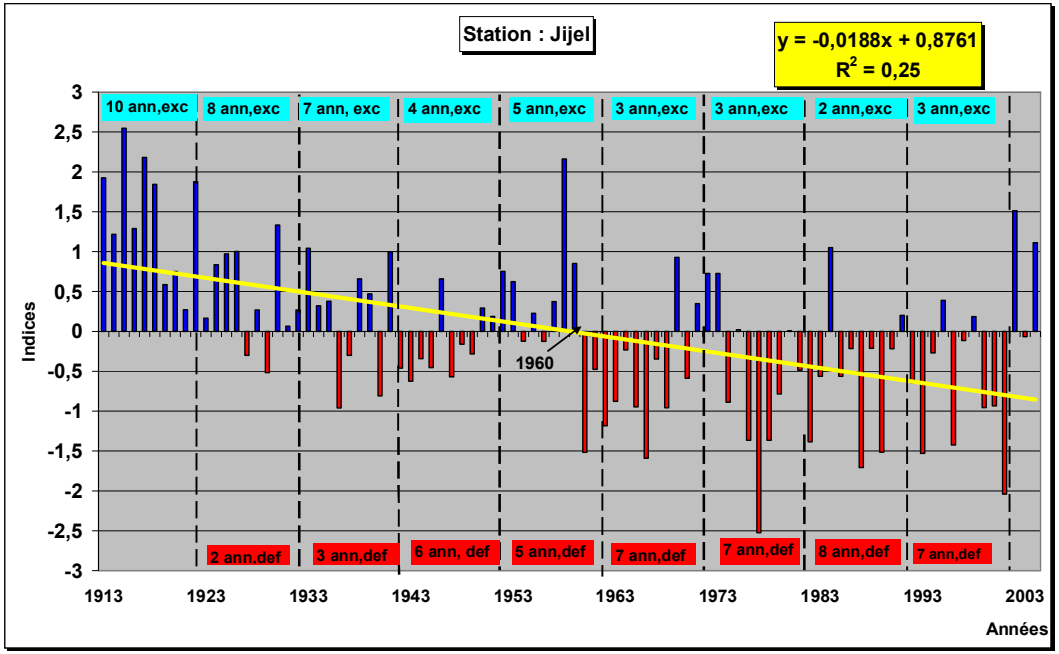
Application and results of the nonparametric tests on annual pluviometry over the period 1936-2004

