



Exploitation of plants from upstream of the Sebou-wadi watershed (province of Taounate, North of Morocco)

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Abstract

Plants have a crucial role in the economy of subsistence of the farming and semi-urban areas of Morocco (food, traditional medicine, handicraft, etc.). In other respects, the integrated management of water resources interferes with the phyto-diversity conservation (soil fixation, bio-indicators of water quality, etc.). One of the approaches to highlight the "phyto-diversity/water management" comprises an assessment of plants exploitation by the riparian population. Based on land studies and prospecting in upstream of the Sebou-wadi watershed (province of Taounate, North of Morocco), we have identified more of 129 plant species and subspecies used in food (60%) and/or in traditional medicine (52%). The financial income of the marketed plants is very variable [667 MAD.ha⁻¹.year⁻¹ (*Pisum sativum*) – 114,133 MAD.ha⁻¹.year⁻¹ (*Capparis spinosa*); MAD = Moroccan Dirham], with a total average of 16,464.80 MAD.ha⁻¹.year⁻¹. *Capparis spinosa* and *Olea europaea* have casually a significant economic importance. The current plants exploitation would have negative repercussions on superficial waters.

Key words: Northern Morocco, Flora, Exploitation, Water Management

1. Introduction

Morocco is considered among the five Mediterranean countries having a richly flora. According to biogeographical data, the Moroccan flora comes largely of autochthonous stock, and supplied with holarctic and tropical elements or Saharain, Iran-Turanian and Macaronesian ones (Fennane, 2004). The wealth of Moroccan vascular flora is estimated to c. 4500 indigenous or naturalized species and subspecies, belonging to 920 genus and 130 botanical families, with an endemic flora corresponding to c. 60 botanical families (in Fennane, 2004).

Previous works achieved in the Northwest of Morocco showed that the vascular plants (spontaneous or cultivated) could have a primordial interest for subsistence economy of the farming and semi-urban zones of Morocco, because of their food, medicinal and toxic virtues, etc. (e.g. Ennabili *et al.*, 2000b, 2006).

Otherwise, water management is a main concern of Local Authorities of Morocco (Anonymous, 2010c). Among the main problems of water management in the Sebou-wadi watershed are surface water pollution, steep decline of wetland ecosystems and their functions... (Anonymous, 2010d). Vegetation can fight against water erosion (Snoussi *et al.*, 1990; Rey *et al.*, 2004); as regulating factor of water flood (Galea *et al.*, 1995).

This work aims to inventory the exploited plants from upstream of the Sebou-wadi watershed (North of Morocco) on basis of socioeconomic inquiries and land prospecting (flora, plants sampling, etc.). Plant-species exploitation and its interference with water management are also approached.

2. Materials and methods

2.1. Study area

The study area (Figure 1) depends on the Taza-Al Hoceima-Taounate region and appertains to the Pre-Rif zone (Anonymous, 2003), spanning 5600 Km² (Anonymous, 2008e), and the relief altitudes vary between 80 m and 1600 m (Bahraoui and Oved, 1970).

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The soil type corresponds to Rendzinas, i.e. It is correlated to Vertisol, calcium and magnesium categories (Anonymous, 2008a, 2009c); 80% of the study area have a high to moderate agricultural ability for olive tree and wheat (Anonymous, 2008b). The main productions concern the cereal (44% of the Utilized Agricultural Area - UAA), the food legumes (16%) and arboriculture (28%), particularly based on olive tree (Anonymous, 2003). The climate fluctuates from a semi-arid Mediterranean to sub-humid one (Anonymous, 2008c).

The forest occupies 8% of the study area, and includes holly-oak (29%), thuja and secondary species (28%), cork oak (12%) and the Pyrenean and Zen oaks (3%). Artificial plantations cover 28% of the total forest surface (Anonymous, 2008d). In spite of their weak surfaces, the forest resources generate moderate economic returns for the Townships Administration of about 1,326,276 MAD.year⁻¹ (Anonymous, 2008d).

The local population is almost entirely farming (91.6%), with an average density of 112 inhabitants.km⁻². The local economy is essentially based on agriculture, which occupies 81.1% of the active population (Anonymous, 2003).

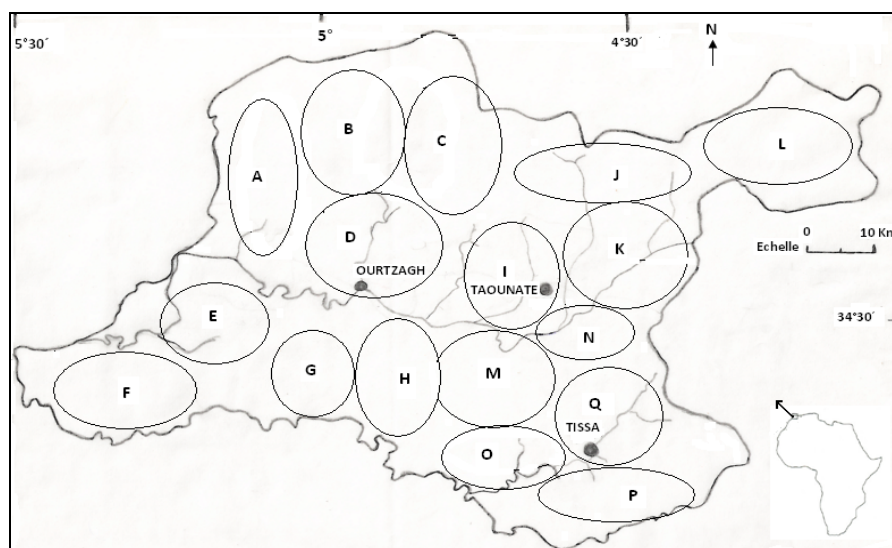


Figure 1. Localization of the prospected stations in upstream of the Sebou-wadi watershed (province of Taounate)

