

Assessment of Citizens' Knowledge, Attitudes and Behaviours toward Ecological and Environmental Problems in Morocco for Natural Resources Conservation and Sustainable Waste Management

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Abstract: Environmental behaviors are essential to ecological conservation and to environmental protection. The objective of this work was to assess knowledge and behaviors toward ecological and environmental problems, to determine the main environmental risks, and to propose practical solutions for natural resources conservation and sustainable waste management in Morocco. The survey results revealed that rural villagers reported a higher level of ecological knowledge. Nevertheless, the inhabitants continue to overexploit natural resources to survive. They cut trees, transform natural habitats into cultivated land, put livestock into forest to graze, and capture and kill wild animals. The survey results revealed that the urban respondents reported a higher level of environmental knowledge. But a large fraction of the respondents do not use energy efficient light bulbs, do not have low flow water faucets, and do not separate household waste. In addition, they throw out hazardous materials in household waste, they discharge the expired and hazardous liquids to sewers and they do not reuse a fraction of domestic wastewater. Preliminary data collected on waste management systems showed that in rural areas the inhabitants reduce amounts of waste and reuse and recycle a large fraction of waste. Based on this study, we recommend several measures to encourage the conservation behaviors and the sustainable waste management. Because the mosques and the schools are the two main sources of environmental information, we highly recommend working on projects of Eco-Mosques and Eco-Schools.

Keywords: Environmental and ecological challenges, human behaviours, biodiversity protection, water and power conservation, waste management.

تقييم معارف وآراء وسلوكيات السكان اتجاه المخاطر والتحديات البيئية بالمغرب من أجل حماية الموارد الطبيعية والتدبير المستدام للنفايات

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الملخص: يعتبر السلوك غير المسؤول للإنسان من أهم العوامل التي أدت إلى تفاقم المشاكل البيئية حول العالم. ففي المغرب كما في باقي الدول النامية تسببت الأنشطة البشرية في تدهور الأوساط البيئية والموارد الطبيعية. وأكد عدد لا يحصى من الأبحاث بأن تحسين سلوك الناس هو مفتاح نجاح المشاريع الرامية للحفاظ على الموارد الطبيعية وتدبير النفايات. تهدف هذه الدراسة تقييم معارف وآراء وسلوكيات السكان حول أهم التحديات البيئية بمنطقة بني ملال-خنيفرة التي تعتبر منطقة استراتيجية بالمغرب لكونها تحتوي على غابات

غنية إحيائيا وتضم ثلث القدرة المائية كما تنتج تلي الطاقة الكهربائية بالمغرب. بينت نتائج الدراسة أن السكان المحليين بجبال الأطلس لديهم بعض المعارف حول البيئة ولكنهم لا يزالون يعتمدون من أجل عيشهم على أنشطة تهدد الأوساط الطبيعية والتنوع الإحيائي: كقطع الأشجار الغابوية والرعي الجائر واستصلاح الغابات من أجل الفلاحة والقبض وقنص وقتل بعض الحيوانات. كما بينت الدراسة كذلك أن المواطنين رغم توفرهم على معارف مهمة حول الماء والطاقة والنفايات فإن ممارساتهم وسلوكياتهم لا تتطابق مع هذا الوعي. فأغلب المستجوبين لا يحرصون على ترشيد استخدام الماء والطاقة أو التدبير المستدام للنفايات. واعتمادا على نتائج هذه الدراسة فقد تم اقتراح عددا من الحلول العملية لإشراك المواطنين وإكسابهم سلوكيات صديقة للبيئة. اعتمادا على نتائج هذه الدراسة التي بينت أن السكان يعتمدون أساسا على المساجد والمدارس كمصدرين أساسيين للمعرفة والأخبار، فقد قدمنا مشروعا حول المساجد والمدارس الإيكولوجية يعتمد على استعمال الطاقة النظيفة وتدوير المياه وتوعية الناس.

الكلمات المفتاحية: التحديات البيئية، سلوك الإنسان، صون التنوع البيولوجي، الحفاظ على الماء والطاقة، التدبير المستدام للنفايات.

1- Introduction

Many researchers reported that the most environmental problems, including pollution, biodiversity degradation, and drought are caused by human behaviors (Du Nann Winter and Koger 2004; Vlek and Steg 2007). Conservation behaviors and waste management behaviors are considered essential actions that tremendously influence ecosystems. The potential determinants of the pro-environmental behavior are: social, dispositional and cognitive, attitudinal, and psychosocial characteristic (Janmaimool and Denpaiboon, 2016). Research in behavioral change is considered among central components for the research requirement for waste management (Mbeng et al., 2009). In general, the monotheistic religions call for respect for the environment and the human being. L'Islam underlined the importance of preserving the elements of the ecosystem and called for exploiting it wisely and rationally, without any change whatsoever so that the system could keep on fulfilling its function of feeding life on a sustainable basis (Assayed Jamil, 1999). This author reported also that The Qu'ran contains a large number of references to ecology and environment, and the Hadith contains a number of passages concerning water, wild animals, livestock, and flora. L'Islam prohibits also us from inflicting damage on environment (e.g. "الأعراف: 56 " وَلَا تُفْسِدُوا فِي الْأَرْضِ بَعْدَ إِصْلَاحِهَا" Surah Al-Araf-56: "Do not corrupt the earth after it has been straightened.") and encourage the ecological and pro-environmental behaviors (e.g. The prophet (SAW) said: "If a Muslim plants a tree or sows seeds, then a bird, or a person or an animal eats from it, it is regarded as a charitable gift for him." عن أنس بن مالك - رضي الله عنه - قال: قال رسول الله - صلى الله عليه وسلم - "ما من مسلم يغرِسُ غرساً أو يزرعُ زرعاً فيأكلُ منه طيرٌ أو إنسانٌ أو بهيمةٌ إلا كان له به صدقة" (29).

