International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2015): 6.391

Household Capabilities, Perception of Water Vulnerability and Coping Strategies in the Western High Atlas: Case of the Anougal Valley

Abdellah AHOUACH[1], Mohamed Cherkaoui[2]

[1,2]Laboratory of Human Ecology, Department of biology, Cadi Ayyad University, Faculty of Sciences, Marrakech, Morocco

Abstract: ***The purpose of this study was to focus on the role of the households' capabilities in terms of the perceptions and adapting strategies for the water vulnerability in the Western High Atlas Mountains. Therefore, a survey was conducted among 246 individuals in the Anougal Valley. In total, six variables summarizing the main indicators of household capabilities, three variables expressing the perceptions of water vulnerability, and two variables formulating household coping strategies, were used to capture this objective. The results showed that people are aware of the weight of droughts, floods and pollution that weaken the resource. To cope with this, households with weak capabilities prefer traditional strategies, others with relatively strong capabilities lean toward modern strategies whose effect seems to be degrading water. So, the improvement of households' capabilities through hydro-agricultural projects that ignores the local hydraulic capital related to water, risks to jeopardize the sustainability conditions of water resources in the western High Atlas.***

Keywords: Capabilities, water vulnerability, coping strategies, durability, High Atlas

1. Introduction

In the High Atlas Mountains, like the other regions of Morocco, water resources are very vulnerable; their availability is subject to an extreme fluctuations and their quality seems to be more threatened than previously **[1]**. The rainfall is not more regular and abundant **[2]**, the waters are becoming scarce and therefore not able to support the biological productivity of the local ecosystem. The stormy character of precipitation, leading to destructive floods, since two decades, has become a factor responsible for the erosion having shown negative effects on natural resources in High Atlas Mountains **[2]**. The introduction of productive activities in search of the increase of yields with their corollary of behaviors pollutants and over-exploiting in this ecosystem of mountain, expose the water resources to an increase of vulnerability **[3]**. This vulnerability of water represents a limiting factor for sustainable development, in the sense that it mortgages the well-being of populations and exposes the resource to an extremely serious fragility **[4]**.

According to the Brundtland Report (1987), the concept of sustainable development is defined as development that meets the needs of the present without compromising the ability of the future generations to meet their own. Based in the beginning on three principles which are the ecological effectiveness, social justice and the economic profitability, this concept have been enriched by a complementary element. It is the importance of the capacities or capabilities as a support to the sustainability **[5]**. In other words, of the usefulness of the capitals and social opportunities that a social actor, individual or group, uses to durably satisfy his needs **[6]** and thus reduce its exposure to vulnerabilities **[7]**. However, the capabilities improvement should not lead to irreversible erosion of natural resources of whose future generations will need **[8]**.

Therefore the main issue of this article concerns the relationship between the improvement of the capabilities and behaviors for the preservation of water resources in the High Atlas Mountains where a traditional hydraulic knowledge is still well present.

2. Material and Method

2.1. The area studied

The valley of Anougal, the object of our study, is located on the northern hill of the Western High Atlas Mountains at a distance of 75 km to the south of the Marrakech city (figure **1**). The population of the valley has approximately 5000 inhabitants distributed over 24 villages that are spread along the oued of Anougal, the main tributary draining the valley **[9]**. The total area of the valley is estimated at 22.160 ha, of which 49% is occupied by the courses, 38% by forests and 13% by the irrigated terroir **[10]**.

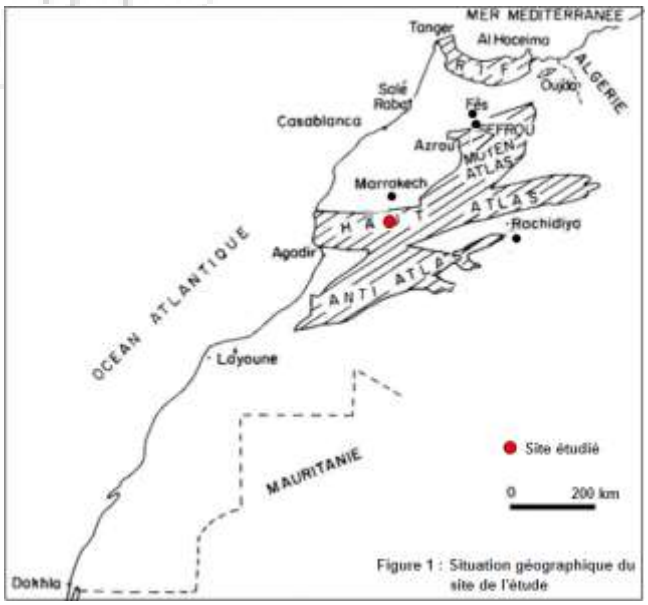

Figure 1 : Situation géographique du site étudié

The climate is of the Mediterranean type with semi-arid component **[11]**. The relief of the valley, being very hilly with steep slopes, explains the density of the local hydrographic network feeding the oued of Anougal. Water resources are generally scarce. Irrigation water is provided either directly by the resurgence of aquifers, either derived from the oued, *the Assif* [Assif, vernacular term used locally to mean the course of water main] by a series of small rudimentary dams, called *Ouggoug [*Ouggoug, corresponds to a dam constructed from materials rudimentary premises. Of oblique orientation in the direction of flow of waters, this dam is used to divert the waters of the main watercourse toward the *Tirguines]*. This water is then distributed to the parcels by a network of *Targa [*Targa, the singular *Tirguines*, designates channel of supply of water to the irrigable plots*]*, in accordance with the practices and traditional rules. With a regard to the water consumption, the majority of the population is supplied from drilling providing households via an adduction network, recently put in place by the involvement of local development associations.

