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ORIGINAL ARTICLE

Water Need of the Apricots Trees and Olive Trees, case: Tinibaouine, Algeria

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ABSTRACT
The Tinibaouine region, located in north-eastern Algeria on the borders of the Batna-Belezma Mountains, is characterized by a semi-arid to arid climate with an average annual rainfall not exceeding 465 mm and an average annual temperature of around 22°C. This region is characterized by the cultivation of apricots as essential crop followed by that of olives, whose plots are all irrigated with the Tinibaouine source water. These are 450 Ha of trees for apricot and 108 Ha for olives which constitute the principal revenue of the citizens of this small village. This source is the natural emergence of water which has as reservoir Refâa Mountain located in the foothills south of the plain where the source emerges. Its current flow is of the order of 100 to 110 l/s (measured in March 2015) while it had reached 200 l/s in the past. The objective of this work is to identify natural and anthropogenic stresses which have a direct impact on the use of Tinibaouine source and seek appropriate management method that takes into account not only technical solutions but also draws on the social rules that govern its use and permit to mitigate conflicts of use.
Keywords : *seguias, Tinibaouine, socio-economic, farm.*

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INTRODUCTION

This note concerns the determination of the water needs of the apricot crop in Tinibaouine region, located in arid climatic zone, in the North East of Algeria. The cultivation of apricots is the main natural resource exploited in this region, the olive tree being accessory, making the Tinibaouine source, from which the irrigation is done with a rate of around 100 l/s, becomes a high center of interest for a depending population of around $1*10^4$ inhabitants.
The annual rainfall measured varies between 140 to 464 mm, with an average of 245 mm and the annual average of temperature is around 22 °C.
The comparison between the crops water needs estimated by Cropwat and the flows delivered by the source shows a large imbalance.
Erratic rainfall and reduced flows of the Tinibaouine source observed in recent year's raises with acuity the problem of the water management in this region.
The diminution of water loss through notably the reduction of evaporation was discussed in this note.

MATERIALS AND METHODS

General Overview

Geology

The studied area is located in the eastern extension of the plain Hodna, it corresponds to a depression wedged between the reliefs of Hodna Mountains to the north, El Guetiane Djazzar in the East and Djebel Ech Cheffa in the West.
Geological and geophysical geological formations may constitute aquifers noted the existence of the following aquifers: The tank assembly Moi-Pliocene Quaternary formed by lacustrine calcareous sandstone, conglomerate and sand. The tank assembly of upper Cretaceous limestone and consists of dolomitic formations permeable because joints and cracked, waterproof wall (hydrogeological bedrock) form by the Cenomanian marls and a semi-permeable roof (partial coverage) represented by the formations calcareous marl containing both permeable and impermeable levels (Fig. 2) .

The source is located in the village center of Tinibaouine. It emerges by a flow in Quaternary alluvial formations, in favor of a NW-SE fault that runs along the south Kef Rached (Bellion 1972), (Fig. 1 and 2). The outflow of the source is currently in the order of 100 l/s.

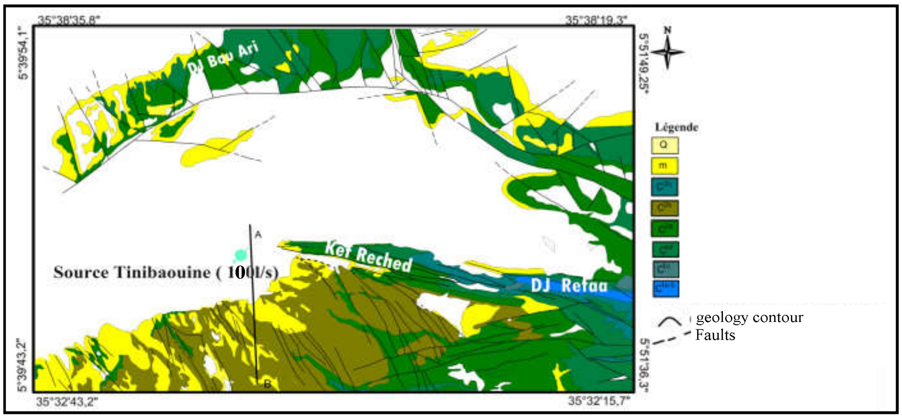
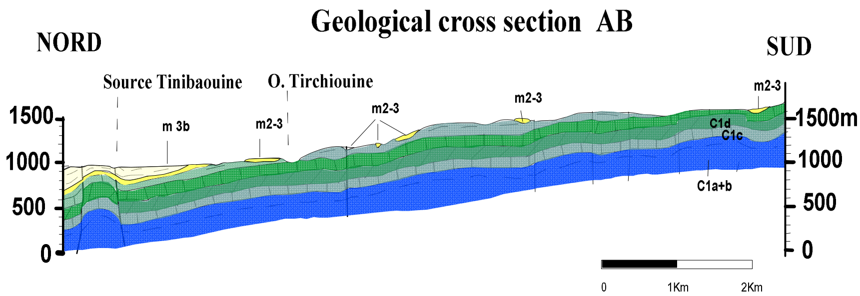