Morocco, as the other Arab and African countries, now is facing the potential risk of environmental degradation and pollution. In the last decades, the demand for natural resources had increased because of the urban and rural population growth. In this country, biodiversity has been declining at an alarming rate in recent years and there are increasing ecological and environmental problems. In Morocco, the Mountain ecosystems of Beni Mellal-Khenifra are strategic because of their various socioeconomic and ecological roles. They are living and working environments for local populations, they provide water for irrigation and fresh water for most of the urban population living in

the lowlands, and they are the source of wood and of various forest products. Water resources of the region are extremely important, as they are used in the strategic economic zone of Morocco (Tadla, Doukkala and the inshore zone Casablanca-Safi). In the region of Beni Mellal-Khenifra, human development activities have negative impacts on environmental quality and generate adverse consequences for natural ecological systems (El Alami et al., 2013; El Alami, 2019a; El Alami et al., 2020). This region is also facing massively increasing amounts of wastes (Ouigmane et al., 2017). Conservation efforts on behalf of wildlife and ecosystems should consider the behaviors of local people and environmental management should be laid with local communities and citizens. The main purpose of this work was to determine the main ecological and environmental risks in the region of Beni Mellal-Khenifra, to assess knowledge and behaviors towards degradation of habitats, biodiversity loss, water and power conservation, and waste management, and to propose practical solutions for natural resources conservation and sustainable waste management.

2- Materials and Methods

Study Area

The study was conducted in the central High Atlas Mountains and in the towns of Beni Mellal and Souk Sebt (Fig.1), region of Beni Mellal-Khenifra, Morocco. The central High Atlas Mountains encompass an area of 10 502 km² and have a rich and varied biological diversity. The terrain, mainly calcareous, consists of steep mountain slopes and rocky gorges dissected by swiftly running streams. Altitudes range between 600 m and 4 071 m and the climate varies from semi-arid to humid (Ouchbani and Romane, 1995). The habitat types are principally pure forests of holm oak *Quercus ilex*, forests of holm oak mixed with *Juniperus phoenicea*, *Juniperus oxycedrus*, *Pistacia lentiscus*, *Phillyrea* sp. and *Arbutus unedo*, forest of Barbary thuya *Tetraclinis articulata* (pures or mixed with other junipers), forests of Aleppo pine *Pinus halepensis*, sparse cork oak *Quercus suber* and open forests of *Juniperus thurifera* (El Alami et al., 2013). The Beni Mellal-Khenifra Mountains are the source of many important Moroccan rivers, especially the Oum Er Rbia River. This River is one of the major rivers in Morocco and is 550 km long. The most important tributaries of the Oued Oum Er Rbia River are Oued El Abid, Oued Derna, Oued Tessaoute, Oued Lakhdar, Assif Melloul and Oued Ahansal Rivers. The Oum Er Rbia River and its tributaries have 15 Dams with a water capacity of 5 100 Million cubic meters, which represents 33% of the water capacity of Morocco. According to the Hydraulic Basin Agency of Oum Er Rbia, the total irrigated area by Oum Er Rbia River and its tributaries is approximately 323 000 hectares, and the hydropower production in the Hydraulic Basin of Oum Er Rbia is about 1 887 Million kilowatt hours (kwh) per year (70% of hydropower production in Morocco). The Mountain ecosystems of Beni Mellal-Khenifra have also a rich and varied biological diversity.

The study focused on inhabitants of five villages (Beni Ayat: 32°12'0"N,6°42'0"W; Ait Attab: 32°3'36"N,6°37'48"W; Tagueleft (32°15'0"N,6°7'48"W); Ouzoud: 32°1'48"N,6°46'48"W and Ait Waazik: 32°09'32"N,6°21'14"W) located in the central High Atlas Mountains and of citizens living in the towns of Beni Mellal (32°19'0"N,6°28'0"W) and Souk Sebt (32°18'0"N,6°42'0"W). The town of Beni Mellal is located in the piedmont of the Beni Mellal Atlas Mountains. It covers an area of approximately 39 km² and had approximately 192 676 inhabitants according to the 2014 census. The large fraction of the population comes from the tribes of the plain of Tadla, the Middle Atlas and the central High Atlas Mountains. The town of Souk Sebt belongs to the plain of Tadla. According to the 2014 general population and housing census, the region of Souk Sebt has about 30 000 inhabitants. The large fraction of the population comes from the Arabs tribes of Beni Moussa, but a considerable number of the inhabitants come from the regions of the central High Atlas Mountains.