The main activity of the populations is based on subsistence agriculture and livestock. Immigration is also another source of income. Almost all households have at least one member who is absent for at least a few months of the year.

Regarding the basic infrastructure, the valley is poorly equipped. The network of sanitation does not exist, the population uses, to get rid of the domestic effluents, a traditional process said *Tisrafines [*Tisrafines, plural of *Tasrafte* who wants to say a septic tank traditional. Dug in the rock in the vicinity of every dwelling, it is intended to receive the domestic waters responsible for organic materials of fecal origin*]*, while the solid waste is directly thrown into the natural environment.

The valley has known since two decades the actions of development. However, these interventions having among their goals the improvement of the populations living conditions are modest in terms of effectiveness **[12]**. Among the most important of these actions, we quote the hydro-agriculture and the introduction of fruit cultivation **[13]**. The promotion of the local development associations including the associations of users of agricultural water (AUAW) is also part of these actions. Such structures aim essentially to organize the management of the water in a manner that ensures the financial participation of populations **[14]**.

The Anougal valley has been chosen as the study area mainly for three reasons. Firstly, because it is located in one of the agro-ecological zones know as the most vulnerable to the hydro-climatic vagaries in Morocco **[15]**. Secondly, due to the existence of a population that still depends largely on water resources for its well-being and mobilizing for this fact a rich local hydraulic heritage **[16]**. Finally, this choice is justified by the presence of an observatory concerned with population dynamics of the Anougal valley at the level of the Human Ecology Laboratory of the FSSM [Faculty of Sciences Semlalia of Marrakech] Since several years **[17]**.

2.2. Population studied

The survey was conducted between the years 2015 and 2017 in 19 villages on the high and medium valley of Anougal. The data have been obtained by a survey with a sample of 246 individuals, accompanied by a field observations and direct conversations with resource persons deemed by their knowledge. We have collected data that concerning the perceptions of water vulnerability, the capabilities and the strategies adopted in order to face this vulnerability. The variables expressing these three aspects are as follows.

2.2.1. The variables expressing the households' capabilities

The evaluation of households capabilities has been done with six variables, four express the possessions in capital (number of people active in the household, the surface of the agricultural property, number of the livestock in possession, sustainability of water resources for irrigation) and two express the social opportunities offered (schooling of the household head and participation in a training at the hydro-agricultural development). The reasons for these variables choice can be explained as follows:

- Number of active people in the household; it is a source of productive values in this environment where needs of workforce are high and the financial resources are low. According to the population estimation, a household will be considered capable if it has at least two active members.
- Surface of the agricultural property; this constitutes a physical capital expressing the level of wealth held by a household. Generally, a household will be considered much more capable when the surface of its agricultural property is high. Below a threshold (less than 5 *abras [*Abras, means a unit of measure used in the High Atlas Mountains to assess the surface of agricultural land. It measures approximately 850 m² in irrigated land and approximately 1450 m² in dry lands "bour" **[18]***]* according to population), the household becomes unable to respond to its basic needs especially when a hydro-climatic crisis occurs.
- Number of the livestock in possession; from the view point of the population questioned, the livestock in possession can't be meaningful and thus represents a real capital unless the owned livestock by the household is greater than or equal to 2 cattle and/or 25 sheep and goats cumulated.
- Sustainability of irrigation water; natural capital influencing the level of life of households. A household will therefore be more capable to improve his well-being only if it has the perennial irrigation water throughout the whole year. Otherwise, the capabilities of the household would be severely weakened.
- School enrolment of the household head; it provides a social opportunity which allows to increase significantly the possibilities of transforming capital elements to the well-being of household. As well, the household is defined as relatively capable if his leader has received at least a statement equivalent to primary school education.
- Training at the hydro-agricultural development; better familiar with the technical requirements of the actions of development, a head of household will be considered

more capable if he received once, at least, a training during the last ten years.

2.2.2. The variables expressing the water vulnerability perceptions

Three indicators of the water vulnerability in the Anougal valley have been taken into account. It is of floods, drought and pollution. For each of these vulnerabilities, respondents are called upon to give at least one aspect characterizing them. Three questions are formulated to this effect:

- Are the droughts the origin of the water shortage in the valley? If yes, quote an aspect that allows you to identify them?
- Do floods threaten the availability of water in the valley? If yes, give a characteristic aspect of this alea?
- Is the water surface polluted? If yes, what is the aspect of pollutants identified?