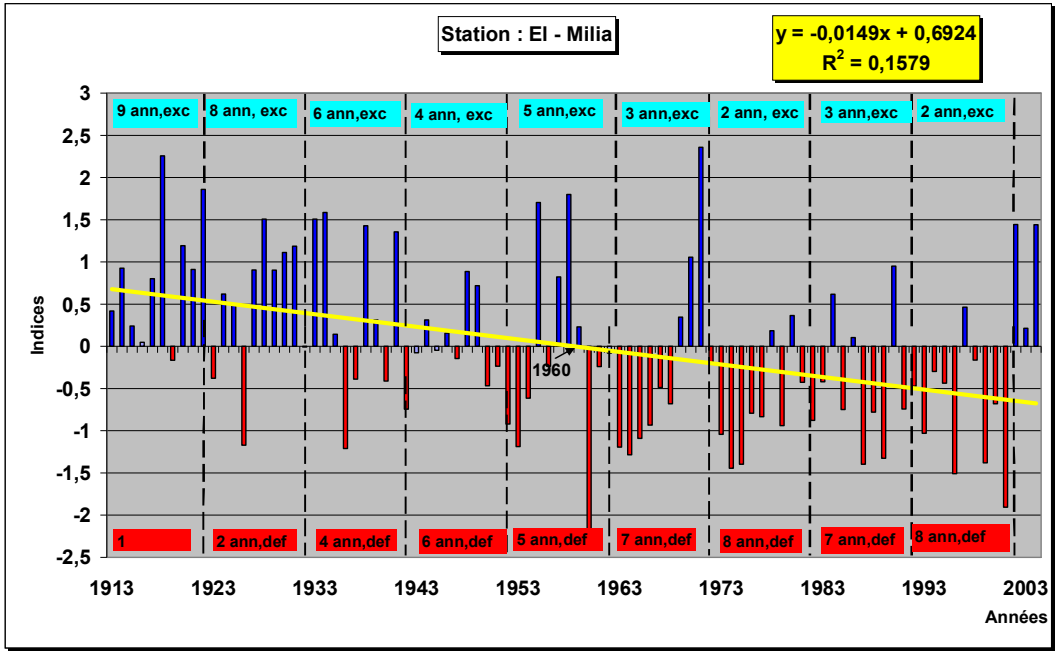
Stations	Codes	Résultats du Test de Mann Kendall	Résultats du Test de Spearman
Jijel	030301	Tendance à la baisse	Tendance à la baisse
El Harrouche	030801	tendance nulle	tendance nulle
Annaba	031410	tendance nulle	tendance nulle
Ain Yakout	070306	tendance nulle	tendance nulle
Hamla	070308	tendance nulle	tendance nulle
Batna	070316	tendance nulle	tendance nulle
Ain El Beida	070707	tendance nulle	tendance nulle
Oum El Bouagui	070716	Tendance à la baisse	Tendance à la baisse
Boumalek	100401	Tendance à la baisse	Tendance à la baisse
Mila	100606	tendance nulle	tendance nulle
Constantine	100608	tendance nulle	tendance nulle
El- Milia	100706	tendance nulle	tendance nulle
La Meskiana	120201	Tendance à la baisse	Tendance à baisse
Tébessa	120301	tendance nulle	tendance nul
M'daourouche	120403	Tendance à la baisse	Tendance à baisse
El Kouif	120504	Tendance à la baisse	Tendance à l baisse
Guelma	140407	tendance nulle	tendance nul
Mechrouha	140502	tendance nulle	tendance nul

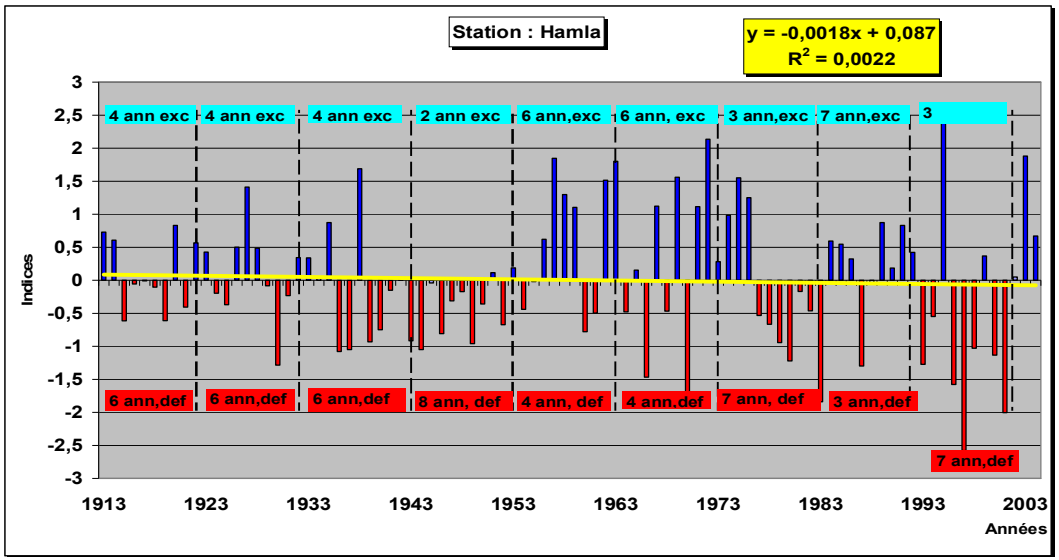
The tests of Spearman and Mann-Kendall applied to the series of annual pluviometric data of the 18 stations chosen over one period of 1936-2004, detected a downward trend significant on the level of 95%. For 6 stations only. 12 series did not know any significant tendency. This result thus does not translate a specific regional behavior,