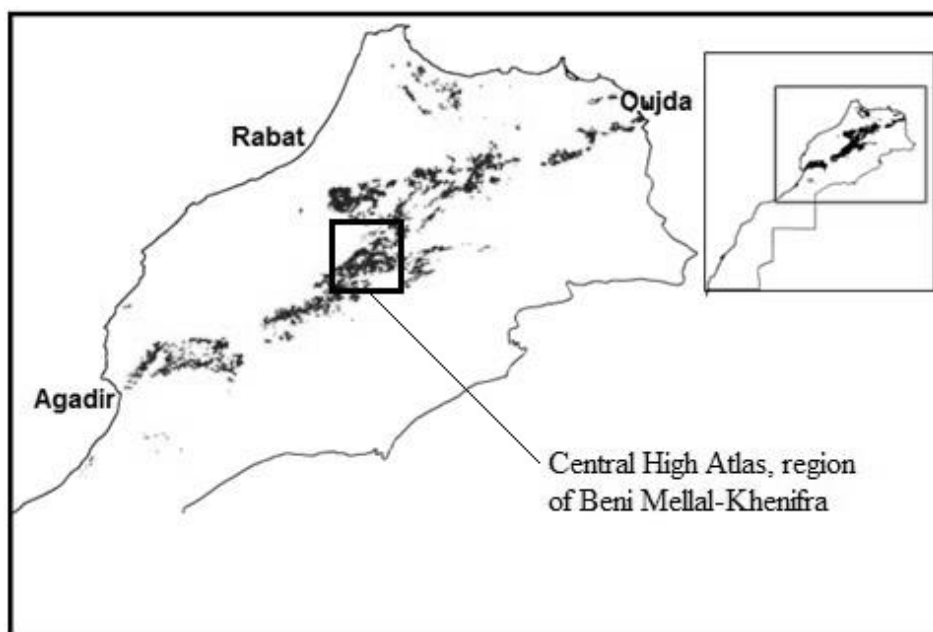


Fig. (1) Localisation of the region of Beni Mellal-Khenifra in the Map of Morocco.

Survey participants

A total of 368 people participated in the pilot survey, 161 of them live in five villages (Beni Ayat, Ait Attab, Tagueleft, Ouzoud and Ait Waazik) belonging to the central High Atlas Mountains (Rural sample) and 207 live in the towns of Souk Sebt and Beni Mellal (Urban sample). A description of the two samples is provided in Table 1. The urban sample consists of 41.55 % of women, whereas the rural sample consists only of 22.36 % of women. In rural localities, the number of women is lower than that of men because women are generally reluctant to participate in the interviews. The percentage of the young adults aged of 18-29 years is higher in the urban sample. The level of education is poor in rural sample and the major occupations of the interviewees are shifting agriculture and pastoralism. The major urban interviewees are students, civil servants, traders and journeymen.

Table (1) Profile of sample

	Rural sample		Urban sample	
	Frequency	Percent %	Frequency	Percent %
Gender				
Male	125	77.64	132	58.45
Female	36	22.36	75	41.55
Total	161	100	207	100
Age				
18-29	19	11.80	82	39.61
30-44	72	44.72	68	32.85
45-59	58	36.02	50	24.15
60+	12	7.45	07	3.38
Educational qualification				
No formal	24	14.91	03	1.45
Primary	67	41.61	18	8.70
Middle (college)	35	21.74	34	16.42
Secondary (secondary school)	22	13.66	88	42.51
Tertiary	13	8.07	64	30.92

Data collection and analysis

Data on the ecological knowledge, attitudes and behaviours were collected between February 2012 and December 2020 by the use of questionnaires among the boarded villages around forests in the central High Atlas Mountains. Five villages were selected: Beni Ayat, Ait Attab, Tagueleft, Ouzoud and Ait Waazik. Simple random sampling was carried out in the five villages. Based on our previous studies on wild fauna and natural habitats in the central High Atlas Mountains, 19 items were selected to assess ecological attitudes and behaviours. These items were grouped into three ecological behavior subscales: loss and degradation of habitats (6 items), local people-wildlife interaction (5 items) and knowledge and opinions (8 items) (Table 2). Ecological attitudes and behaviours towards degradation of habitats and wildlife conservation were measured using five point Likert scale (1. Never, 2. Rarely, 3. Sometimes, 4. Often, and 5. Always). The two items KO7 and KO8 of Knowledge and opinions subscales were measured using five point Likert scale (1. Completely disagree, 2. Slightly disagree, 3. Neither agree nor disagree, 4. Slightly agree, 5. and Completely agree.). To assess the internal consistency of the questionnaire, a Cronbach's alpha was used. Using the SPSS 10.0 software, the reliability (α -Cronbach), the means, and the standard deviations were calculated (Table 2).

Table (2) Ecological behaviours and attitudes: reliability (α -Cronbach), means, and Standard Deviations (SD).