Fig. 1 Geological context of Tinibaouine region.



m^{2-3}: miocene indifférencié, c^{5-6a}:uper Stantonian to Maastrichtian, c^{3-4}: coniacian,lower stantonian, c^{2b}:uper Turonian, c^{2a}:lower Turonian, c^{1d}:uper Cenomanian - turonian, c^{1c}: middle - uper Cenomanian, c^{1a-b}: lower Cenomanian.

Fig. 2 Geological cross section of Tinibaouine area [1]

hydroclimatic context

The climate is semi-arid influenced by the humid stream of the Mediterranean sea in winter and warm and influenced by the Sahara in summer. For the period 1998-2010, annual rainfall measured varies between 140 to 464 mm and the annual average of temperature is around 22 °C. The evaporation is intense and leads to a loss-water balance (Fig. 3) .

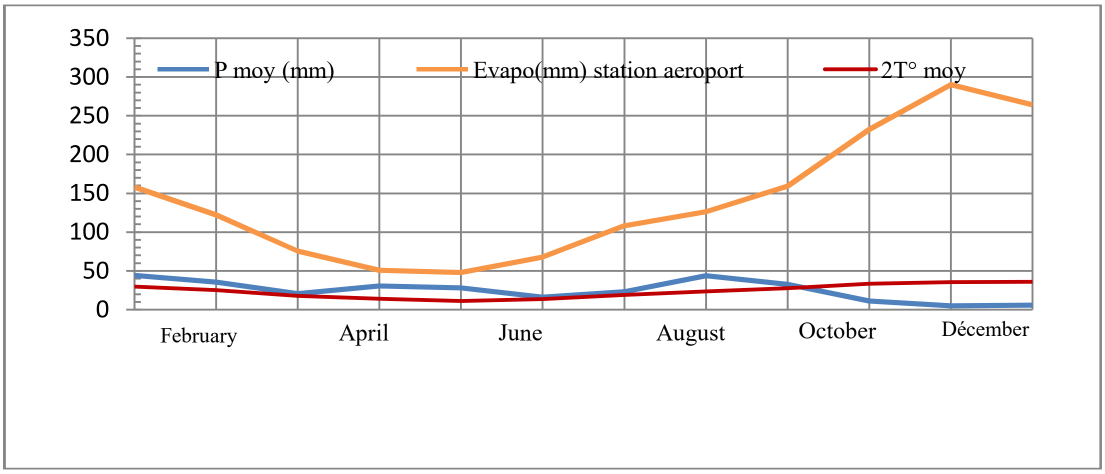


Fig. 3 Rainfall, temperature and evaporation from 1998 to 2010.

The annual average of rainfall is of 245 mm, on all sub basins of Achou and Boureghda (135.3 km^2) representing a contribution to the outflow of 100 l/s from the Tinibaouine source. The rainfall decreased gradually since 1970 causing a decrease in the outflow from 200 l/s in 2005, to 100 l/s actually (Fig. 4).