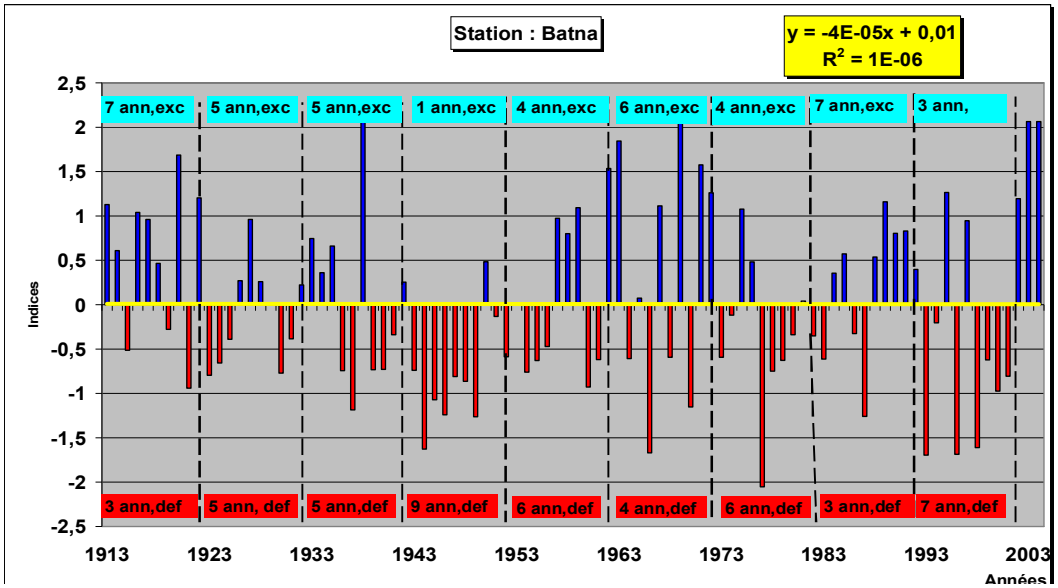
Spacial Distribution of Tendency of the annual rains by the test of Mann- Kendall




Station : Jijel
y = -0,0188x + 0,8761
R2 = 0,25
10 ann,exc
8 ann,exc
7 ann, exc
4 ann,exc
5 ann,exc
3 ann,exc
3 ann,exc
2 ann,exc
3 ann,exc
2 ann,def
3 ann,def
6 ann, def
5 ann,def
7 ann,def
7 ann,def
8 ann,def
7 ann,def
1960
Indices
Années


Station : El - Milia
y = -0,0149x + 0,6924
R2 = 0,1579
9 ann,exc
8 ann, exc
6 ann,exc
4 ann, exc
5 ann,exc
3 ann,exc
2 ann, exc
3 ann,exc
2 ann,exc
1
2 ann,def
4 ann,def
6 ann,def
5 ann,def
7 ann,def
8 ann,def
7 ann,def
8 ann,def
1960
Indices
Années


Station : Hamla
y = -0,0018x + 0,087
R2 = 0,0022
4 ann exc
4 ann exc
4 ann exc
2 ann exc
6 ann,exc
6 ann, exc
3 ann,exc
7 ann,exc
3
6 ann,def
6 ann,def
6 ann,def
8 ann, def
4 ann, def
4 ann,def
7 ann, def
3 ann,def
7 ann,def
Indices
Années


Station : Batna
y = -4E-05x + 0,01
R2 = 1E-06
7 ann,exc
5 ann,exc
5 ann,exc
1 ann,exc
4 ann,exc
6 ann,exc
4 ann,exc
7 ann,exc
3 ann,
3 ann,def
5 ann, def
5 ann,def
9 ann,def
6 ann,def
4 ann,def
6 ann,def
3 ann,def
7 ann,def
Indices
Années

