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Diagnosis of wetland ecosystem health in the Ain Skhouna wetland, Western of Algeria.

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Abstract: Wetlands are very important for maintaining the ecological balance and for animal and human well-being. This study applied the Rapid Assessment of Wetland Ecosystem Services approach to assess the ecosystem services provided by the Ain Skhouna wetland (Saida, Western Algeria). The wetland assessment was carried out in 2020-today (The diagnosis is still ongoing and permanent) and enabled ecosystem services to be classified into provisioning, cultural, regulating and supporting groups. The results showed that among the provisioning services, freshwater (++ = 13) and food (++ = 11) made significant positive contributions. Regulating services, particularly air quality (+ = 20) and climate regulation (+ = 22), made excellent (positive) contributions, while services such as pest control (- = 24), epidemic and disease control (0 = 0) and nutrient cycling made poor contributions (negative), mainly due to anthropogenic actions and salinity pollution. Cultural services such as eco-tourism (++ = 3) made positive contributions, while educational services had fairly limited benefits. Vegetation analysis showed the dominance of ecologically and culturally important tree species (rare and endemic and protected) such as, *Spergularia salina, Arthrocnemum macrostachyum, Suaeda maritima, Salsola vermuculata, Tamarix articulata* and *Tamarix boveana.*

Key words: Ain Skhouna, ecosystem health, wetland, conservation.

Diagnoza zdravja mokriščnega ekosistema v mokrišču Ain Skhouna na zahodu Alžirije

Izvleček: Mokrišča so zelo pomembna za ohranjanje ekološkega ravnovesja ter za dobro počutje živali in ljudi. V tej študiji je bil uporabljen pristop hitre ocene ekosistemskih storitev mokrišč za oceno ekosistemskih storitev, ki jih zagotavlja mokrišče Ain Skhouna (Saida, zahodna Alžirija). Ocena mokrišča je bila izvedena v letih 2020–2025 in omogočila razvrstitev ekosistemskih storitev v skupine oskrbe, kulture, regulacije in podpore. Rezultati so pokazali, da sta med oskrbovalnimi storitvami pomembno pozitivno prispevala sladka voda (++ = 13) in hrana (++ = 11). Regulativne storitve, zlasti kakovost zraka (+ = 20) in uravnavanje podnebja (+ = 22), so imele odličen (pozitiven) prispevek, medtem ko so storitve, kot so zatiranje škodljivcev (- = 24), zatiranje epidemij in bolezni (0 = 0) ter kroženje hranil, imele slab (negativen) prispevek, predvsem zaradi antropogenih dejavnosti in onesnaževanja s slanostjo. Kulturne storitve, kot je ekološki turizem (++ = 3), so imele pozitiven prispevek, medtem ko so imele izobraževalne storitve precej omejene koristi. Analiza vegetacije je pokazala prevlado ekološko in kulturno pomembnih drevesnih vrst (redkih, endemičnih in zaščitenih), kot so *Spergularia salina, Arthrocnemum macrostachyum, Suaeda maritima, Salsola vermiculata, Tamarix articulata* in *Tamarix boveana*.

Ključne besede: diagnoza, Ain Skhouna, zdravje ekosistema, mokrišče, ohranjanje

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1 INTRODUCTION

According to the Millennium Ecosystem Assessment (2005) and Russi et al. (2013), wetland ecosystems play an essential role in human well-being. There are many indications that wetlands can offer a multitude of benefits to human society and wildlife (Ghermandi et al., 2010; Aouadj et al., 2020). These benefits include, but are not limited to, flood risk management (Mitsch & Day, 2006) and reduced peak air temperatures (Sun et al., 2012) which improve water quality (Shutes, 2001; Dhote & Dixit, 2009) highlight the importance of protecting coastal communities from storms (Gedan et al., 2011), facilitate agricultural production (Lannas & Turpie, 2009; Verhoeven & Setter, 2009) and provide essential contributions. natural resources (McGregor et al. 2010) and providing sites for numerous educational and recreational opportunities (Cachelin et al., 2009; Finlayson et al., 2013).

Wetlands are considered to be one of the most biologically productive ecosystems in the world. They support human societies by playing biological, ecological, hydrographic and geological roles. Many species and ecosystems around the world are maintained and supported by wetlands (Mwakaje, 2009). By definition, wetlands are environments characterised by the presence of water and vegetation, which may be natural or man-made and include marshes, swamps, bogs, fens and many others. Ecosystem services are an umbrella term for the various goods and services generated by ecosystems that provide benefits to humanity (Jenkins et al., 2010).