Loss and Degradation of Habitats ($\alpha = 0.71$)	Mean	SD
LDH1: I cut the forest trees in order to make the charcoal.	1.96	1.07
LDH2: I collect firewood for commercial purposes.	1.49	1.08
LDH3: I collect firewood for home use.	3.04	1.37
LDH4: I collect other forest products.	2.48	1.27
LDH5: I transformed habitats into cultivated fields.	2.45	1.42
LDH 6: I put livestock into forests to graze.	2.56	1.74
Local People-Wildlife Interaction ($\alpha = 0.72$) ^(b)	Mean	SD
LPWI1: The presence of wild animals near my village is unfavorable.	3.20	1.32
LPWI 2: My village have some problems with wild animals.	3.32	1.28
LPWI 3: I participated in the capture of wild animals.	2.15	1.34
LPWI 4: I contributed in the poisoning or the killing of wild animals.	2.02	1.34
^(a) LPWI 5: I contributed in the protection of wild animals.	-	-
Knowledge and Opinions ($\alpha = 0.62$) ^(b)	Mean	SD
KO1: Habitats have been destroyed in the last 20 years.	4.16	.86
KO2: Water resources are decreasing in the last 20 years.	3.81	.95
KO3: There are alterations of the sources of water resources.	3.71	1.12
KO4: There is a decline of wildlife populations in my region.	3.76	1.18
KO5: I know that cutting forest trees without permission is prohibited.	3.14	1.39
KO6: I know that it is forbidden to capture or kill wild animals.	1.91	1.07
^(a) KO7: I benefit from an awareness session about ecological problems.	-	-
* KO8: why do you cut forest trees and/or capture wild animals?	-	-

^(a) Removed items to improve reliability. ^(b) The α -Cronbach coefficient was calculated using raw data and does not include the items that were omitted. * These questions are not multiple choice questions and are not included in the calcul of α -Cronbach.

Data on the environmental knowledge, attitudes and behaviours were collected between January 2018 and December 2020. The method consisted of the use of questionnaires among the inhabitants of the towns of Beni Mellal and Souk Sebt. Simple random sampling was carried out in the two towns. 34 items were selected to assess ecological attitudes and behaviours. These items were grouped into five environmental behavior subscales: water conservation (7 items), power conservation (7 items), domestic solid waste management (8 items), domestic wastewater management (4 items), and knowledge and opinions (8 items) (Table 3). Environmental attitudes and behaviours were measured using two point Likert scale (1. Yes, 2. No). The item KO8 of the knowledge and opinions subscale is a direct question that the respondents answer by the media sources they preferred as source of environmental information. During this study, we collected also data on solid and liquid waste management systems in rural and urban areas. Information on the collection, transportation, valorization and disposal of waste were collected.

Table (3) Questionnaire on the environmental knowledge, attitudes and behaviours

Water conservation
WC1: Water bills have increased in recent years.
WC2: I repair leaky faucets quickly.
WC3: I irrigate my garden with tap water.
WC4: I wash my car or motorcycle with a water hose.
WC5: I wash dishes using directly tap water.
WC6: I use the bathroom sprinkler.
WC7: I have at least one low flow water faucet.
Power conservation
PC1: I make the most use out of natural light.
PC2: I turn off any lights I'm not using.
PC3: I unplug any electrical appliances I'm not using.
PC4: I use energy efficient light bulbs.
PC5: In winter, I use the electric or/and heater in my house.
PC6: In summer, I use the room air conditioner.
PC7: Do family members spend more time together in the same room?
Domestic solid waste management
SWM1: I sort household waste (at least partially).
SWM2: I separate from household waste the waste that I can reuse.
SWM3: I separate from household waste the waste that I can recycle.
SWM4: I separate from household waste the waste that I can sell.
SWM5: I throw out batteries and electronic materials in household waste.
SWM6: When I go shopping, I use plastic bags.
SWM7: Is there an excess of food that you throw away?
SWM8: Is there an excess of other materials, clothing, etc. that you throw away?
Domestic wastewater management
WWM1: My house is linked to the public sewage network.
WWM2: I reuse a fraction of domestic wastewater.
WWM3: I discharge the expired and hazardous liquids to sewers.
WWM4: I minimize as far as possible the volume of household wastewater.
Knowledge and Opinions
KO1: Waste is harmful to the environment in many ways.
KO2: Waste is harmful to the human health.
KO3: Wastewater is major contributors to a variety of water pollution problems.
KO4: Waste can affect your health and your life.
KO5: Municipalities are the only responsible for the management of waste.
KO6: Citizens have responsibility with regard to the waste.
KO7: Did you benefit from a sensitizing session about waste.
KO8: What media sources do you trust most to be well informed on environmental matters?

3- Results and discussion

Knowledge, attitudes and behaviors toward ecological problems

Based on the calculi of α -Cronbach coefficient, the item of WC5 from wildlife conservation scale and the item of KO7 from knowledge and opinion scale were eliminated to improve reliability (Table 2). An analysis of the ecological behavior subscales revealed acceptable levels of reliability on loss and degradation of habitats ($\alpha = 0.71$) and on local people-wildlife interaction ($\alpha = 0.72$), and knowledge and opinions showed relatively lower levels of reliability ($\alpha = 0.62$). According to the rule of George and Mallery (2003), the ecological behavior subscales revealed acceptable levels of reliability on loss and degradation of habitats ($\alpha = 0.71$) and on local people-wildlife interaction ($\alpha = 0.72$), and knowledge and opinions showed relatively lower levels of reliability.