2.2.3. The variables expressing the adaptation strategies to the water vulnerability

We questioned the population on the strategies to adopt for better preservation of the water resource in the valley through two questions:

- The water valorization (arboricultural activity based on a modern culture intended for marketing / agropastoral activity centered on a food production).
- The water management (local development associations / *Jmaâ [*Jmaâ: traditional committee responsible for coordinating the cultural affairs and the actions socio-ecological of village communities in the High Atlas*]* or traditional village committee)

3. Analysis of the data

The analysis of the data has been carried out according to a usual statistical approach. The whole data of the survey were coded, entered, purified and analyzed by the 18 version SPSS software. In order to validate the level of association between the qualitative variables, a Pearson's chi-square tests (X2 test) of have been conducted. We used the thresholds of 5% significance to validate the assumptions of study for the tests of chi-square.

4. Results

4.1. Socio-economic and demographic households' characteristics

Among our 246 respondents, 175 (71.1%) are men while 71 (28.9%) are women. Their average age is 51.32 ± 17.28 years. Among them, 143 are heads of households and their socio-economic structure and demographic figure in table **1**.

Table 1: Socio-economic and demographic characteristics of the household head.

Demographic variables	*Modalities*	*Size (%)*
Sex	Male	137 (95.8)
	Female	6 (4.2)
Age class	18-39 years	25 (17.5)
	40-64 years	80 (55.9)
	65 years and more	38 (26.6)
Marital Status	Married	131 (91.6)
	Widowed	7 (4.9)
	Divorced	1(0.7)
	Single	4 (2.8)
Social variables	**Modalities**	**Size (%)**
Schooling	No	73 (51.0)
	Koranic	55 (38.5)
	Primary	13 (9.1)
	Secondary	2 (1.4)
Main activity	Arboricultural	60 (41.7)
	Agropastoral	47 (32.6)
	Not agricultural	37 (25.7)
Household structure	Nuclear	109 (44.3)
	Extended	137 (55.7)
Opening to the media via TV or radio	Yes	124 (86.1)
	No	20 (13.9)
Member of an association	Yes	44 (30.6)
	No	100 (69.4)
Economic variables	**Modalities**	**M ± σ**
Cattle	Number	1.34 ± 0.57
Sheep	Number	5.58 ±10.76
Goats	Number	40.52 ± 40.34
Apple trees	Number	115.52 ±182.68
Land in irrigated	Surface in abras	4.43 ± 4.57
Land in bour (not irrigated)	Surface in abras	6.11 ± 5.77
Monthly expenses	Sum in Dirham	1204.29 ± 435.27

M ± σ: average ± standart deviation

95.8% of heads households are male but only 4.2% are female. Their distribution by age classes shows that 17.5% belong to the class of 18 to 39 years, 55.9% to the class of 40 to 64 years and 26.6% to the class of 65 years and more. With respect to the instruction level, the majority of the population is illiterate, 38.5% have followed a Koranic education [Preschool education provided in the *Timezguida* (mosque) of the village, and intended for a basic learning of the Koran and an initiation of the students to the Arabic language] and only 10.5% have attended a school. Only two individuals have reached the level of high school education. The main activity of households heads is farming with a rate of approximately 74.3%, divided into 32.6% of subsistence agropastoral activity and 41.7% of arboricultural activity reserved to fruit cultivation for the market. The 25.7% remaining exert a non-agricultural activity such as small trade, crafts or other occupations outside of the valley. Concerning the opening over the modern world, 86.1% have access to the information via the media and 30.6% are members of a local development association. With respect to economic assets in possession, on average, the number of cattle per household is 1.34 ± 0.57, while this average for sheep is 5.58 ±10.76 and for goats is 40.52 ± 40.34. The number of apple trees (main fruit cultivated introduced) is 115.52 ± 182.68 per household. The agricultural irrigated land in the possession of the households is in average 4.43 ± 4.57 abras while the average possession of bour (non-irrigated) is 6.11 ± 5.77 abras. The monthly household expenditures are in average estimated to 1204.29 ± 435.27 Dirham.

4.2. The Households' Capabilities

Table **2** gives the results relating to the six indicators that make up the capability. The results obtained show that this last depends essentially on capital in possessions. Therefore, 67.1% of households have at least two active members in the

home, 52% possess irrigation water throughout the year, 30.1% have a herd of cattle and/or herd of sheep and goat more adequate, and finally 23.6% have a farm property beyond 5 abras. The opportunities related to the education and training provided by the public actors participate contribute weakly to the households capabilities in the valley. Only 11.1% were able to benefit of a modest schooling which does not exceed the primary school and 22.2% had the opportunity to follow training in the hydro-agricultural sector.