Barbier (2011) defines ecosystem services as natural assets generated by the environment and used by humans, in particular clean air, water and food. Ecosystem services improve social and cultural well-being (Fischer et al., 2009) and have significant economic value (Barbier et al., 1997, Emerton and Bos, 2004; Turner et al., 2008). Over the last twenty years, progress has been made in understanding how ecosystems provide services and how the provision of these services is converted into economic value (Daily, 1997; MA, 2005; NRC, 2005; Aouadj, 2021). In a widely respected study evaluating ecosystem services, Costanza et al. (1997) estimated the annual value of the services provided by the Earth's ecosystems at a minimum of 33 billion dollars.

Valuation of wetland ecosystem services is essential for many reasons. Wetlands in natural areas provide important ecosystem services that improve human well-being and quality of life (Pedersen et al., 2018). Evaluating of these services quantifies their importance and value to urban populations, which is essential for gaining public approval and support for wetland preservation and development (Pedersen et al.; 2018; Aouadj et al., 2023). Wetlands are facing considerable challenges as a result of accelerating urbanisation and changes in land use. Ecosystem services assessment facilitates the identification of the effects of urban growth on wetland ecosystems and their capacity to provide services (Huang et al., 2019). The evaluation of ecosystem services offers essential insights for urban planning and policy formulation. They help to recognize trade-offs and synergies between different services, which is essential for sustainable urban development (Pan et al., 2023). In addition, assessing the ecosystem services provided by wetlands can facilitate the formulation of effective management strategies and policies (Xu et al., 2018; Zhang et al., 2023).

Urbanisation affects wetland ecosystems by causing habitat loss and fragmentation, leading to a reduction in wetlands and ecosystem disruption (Mitsch & Gosselink, 2015, Aouadj et al., 2022a-d). Wetlands are subject to pollution, particularly from heavy metals and fertilisers, which adversely affect water quality and aquatic life (Zedler and Kercher, 2005). Pollution of wetlands harms biodiversity and poses risks to human health, particularly where wetlands provide drinking water or recreation. The main challenges are invasive species, pollution and habitat loss. To remedy this, it is essential to implement effective pollution management strategies and create buffer zones and green infrastructures (EPA, 2021). Habitat conservation and restoration are important for species health and filtering contamination from wetlands, involving the reintroduction of native vegetation and community engagement (Mitsch and Gosselink, 2015).

2 MATERIALS AND METHODS

2.1 STUDY AREA

The municipality of Ain Skhouna, located on the high steppe plains of the west, has an area of area of 404.40 km², with a population of around 7272 inhabitants according to the 1998 census. It is bounded (Fig. 1), to the south by the commune of Roggassa (wilaya of El Bayadh); To the east and north by the wilaya of Tiaret; To the west and north by the commune of Mâamora (wilaya of Saida).

2.2 SOCIO-ECONOMIC CHARACTERISTICS

The population of Ain Skhouna has risen from 4,500 (1977) to 7,650 now, as shown in the table below.

Resident population of ordinary and collective households (MOC) by municipality of residence, sex and average annual growth rate (Table 2).

The main activities in the commune are pastoral-

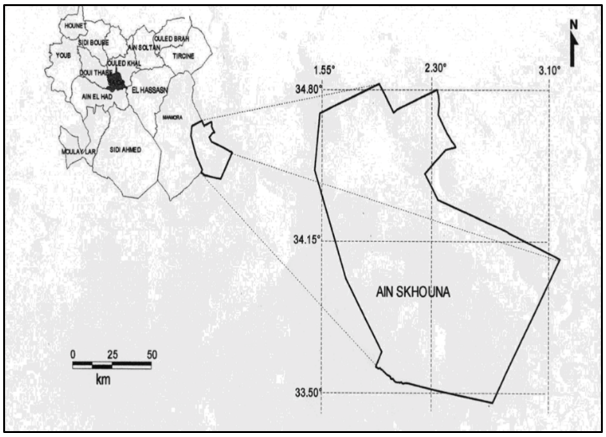

Figure 1: (a) and (b) location of the study area (Directed by: Aouadj, 2025).

ism, agriculture and tourism. The dominant activity is livestock farming (Table 3).

The following table shows the census of the commune's population, following their activities.

2.3 CLIMATOLOGY

The land or district is located in a region of minimum rainfall of between 110 and 160mm/year.