Results showed that 81.4% of the interviewees slightly agreed or completely agreed that natural habitats have been destroyed in the last 20 years, 61.5% slightly agreed or completely agreed that there is a decline of wildlife population and more of the half of the interviewees reported the decrease and alterations of water resources in the central High Atlas Mountains (Table 4). Interview results showed that human activities have many effects on natural habitats and wildlife. In the central High Atlas Mountains, a large fraction of the human population depends on natural habitats, especially forest habitats, to survive. The main land uses are shifting agriculture, pastoralism and cutting and collecting wood. Results showed that 10.5% of the interviewees often or always cut the forest trees in order to make the charcoal, 8.1% collect firewood for commercial purposes, 42.2% collect firewood for home use, 23% collect other forest products, 27.4% transformed habitats into cultivated fields and 37.8% put livestock into forests to graze (Table 4).

A percent of 45.5% of the interviewees slightly agreed or completely agreed that the wild fauna presence near their villages or agricultural lands is unfavorable and that they have problems with some several animal species (Table 4), especially the wild boar *Sus scrofa*, the Barbary macaque *Macaca sylvanus*, the red fox *Vulpes vulpes*, the golden jackal *Canis aureus*, the common genet *Genetta genetta*, and some avifauna species. About one-fifth of the interviewees reported that they participated in the capture or/and in the killing of wild animals (Table 4). Surveys showed that 87.6% of the interviewed inhabitants are not interested in wildlife protection; few interviewees (13.1%) know that it is forbidden to capture or kill wild animals and 45.9% of the interviewees know that cutting forest trees is prohibited.

Table (4) Frequencies of responses for each ecological item. 1. Never, 2. Rarely, 3. Sometimes, 4. Often, 5. Always, 1*. Completely disagree, 2*. Slightly disagree, 3*. Neither agree nor disagree, 4*. Slightly agree, 5*. and Completely agree.

Loss and Degradation of Habitats	1	2	3	4	5
I cut the forest trees in order to make the charcoal.	40.4	37.3	11.8	6.8	3.7

Loss and Degradation of Habitats	1	2	3	4	5
I collect firewood for commercial purposes.	78.3	7.5	6.2	3.1	5.0
I collect firewood for home use.	16.1	24.2	17.4	24.2	18
I collect other forest products.	25.5	33.5	18.0	13.7	9.3
I transformed habitats into cultivated fields.	41.6	8.1	23.0	19.3	8.1
I put livestock into forests to graze.	49.7	7.5	5.0	13.0	24.8
Local People-Wildlife Interaction	1	2	3	4	5
The presence of wild animals is unfavorable.	14.3	16.1	24.2	26.1	19.3
My village has some problems with wild animals.	11.2	15.5	24.2	28.0	21.1
I participated in the capture of wild animals.	46.6	21.7	8.7	16.1	6.8
I contributed in the poisoning or the killing of wild animals.	55.3	14.9	8.1	17.4	4.3
I contributed in the protection of wild animals.	52.2	26.1	9.3	7.5	5
Knowledge and Opinions	1*	2*	3*	4*	5*
Habitats have been destroyed in the last 20 years.	1.2	2.5	14.9	41.6	39.8
Water resources are decreasing in the last 20 years.	1.9	5.0	30.4	36.0	26.7
There are alterations of the sources of water resources.	3.1	11.2	29.2	24.8	31.7
<u>There is a decline of wildlife populations in my region.</u>	3.7	13.7	21.1	26.1	35.4
I know that cutting forest trees is prohibited.	14.9	23.6	15.5	24.8	21.1
I know that it is forbidden to capture or kill wild animals.	44.7	34.2	8.1	11.2	1.9

The survey results revealed that rural villagers reported a higher level of knowledge about the degradation of habitats and the decrease of natural resources. Nevertheless, the inhabitants continue to overexploit natural resources to survive. They cut trees, transform natural habitats into cultivated lands, put livestock into forest to graze, and capture and kill wild animals. The survey results are in line with our previous studies, and indicate that overall, the major ecological problems in the central High Atlas are habitat destruction, biodiversity loss and the decrease and alteration of water resources. The effects of human activities and the human-wildlife conflict may act as factors in the deterioration of natural habitats and the decline of biodiversity. The central High Atlas Mountains have a great diversity of habitats and of plant and animal species (El Alami et al., 2013). This area is home to a variety of animal species especially mammals with more than 24 wild mammal species (El Alami, 2016) and more of 100 bird species (El Alami and El Alami, 2018). The forest ecosystems of the central High Atlas are strategic because of their various socioeconomic and ecological roles. But since the beginning of 20th century, habitats were subject to destruction and pressures from human activities, consequently many species were extinct in this area. For example, in this area, there were the last observations of several mammal species in Morocco as the case of the serval (1966: Lambert 1967), the panther (1983: Cuzin 2003) and the Barbary lion (1942: Black et al., 2013). Our previous studies indicated that biodiversity has been declining at an alarming rate in recent years in this area and blamed this decline on habitat destruction, impact of livestock grazing, the population fragmentation, the illegal capture and the effects of human activities (The Barbary macaque

Macaca sylvanus : El Alami et al, 2013; El Alami and Chait, 2014; Mammal species : El Alami, 2016; Avifauna : El Alami and El Alami, 2018; The wild boar *Sus scrofa*: El Alami, 2019a, The Cuvier's gazelle *Gazella cuvieri* : El Alami, 2019b; The Eurasien otter *Lutra lutra* : El Alami et al., 2020). This study and our previous studies reported that during the last decade, there is an increasing in habitat and biodiversity loss and in the local people-wildlife conflict. Without adequate ecological practices carried out with local people, it is not possible to protect habitats and to conserve wildlife. Conservation efforts on behalf of the wildlife fauna should consider the local people's opinion regarding human-wildlife conflict and the effects of human activities on natural habitats (e.g. El Alami and Chait, 2015).