Toponyms caption. **A:** Elmizab, Tawldmame, Essafah. **B:** Sidi Lhaj Mhamed, Oulad Salah, Ezzaouiya, Mchaâ, Hllaba. **C:** Ghafsai, Ounane, Santiya, Khmisse. **D:** Ourtzagh, Aine Atmane, Laâzibe, Tamdernite, Bab Lhamra. **E:** Tassanfecht, Lrouiba, Lbouyed, Oulad Ben Jilali. **F:** Karia, Pont de Sebou, Oulad Slama. **G:** Bni Oukil, Lkolla. **H:** Chtiouiyyine, Zraoula. **I:** Oulad Taher, Karakire, Lâanssare, Oued l'Mellah. **J:** Lkhtatba, Kalâa, Bab Behreze. **K:** Aine Mediouna, Bni Oulid, Bouadel, Bouda. **L:** Oulad Ahmed, Tariya, Khmisse Sloume. **M:** Oulad Daoued, Ahl Louad, Aine Bouhsina, Aine Jaber, Bni Oukil, Lbhahda, Skarna, Zragna, Oulad Jaber. **N:** Aine Aïcha, Aine Bouchala, Bni Khlifa, Mezdou, Taâaouniya, Aine Nehasse. **O:** Aine Malha, oued Inaouène, Lbsabsa. **P:** Aine Gdah, Blitiouate, Lhrachna, Oulad Jaber, Lwrada. **Q:** Tissa, Belâajiyate, Kolala

2.2. Methods

Gathering data was led in 67 stations in the study area (Figure 1) according to a predetermined based on previous works (Ennabili *et al.*, 2000b, 2006; Rivera *et al.*, 2005; Aleem Qureshi *et al.*, 2009; Sardar and Khan, 2009). This prospecting is to achieve field socio-economic investigations, to collect plant samples, and to identify the plant species sampled by using the available floras (Negre, 1961, Quezel and Santa, 1962-1963; Fennane *et al.*, 1999-2007) and the related data bases (Anonymous, 2010a-b). The un-sampled plant species (species in decline, extinct species, imported plant-subproduct, etc.) are checked and named according to Bertrand (1991) and Bellakhdar (1997, 2006).

The inquiry forms are randomly completed without consideration neither age nor social category (González-Tejero *et al.*, 2008). Seen the high variability of the quantitative data, due to the interviewees heterogeneity (age, sex, profession, etc.), data processing was limited to calculation of percentages, averages and standard-deviations..

3. Results

3.1. Interviewees

Card-indexed data result from 90 interviewees from 67 stations (c. 80% male; 6.84 completed forms per interviewee). The average size of the interviewed household equals 5.73 persons. The categories of ages fluctuate from 13 and 73 years; more than 51% of the interviewees belong to the "40-59 years" age-group. These interviewees practice 25 different professions, but 53% among them are fellahs (farmers).

3.2. Used flora

On the basis of 616 completed forms or "station-plant-interviewee" combination, we identified 129 plant species and subspecies, belonging to 108 genus and 50 botanical families. *Lamiaceae*, *Fabaceae* and *Asteraceae* are the most represented, with 29% of the identified species (Table 1). *Arundo donax* (*Poaceae*) is the most used among wetland species from the region.

About 45% of completed forms are related to 10 species collected by the native population (Tableau 1). The harvested species occur in fields, forests, roads sides, gardens and wadis beds, and are cultivated (47%), spontaneous (40%), introduced and/or naturalized (7%), commercialized (5%) or domesticated (1%) (Table 1). Moreover, 73% of exploited species bloom in spring, 19% in summer, 4% in summer and 2% in winter.

We also note that 13.8% of the identified species possess more than vernacular name, due probably to an ethnic heterogeneity in the study area (Berber and Arabian origins). Locally, the plants vernacular names could indicate their use as "Harraste lahjar" (*Herniaria hirsuta*), used in traditional medicine against renal lithiasis, and "qattal l'klab" (*Ricinus communis*) whose seeds are used in mixture with bread to kill dogs. Whereas *Arisarum vulgare* was used in food during the 1945-famine year. The under-ground part of this plant (tubercle) is oven-cooked and transformed then in powder to make bread (Station E, Figure 1).