2.3.1 Air temperatures in (°C)

Average minimum (m): 7.6
Average maximum (M): 22
Average of thermal amplitude $[(M+m)^{-2}]$: 14.8 °C
Absolute minimum recorded: 7.9
Absolute maximum recorded: 39.8

2.3.2 Air humidity in ($g.m^{-3}$)

Average minimum: 25
Average maximum: 82
Average minimum: 4.3 $g.m^{-3}$ of air.
Average maximum: 7.3 $g.m^{-3}$ of air.
2.3.3 Evaporation at Ain Skhouna

Average annual evaporation would therefore be in the order of 200 to 250 mm. Evaporation measurements were carried out using canopies placed on the chott, the bent results of which were corrected to take into account the climatic conditions that the canopy may have disturbed (temperature, wind, formation of a saline crust).

2.3.3 Climate summary

The district of Ain Skhouna lies at an altitude of 1005 m and has a semi-arid steppe climate (CS, 2025):

Table 1: Distribution of the population of Ain Skhouna (APC, 2019).

Ain Skhouna	Number of habitats
Town centre	4278
Zeraguet	1707
The nomads	503
zone esparce	1162
Total	7650

Table 2: Average annual growth rate (APC, 2019).

Male	Female	Total	Growth rate
3582	3547	7129	2,3

Table 3: Census of the population of Ain Skhouna following their activities (APC, 2019).

Population	Male	Female
Assets	1985	1513
Pensioners	40	42
Retirees	146	30
farmers	639	-
Breeders	124	-
Students schoolchildren	327	334

- Average annual rainfall is 160 mm, with 47 days of rain.
- There are 3 days of snow.
- The number of sirocco days is 22.
- The number of days with frost is 48.
- The dry season is long (6 to 7 months).
- Summer temperatures are very high (average minimum temperatures) for the hottest months between 30 °C and 40 °C, winter is harsh (average minimum temperatures) for the coldest months between 0 °C and 2 °C.
- Average humidity varies from 74.5 % (December) to 37.1 % (July).
- Evaporation is 2,150 mm $year^{-1}$.

2.4 APPROACH ADOPTED

In an attempt to understand the aspects of plant biodiversity in the study region in terms of wild plants and to recognize the phylogenetic potential of Ain Skhouna and their socio-economic value, our work was divided into two stages.

2.4.1 Gathering basic data

The main aim is to gather information on existing plants in the region and how they are used by the local population (traditional industry, medicinal plants, etc.).

2.4.2 Preliminary reconnaissance of the terrain

Initially, it was decided to survey the region in order to locate our stations with the most accessible areas of interest. The areas of interest were surveyed in the field with the help of the local population. The areas of interest were then located and the study sites fixed on the topographical map of the region.

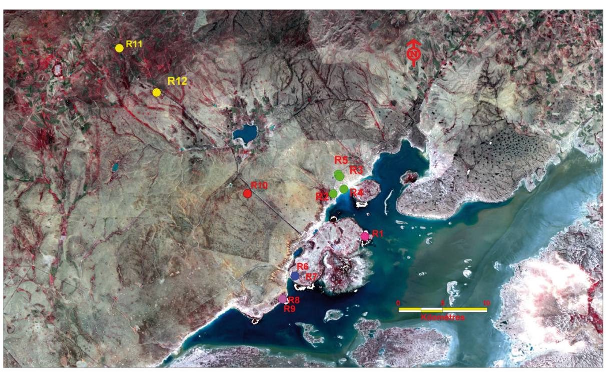

Figure 2: Positioning of the stations (Directed by Aouadj (2025).

Table 4: Census of the population of Ain Skhouna following their activities.

N°	Station	Geographical coordinates
1	Zone 1 (Z1): Wetland C6	R1: N: 34°31'02.7" E: 00°50'2,5"
2	Zone 2 (Z2): Faid er Rmel	R2: N: 34°33'606" E: 00°50'623"
		R3: N: 34°33'880" E: 00°51'403"
		R4: N: 34°34'722" E: 00°51'091"
		R5: N: 34°34'814" E: 00°50'98"
3	Zone 3 (Z3): EZ Zawia	R6: N: 34°28'531" E: 00°47'933"
		R7: N: 34°28'536" E: 00°47'933"
4	Zone 4 (Z4) : Hamiet Es Souf	R8: N: 34°27'082" E: 00°47'060"
		R9: N: 34°27'080" E: 00°47'058"
5	Zone5 (Z5): Guenatis	R10: N: 34°33'52.0" E: 00°44'25,0"
6	Zone6 (Z6): Rjem el Ogab	R11: N: 34°39'36.2" E: 00°37'22,1"
		R12: N: 34°42'16.9" E: 00°34'32,5"

Figure 3: Prospection (Directed by Aouadj, 2025).