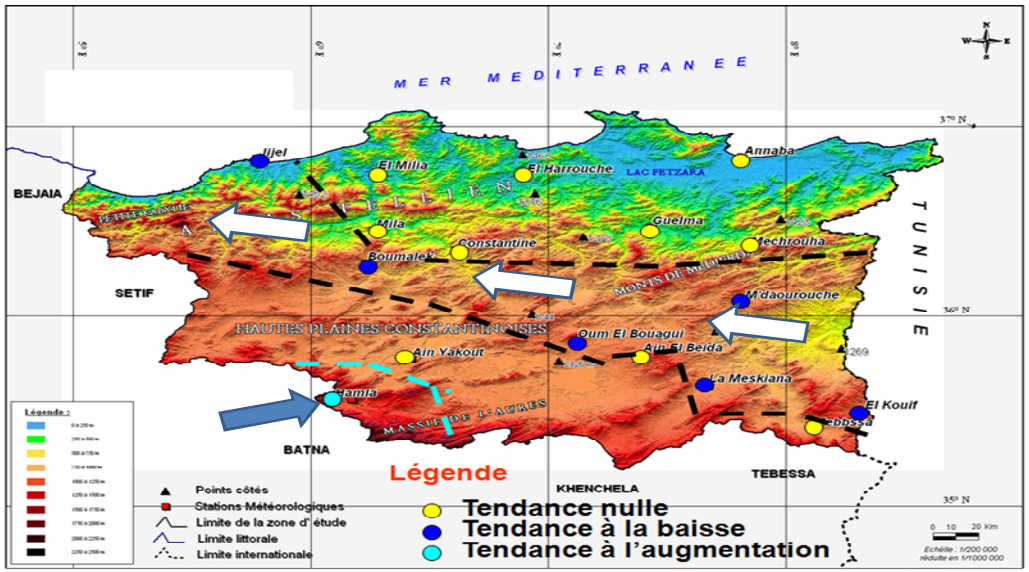


Fig.19. Tendance des pluies saisonnières : season of winter

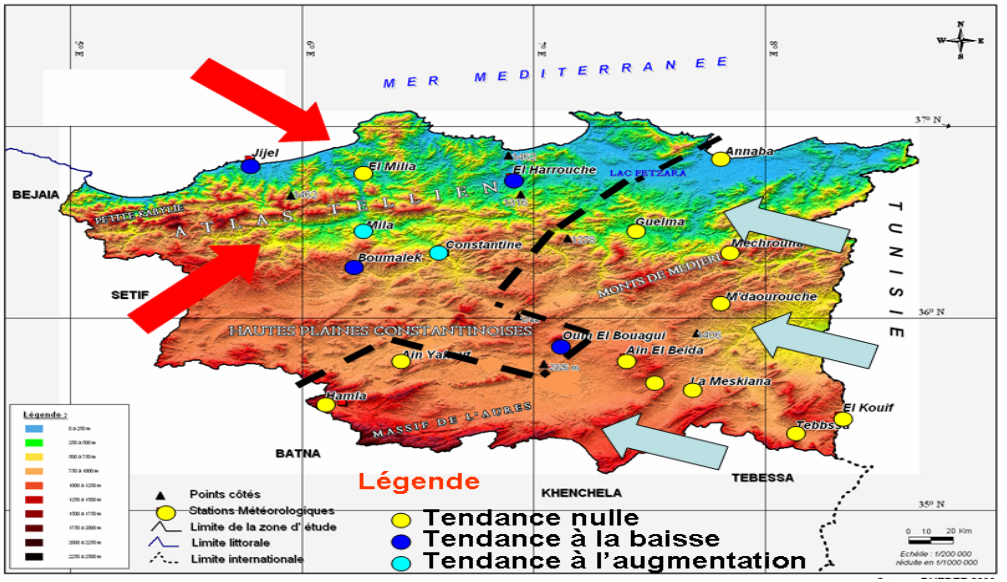


Fig.19. Tendance des pluies saisonnières :season of autumn

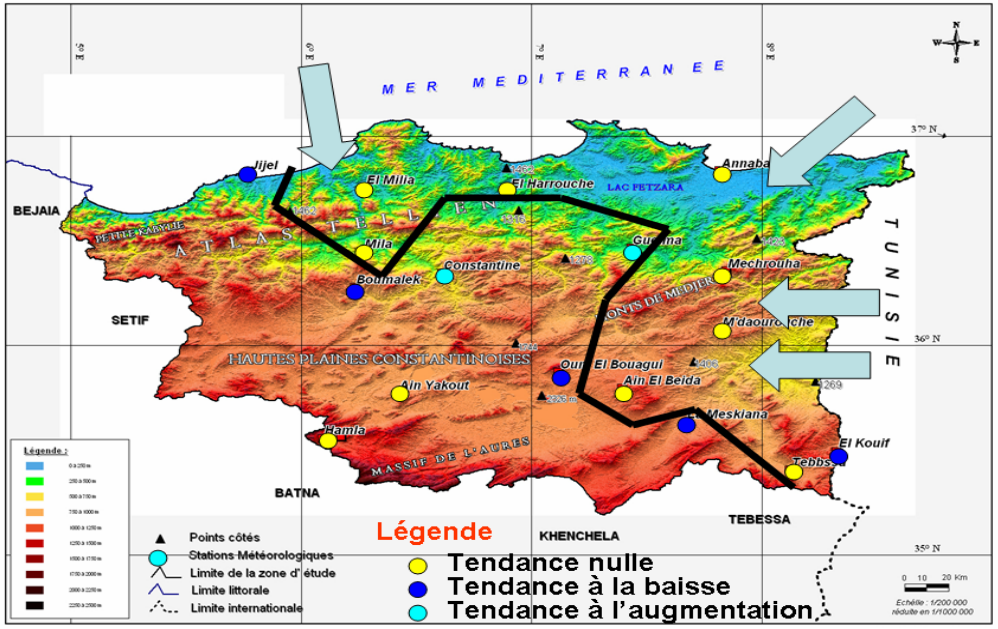


Fig.19. Tendance des pluies saisonnières : season of spring

Study of the evolution and the variability of the structure of the rains

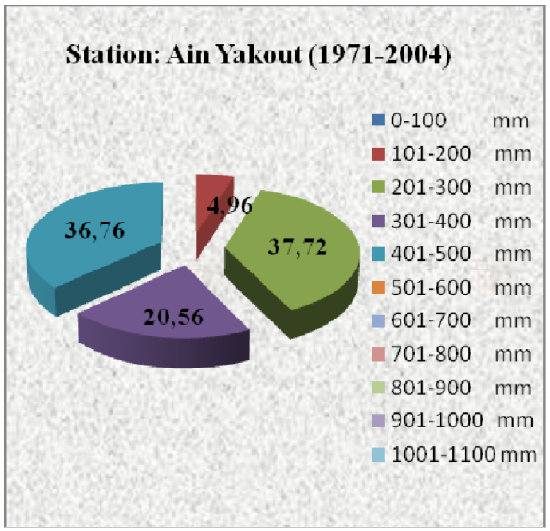
The purpose of is the study of the evolution and the variability of the structure of the rains to see