Knowledge, attitudes and behaviours toward environmental problems

Frequencies of responses for each environmental item are given in the table 5. Results showed that 83% of the interviewees slightly agreed that water bills have increased in recent years, 74% repaired leaky faucets quickly, 31% irrigated their garden with tap water, 61% washed their car or motorcycle with a water house, 88% washed dishes using directly tap water, 55% used the bathroom sprinkler, and only 51% have at least one low flow water faucet. A percent of 92% of the interviewees make the most use out of natural light, 95 % turn off any lights they are not using, 84% unplugged any electrical appliances they are not using, and 74% used energy efficient light bulbs. Results showed that 38% of the interviewees used the electric or/and heater in winter, 32% used the room air conditioner in summer, and that 44% family members do not spend more time together in the same room. Results showed also that 78% of the interviewees do not sort household waste, and the majority of them do not separate from household waste the waste that can be reused, recycled or that can be sold. A percent of 79% of the interviewees throw out batteries and electronic materials in household waste. More than half of the interviewees confirm that they use plastic bags when shopping and that there is an excess of food and of other materials that they throw away. Results showed that only 12% of the interviewees reuse a fraction of domestic wastewater. A percent of 69% of interviewees discharge the expired and hazardous liquids to sewers and 71% declared that they minimize as far as possible the volume of household wastewater. Results showed that 100% of the interviewees confirmed that they know that waste is harmful to the environment and to human health, and that waste is major contributors to a variety of water pollution problems and can influence negatively their health. The majority of the interviewees confirmed that the municipalities are not the only responsible for organizing the management of waste and that citizens have responsibility with regard to the waste, but only 34% of them have benefited from an awareness session about waste management.

Table (5) Frequencies of responses for each environmental item.

Water conservation	Yes (%)	No (%)
WC1: Water bills have increased in recent years.	83	17
WC2: I repair leaky faucets quickly.	74	26
WC3: I irrigate my garden with tap water.	31	69
WC4: I wash my car or motorcycle with a water house.	61	39
WC5: I wash dishes using directly tap water.	88	12
WC6: I use the bathroom sprinkler.	55	45
WC7: I have at least one low flow water faucet.	51	49
Power conservation	Yes (%)	No (%)
PC1: I make the most use out of natural light.	92	8
PC2: I turn off any lights I'm not using.	95	5
PC3: I unplug any electrical appliances I'm not using.	84	16
PC4: I use energy efficient light bulbs.	74	26
PC5: In winter, I use the electric or/and heater in my house.	38	62
PC6: In summer, I use the room air conditioner.	32	68
PC7: Do family members spend more time together in same room?	56	44
Domestic solid waste management	Yes (%)	No (%)
SWM1: I sort household waste (at least partially).	22	78
SWM2: I separate from household waste the waste that I can reuse.	42	58
SWM3: I separate from household waste the waste that I can recycle.	21	79
SWM4: I separate from household waste the waste that I can sell.	45	55
SWM5: I throw out batteries and electronic materials in household waste.	79	21
SWM6: When I go shopping, I use plastic bags.	39	61
SWM7: Is there an excess of food that you throw away?	43	57
SWM8: Is there an excess of other materials, clothing, etc. that you throw away?	47	53
Domestic wastewater management	Yes (%)	No (%)
WWM1: My house is linked to the public sewage network.	92	8
WWM2: I reuse a fraction of domestic wastewater.	12	88
WWM3: I discharge the expired and hazardous liquids to sewers.	69	31
WWM4: I minimize as far as possible the volume of household wastewater.	71	29
Knowledge and Opinions	Yes (%)	No (%)
KO1: Waste is harmful to the environment in many ways.	100	00
KO2: Waste is harmful to the human health.	100	00
KO3: Wastewater is major contributors to a variety of water pollution problems.	100	00
KO4: Waste can affect your health and your life.	100	00
KO5: Municipalities are the only responsible for the management of waste.	35	65
KO6: Citizens have responsibility with regard to the waste.	82	18
KO7: Did you benefit from a sensitizing session about waste.	34	66

Preliminary data collected on waste management systems showed that in rural areas the inhabitants reduce amounts of waste and reuse and recycle a large fraction of solid waste and of water waste. In urban areas, there is no separation of solid waste by type and every day, solid waste are collected and transported to landfills. Wastewater produced by every house including detergents and hazardous liquids are expired to the public sewage network. In rural areas, large fractions of water waste are reused: (1) for irrigation of plants, (2) for domestic animals, (3) in construction works, etc. A large fraction of solid waste are sorted, reused and/or recycled by rural inhabitants: (1) plant matter (like rinds of fruits and vegetables) are used to feed herbivorous animals, especially donkey, mule, cow, goats, sheep and rabbits, (2) leftovers from meals are used to feed cats and dogs, (3) the excess of bread is used to feed domestic birds and cats, (4) cardboard, plastic and paper are used to start a roaring fire because they usually catch fire quickly and the wood is often used as firewood, (5) the clothes are used in the traditional manufacture of rugs, (6) plastic and glass bottles are reused at-home for water, oil, spices, etc., and (7) hazardous liquids and materials are buried in the ground.