2.5 CHOICE OF STATIONS

Six representative stations were selected in the study area (Table 4).

2.6 ASSESSMENT OF ECOSYSTEM SERVICES

A consensus was reached to finalize the list of ecosystem services before beginning field assessments by consulting with experts knowledgeable about wetlands. According to the according to the 54th Meeting of the Standing Committee (RAMSAR Convention) was held in Gland, Switzerland, from 23 to 27 April 2018, a total of 37 services were identified and categorized into four functional groups: provisioning, regulating, cultural and supporting services. The thorough evaluation was carried out by the assessors during 2020-2025 across 6 selected wetlands (6 stations) within the urban settlement area, involving regular site visits to gather data relevant to the assessment of the wetland. The assessors employed a blend of field observations and visual cues or indicators, along with their capability to ask and respond to a range of questions to gauge the significance of each ecosystem service documented on the R.A.W.E.S field assessment sheet. A five-point scale (Table 5) was implemented to log the significance of each ecosystem service. This scale is non-dimensional, meaning there are no defined units or measures between the varying points on the five-point scale.

2.7 CALCULATION OF E.S.I

The E.S.I represents an index of actual ecosystem service production compared to the potential maximum service production.

Table 5: Five-point scale used to record the importance of each ecosystem service (54th Meeting of the Standing Committee (RAMSAR Convention, 2018).

Importance score	Numerical value	Assessment of ecosystem service	Rationale
++	2.0	Significant positive contribution (> 1,000 people benefitting)	Significant service provided by the wetland and a key element of its ecological character Large number of beneficiaries (relative to wetland context)
+	1.0	Positive contribution (1-1,000 people benefitting)	One of many services provided by the wetland and an element of its ecological character Limited number of beneficiaries (relative to wetland context)
0	0	Negligible contribution	No obvious beneficiaries or benefits Not an important known part of the wetland's ecological character
-	-1.0	Negative contribution (1-1,000 people dis-benefitting)	Limited number of dis-beneficiaries
--	-2.0	Significant negative contribution (> 1,000 people dis-benefitting)	Large number of dis-beneficiaries
?	Remove from analysis	Gaps in evidence	Further evidence needs to be obtained

Table 6: Assessment of scale of E.S.I (McInnes and Everard, 2017).

Benefits	Assessment
Local	These are encountered by households, individuals, or communities residing and working in close proximity to the wetland.
Regional	These are offered to individuals, households, or communities living and working in the broader catchment area of the wetland
Global	These extend beyond national borders
Vegetation analysis	A survey of vegetation was conducted in and around the wetlands by counting the variety of tree species present around the wetlands. This approach yielded detailed information on the composition and structure of vegetation surrounding the sites, which can play a role in the various functions and services of wetlands.

$$E.S.I = (2n + 1n - 12 - 2n)/(2 * Total)$$

2.8 ASSESSMENT OF SCALE OF E.S.I

By utilizing the R.A.W.E.S method, the advantages offered by wetlands emerge at various geographic levels, spanning from the wetland environment itself to local, regional and even global dimensions (McInnes and Everard, 2017). The assessment of R.A.W.E.S involves three tiers of benefit delivery, which are (Table 6).

3 RESULTS AND DISCUSSION

3.1 RESULTS

3.1.1 Ecosystem service scores

The count data obtained for the frequency of ecosystem service scores are as follows (Table 7).

3.1.2 Floristic richness

The results of the floristic inventory of the Ain Skhouna wetland are as follows (Table 8 and Figure 5).

Table 7 : Count data for the frequency of the ecosystem service scores.