The plant fruit is the most collected (20%), followed by aerial part (19%), leaf (16%), seed (13%), root (9%), wood and the whole plant (4.7% each), inflorescence and branch (3.5% each), flower (2.9%), bulb (1.7%), stem (1%) and tubercle and trunk (0.5%). Some plants are well-known by their traditional use in human therapy and are generally used in mixture or sometimes with other products (olive oil, bread, honey, henna, tea, milk, egg, saffron, etc.).

The uses of identified plants are consigned in Table 1, showing that (i) 60% of these species have food virtue, (ii) 52% have medicinal virtue, and (iii) 22% are used in both food and traditional medicine. 16.1% of the identified species interest apiculture, followed by pastoralism (10.7%), craft, agro-alimentary, pharmaceutical and tobacco industries (10.7%), wood supplies (6.9%) and in fat or essential oils extraction (2.3%). Other uses, such drug, building materials, etc. represent 6.8%. The underutilization of plants in traditional medicine could be explained by the native-expertise regression. We note also that local herbalists don't overcome sufficiently administration of herbal prescriptions.

Local use types of plants show indirectly the frequent illnesses in the region. Thus, the bodily systems concerned by the local therapy are digestive (17%) and epidermis (13%). These systems are followed by nervous and cardiovascular systems (7.6% each), respiratory system (7%) and urinary system (3.8%). Furthermore, *Coriandrum sativum* and *Petroselinum crispum* induce death of the rabbits, and *Sorghum* spp. for sheep.

Table 1. Plants inventory and utilization in upstream of wadi-Sebou watershed (province of Taounate) (A, aerial part; Ap, apiculture; C, cultivated; Co, construction; E, edible; Eo, extraction of essential oils; F, fruit; Fw, firewood; I, introduced; Ind, industry; Inf, inflorescence; L, leaf; M, traditional medicine; Mbp, marketed by-product; N, naturalized; P, pastoral; R, root; S, spontaneous; Se, seed; Uf, utilization frequency; Vmn, unrecognized medicinal-virtue by the interviewees; W, woods)

Taxon	Vernacular name	Used part / utilization / type of the plant	Uf (%)
Poaceae			16.8
<i>Triticum aestivum</i> L.	farina, tiguier, achṭar, marzan, marchoch	Se, A / E, P / C	7.3
<i>Triticum turgidum</i> L.	Gam'h, karim, krifla, vitro, l'kanz, sbou,	Se, A / E, P / C	5.40
<i>Hordeum vulgare</i> L. subsp. <i>vulgare</i>	châir	Se, A / E, P / C	3.30
<i>Arundo donax</i> L.	l'q'sab	stem / Ind / S	0.30
<i>Zea mays</i> L.	d'ra ch'qobi, d'ra	Se / E / C	0.30
<i>Sorghum bicolor</i> (L.) Moench	d'ra l'biḍa	Se / E / C	0.20
Fabaceae			16.4
<i>Vicia faba</i> L.	l'foul, fillet	Se, A / E, P, M (tuberculosis) / C	5.20
<i>Cicer arietinum</i> L.	l'hamouss	Se, whole plant / E, P / C	4.40
<i>Lens culinaris</i> Medik.	l'âdass	Se / E / C	2.30
<i>Vicia ervilia</i> (L.) Willd.	kersanna	Se / P / C	1.00
<i>Pisum sativum</i> L.	jalbana	Se, A / E / C	0.90
<i>Trigonella foenum-graecum</i> L.	ḥolba	Se, L / E, M (stomachic, heart) / C	0.90
<i>Phaseolus vulgaris</i> L.	lowbya	Se / E / C	0.50

Table 1. (Continued)