The figure 2 recorded the main sources of ecological and environmental information listed by the respondents. Most of the respondents indicated that their main source of environmental information was mosque (87% of the interviewees), followed by school (76%), television (69%), radio (57%), newspapers (54%), and books (49%). The least sources of information were internet, social network and official authorities that obtained less than 34 percent of the respondents.

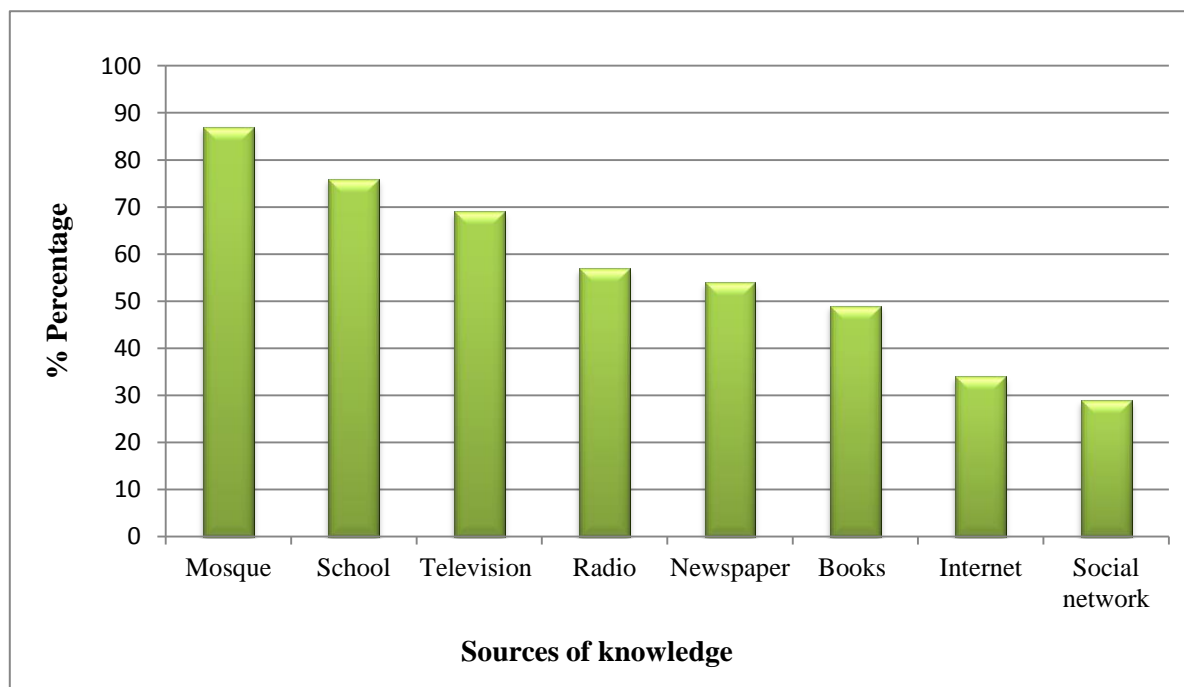


Fig. (2) Sources of Ecological and Environmental Knowledge.

The survey results revealed that the respondents reported a higher level of knowledge and practices in water and power conservation and in waste management. They know also very well that

waste is harmful to environment and to the human health and that they have responsibility for the management of waste. But a large fraction of the respondents do not use energy efficient light bulbs, do not have low flow water faucets, do not separate from household waste the waste that can be reused, recycled or sold; in addition, they throw out batteries and electronic materials in household waste, they discharge the expired and hazardous liquids to sewers and they do not reuse a fraction of domestic wastewater.

Currently, there is no separation of waste by type in the study region. Landfilling is the most popularly used method of waste disposal today, and this leads to a considerable energy loss (Ouigmane et al., 2017). Landfill leachate is characterized by high organic and inorganic pollutant concentrations (Bodzek et al., 2006) and is a great danger to the environment (Razak and Adamou, 2020). Generally, waste in different Moroccan regions is currently 50-70% organic matter, 8-10% paper and cardboard, and 6-8% plastic (El Maguiri et al., 2017). Mechadi et al. (2016) reported that recyclable waste fraction in one zone of the commune of Beni Mellal reached 80,69% dominated by the Carton (88,86 tons or 49,50%), followed by paper (28,81 tons or 16,05%). Used batteries and other electrical and electronic equipment waste are disposed with household waste. These types of pollutants cause harm to the environment (Mihai et al., 2019). The Moroccan government has established a number of national plans in environmental management and carries out a multitude of activities promoting environmental education and education for sustainable development. This study shows that the opinion and behavior of citizens is important for the success of these projects. Several studies suggest that positive attitudes are important antecedents of pro-environmental behavior (Fielding et al. 2008). This study showed that environmental attitudes vary between urban and rural areas; it documented also an increasingly positive disposition toward environmental issues in rural areas. Today, the management of waste is a priority for the Government. Since 2003, Morocco has adopted several environmental laws in the domain of the conservation of the environment, air protection, water and waste management, biodiversity and protected areas, health, industry, energy and agriculture (Msaad et al., 2020) and was also ratified several conventions in the domain of the biodiversity conservation, combating air pollution and environmental impact assessment.