Ecosystem service	N	++	+	0	-	--	L	R	G
Fresh water	6	13	15	3	9	0	26	0	0
Food		11	19	3	4	0	29	1	0
Fuel		0	0	38	0	0	0	0	0
Fibre		0	0	38	0	0	0	0	0
Genetic resources		0	0	36	1	1	0	0	0
Natural medicines and pharmaceuticals		0	0	37	1	0	0	0	0
Ornamental resources		0	2	35	1	0	0	0	0
Clay mineral, aggregate harvesting		0	1	36	0	1	0	0	0
Energy harvesting from natural air and water flows		0	0	38	0	0	0	0	0
Air quality regulation		2	20	5	6	0	28	0	0
Local climate regulation		3	22	7	4	0	26	0	0
Global climate regulation		0	0	28	8	0	0	0	0
Water regulation		0	20	13	4	0	21	0	0
Flood hazard regulation		0	12	11	12	0	13	0	0
Storm hazard regulation		0	0	17	19	0	0	0	0
Pest regulation		0	0	9	24	0	0	0	0
Disease regulation human		0	0	15	21	1	0	0	0
Disease regulation livestock		0	0	14	20	1	0	0	0
Erosion regulation		0	14	13	11	0	14	0	0
Water purification		1	4	26	7	0	5	0	0
Pollination		0	12	14	8	0	16	0	0
Salinity regulation		0	0	32	6	0	0	0	0
Fire regulation		0	0	38	0	0	0	0	0
Noise visual buffering		0	0	34	4	0	0	0	0
Cultural heritage		8	10	25	1	0	12	0	0
Recreation and tourism		12	10	24	0	0	14	0	0
Aesthetic value		2	11	25	0	0	13	0	0
Spiritual and religious		1	8	29	0	0	9	0	0
Inspirational value		0	2	35	1	0	2	0	0
Social relation		0	16	22	0	0	16	0	0
Education and research		0	3	32	3	0	3	0	0
Soil formation		0	4	25	9	0	4	0	0
Primary production		0	14	17	7	0	14	0	0
Nutrient cycling		0	1	22	16	0	1	0	0
Water recycling		0	1	22	15	0	1	0	0
Provision of habitat		0	0	22	16	0	0	0	0

Table 8: Distribution of plant species around the wetland studied.

Stations	1		2				3		4	5		6
Serial number of statements on the map	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
1 *Aerva javanica* (Burm.f.) Schult.	-	+.+	-	-	-	-	-	+.+	-	-	-	-