Table 2: Frequency of the variables' modalities composing the households' capability and the one the Capability' groups in the Anougal valley

Capabilities' variables	Modalities	% of households
Active people in the household	0- One active	32.9
	1- Two active or more	67.1
Surface of the agricultural household property	0- Less than 5 abras	76.4
	1- Greater than or equal to 5 abras	23.6
Number of the livestock owned by the household	0- Less than 2 cattle or 25 sheep + goats	73.4
	1- Greater than or equal to 2 cattle or 25 sheep + goats	26.6
Irrigation water sustainability	0- Not a perennial	47.2
	1- A perennial	52.8
Schooling of the household head	0- Illiterate or Koranic education	88.9
	1- The primary level at least	11.1
Training at the hydro-agricultural development	0- No	87.8
	1- At least one during the past 10 years	22.2
Capability' groups	0- Little capable	52.8
	1- Capable	47.2

To estimate the households capabilities level, we calculated a synthetic variable from the six variables previously cited by making use of the correspondences factorial analysis. To do this, each of the six variables was codified in two modalities 0 or 1 to respectively express the absence or the presence of the capital or of the opportunity in question for the household. The factorial axis 1 (23.8% of the inertia) divides the households in two categories according to the modalities of the six variables introduced in the analysis (figure **2**): the negative side of the axis, represents households with a high level of capabilities (modalities 1 of the six variables studied), however, on the positive side, we have households with a level of low capabilities (modalities 0). According to the obtained results, the group of low capabilities represents 52.8% while the group having a level of relatively high capabilities represents 47.2%.

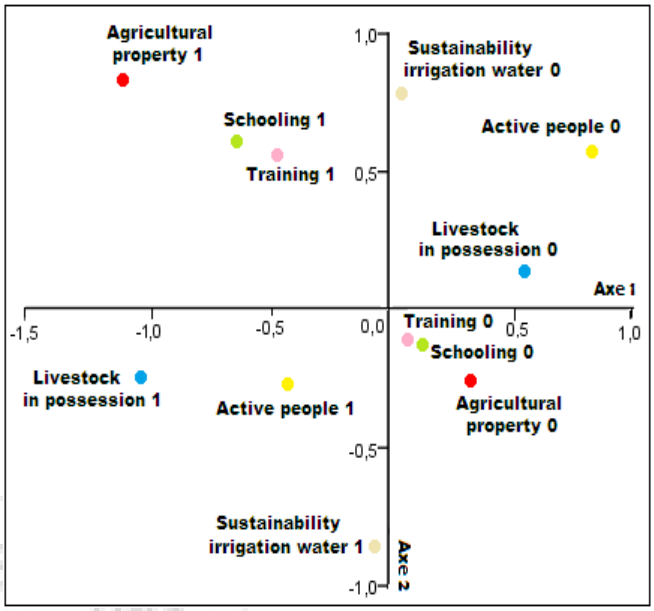

Figure 2: Households distribution according to the modalities of the six capabilities variables in a system of factorial axis

4.3. The water vulnerability

4.3.1. Perceptions of the water vulnerability and its aspects

The majority of populations of the valley participating in this study have related the water resources vulnerability to droughts, floods and pollution, respectively, with the response rates of 88.6%, 76.0% and 54.5%, and pointed out several aspects of this vulnerability (table **3**). The aspects as well identified by the population are respectively of climatic (78.5%) and hydrologic type (21.5%) for droughts, while these are of pedologic (46.7%), hydrologic (28.0%) and climatic type (25.2%) for floods. For the surface water pollution, the visible aspects are the most described, either 70.7% of replies stating the presence of domestic solid waste and suspension contents. The domestic sewage, the effluents from washing powder and the products used in the agricultural activities like pesticides, nitrogen fertilizers and manure, are little perceptible because of their dissolving character in the water which makes them invisible to the population. Only 29.3% of replies affirmed the contrary.

Table 3: The presence perception of the three types of water vulnerabilities and their aspects by the population of Anougal valley

Water vulnerability	Perception	Size (%)	Aspects mentioned by the Populations	Nature of the aspects	Size* (%)
Droughts	Yes	218 (88.6)	- Scarcity of snow - Rain rare - High temperature - Late rain	Climatic	193 (78.5)
			- Rapid depletion of certain water sources - Long low water period of watercourses	Hydrologic	53 (21.5)
	No	28 (11.4)			
Floods	Yes	187 (76.0)	- Eroded soils by precipitation	Pedologic	115 (46.7)

			- Soils can no longer absorbed the runoff water		
			- Summer storm - Downpour - Rain accompanied by strong winds - Unexpected storm	Climatic	69 (28.0)
			- Runoff concentrated on the slopes - Devastation of the fields by the rainwater	Hydrologic	62 (25.2)
	No	59 (24.0)			
Pollution of the surface water	Yes	134 (54.5)	- Solid waste - Matter in suspension	Visible	210 (70.7)
			- Pesticides - Nitrogenous fertilizers - Organic matter (manure) - Water worn - Washing powder effluents	Invisible	87 (29.3)
	No	112 (45.5)			

*: Each respondent is led to cite one or several aspects of the water vulnerability in question

4.3.2. The relationship between the capability level and the water vulnerability perceptions

Table **4** summarizes the relationship between the capability level of respondents and their perceptions of the water vulnerability. The results show the absence of a significant relationship between the capability level and the water vulnerability perception to droughts. However, when it comes to flooding and pollution, the two groups of capability can be differentiated. As well, the group of strong capability is more inclined to stress the vulnerability to pollution, while low capability group is more leaning to the flooding.