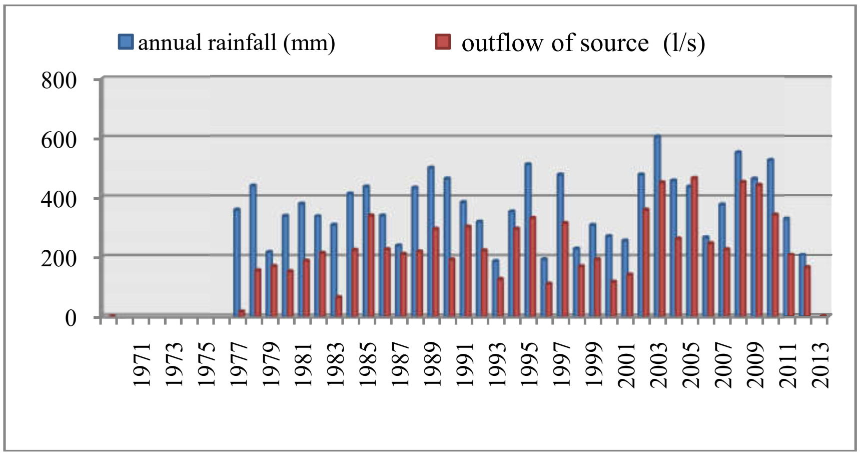


Fig. 4 Evolution of annual rainfall in the station of N'gaous (period 1970-2014) and the outflow of Tinibaouine source.

Agricultural context:

The Tinibaouine region is characterized by tree crops (450 Ha for apricot trees and 105 Ha for olive). The apricot crop and incidentally that of olives are practically the only self-sustaining economy of the region. The other crops represent only 4 % of the total area (652 Ha). All plots are irrigated from the Tinibaouine source with a well-developed network (called seguias) (Fig. 4). Water needs increase gradually from autumn to source with a decrease during the winter season.

The increase of water needs and the reduced flow of the source lead farmers living far from the source to resort to buying water from farmers' seguias located close to the source. In some cases, farmers whose plots are subject to water stress during periods of irrigation, use in boreholes, often illegal, to meet their needs, thus threatening the sustainability of the source outflow, even if the aquifer is located several km to the south.

Water management of Tinibaouine source:

The water management system distributed by seguias has required the establishment of an elaborate legal and technical framework [2]. This former supply and distribution system was known to the Romans who surrounded it by constructs to use its pure and clear water. Water Units of irrigation (called Nouba) are calculated for all the owners according to the areas to be irrigated. This distribution is registered and regulated by an official act. The shindig is planned on a definite period and increases each time we move away from the source (6, 21 and 30 days).

The source flow is shared with a diverter in 05 major seguias whose distribution is reported in figure 5. The distribution of flow rates and seguias lengths are reported in table 1.

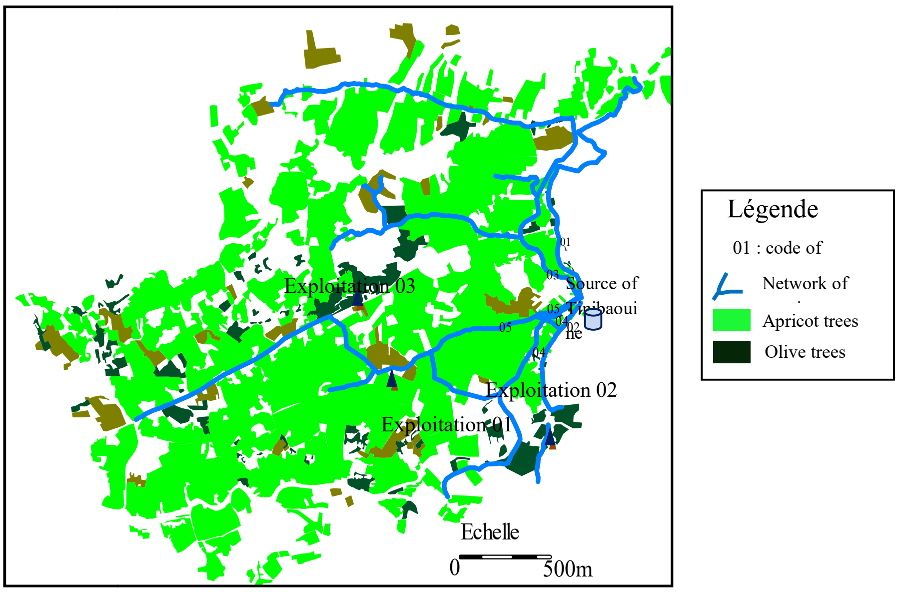


Fig. 5 Distribution of the seguias network.

Table 1 Categories of systems of seguias.