2	*Ajuga iva* L.	-	-	-	+.+	+.+	-	-	-	-	-	-	-
3	*Artemisia herba alba* Asso	-	+.+	+.+	-	+.+	-	-	-	-	+.+	2.2	-
4	*Arthrocnemum macrostachyum* (Moric.) K.Koch	+.+	-	-	-	-	-	-	-	-	-	-	-
5	*Astragalus lusitanicus* Lamk sp.	-	-	-	-	-	-	-	-	-	-	+.+	-
6	*Atractylis cancellata* L.	-	-	+.+	2.2	-	+.+	-	-	-	-	-	-
7	*Atriplex halimus* L.	-	-	-	-	-	-	-	1.1	2.2	-	-	-
8	*Cynara carduncula*s L.	-	+.+	-	-	1.1	-	-	-	-	-	-	-
9	*Echinops spinosus* L.	-	-	1.1	-	-	-	-	-	-	-	-	-
10	*Eruca vesicaria* L.	-	-	-	-	-	-	-	-	-	-	-	+.+
11	*Helianthemum apertum* Pomel	-	-	-	-	-	-	-	-	-	+.+	1.1	-
12	*Helianthemum pilosum* L.	-	-	-	+.+		+.+	-	-	-	1.1	+.+	-
13	*Helianthemum vergatum* (Desf.) Pers.	-	-	-	+.+	1.1	-	-	-	-	-	-	-
14	*Herniaria hirsuta* L.	-	+.+.	+.+	-	+.+	-	-	1.1	-	-	+.+	+.+
15	*Juncus acutus* L.	-	-	-	-	-	-	-	2.2	1.1	-	-	-
16	*Juncus maritimus* Lamk.	2.2	-	-	-	-	-	-	-	-	-	-	-
17	*Lygeum spartum* L.	-	-	+.+	-	-	-	+.+	-	-	-	-	-
18	*Marrubium vulgare* L.	-	+.+	-	-	-	-	-	-	-	-	+.+	-
19	*Noea mucronata* (Forssk.) Asch. & Schweinf.	-	-	-	-	-	-	-	-	-	2.2	-	1.1
20	*Paronychia argenta* Lam.	-	-	-	-	-	-	-	-	-	+.+	-	-
21	*Peganum harmala* L.	-	+.+		+.+	3.3	-	+.+	-	+.+	1.1	-	+.+
22	*Phillyrea angustifolia* L.	-	-	-	-	-	+.+	+.+	-	-	-	-	-
23	*Phlomis crinita* L.	-	-	-	+.+	+.+	-	-	-	-	-	-	-
24	*Phragmites communis* Trin.	1.1	-	-	-	-	1.+	-	1.1	-	-	-	-
25	*Poa bulbusa* L.	-	-	-	-	-	-	-	-	-	+.+	+.+	+.+
26	*Pyrus gharbiana* Trab.	-	-	-	-	-	-	-	1.1	2.2	-	-	-
27	*Salsola fruticosa* L.	1.1	-	-	-	-	1.+	-	1.1	-	-	-	-
28	*Salsola vermiculata* L.	+.+	+.+	+.+	-	-	+.+	4.4	2.2		-	-	-
29	*Scolymus grandiflorus* L.	-	1.1	-	-	-	-	-			-	-	-
30	*Scirpus maritimus (L.) Palla.*	-	-	-	-	-	-	-	1.1	+.+	-	-	-
31	*Senecio vulgaris* L.	-	+.+	-		-	-	-	3.2	3.3	-	-	-
32	*Silybum marianum* (L.) Gaerth.	-	+.+	-		-	-	-	3.3	3.3	-	-	-
33	*Sinapis arvensis* L.	-	-	-	-	-	-	-	1.1	2.2	-	-	-
34	*Stipa barbata* Desf.	-	-	-	-	-	-	-	-	-	-	+.+	1.1
35	*Stipa parviflora* Desf.	.-	-	-	-	-	-	-	-	-	1.1	-	+.+
36	*Stipa tenassicima* L.	-	-	-	-	-	-	-	-	-	-	-	2.2
37	*Spergularia salina* L.	-	-	-	-	-	-	-	-	-	1.1	-	+.+
38	*Sueda fruticosa* Forsk.	-	-	-	-	-	-	-	1.1	+.+	-	-	-
39	*Sueda maritima* (L.) Dumort.	-	-	-	-	-	-	-	-	-	-	-	-
40	*Tamarix articulata* Vahl.	-	-	-	-	-	-	-	-	1.1	-	-	-
41	*Tamarix boveana* Bunge.	-	-	-	+.+	-	+.+	-	1.2	+.+	-	-	-
42	*Tamarix gallica* L.	-	-	-	+.+	-	+.+	-	2.2	+.+	-	-	-
43	*Tymus hirtus* (Boiss. & Reut.) Murb.	-	-	-	+.+	-	+.+	-	1.1	+.+	-	-	-
44	*Ziziphus lotus* (L.) Lam.	-	+.+	+.+	-	+.+	-	-	-	-	+.+	2.2	-