which is the section of rains which at summer touched by the reduction? To answer this question we shared the series of the rains of the stations retained in two under-series, and this according to the year of the rupture (1970), then we calculated the statistical parameters which characterize variability for the two periods

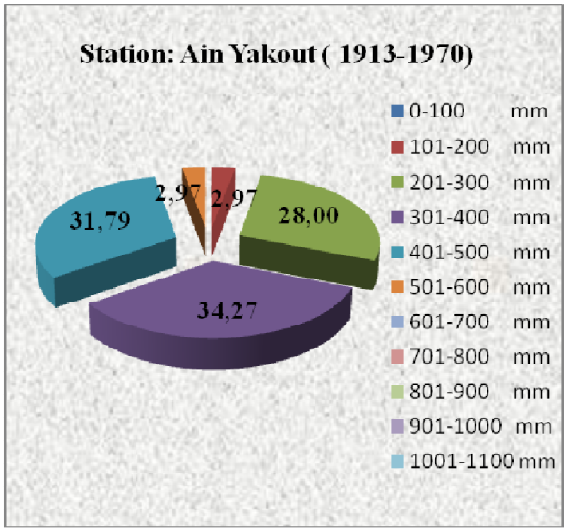
The analysis of the results, shows that it y' has a reduction in the rains between the two periods of study 1913-1970 and 1971-2005 enough for some stations,