Principals Seguias		Code		Length of seguias (Km)		Outflow l/s
Outflow of the source						104
Tamtelt		01		1.93		23.36
Tabourit		02		1.07		11.7
Rhaouat	Bala	03	03-01	0.62	1.58	29.9
	Maadjidj		03-02		2.54	
Sidhoum		05		3.23		25.9
Hemada		04		2.17		13.69

Determination of the water needs:

The water needs of the apricot and olive crops will be determined by the use of Cropwat (in its free version) that is irrigation management support software developed by FAO in 1992. It is based on the evaporation formula of Penman - Monteith modified. It offers the opportunity to develop an irrigation schedule based on various agricultural practices and it permits to assess the effects of lack of water on crops and efficiency of different irrigation practices.

The climate data used in the calculation of water needs:

The temperature data. Relative humidity and wind velocity are those of Barika climate station remote from Tinibaouine of 35 km with a series of 14 years. Given the total lack of data on sunshine duration. we used those of Biskra due to similar climate and the distance (80 km in the South-East). Monthly precipitation data are those of the rainfall station of the same study area (N'gaous) for the same period (Fig.6).

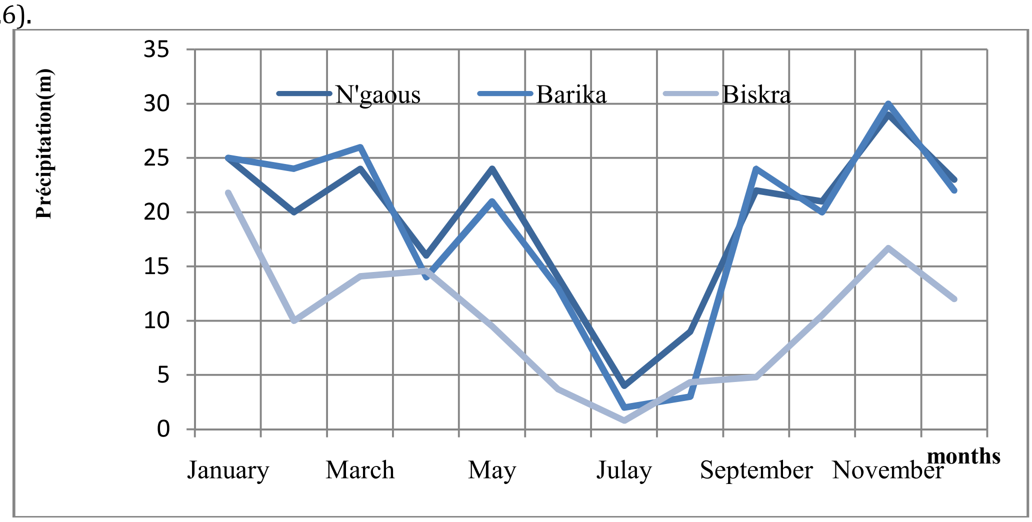


Fig. 6 : Monthly rainfall variations - stations of N'gaous. Barika and Biskra (1977-1990).

Soil and agricultural related data

The soil features required in the management of irrigation and the determination of the useful reserve. are related to two factors: the soil texture (Most of the perimeter is composed by sand and clay) and the deep of rooting [3].

Table 2 The soil-related data

	Texture	
	Sand	Clay
Usable water	140 mm/m	180 mm/m
Maximum rate of rainfall infiltration	40 mm/day	40 mm/day
Maximum rooting depth	0.6 ou 1.2 m	0.6 ou 1.2 m
Initial dry soil moisture (% Of usable water)	0%	0%
Initial soil moisture available	140 mm/m	180 mm/m

The crop coefficient values (KC) of apricot and olive introduced in Cropwat are defined depending on the growth stage of the plant. the force of the wind and the average value of the minimum humidity prevailing in our study area [4]. Cropwat requires the entry of 3 values KC (initial. mid-season. harvest). We adapted planting dates by considering agricultural practices in northern Algeria [5-7].