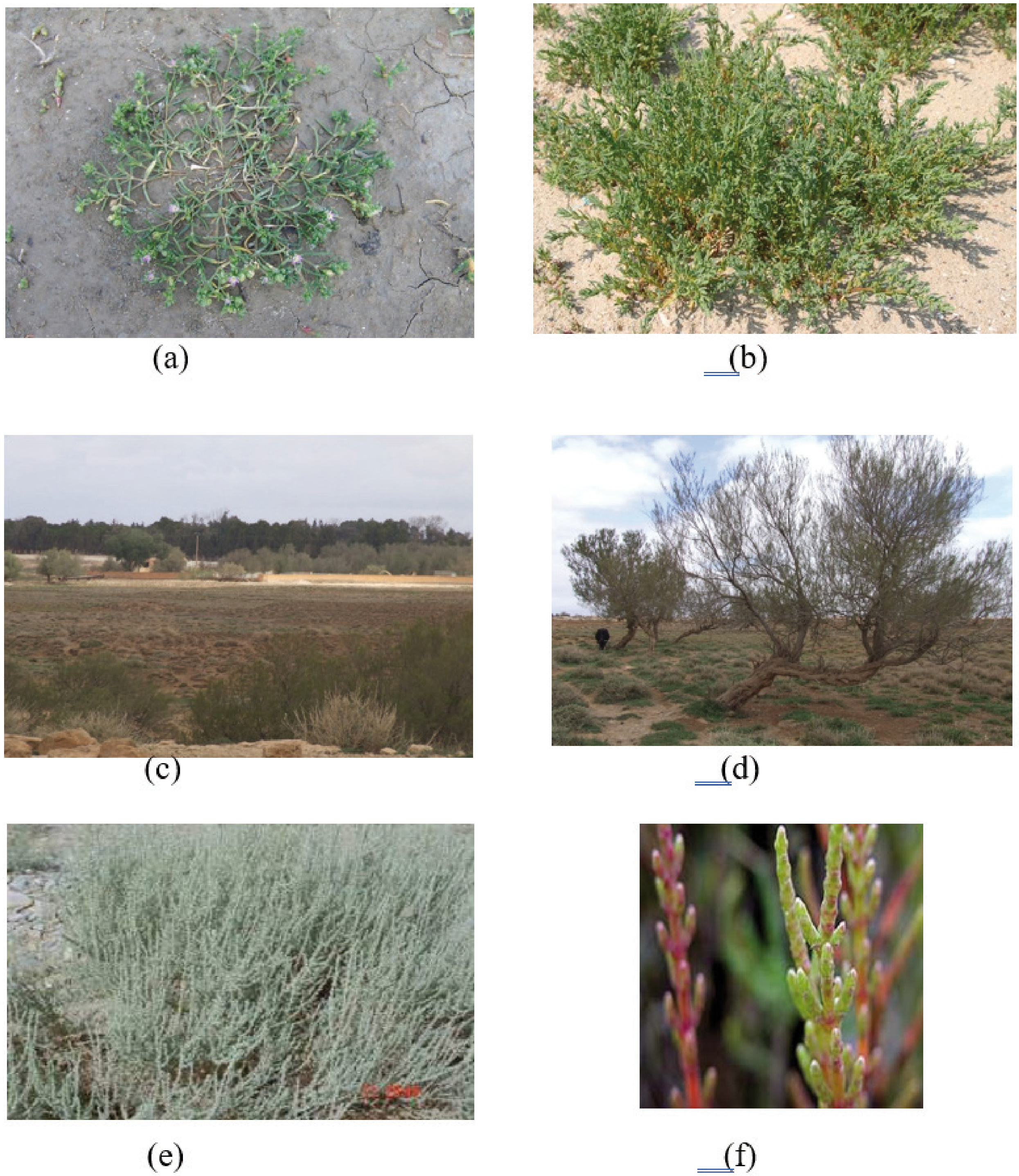

Figure 5: Photos of some characteristic species : a- *Spergularia salina;* b- *Suaeda maritima*; c- *Tamarix boveana*; d- *Tamarix gallica*; e- *Salsola vermiculata* ; f- *Arthrocnemum macrostachyum* (Directed by Aouadj, 2025).

3.2 DISCUSSION

3.2.1 Assessment of ecosystem services

The ecological assessment of this approach was carried out at six stations in the Ain Sokhouna wetland, highlighting various contributions (socio-economic and ecological services). The most significant positive contributions (++) are food (++ = 11) and fresh water (++

= 13), indicating that the wetland is important for basic daily needs. Other positive contributions include air quality and local climate regulation (+ = 20 each), water regulation (+ = 20), food (+ = 19), pollination and, above all, social relations (+ = 12 each). This shows that wetlands play an essential role in climate change mitigation, ecological interaction and social cohesion in wetland areas. Regulatory services, especially pest regulation (- = 24), livestock disease regulation (- = 21) and human disease regulation (- = 20), showed negative contributions due to degradation or ecological stress. Other services such as renewable energy, fuel, fibre and fire regulation showed no contribution. Cultural services (eco-tourism) (++ = 8 and + = 12) showed significant benefits in wetlands, while religious values, inspirational value, scientific research and education did not show significant contributions.

3.3 VEGETATION ANALYSIS

44 plant species have been identified, including 2 rare species, 3 endemics and 4 protected species. Some species have been reported for the first time in this area, such as *Spergularia salina*, *Arthrocnemum macrostachyum, Suaeda maritima, Salsola vermuculata, Tamarix articulata and Tamarix boveana*. The latter is a rare, endemic and threatened taxon on the UCIN red list.

According to our surveys, *Stipa tenassicima and Artemisia herba alba* are found in the commune of Ain Skhouna, on the edge of Maamoura, and *Peganum harmala*, which indicates the degradation and disappearance of *Artemisia herba alba*, is found in the surveys we carried out in the region. Most of the plants found in these areas are steppe plants in a degraded state, as well as globular plants and plants sensitive to salinity.

The presence of valued or environmentally-friendly trees highlights a link between biodiversity and cultural heritage, underlining the need for plants to provide vital services.