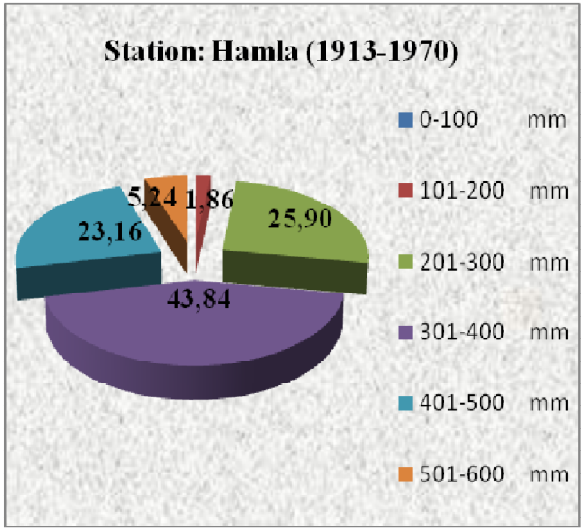
Jijel a variation of 265mm
Boumalek a variation of 151mm.

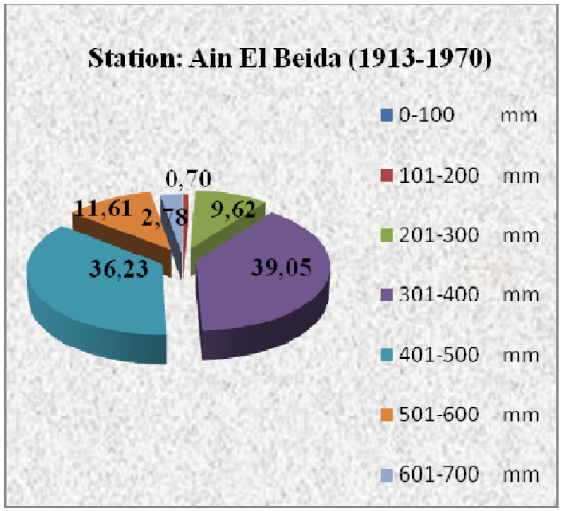
On the other hand, the difference was unimportant for;
Annaba with 9mm ,
Mechrouha with 1mm
Hamla with 4mm
The annual maximum quantities also have also recorded reductions
Annaba with 146 mm

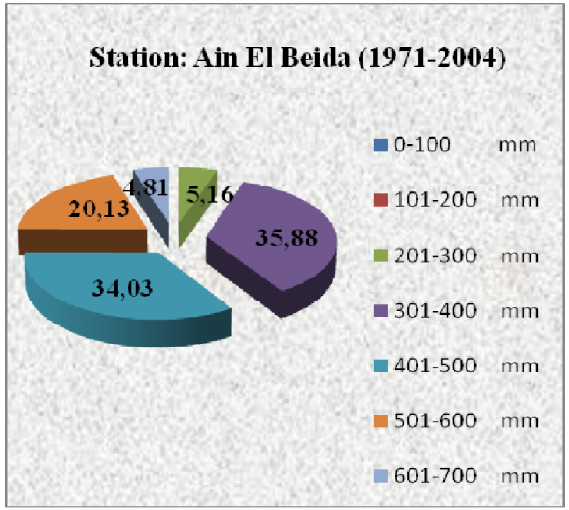
With regard to the classes of rains, one observes that it has a displacement of the sections rains. One observes a reduction in the frequency of strong rains for the second period and that one observes it in the first period and the small quantities of rain became more frequent











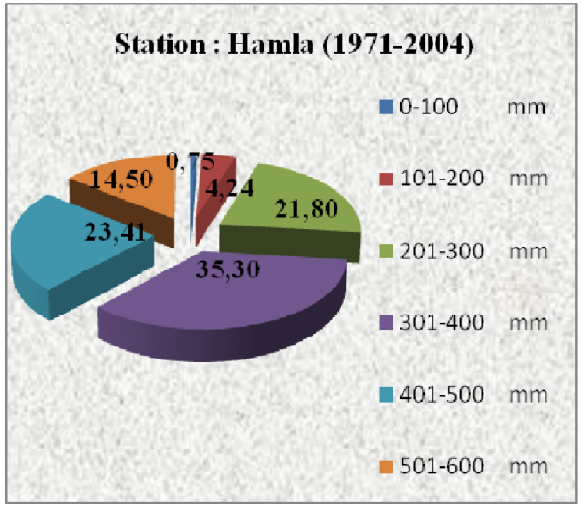


Figure 32 . Répartition des pluies par tranches d'intensités pour quelques stations