Table 4: Relations between the capabilities level of respondents and their perceptions of the water vulnerability

Water vulnerability		Capabilities level : Size (%)		X2 Test
		High	Low	
Droughts	Yes	106 (91.4)	112 (86.2)	1.65 (n.s)
	No	10 (8.6)	18 (13.8)	
Floods	Yes	81 (69.8)	106 (81.5)	4.61 (*)
	No	35 (30.2)	24 (18.5)	
Pollution of surface water	Yes	73 (62.9)	61 (46.9)	6.33 (*)
	No	43 (37.1)	69 (53.1)	

n.s: test X2 not significant, *: test X2 significant at the 5%

4.4. Favorite strategies to face of the water vulnerability

The questions regarding the modes of water valorization and management preferred by the population to cope with the negative effects of the water vulnerability, the respondents have expressed a preference to traditional strategies. Table **5** summarizes the frequencies of the different responses. It may be noted the dominance of favorable responses to the agropastoralism in comparison to the arboricultural activity considered as a consumer of water and agricultural inputs, either 54.1% against 45.9%. Concerning the modes of water management, the surveyed who prefer a management by the *Jmaâ* exceeds far those who opt for a local development association.

Table 5: Favorable responses frequencies to the agricultural water valorization and management strategies in the Anougal valley.

The adaptation strategies to the water vulnerability		Size (%)	Nature of strategies
Water valorization mode	Arboricultural activity	113 (45.9)	Modern
	Agropastoral activity	133 (54.1)	Traditional
Water management mode	Local development association	64 (26.0)	Modern
	Jmaâ	157 (63.8)	Traditional

In relation to the households capabilities (Table **6**), it may be noted that the modern strategies seem to be preferred by the high capabilities group, while the choice of the second group is essentially for the traditional. However, the *Jmaâ*, as traditional mode of social organization responsible for managing the water resources by the use of local knowledge, seems still retain its legitimacy among the population no matter the level of the group of capabilities.

Table 6: Relationship between capabilities level and preferred strategies for the valorization and management irrigation water.

The strategies	Modalities	Capabilities level : Size (%)		**X2 Test**
		High	Low	
Water valorization	Arboricultural activity	68 (58.6)	45 (34.6)	14.22 (***)
	Agropastoral activity	48 (41.4)	85 (65.4)	
Water management	Local development associations	41 (35.3)	23 (17.7)	9.92 (**)
	Jmaâ	75 (64.7)	107 (82.3)	

X2 test significant at threshold of: ** = 1%, *** = 1‰

5. Discussion

5.1. Perception of the water vulnerability and its aspects

Through this study, it is clear that the local populations, without regard to the level of capabilities, are very aware of the water resources vulnerability especially to droughts and floods. Furthermore, advanced aspects to characterize this phenomenon can be assimilated to the main factors leading to this vulnerability. This perception is in concordance with results obtained by other authors dealing with the water issue in the High Atlas Mountain.

In fact, droughts and floods are frequent in the region **[19]**, and the major factors responsible for their occurring are respectively climatic, pedologic and hydrologic. For the climatic factor, any disturbance induces inevitably either droughts or floods **[20]**. For the pedologic factor, the predominance of impermeable and significantly bare soil is the territory characteristic most responsible of the rapid triggering of flooding **[21]**. Finally, the marked dependence of the water to the surficial runoff exposes its abundance to watercourses hydrological regime variations **[19]**.

In addition to these hydro-climatic anomalies, water is also perceived to be vulnerable to anthropogenic pollution, linked to the presence of domestic and agricultural activities polluting. For this point, the group of strong capabilities has shown more advanced awareness compared with the group whose capabilities are weak. For this group, the anthropic factor has now become a determining factor for the surface water quality in the High Atlas. The same note was made by studies dealing with the surface waters pollution in Morocco. Thus, today anthropogenic pollution, either by sewage and waste dumping in the nature, or because of the fertilizers and pesticides misuse in agriculture, constitutes a source of water surface contamination in the High Atlas **[22]**, **[23]**.

The knowledge indeed proved among the group of strong capabilities is probably explained by the opportunities offered by followed schooling and training. In fact, this allows them to have a relatively easy access to the information circulated via the media and through the development programs in High Atlas. Therefore, the group becomes more capable of better understanding the constraints and risks to which are exposed the environment resources. The absence of such opportunities among the group of low capabilities seems to be at the origin of its insufficient knowledge concerning the anthropogenic factors of the water vulnerability.

5.2. The strategies adopted to face of the water vulnerability.

To face the water vulnerability, populations react differently. The strategies then developed depend on the level of the households capabilities. Each group of capabilities reacts, seemingly, according certain rationality in adequacy with its priorities, which, inevitably can be seen in different behaviors vis-a-vis the water resource.