Morocco has today limited availability of water resources and the region of the Beni Mellal-Khenifra represents 33% of the water capacity of Morocco. A large proportion of water waste is still disposed in or along streams or riverbeds and in areas where water resources are vulnerable, and this causes water pollution. The Oued Oum Er Rbia River is one of the major rivers in Morocco and is the major river in the region of the Beni Mellal-Khenifra. This river receives wastewater from the study towns (Beni Mellal and Souk Sebt) and many other towns and villages of the central High Atlas and of the Middle Atlas. The Oum Er Bia River water is affected by the pollutants in the river catchment area and highlighted

the need to treat industrial and municipal wastewater and to encourage sustainable agricultural practices to prevent adverse health effects (Barakat et al., 2016).

4- Conclusion

The local people opinion plays a vital role in the conservation of biodiversity and environment. In the region of the Beni Mellal-Khenifra, the major ecological problems in the central High Atlas are habitat destruction, biodiversity loss, the decrease of natural resources and pollution. In the mountains of the central High Atlas, there are increasing problems of conflict between inhabitants and wild animals. Without adequate ecological practices carried out with local people, it is not possible to protect habitats and to conserve natural resources. The survey results revealed also that the respondents reported a lower level of practices in water and power conservation and in waste management that there is also a lack of organization among residents. Human activities and behaviors have negative impacts on environmental quality and generate adverse consequences for environment. Environmental behaviors of inhabitants are essential to ecological conservation and to environmental protection. Waste reduction plays a key role in reducing pollution. Wastewater reuse is expected to attain the goal of 100 per cent in 2030 according to the current Moroccan national plan of sanitation and wastewater treatment. This study confirmed that it will be important to involve the citizens in the domain of the conservation of the environment, water and waste management, and biodiversity conservation.

5- Proposals and practical solutions

Based on this study, we recommend several measures to encourage the conservation behaviors, to reduce the likelihood of the endangered species becoming extinct and to protect wild habitats in the central High Atlas of Morocco: (1) encouraging development projects involving inhabitants, local authorities and associations in the surveillance of the wild habitats and species, (2) establishment of protected areas specifically for the endangered species in locations where it is extant, (3) increasing surveillance of wild habitats to minimize the effects of overgrazing and degradation of habitats due to transformation of forests to cultivated lands, (4) the enforcement of the existing law against illegal capturing, empoisoning and killing of wild fauna, (5) education to raise the awareness of the local people about the ecological and economical roles of ecosystems and wild fauna, and (6) conduction of scientific research on the effects of human activities and behaviors on biodiversity and ecosystems.

We recommend also several measures to encourage the power and water conservation behaviors and waste management behaviors: (1) the use of low flow water faucet, (2) the reuse of water and repair leaky faucets, (3) the use of energy efficient light bulbs and using natural light instead of artificial light, (4) turning off any light and unplugging electrical devices when not in use, (5) sorting household waste and separating of waste that they can reused and recycled, (6) don't dispose of hazardous waste in the

garbage, (7) the reuse of domestic wastewater, (8) don't discharge the expired and hazardous liquids to sewers, (9) Reducing the excess of food and other materials in solid waste and of the volume of household wastewater, and (10) education to raise the awareness of the citizens about the conservation of natural resources and waste management.

Based on the results of this study, we recommend the use of mosque, school, television, radio, and newspapers to educate and to raise public awareness about the ecological and environmental problems and management. Because the mosque and the school are the two main sources of environmental information, we propose to researchers, authorities and associations a project of Eco-Mosques) and Eco-Schools (e.g. The Cambridge Central Mosque: <https://cambridgecentralmosque.org/the-mosque/#ecomosque>; e.g. Eco-Schools in Morocco: <https://ecoecoles.ma/principes-du-programme-eco-ecoles>). The idea is based on the transitioning to 100% renewable energy and the reuse of water in mosques and schools in Morocco. This will have two goals: (1) saving energy, water and environment, (2) Educating the worshipers and students and acquiring knowledge about clean energies and water conservation. We noted that huge amounts of water are used by students to wash their hands and by worshipers during ablution. This water is not contaminated and does not contain detergents. In Morocco, as in all countries of the Islamic world, million cubic meters of water are used annually during ablution. In most cases this water is lost along with the wastewater into the sewers. For Eco-Schools, we present the experience of High School of Khwarezmi (where the first author works since 2009). In this establishment, there is a garden of 300 m² which contains more than 30 trees and a large number of herbaceous plants. In 2014, we installed 10 taps (5 on the east side and 5 on the west side) for the students to use for drinking or washing their hands. The used water is reused to irrigate this garden. The establishment did not only save water, but this garden had well evolved and it became a favorite habitat (site for resting, feeding, drinking, nesting, etc.) for more than 25 species of birds. In addition, certain fruit plants (palm trees, medlar, orange trees, and lemon trees) give important harvests each year. For Eco-Mosques, we suggest several measures: (1) Taking into account not to harm the environment during the construction of mosques (site - building materials - tools ...), (2) Take advantage of natural light and natural ventilation, (3) use of renewable energies, in particular solar energy, (4) minimize the amount of water used for ablution (e.g. signs indicating the maximum and minimum amounts of water needed for ablution), and (5) reuse of water to irrigate the garden of the mosque or nearby public gardens.

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