<i>Vicia sativa</i> L.	kerfalla	Se, A / P / C	0.50
<i>Medicago sativa</i> L.	l'faša	A / P / C	0.30
<i>Glycyrrhiza glabra</i> L.	âarq s'sous	R / M (tooth) / Mbp	0.20
<i>Trifolium alexandrinum</i> L.	l'barsim	A / P / I, N	0.20
Lamiaceae			13.1
<i>Mentha pulegium</i> L.	f'layou	A / E, Ind (Eo, other), insecticide, deodorant, M (flu, cold, throat, massage) / S	3.80
<i>Origanum</i> spp.	zaâtar	A / E, Ind (Eo), M (cooling of the intestine, stomachic, intestinal) / S	3.50
<i>Rosmarinus officinalis</i> L.	azir	A / E, Ap, M (tonic, stomachic) / C	0.90
<i>Salvia officinalis</i> L.	salmiya	A / M (head, hypertension, tonic) / I,S	0.90
<i>Calamintha sylvatica</i> subsp. <i>ascendens</i> (Jord.) P.W.Ball	manta	A / E / S	0.70
<i>Mentha spicata</i> L.	liqama, naânaâ	A / E, M (head) / C	0.70
<i>Lavandula dentata</i> L.	l'khezama	A / E, Ap, M (head) / C, S	0.50
<i>Lavandula multifida</i> L.	hlihla, koħila	A / E, M (stomachic) / S	0.50
<i>Marrubium vulgare</i> L.	m'riwa jrihiya, m'riwa	A / M (cooling of the stomach, otitis) / S	0.50
<i>Ocimum basilicum</i> L.	l'hbaq	A / Ap, M (lung) / C	0.30
<i>Ajuga iva</i> (L.) Schreb.	chandgora	L / M (asthma) / S	0.20
<i>Lavandula stoechas</i> L.	ħalħal	A / E, M (Vmn) / S	0.20
<i>Mentha suaveolens</i> Ehrh.	m'chichtrou	A / M (tonic, cooling of the stomach) / S	0.20
<i>Thymus</i> spp.	z'âitra	L / Ap, M (stomachic, intestinal) / S	0.20
Oleaceae			6.20
<i>Olea europaea</i> L. subsp. <i>europaea</i>	zitoun	W, F, S / E, Ind, Fw, M (cooling of the lung, bad eye, massage) / C	
Asteraceae			5.70
<i>Dittrichia viscosa</i> (L.) Greuter	taraklan, bagraman	L, R / Ap, M (hemorrhage, diabetes, rheumatism, stomachic, injury, mouth) / S	1.70
<i>Artemisia arborescens</i> L.	chiba	A / E, Ap, M (otitis, vertigo, poisoning, facilitate digestion) / I, N	0.90
<i>Rhaponticum acaule</i> (L.) DC.	tafgha	R, Inf / E, M (stomachic) / S	0.70
<i>Carlina gummifera</i> (L.) Less.	addad	R / body bad smells / S	0.50
<i>Cynara cardunculus</i> L.	l'kharchouf, l'qouq	L, Inf / E / C	0.50
<i>Anthemis cotula</i> L.	l'babounj, nowara l'bayða	Inf / E, Ind (Eo), M (tooth, hair) / S	0.20
<i>Artemisia herba-alba</i> Asso.	chih	L / M (rheumatism) / S	0.20
<i>Echinops strigosus</i> L.	taymart	A / M (burn) / S	0.20
<i>Lactuca sativa</i> L.	l'khass	L / E / C	0.20
<i>Scolymus hispanicus</i> L.	l'gornina	A / E / S	0.20
<i>Scolymus maculatus</i> L.	zarnij	L,stem / E, Ap / S	0.20
<i>Silybum marianum</i> (L.) Gaertn.	tawra	A, Inf / E, Ap, Co / S	0.20
Apiaceae			3.20
<i>Ammi visnaga</i> (L.) Lam.	l'bachnikha	A, Inf, S / Ap, Co, M (diarrhea, stomachic, eczema, injury, mouth, tooth) / S	1.00
<i>Apium graveolens</i> L.	l'krafes	A / E, M (Vmn) / C	0.30
<i>Coriandrum sativum</i> L.	l'qasbour	A / E, Ap / I, N	0.30
<i>Foeniculum vulgare</i> Mill	l'besbas	young stem / M (vomiting) / S	0.30
<i>Petroselinum crispum</i> (Mill.) A.W.Hill	l'mâadnous	A / E, M (Vmn) / C	0.30
<i>Ammodaucus leucotrichus</i> Coss. & Durieu	l'kamoun sofi	F / M (cooling) / Mbp	0.20
<i>Carum carvi</i> L.	kharwiya	F / M (Vmn) / C	0.20
<i>Conium maculatum</i> L.	ziyata	L / E / S	0.20

Table 1. (Continued)