RESULTS AND DISCUSSION

Estimation of the evapotranspiration by Cropwat

The evapotranspiration values calculated by the formula of FAO (Penman - Monteith) are presented in Table 3 and reported in Figure 7. The expression of this formula (1) is:

$$ETo = C \ x \ [w \ x \ Rn + (1 - w) \ x \ F(u) \ x \ (ea \quad ed) \qquad (1)$$

ETo : represents the reference evapotranspiration in mm / day.
w: weighting factor reflecting the effect of radiation on different temperature and altitude.
Rn : net radiation
F(u) : wind-related function.
ea : saturation vapor pressure at the average temperature of the air in millibars.
ed: average of actual vapor pressure of the air. Expressed in millibars.
(ea - ed) and C: correction factors to compensate day and night weather

Table 3 The evapotranspiration (*mm/d*) of N'gaous region. [8-10]

Mois	Temp Min	Temp Max	Humidité	Vent	Insolation	Ray.	ETo
	°C	°C	%	km/jour	heures	MJ/m^2/jour	mm/jour
January	-5.0	7.1	67	164	7.0	11.0	1.17
February	-5.8	10.0	69	181	7.6	14.0	1.63
March	-3.6	13.0	48	207	8.8	18.5	2.81
April	-2.4	16.7	46	233	9.2	21.8	3.77
May	5.6	21.3	54	216	9.9	24.3	4.49
June	8.8	26.9	31	224	10.9	26.2	6.25
Julay	16.0	30.9	26	207	12.2	27.7	7.15
August	15.0	29.8	34	198	10.4	23.9	6.30
September	6.0	25.3	45	216	9.4	20.1	4.84
October	0.4	19.1	54	181	8.1	15.3	2.97
November	-2.6	13.3	58	172	6.8	11.3	1.87
Décember	-6.2	8.6	62	155	7.1	10.4	1.25
Average	2.2	18.5	50	196	8.9	18.7	3.71

It is found that the peak month for global demand (ET0) is in August. with an average of 6.30.

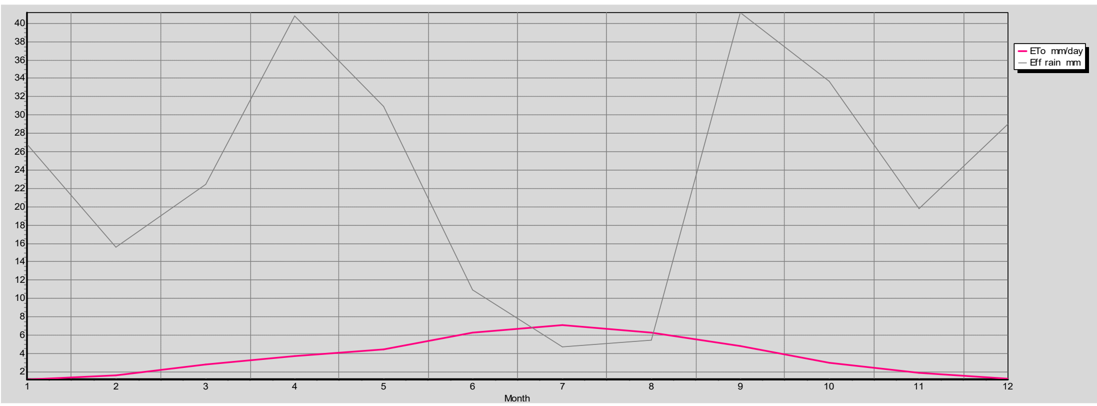


Fig 7 The evapotranspiration (*ETo*) and water supply by effective rainfall during the Period (1998-2011).

Determination of the effective rainfall

We opted to work on Cropwat with the USDA method to account losses due to surface runoff and deep percolation. It's a formula recommended by United States Department of Agriculture and Soil Conservation Service. Table 4 gives the values of effective rainfall calculated by the method (2) of the USDA.