3.3.1 Calculation of E.S.I

The Ecosystem Services Index (E.S.I) calculation helped in the quantification and comparison of ecosystem service contributions across different study sites and different service types. Provisioning services and regulating services showed positive contributions as compared to supporting services with limited benefits as observed which shows that the wetlands provide services locally. Further various services such as, storm hazard regulation, disease regulation and nutrient cycling showed significant negative benefits because of pollution, urbanization or degradation.

The highest E.S.I is showed by food (0.4), which indicates strong provisioning services. Climate regulation, air quality, water regulation (0.2-0.4), indicating regulating services. Whereas, pest and disease regulation, nutrient cycling showed negative contributions in E.S.I. Recreation and tourism (0.3) showed positive contribution in cultural services.

3.3.2 Key elements for the management, conservation and restoration of wetlands

The management, conservation and restoration of wetlands aim to maintain their vital ecological functions (water quality, biodiversity, erosion control), through integrated approaches such as the Ramsar Convention, which promotes rational use and local/international actions involving users (limiting pollution and withdraw-

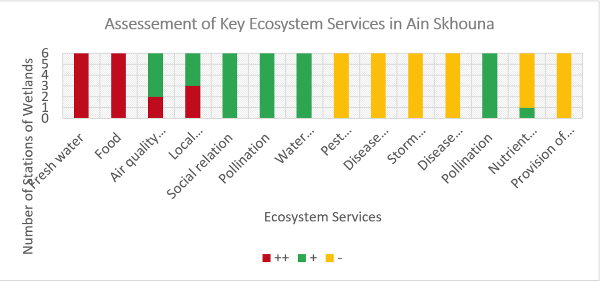

Figure 6: Assessment of key Ecosystem Services (Directed by Aouadj, 2025).

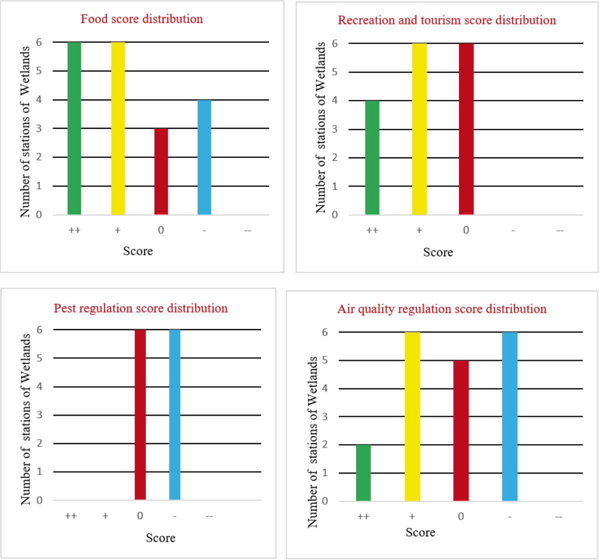

Figure 7: Comparison of four different ecosystem services (Directed byAouadj, 2025).

als) and ecological engineering projects to restore their physical and biological characteristics. These efforts, supported by funding (sponsorship) and public policies, strengthen climate resilience and sustainable development by protecting essential ecosystem services (clean water, food, livelihoods).

3.3.2.1 Main conservation actions

Good user practices: Reduce water withdrawals, avoid toxic substances, limit inappropriate developments.

Habitat protection: Prioritise non-disruptive activities and native species.

Awareness raising: Educate people about the importance of wetlands, including small ones.

3.3.2.2 Restoration actions

Restoring functions: Restore the natural physical and biological characteristics of a degraded area.

Ecological engineering: Design and implement projects to restore habitats.

Nature-based solutions: Use wetlands to mitigate climate change and build resilience.

4 CONCLUSION

The study of 6 wetland stations in Ain Skhouna using the R.A.E.W.S approach indicated that these wetland ecosystem services provide important provisioning and regulating services, with freshwater, food, air quality and climate regulation being the most beneficial services. However, regulating services such as pest and disease control, nutrient cycling and storm regulation are suffering as a result of ecological degradation or stress.

The presence of various tree species around wetlands that are culturally important, such as peepal and neem, shows the combined nature of ecological and cultural values. For sustainable urban planning, it is important to implement ecosystem service assessments in decision-making by strengthening public participation, promoting vegetation and implementing pollution control measures. These measures are essential to improve the health and functioning of wetland.

5 STATEMENT

This research was funded solely with my own money and resources, and exclusively within the framework of the scientific research I conduct. All the data used here is recent, given that this area has not been studied before. Therefore, the results are the result of my fieldwork, especially the plant inventory.

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