<i>Daucus carota</i> L.	khizou	R / E / C	0.20
<i>Pimpinella anisum</i> L.	ħabat ħlawa	F / E / S	0.20
Moraceae			3.10
<i>Ficus carica</i> L.	l'karmos, l'k'ram, chijar	W, L, F / E, Ap, Fw, P / C, domesticated	2.90
<i>Morus alba</i> L. a	t'out	F / E / I, N	0.20
Rosaceae			2.70
<i>Prunus dulcis</i> (Mill.) D.A.Webb	l'ouz, l'ouz l'ħar	F / E, Ap, M (Vmn) / C	1.10
<i>Eriobotrya japonica</i> (Thumb.) Lindl.	l'mzah	F / E / C	0.30
<i>Prunus domestica</i> L.	l'barqouq	F / E / C	0.30
<i>Crataegus monogyna</i> Jacq.	admam	A / M (Vmn) / S	0.20
<i>Malus sylvestris</i> Mill.	t'ffah	F / E / C	0.20
<i>Prunus persica</i> (L.) Batsch	l'khokh	F / E / C	0.20
<i>Pyrus communis</i> L.	n'gaš	F / E / C	0.20
<i>Rosa</i> spp.	l'ward	flower / M (Vmn) / Mbp	0.20
Capparaceae			2.60
<i>Capparis spinosa</i> L.	l'kabbar	flower, F / E, Ap, Ind (oil, other), M (heart, cooling of the bladder, stomachic, rheumatism, beck) / C, S	2.60
Anacardiaceae			2.20
<i>Pistacia lentiscus</i> L.	d'rou	branch, L, S / E, Ap, Fw, Ind (oil), P, M (stomachic, throat) / S	1.90
<i>Pistacia atlantica</i> Desf.	l'bġam	branch, F / E, Fw, P / S	0.30
Myrtaceae			1.90
<i>Myrtus communis</i> L.	r'rayħan	L / E, M (tonic, antiseptic, injury, head, stomachic, intestinal, urinary disorders, cough, hair, throat) / S	1.20
<i>Eucalyptus camaldulensis</i> Dehnh.	kalytous	W, L / Ap, Fw, Co, M (Vmn) / C	0.70
Fagaceae			1.80
<i>Quercus ilex</i> subsp. <i>ballota</i> (Desf.) Samp.	l'balouġ	W, F / E, Fw, Co, Ind / S	1.40
<i>Quercus faginea</i> Lam.	tacht	W / Fw, Co / S	0.20
<i>Quercus suber</i> L.	d'lam	W / Fw, Co / S	0.20
Cannabaceae			1.70
<i>Cannabis sativa</i> L.	l'kif	A / Ap, drug, M (Vmn) / C	1.70
Cucurbitaceae			1.60
<i>Cucumis melo</i> L.	battikh	F / E / C	0.80
<i>Citrullus lanatus</i> (Thunb.) Mansf.	dallah	F / E, M (burn) / C	0.30
<i>Cucurbita pepo</i> L.	l'graâ	F / E / C	0.30
<i>Cucumis sativus</i> L.	l'khyar	F / E / C	0.20
Solanaceae			1.60
<i>Lycopersicon esculentum</i> Mill.	maġicha	F / E / C	0.30
<i>Solanum tuberosum</i> L.	baġaġa	tubers / E / C	0.30
<i>Capsicum annuum</i> L.	l'felfel	F / E, M (hyper-cholesterol) / C	0.20
<i>Capsicum annuum</i> L.	soudaniya	F / E, M (veterinarian) / C	0.20
<i>Mandragora autumnalis</i> Spreng.	byd lghol	R, L / M (toxic) / S	0.20
<i>Nicotiana rustica</i> L.	ġ'aba l'baldiya	L / drug / C	0.20
<i>Nicotiana tabacum</i> L.	ġ'aba roumiya	L / Ind / C	0.20
Cactaceae			1.40
<i>Opuntia maxima</i> Miller	l'handiya	A, F / E, Ap, M (Vmn) / I, N	1.40
Cupressaceae			1.40
<i>Tetraclinis articulata</i> (Vahl) Mast.	l'āarāar	branch / Fw, Co, Ind, M (bad eye, hair) / S	1.20
<i>Cupressus sempervirens</i> L.	l'āarāar roumi	W / Fw, Co / C	0.20
Vitaceae			1.40
<i>Vitis vinifera</i> L.	l'āneb, dalya	L, F / E, P / C	1.40

Table 1. (Continued)

Leguminosae			1.40
<i>Cerantonia siliqua</i> L.	l'kharroub, slaghwa	F, S / E, , Ind (Eo), P, M (stomachic) / C, domesticated	1.40
Alliaceae			1.20
<i>Allium sativum</i> L.	touma	bulbs / E, M (cooling of the lung, hair, intestinal) / C	0.90
<i>Allium cepa</i> L.	l'başla	bulbs / E, M (stomachic, head) / C	0.30
Gentianaceae			1.00
<i>Centaurium erythraea</i> Rafn	qarşat l'haya	A / M (diabetes, fever, hair) / S	1.00
Thymelaeaceae			1.00
<i>Daphne gnidium</i> L.	l'zaz, metnan	L / M (bladder, hair, toxic) / S	1.00
Rutaceae			0.80
<i>Citrus limon</i> (L.) Burm.f.	laymoun	flower, F / E, Ap / C	0.30
<i>Citrus aurantium</i> L.	l'tchin	F / E / C	0.30
<i>Ruta chalepensis</i> L.	l'fijel	A / M (injury) / S	0.20
Apocynaceae			0.70
<i>Nerium oleander</i> L.	dafla	R, L / M (head, injury, mouth, throat, tooth) / S	0.70
Ericaceae			0.70
<i>Arbutus unedo</i> L.	bakhano, sasno	F / E / S	0.70
Brassicaceae			0.60
<i>Brassica oleracea</i> L.	chifleur	Inf / E / C	0.20
<i>Brassica rapa</i> L.	laft	R / E / C	0.20
<i>Raphanus sativus</i> L.	l'fjel	R / E / C	0.20
Arecaceae			0.50
<i>Chamaerops humilis</i> L.	doum	A, F / E, Ind, P / S	0.50
Aristolochiaceae			0.50
<i>Aristolochia fontanesii</i> Boiss. & Reut.	b'raztam	whole plant / M (poisoning, injury) / S	0.50
Chenopodiaceae			0.50
<i>Chenopodium ambrosioides</i> L.	m'khinza	L / M (fever, head, heart) / I, N	0.30
<i>Beta vulgaris</i> L.	l'barba	R / E / C	0.20
Hyacinthaceae			0.50
<i>Drimia maritima</i> (L.) Stearn	l'boşşila	bulbs / M (Vmn) / S	0.50
Pinaceae			0.50
<i>Pinus halepensis</i> Mill.	tayda	W / Fw, Co / C	0.50
Punicaceae			0.50
<i>Punica granatum</i> L.	romman	F / E, M (stomachic) / C	0.50
Boraginaceae			0.40
<i>Borago officinalis</i> L.	l'horrich	R, L / M (fracture, injury) / S	0.20
<i>Echium horridum</i> Batt.	l'horrich	R, L / M (fracture, injury) / S	0.20
Rhamnaceae			0.40
<i>Ziziphus lotus</i> (L.) Lam.	sedra	flower, F / E, Ap / M (stomachic, renal lithiasis) / S	0.20
<i>Ziziphus zizyphus</i> (L.) H.Karst.	zefzouf	F / E / C	0.20
Asparagaceae			0.30
<i>Asparagus albus</i> L.	s'koum	young branch / M (cooling) / S	0.30
Caryophyllaceae			0.30
<i>Herniaria hirsuta</i> L.	harras l'hjar	L / M (renal lithiasis) / S	0.30
Portulacaceae			0.30
<i>Portulaca oleracea</i> L.	r'jla	A / E / C	0.30
Urticaceae			0.30
<i>Urtica dioica</i> L.	l'horriga l'harcha	A / M (back, hair) / S	0.30
Verbenaceae			0.30
<i>Aloysia citriodora</i> Palau	lwiza	A / E, M (cooling) / C	0.30
Agavaceae			0.20