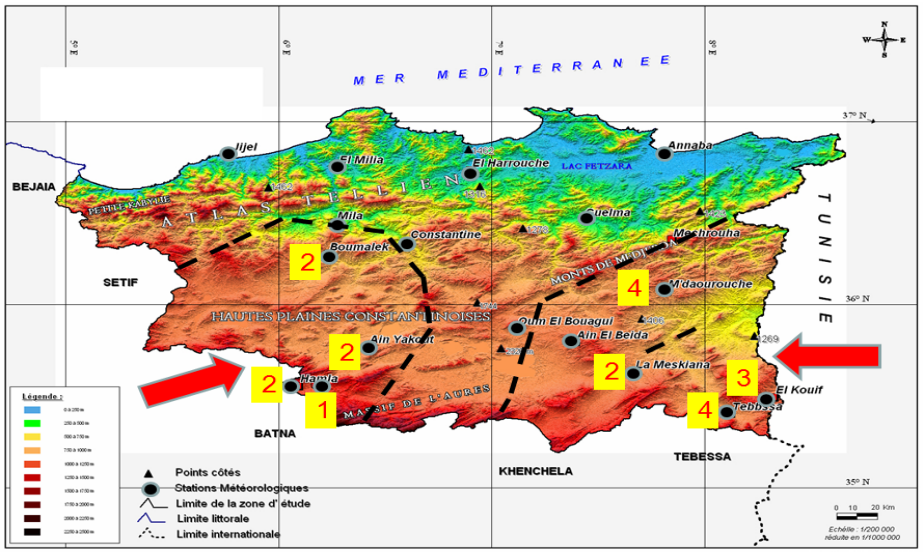
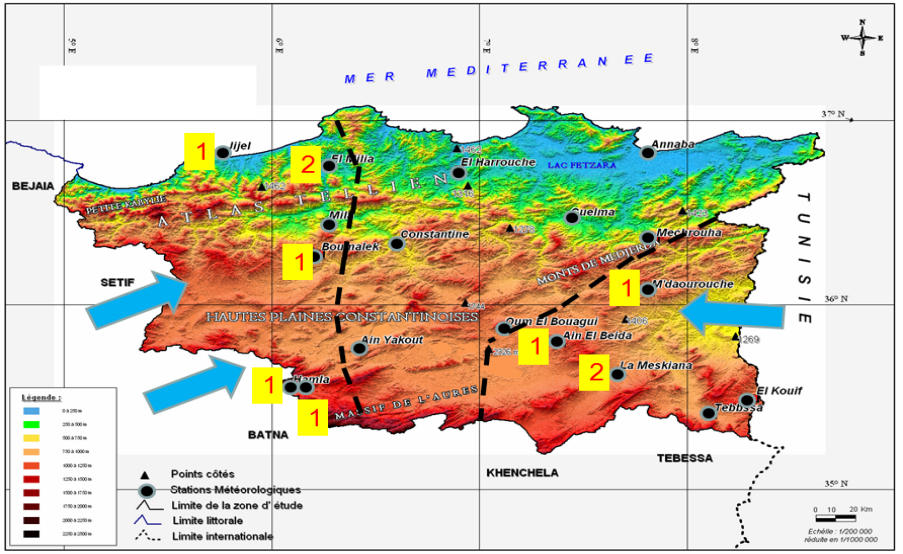
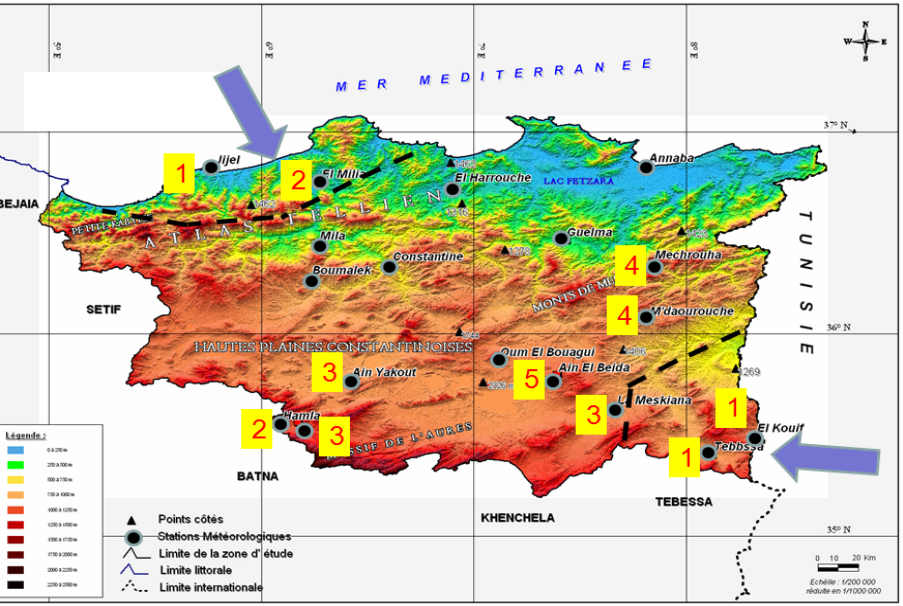