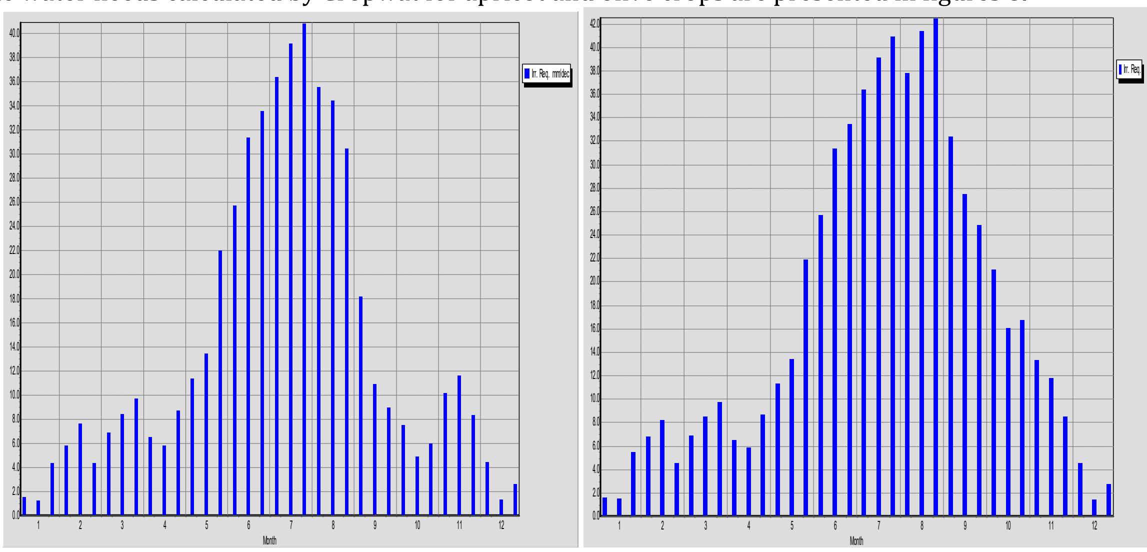
$Peff$ = (Pmean(125   0.2Pmean))/125   pour P_{mean}< = 250 mm/month.   (2-1)
$Peff$ = 125 + 0.1Pmean   pour P_{mean} > 250mm/month.   (2-2)

Table 4 Effective rainfall of N'gaous region.

Months	Rainfall (mm/month)	Effective rainfall (mm/month)	Month	Rainfall (mm/month)	Effective rainfall (mm/month)
	mm	Mm		mm	Mm
January	28.1	26.8	July	4.8	4.8
February	16.0	15.6	August	5.5	5.5
March	23.3	22.4	September	44.3	41.2
April	43.9	40.8	October	35.7	33.7
May	32.6	30.9	November	20.5	19.8
June	11.1	10.9	December	30.5	29.0
Total	296.3	281.4			

Computation of the water requirements per decade:

The water needs calculated by Cropwat for apricot and olive crops are presented in figures 8.



Apricot Olive

Fig. 8 Crops water needs (*mm/dec*).

It appears that water needs of olive trees grew in the period June to August. this is mainly due to the increase of the crop coefficient during the foliage stage [11]. Which is the summer season which also corresponds to the Eto highest period [12] (Fig. 9).

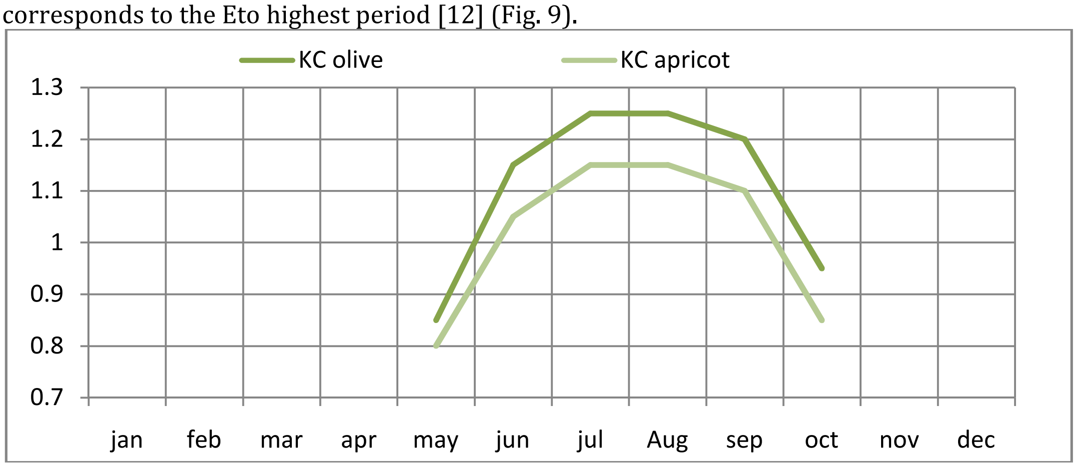


Fig. 9 Crop coefficient (*Kc*) variation.

Determination of the irrigation dose on field

Fieldwork focused on the quantification of the irrigated area. crop type. method of access to water and the allocated water flow [13].