Table 1. (Continued)

<i>Agave americana</i> L.	şabra	trunk / Ind / I, N	0.20
Araceae			0.20
<i>Arisarum vulgare</i> Targ. Tozz.	yerna	R / E / S	0.20
Asphodelaceae			0.20
<i>Asphodelus ramosus</i> L.	berwag	flower / Ap / S	0.20
Euphorbiaceae			0.20
<i>Ricinus communis</i> L.	qattal l'klab	Se / M (hemorrhoids) / I, N	0.20
Geraniceae			0.20
<i>Pelargonium graveolens</i> L'Hér.	âaṭricha	L/ E, Ind (Eo) / C	0.20
Juglandaceae			0.20
<i>Juglans regia</i> L.	l'gorgaâ	F / E / C	0.20
Malvaceae			0.20
<i>Malva sylvestris</i> L.	l'bqoul	A / E, M (blood) / S	0.20
Myristicaceae			0.20
<i>Myristica fragrans</i> Houtt.	l'gouza	Se / M (Vmn) / Mbp	0.20
Polygonaceae			0.20
<i>Rumex</i> spp.	l'homiḍa	L / E / S	0.20
Ranunculaceae			0.20
<i>Nigella sativa</i> L.	sanouj	Se / Ind (Eo), M (nervous system) / Mbp	0.20
Theaceae			0.20
<i>Camellia sinensis</i> (L.) Kuntze	atay	L / E, M (Vmn) / Mbp	0.20
Zygophyllaceae			0.20
<i>Peganum harmala</i> L.	l'harmel	Se / M (bad eye) / Mbp	0.20

3.3. Production

The plant production varies from the high productive species in irrigated cultivations as *Malus sylvestris* (18,000 kg.ha⁻¹.year⁻¹) to the lowest productive ones like *Pisum sativum* (200 kg.ha⁻¹.year⁻¹). Whereas for *Cannabis sativa*, newly introduced in the region, the production averages 414±107 kg.ha⁻¹.year⁻¹ (n=7).

The local plant-production is declining, because of the climatic drought risks and the high cost of seeds, fertilizers and labor. *Ficus carica* orchards are regressing because of pollination lack, ageing and overuse of chemical fertilizers. *Olea europaea* subsp. *europaea*, widely domesticated and cultivated in the region, is suffering from ageing and fog dominance during May -due to the Al Wahda dam, recently constructed- disfavoring pollination. Contrariwise, production of *Capparis spinosa* is in progression (4%); other species production varies from one year to another. 95% of plants production is intended for local consumption, and plants by-products are generally harvested during the summer (70%), v. 30% for other seasons.

Regarding to involvement of employees categories in plants exploitation, the women are the most implied (74.9%), followed by children (63.7%) and exogenous (8.10%).

The necessary full-time for cultivation and/or its maintenance and collection is lower for *Pisum sativum* (13.3±5.70 days.ha⁻¹.an⁻¹, n=3) when compared to *Capparis spinosa* (320 days.ha⁻¹.an⁻¹), including 3 months of caper picking each year.

3.4. Marketing

Plants are sold by kilogram of dry weight (dw), wet weight (ww), fruits or seeds. According to plants rarity, economic and/or nutritional importance, demand, etc., the unit price varies from 0.78±0.14 MAD.kg⁻¹ (n=5) for *Ammi visnaga* to 250±70.7 MAD.kg⁻¹ (n=2) for *Nicotiana rustica*. *Cannabis sativa* is particularly marketed at 45.0±22.9 MAD.kg⁻¹ (n=10). The hashish, a preparation extracted from female-feet heads, reaches unusually 3,400±2,162 MAD.kg⁻¹ (n=5).

Essential oils of *Origanum* spp. species are sold at 100 MAD.l⁻¹ (Station A, Figure 1). Only 24.4% of identified medicinal-species are marketed, due probably to plants scarceness. Whereas, *Capparis spinosa* is increasingly in demand, and generates locally 11% of the economic incomes. Otherwise, plants seeds are bought from 3.00 MAD.kg⁻¹ for *Sorghum* spp. to 30.0 MAD.kg⁻¹ for *Cannabis sativa*.