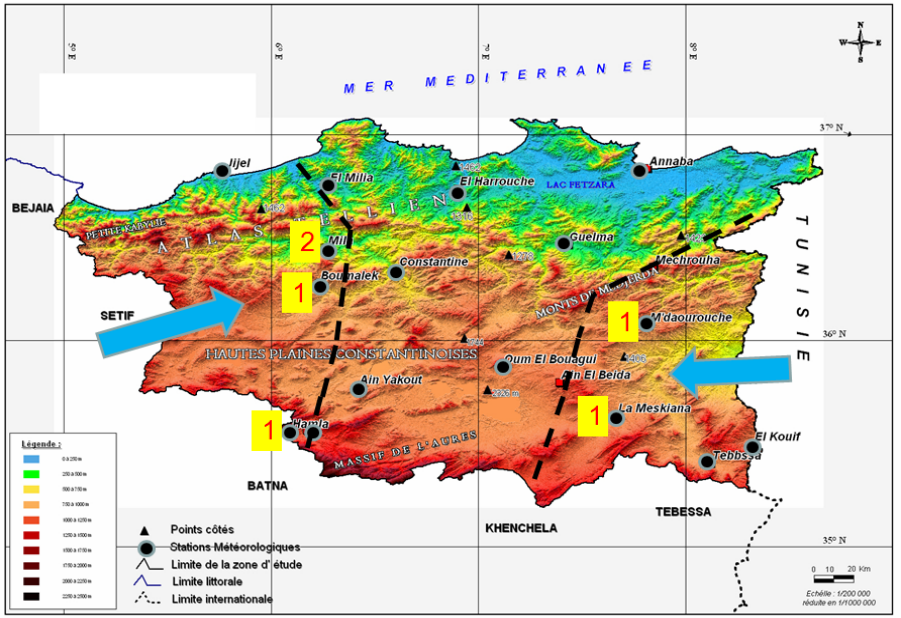
Fig.35. Space distribution of the number of 2 **years the very dry sequences**



Répartition spatiale du nombre des séquences **très sèches de 3 années**



Space distribution of the number of the sequences dry 2 years



Conclusion

The study that we carried out throughout this work was based on two stages first related to the correction of the inhomogeneous in the climatic series, and the second study carried the analysis of the variability of precipitations

In the first part we could homogenize the annual series the second part was based on the climatic study of variability The three approaches enabled us to validate the existence of the change in pluviometry and the choice of the year of rupture in the Northern area – Is Algeria more precisely " coast plaine

SHUCRAN - THANK YOU