To check out some of the answers. we conducted flow measurements in three farms (Taabache. Mechaala and Ghenfoud) (Table 5).

Table 5 irrigation needs estimated in situ (m3 / ha).

			Taabache	Mechaala	Ghenfoud
Measurements	Measurement of outflow		QHemada =13.6l/s QBorehole = 15l/s	Q Sidhoum = 25.9l/s QTabourit = 11.7l/s QHemada=13.6l/s Qtotal = 51.2l/s	QTaldo = 9.93l/s
	Measurement of irrigated area		750 000 m^2 Apricot trees 50 000 m^2 olive trees	360 000m^2 apricot 40 000 m^2 olive	30 000 m^2 apricot 10 000 olive
Gross volume	Duration (hours)	Apricot	258	14	48
		Olive	2	2	12
Gross dose	Apricot		28.6 x 928800 / 750000 =35.4 mm or 354 m^3/ha	7.168 mm or 71.68 m^3/ha	171.07 mm or 1710.7 m^3/ha
	Olive		4.11mm ou 41.1 m^3/ha	9.21mm ou 92.16m^3/ha	14.29 mm ou 142.9 m^3/ha
Estimation of irrigation requirements per cycle	Start irrigation	apricot	June 20	June 20	July 20
		Olive	July 10	July 10	July 10
	End	apricot	October 15	October 15	October 15
		Olive	July	July	July
	Number of irrigations	apricot	7	9	5
		Olive	2	2	1
	Water needs	apricot	2478 m^3/ha	645.12 m3/ha	8553.5 m^3/ha
		Olive	82.22 m^3/ha	184.32 m3/ha	142.9 m^3/ha

The comparison between the theorical demand and the water flow delivred by Tinibaouine source shows a large deficit (Table 6) that forces farmers to reduce irrigated plots or to adopt other alternatives like: buying water elsewhere. digging deep boreholes or the storage of rainfall in small hill dams.

Table 6 comparison between water requirements estimated by Cropwat and Irrigation needs.

Cultures	water requirements by *CROPWAT*	Irrigation needs estimated on land (m3 / ha)
Apricot trees	35800	12957.1
Olivie tress	6980	695.58

Technical measures for water economy:

Using low pressure underground pipes can significantly reduce water losses caused by transportation, Irrigation time, Evaporation and infiltration. These last two settings are naturally higher in seguias (ground gutter) with cracked walls. In addition, evaporation losses are also important especially in distribution seguias at low flow with a large base and a small height. The diameter of the main pipe and the distribution network is calculated by the formula of BONNIN [14] and the pressure drop calculation in the distribution network is performed according to the formula (3) of Darcy Weisbach [15].

$$D = Q\ ½ \qquad (3)$$

Calculating of the velocity (formula 4):

$$V = 4Q/\pi D\ 2 \qquad (4)$$

where Q= outflow in l/s et D = diameter in m.

Calculation of pressure drop (formula 5):

$$\mathrm{J} = \frac{\gamma v^2}{D2g} = \frac{8\gamma q}{\pi^2 g D^5} \qquad (5)$$

J: loss (in m of fluid charge per m of pipe)

γ: coefficient of loss

V : velocity in m/s

D : internal diameter of the pipe in m

q : outflow in m^3/s

g : gravity acceleration in (m/s^2).

$$g = J1Xl \qquad (5\text{-}1)$$

$$Q2 = \sqrt{Q_1^2\ x(J2\ /\ J1)} \qquad (5\text{-}2)$$

L=length of the pipe in m.

The results of pressure drop calculation and the comparison between the outflow provided by seguia and pipes (high density pipes) are presented in table 7 and 8 below:

Table 7 Estimation of the pressure drop and the pipe outflow.

Seguias	Length m	Diameter mm	Outflow Q1 l/s	Velocity m/s	Unit.loss	Outflow Q2 l/s	Unit loss.
Hmadda	2170	116	13.6	1.29	0.0312719313	20.01	0.06770445
Sidhom	3230	172	29.9	1.29	0.0165835315	46.55	0.05356480
Tabourite	1070	108	11.7	1.27	0.0363560601	12.10	0.03890098
Taljoustin	2452	99.6	9.93	1.27	0.0423444414	15.55	0.103825703

Losses in the path between the source and plots by infiltration into the ground in conduct. In addition to evaporative losses.