The financial income of exploited plants-species fluctuates from 667±116 MAD.ha⁻¹.year⁻¹ (n=3) for *Pisum sativum* to 114,133±150,989 MAD.ha⁻¹.year⁻¹ (n=3) for *Capparis spinosa*. The exploitation cost of this former is related

unusually to capers harvesting (3.00 MAD.kg⁻¹ of harvested capers). The caper exploitation generates a considerable seasonal jobs and an important economic-input, i.e. a turnover of 468,576±441,777 MAD.year⁻¹ (n=2) in the Tissa souk (Station Q, Figure 1). The average financial-income of used plants equals 16,465±24,226 MAD.ha.year⁻¹ (n=28). Why native inhabitants choose the *Cannabis sativa* cultivation, whose financial product reaches 12,937±12,582 MAD.ha.year⁻¹ (n=8).

Besides, the most of marketed medicinal-plants in the souks (local markets) by herbalists are brought from Marrakech, and the remaining part of them is produced locally or in the nearest provinces. Local plants-production is particularly marketed in souks (75%), in situ (3%), on roadsides (2%) and for crashing Units (1%). A minor part of this production is intended for other national regions (Farmer-Work Centers, Fez, Ouezzane, Sidi Kacem, Casablanca, Sidi Yahya, Oujda, Meknès, Marrakech and Agadir) or exported abroad (Spain and Italy) (18%). Therefore, exported plants-production is lower and concerns *Capparis spinosa*.

Interviewees signaled a progressive evolution of plant sub-products price in the region (93%) and *Triticum aestivum* exploitation could represent at least 90% of economic incomes for some native households. But, medicinal and aromatic plants play a secondary role in local economy.

3.5. Apiculture

During this work, we underlined the use of 21 plant species as melliferous plants, belonging to 21 genus and 13 botanical families, and 42.8% of them depend on *Asteraceae* (23.8%) and *Lamiaceae* (19%). More than 71% of these plant species are also used in traditional medicine.

The honey collected during fall is appointed locally “merouana” or “harra” and of very good quality. This honey type corresponds to full honeydew and based *Ditrichia viscosa*.

The bee-keepers represent 26.7% of interviewees and are mostly sedentary type (91.6%). The hives number by bee-keeper is estimated to 28.3±87.3 (n = 22). 85.7% of apiarists have provided bees from the natural environment, and 69% of hives are further traditional.

The honey is collected once (74%) to six times (4.30%) per year, or sometimes once every two years. The economic income based on honey selling reaches 10,330±16,725 MAD.apiarist⁻¹.year⁻¹ (n=25). Honey is also used in traditional medicine or consumed (33% each).

3.6. Phyto-diversity and water management

Our results show that plants exploitation is the basis of subsistence economy in the province of Taounate. However, forest regression would have negative repercussions particularly downstream via the soil-erosion and contribution of dissolved polluting-elements such nitrogen and phosphorus.

In the Sebou-wadi watershed, soil-erosion by water is very active, due to forest deterioration, and to the marly formations in the study area. For instance, eroded materials in of the under-basin of Inaouène wadi are routed toward the Idriss 1st dam. Ploughing, grazing and cutting are major factors of riparian-vegetation elimination in floodplains of the Inaouène wadi.

However, production of species tolerating climatic drought, such as *Capparis spinosa*, could contribute to soil fixing. *Cannabis sativa* is cultivated at the expense of forest area.

Current exploitation of plant resources, in the absence of environmental measures (rationalization of plants cutting, water pollution abatement, etc.), would have negative impacts on water-resources management. These phyto-diversity values should be integrated in the policy management of water resources in the province of Taounate in order to promote water quality, and to fight against the water eutrophication and dams silting up, etc..

4. Conclusions and discussion

The obtained results show that the Taounate region possesses high agricultural potentialities, and have an important medicinal and alimentary flora. *Lamiaceae* and *Fabaceae*, as underlined by González-Tejero *et al.* (2008) in Ouazzane (N of Morocco) and *Asteraceae* are the most represented. The importance use among others of *Asteraceae* and *Lamiaceae* has been reported also by Seyddahmedov and Atamov (2008) in mountainous areas of Azerbaijan.

Many of plant species identified in the study area are used in food and/or in traditional medicine. Our results combined to those of Hseini *et al.* (2007) show that medicinal flora from Rabat and Taounate regions (N of Morocco) is dominated by the nine diversified botanical families of spontaneous flora from Morocco, including *Lamiaceae*, *Asteraceae*, *Fabaceae* and *Apiaceae* (Fenane, 2004; Hseini *et al.*, 2007). *Arundo donax* (*Poaceae*) is the most used among wetland species from the region, as reported by Ennabili *et al.* (1996).

About a half of the used species correspond to cultivated and/or spontaneous plants. The most spontaneous species are exploited in traditional medicine. In accordance with the National Strategy report on medicinal and aromatic

plants, these former plants are spontaneous and therefore collected from natural habitats, and only 2% are cultivated (Anonymous, 2009a).