The choice of traditional strategies, based on the ethics of caution [Way to act which seeks to incorporate the random as essential parameter in any anthropogenic action] **[24]**, **[25]**, by the low capabilities group shows its concern to establish good relationship with the water resource. Two social mechanisms of an important ecological value and part of the logic of this kind of strategies seem to us to be at the origin of this water preservation attitude.

The first, making aware users of their responsibilities, represents a commitment for the future **[26]** and a guarantee of durability by the restrictions it imposes on men behaviors **[27]**. This mechanism, is a practice taken mainly by the initiative of the *Jmaâ*, is particularly required during hydro-climatic crisis moments which are very frequent in the region. After a flood occurring, it takes the form of *Tiwizi[*Tiwizi, term used locally to designate the commitment of the village community to perform activities requiring a mobilization of resources, personnel and the time which exceeds the limited capacity of the individual or the household*]* and intended to correct the inflicted damages on the hydro-system in order to ensure the water availability for the community. In times of shortage, the *Jmaâ* feels the obligation to organize actions making aware more people on their responsibilities. Among these actions, figure, on in one side, the appointment of *Amazzal [*Amazzal, the person designated by the community to enforce the rules of water sharing laid down by the *Jmaâ* **[14]**. It is a kind of the water police which is puts in activity during the summer, a period of low water of watercourses in the High Atlas*]* whose interest is to ensure the proper observance of the water sharing rules and thus reduce the abusive uses and degrading treatment [14]. On the other side, a permanent negociations around the water issue should be performed at many levels, intra-village and inter-village **[28]**, **[29]**. Concequently, the Community gives itself a large ability to innovation, giving him the opportunity to sustainable resource exploiting taking into account the limits of its physical availability **[30]**.

The second mechanism alludes to the idea of the resources levies optimization. Characterizing the reports between societies named traditional with the mid **[31]**, **[32]**, **[33]**, this mechanism seems to us to be imbricate in the *Jmaâ* logic as well as the one the agropastoral production mode.

Regarding the water uses, the *Jmaâ* does not cease to establish a series of social measures and techniques, to optimize the levies especially when the resource is goes rare **[34]**. The reciprocal exchange of the water turns between irrigators and the limitation of the parcels of land to be irrigated, the substitution of the irrigation mode following the topography to irrigation by lineage membership and the choice of crops demanding little of water, are among the actions most adopted in this direction.

Concerning the mode of water valorization, the interest of the agropastoralism is very revealing from the water needs optimization view-point. This activity, based on a complementary use of different Territory resources, is better suited to the hydroclimatic vagaries since it enables dispersing the risk deriving from **[35]**. In other words, if a shortage or a flood affects the water resource, the population is able to mitigate the risk by exploiting other mid components. Hence, anthropogenic pressure on water will be kept inside limits of its natural regeneration.

Regarding the modern strategies, it seems that they are not always adapted to the requirements water sustainability principle. The rationality that they imply, centered exclusively on the quest for profit by the yields maximization, is probably the cause.
Thus, for the water management, the introduction of modern associations is apparently behind the sensitive emergence of a logic which is rather used to manage the water substance based on the criteria of physical and financial order **[36]**. In this case, it is not surprising to be expecting that the users' responsibility and the usages optimization, two principles

important to traditional rationality, are ignored. The reason is that the direct access to the water, for consumption or agricultural, via the supply network of water or by payment of a sum of money, would give the user a sense of abundant resource usable as good seems to him **[28]**. The consequences on the water sustainability are progressively exhibited in the form of the wastage and pollution behaviors in the valley.

With respect to the water valorization, the negative impact of the arboricultural activity, mode of production chosen by the group of strong capabilities, is doubly significant. On one side, the use of pesticides and chemical fertilizers becomes certainly a factor which seriously threatens the ecological sustainability of the resource. On the other side, being demanding in water, this agricultural activity can only lead to the emergence of competition on the resource with its procession of conflict **[37]**, which would be a detrimental effect on the local solidarities. The community thus becomes unable to assume its proper role of control and social mobilization, proved essential on the plan for the sustainable exploitation of resources in the High Atlas **[38]**.

However, the preservation of the water following the prudence rationality of traditional strategies remains a non definitive gain. This sustainability objective would be guaranteed in the future only if the changes affecting the community remain within its tolerance limits. Indeed, it seems that beyond this tolerance interval, any community known as traditional [Indicates any community whose existences' mode is largely refractory at the modern lifestyle, which privileging the productivism logic with respect to the nature and the individualism values at the expense of social solidarity] would lose its balance, and therefore its ability to anticipate the risk and becomes accordingly unable to act with caution **[39]**.

The rejection then expressed toward modern strategies by the population group of low capabilities finds its explanation, seemingly, in fear of disturbing the balance which structures the relationship between community and water resource. In fact, this is due to the uncontrollable damage that they can induce. **[40]** speaks, in this regard, of the heuristics of fear [The heuristic of fear is an expression used by H. Jonas to say that it is at the moment where we are going to lose something that we understand its value] to insist on the positive effect of this fear as informal mechanism of prevention; which lead societies to prefer the risk avoidance that to adopt an action likely to degrade the ecological conditions of their future reproduction.