Table 8 Comparison of outflow provided by seguias and high density polyethylene pipes.

Seguias	Distance from the source (m)	Q (l/s) by seguia	Q (l /s) Waterproof *HDPE* pipe	Economy m^3/day
Hemada	2170	13.6	20.01	353.82
Sidhoum	3230	25.9	46.55	1784.16
Tabourit	1070	11.7	12.10	34.56
Taldjoustyan	2452	9.93	15.55	485.56

An investment in a sealed pipe will result in a great saving of water [16].
The irrigation Passage seguias irrigation to polyethylene pipes provide water saving of 14185.05 m3/d.

CONCLUSION

In our work. we have tried to estimate olives' and apricots' needs of water in the region of tinibaouine. wich is located in an arid area. with a yearly rainfall of around 250 mm.The coparison of the real irrigation needs' doses calculated by CROPWAT showed a huge water deficiency that sinificantly makes the development of the agricultural lands slow.Nevertheless. the use of dripping irrigation system and replacing seguias by solid HDPE pipe allows a relative water field saving.The surveys wich we have conducted showed that farmers are unaware of their crops and the needed doses of water. The experienced irrigation line is most often based on traditional tools.
The measures we have taken allowed us to have a magnitude order on the amount of water that can bring the farmer to apricot and olive trees. The average total volume that must be mobilized to cover the irrigation needs of these crops is 12086. 04 m3/ha of water for 124hectares.
Finally. we must be aware that the rational management of water has concrete implication. particularly the social-economic viability. It will be achievable if all parties work together.

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REFERENCES

1. Vila JM (1977). Geological map of Algeria au1 / 50 000. Sheet No. 172. Merouana with detailed explanatory notes (surveying S. Guellal) . Serv. Map geol. Algeria.
2. Charoy J. Torrent H (1990). Origin. Water Management evaluation of aquifers in the oases. Review Mediterranean options. 11 (2): 229- 235.
3. Ammar Boudjellall Bammoun A. R (2006). Besion determination of crop water using CROPWAT 4.3 software in the wilaya of Tipaza. Memory. State engineer. suprérieure agronomic nationle Ecole EL Harrach. Algeria. p143.
4. Ollier CH. Poirée M (1983). Irrigation: the theoretical irrigation networks technical and economic irrigation. (6th edition). Eyrolles. Paris.
5. Doorenbos Pruitt J. W (1975). The water needs of crops. FAO Bulletin of Irrigation and Drainage 24. Rome.
6. Directorate of Agriculture and Rural Development (DSA 2015). Reports the DSA. Algeria.
7. Technical institute of vegetable and industrial crops ITCMI (2001). Brochures cultures. Algeria.
8. National Agency water ressources ANRH (2013). Rainfall data. Algeria.
9. Sahraoui A (2008). Wind erosion and risk of silting in the region of Barika: A Quantitative Approach and automatic mapping. Magister thesis. Univ. Batna. Algeria. 132 p.
10. Smail H. Derghal Smati A and A (1995). Contribution to the hydrogeological study of the region of Biskra (Tolga area and Doucen) .. Memory. Engineer. univ.batna. Algeria. p80.

11. Masmoudi - Charfi C. Masmoudi and Mr. Ben Mechlia N (2004). irrigation of the olive tree for young intensive plantations. Ezzaitouna review. 10 (3): 8-15.
12. Kadi. K; Chergui. M; Hamli Boukeria. M and Yahia. A. 2007. Water needs of growing garlic for different formulas. European Scientific Journal. 10 (2): 6-19.
13. Ben Nouna B. Zairi A. Ruelle P. Slatni A. Ajmi Yacoubi S and T (2004). Seminar on Modernization of irrigated agriculture. Morocco. P15.
14. Bacharau T. Gossou H and Edmond C. 2012. Water consumption Plan and its use in the calculation of drinking water supply networks. Rev. Isee. Sci. Technol. 19 (2): 159-174.
15. Weisbach J (1845). Lehrbuch der Ingenieur und Maschinenmechanik. Brunswick. Germany.Bellio YJ (1972). geological and hydrogeological study of the western termination of Bellezma Mountains (Algeria) .These Doct. 3rd Round Univ Paris. P221.
16. Algerian National Institute of Agronomic Research (INRA 2007). Natureelles resource management report and improving the well-being of people in mountain areas. Algeria. p15.

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