Plant fruit is the most used, as reported by Ennabili *et al.* (2006) and elsewhere by Uysal *et al.* (2010), and the high representativeness of aerial parts of plants could be related to their harvest ease and wealth in photosynthetic metabolites (El Rhaffari and Zaid, 2002). Some plants are well-known by their traditional use in human therapy and are generally used in mixture or sometimes with other products (olive oil, bread, honey, henna, tea, milk, egg, saffron, etc.), as signaled for instance by El Mansouri *et al.* (2011).

The interviewees have not underlined some medicinal plants as *Coriandrum sativum*, used against renal illnesses (Jouad *et al.*, 2001), and they unrecognized medicinal virtues of others like *Carum carvi*, used against the diabetes and cardiac illnesses including hypertension (Eddouks *et al.*, 2002), *Cannabis sativa*, registered for gastritis treatment and soothing pain (Merzouki *et al.*, 2000), and *Borago officinalis*, advisable for eczema, cough, bronchitis, renal complications and rheumatism treatment or as an expectorant and diuretic (Neves *et al.*, 2009).

The bodily systems concerned by the local therapy are digestive and epidermis, corroborating previous work of Bellakhdar *et al.* (1991), El Rhaffari and Zaid, (2002), Rivera *et al.* (2005), Mehdioui and Kahouadji (2007) and/or González-Tejero *et al.* (2008).

Among the quoted species, there are toxic ones as *Carlina gummifera*, *Mandragora automnalis*, *Ricinus communis* and *Daphne gnidium*, as mentioned by Bnouham *et al.* (2006). Other toxic species, whose toxicity is unrecognized by the interviewees, are *Ceratonia siliqua* (Ennabili *et al.*, 2000b), *Conium maculatum* (Bnouham *et al.*, 2006; Durand *et al.*, 2008), *Daphne gnidium*, *Nerium oleander*, *Charybdis maritima* and *Aristolochia fontanesii* (Bnouham *et al.*, 2006). According to the Poison Control Center of Strasbourg (France), plants are responsible for 5% of poisonings (Flesch, 2005).

Moreover, other melliferous plant-species from the study area were not signaled by interviewees like *Quercus ilex* and *Cistus albidus* (Ennabili *et al.*, 2000b), and honey is anyway recommended for treatment of several illnesses (Meda *et al.*, 2004).

Agricultural production in the area suffers from critical situations, due primarily to the climatic drought risks and the high cost of seeds, fertilizers and labor. In medicinal and aromatic plants, the competition from producers threatens the local plants resources (Anonymous, 2009a).

Three species and subspecies plants (*Capparis spinosa*, *Olea europea* subsp. *europaea* and *Cannabis sativa*) have an economic interest, as highlighted for the latest species in other Northern Regions of Morocco by Ennabili *et al.* (2006). Medicinal and aromatic plants play a secondary role in local economy, such as other regions of Morocco (Ennabili *et al.*, 1997), and the National production of them is nevertheless wholly exported, as *Ceratonia siliqua*, *Myrtus communis*, *Nerium oleander*, *Rosmarinus officinalis* (Anonymous, 2009a). Therefore, an implementation of a development process dedicated to plant species valorization in situ is sine qua non to improve the population economic-incomes.

Dependence of local population on plant resources would have probably negative repercussions on superficial waters (flooding, dam silting up, etc.) and more environmental measures must be undertaken. The forest clearing increases indirectly the flood peak-flow (Galea *et al.*, 1995), and thus accentuates soil erosion and sedimentary production (in Rey *et al.*, 2004; Anonymous, 2009b).

In the Sebou-wadi watershed, soil erosion by water is a very active phenomenon (Snoussi *et al.*, 1990; Sibari *et al.*, 2001). For instance, eroded materials in of the under-basin of Inaouène wadi reduce the water storage-capacity of the Idriss 1st dam (Sibari *et al.*, 2001). Ploughings and grazing, underlined by Ballais *et al.* (2005) and cutting would have negative impacts on sediments retention (Beuselinck *et al.*, 2000; Rey, 2003) and water quality.

In spite of constraints of olive tree based in the region, mentioned above, 15% of the national average-production of olive comes from the province of Taounate, generating about 44,574 m³ of margines (olive vegetable water) per year, without sufficient treatment. The margines pollution threatens seriously the regional water resources (wadis, dams, aquifers, etc.) and particularly the aquatic ecosystems (Anonymous, 2009d)

Besides, Dorioz and Ferhi (1994) showed that in agricultural watershed, dissolved nitrogen and phosphate are evacuated toward the rivers. River wetlands are currently threatened by human activities, including agriculture and dams construction (Ferchichi-Ben Jamaa *et al.*, 2010). These wetlands systems have a water-purifier role by reducing nitrogen and phosphorus (Dorioz & Ferhi, 1994, Ennabili *et al.*, 2000a; Ezzahri *et al.*, 2010). Seeing the prevalence of agricultural activity and the presence of a fragile substrate in the province of Taounate, an integrated management of water based on the phyto-diversity appears thus necessary to protect water resources.

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