6. Conclusion

At the end of this study, and as a part of support offered to the populations in order to become more resilient regarding the water vulnerability, the approach of development projects by the improvement of the modalities for the management and valorization for this resource has shown its limits. The hydro-agricultural projects as well put in place in this direction are likely to compromise at term the sustainability of the fragile balance between the communities and the water resource. As well, it is all the more reasonable that the external intervention to be conducted in a way to allow local communities to enhance their own social mechanisms, instead of bringing practices from outside whose logic is far to be consistent with the rationality of the concerned populations. For this reason, the promotion and the protection of the socio-hydraulic heritage is of such importance that it must be included in any strategy or plan of action dedicated to the objectives of water resources preservation in the High Atlas. Also, the creation of a synergy between the local population knowledge detaining, modern knowledge holders, development officers and researchers, can only improve the socio-ecological conditions of water sustainability in this context of mountain where the fragility of the resources is omnipresent.

References

[1] Laouina A. (2006). *Gestion des ressources naturelles et de la biodiversité au Maroc: Prospective Maroc 2030*. Haut-Commissariat au Plan, Rabat, Maroc.

[2] Jolly G. (2000). *Gestion de l'eau dans le N'Fis (Haouz de Marrakech) et mise en place des Associations d'Usagers d'Eau Agricole*. Rapport de synthèse. Centre National d'Etudes Agronomiques des Régions Chaudes (Montpellier), Institut Agronomique et Vétérinaire Hassan II (Rabat), Faculté de Droit et Sciences Economiques (Marrakech).

[3] Sachs I. (1980). *Stratégies d'écodéveloppement*. Les Editions Ouvrières, Paris, 140 p.

[4] Connor R. (2015). *The United Nations World Water Development Report 2015: water for a sustainable world (vol.1)*. UNESCO Publishing. http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/2015-water-for-a sustainable-world/. Retrieved on 15-12-2017.

[5] Dubois J.L. et Mahieu F.R. (2002). *La dimension sociale du développement durable : réduction de la pauvreté ou durabilité sociale ?* In : J-Y. Martin (éd.), Développement durable ? : doctrines, pratiques, évaluations. IRD Editions, Paris, 73-94.

[6] SEN A.K. (1991). *Capability and Well Being.* In : M. Nussbaum, et A. Sen (éd.), The Quality of Life. Clarendon Press: Oxford, 30-66.

[7] Rousseau S. (2001). *Capabilités, risques et vulnérabilités*. Communication au séminaire pauvreté et développement socialement durable. Presses universitaires de Bordeaux, 11-22.

[8] Levrel H., Bouamrane M., et Kane L. (2008). *Développement humain et conservation de la biodiversité*. In : Annales des Mines-Responsabilité et environnement. (1): 92-101. ESKA.

[9] Aït Hmida A., Bouizgaren A., Lalaoui Rachidi Y., et Sikaoui L. (2007). *Conditions d'existence des communautés rurales et gestion des ressources naturelles dans le Haut Atlas occidental au Maroc.* New Médit. (1) : 28-35.

[10] FIDA (2000). *Projet de développement rural des zones montagneuses de la province d'Al Haouz*. Rapport n°1100-MA Rev.1.

[11] Al-Ifriqui M. (1986). *Contribution à l'étude du milieu et de la végétation du Haut-Atlas Occidental d'Amizmiz (Massifs de l'Erdouz-Igdat)*. Thèse de troisième cycle, Université Cadi Ayyad, Faculté des Sciences Semlalia, Marrakech, Maroc.

[12] Romagny B., Auclair L., et Elgueroua A. (2008). *La gestion des ressources naturelles dans la vallée des Aït Bouguemez (Haut-Atlas) : la montagne marocaine à la recherche d'innovations institutionnelles*. Mondes en développement. (1): 63-80.
[13] El Faïz M. (1999). *Les aménagements hydro-agricoles dans le grand Haouz de Marrakech : histoire d'une idée*. In : M. Marié (éd.), Cultures, usages et stratégies de l'eau en Méditerranée occidentale, tensions, conflits et régulations. Ed. L'Harmattan, 60-78.
[14] Romagny B., et Riaux J. (2007). *La gestion communautaire de l'eau agricole à l'épreuve des politiques participatives : regards croisés Tunisie/Maroc*. Hydrological Sciences Journal. 52 (6) : 1179-1196.
[15] Stoffel M., Monbaron M., et Maselli D. (2002). *Montagnes et plaines : adversaires ou partenaires ? : Exemple du Haut Atlas, Maroc*. Atlas2002/Département de géosciences géographie/Université de Fribourg.
[16] El Faiz M. (2002). *Marrakech, patrimoine en péril*. Actes Sud / EDDIF, 188 p.
[17] Cherkaoui M. (2002). *Etude bio-démographique d'une population humaine du Haut-Atlas marocain (vallée d'anougal, cercle d'amizmiz, wilaya de Marrakech)*. Thèse d'Université Cadi Ayyad, Faculté des Sciences Semlalia, Marrakech, Maroc, archives, n° d'ordre 362.
[18] Hammoudi A., et Bourbouze A. (1976). *Le système de production végétal, l'unité montagnarde expérimentale de développement intégré de la vallée de l'azzaden du Haut-Atlas central*. Ed. INRA et Direction des eaux et forêts, Rabat, Maroc.
[19] Riad S., Mania J., et Bouchaou L. (2006). *Variabilité hydroclimatique dans les bassins-versants du Haut Atlas de Marrakech (Maroc)*. Science et changements planétaires/Sécheresse.17 (3) : 443-446.
[20] Cheylan J-P., et Riaux J. (2013). *Les notions d'aléa et de risque vues du Haut Atlas : pratiques, savoirs et savoir-faire*. VertigO-La revue électronique en sciences de l'environnement.13 (2).
[21] Pascon P. (1977). *Le Haouz de Marrakech, 2 tomes*. Edition Marocaine et international.
[22] Ben Boukdir K. et Afelnoughri H. (2012). *Inventaire bibliographique des sources de pollution dans le bassin hydraulique Tensift, Ksob et Igouzoulen : Analyses des aspects réglementaires et techniques*. Mémoire Licence, Université Cadi Ayyad, Faculté des sciences et techniques, Marrakech, 72 p.
[23] Arioua A. (1995). *Évolution de la qualité des eaux de l'oued Oum Er Rbia (Maroc) avec essai de modélisation*. Thèse de 3ecycle, université Cadi Ayyad, Marrakech, Maroc, 180 p.
[24] Rabourdin S. (2005). *Les sociétés traditionnelles au secours des sociétés modernes*. Ed. Délachaux et Niestlé.
[25] Jacquard A. (2004). *Tentative de lucidité*. Ed. Stock.
[26] Jonas H. (1990). *Le principe de responsabilité (trad. fr.)*. Ed.du Cerf.
[27] Skolimowski H. (1992). *Living philosophy: Eco-philosophy as a tree of life*.
[28] Jolly G. (2002). *La gestion sociale de l'eau : bases conceptuelles et méthodologie*. Centre national des études agronomiques des régions chaudes édition. www.isiimm.agropolis.org/OSIRIS/report/ GSEConceptMethod_Jolly2002.pdf. Retrieved on 20-11-2017.
[29] Madani T. (2005). *La question du partage de l'eau entre amont et aval dans le monde rural marocain médiéval*. Ruralia V, Supplementum. 17 : 68-72.
[30] Chaylan J-P., Riaux J., Elgueroua A., Auclaire L., Romagny B., Vassas A. (2012). *Gestion des ressources, pouvoir et innovations institutionnelles dans la vallée des Ayt Bouguemmez*. In : L. Auclaire, et M. Alifriqui (dir), Agdal : patrimoine socio-écologique de l'Atlas marocain. Ed. IRCAM-IRD, Rabat-Maroc; 357-374.
[31] Ostrom E. (1990). *Governing the Commons*. Cambridge: Cambridge University Press.
[32] Pretty J., and Ward H. (2001). *Social Capital and the Environment*. World Development. 29 (2): 209-227.
[33] Platteau J-P. (2003). *Droits de propriété et gestion efficace des ressources naturelles*. Les Séminaires de l'Iddri, vol. 10, Paris.
[34] Compagne P. (1982). *Etat et paysans : la contradiction entre deux systèmes de reproduction*. Economie rurale. 147 (1): 37-44.
[35] Garrigues-Cresswell M., et Lecestre-Rollier B. (2001). *Gérer les aléas. Les sociétés du Haut Atlas marocain*. Techniques et Culture. (38): 69-95.
[36] Hammoudi A. (1985). *Substance and relation: water rights and water distribution in the Dra Valley*. In: A-E. Mayer (Ed.), *Property, social structure and law in the modern Middle East*. State University of New York Press.
[37] Lecestre-Rollier B. (2006). *La gestion de l'eau : une question d'identité. Le cas des vallées du Haut Atlas marocain*. In : PCSI - 4e Séminaire international et interdisciplinaire, Cirad, 13 p.
[38] Garrigues-Cresswell M. (1994). *La profusion rituelle berbère : une nécessité sociale*. Annuaire de l'Afrique du Nord. 33 : 181-188.
[39] Goldsmith E. (1993). *Le défi du XXIème siècle, une vision écologique du monde*. Ed. du Rocher.
[40] Jonas H. (1998). *Le principe de responsabilité : une éthique pour la civilisation technologique*. Ed. Flammarion, coll. Champs, Paris.

Author Profile

AHOUACH Abdellah, has received (Master) from Jules Verne University, Amiens, France. Presently studying as a doctoral student at the Faculty of Sciences Semlalia of Marrakech. His research project focuses on the study of the relationship between capabilities, water and sustainable development among a traditional population in the High Atlas.

CHERKAOUI Mohamed, has received (Ph.D.) from Cadi Ayyad University, Marrakech, Morocco. Presently working as a professor research at the Laboratory of Human Ecology from the Faculty of Sciences Semlalia of Marrakech. His field of research focuses on bio-anthropology and eco-anthropology.