



RESEARCH ARTICLE

EXPLOITATION OF LOCAL KNOWLEDGE OF FARMERS ON FLUOROSIS FOR MAPPING SOIL IN MOROCCO WESTERN CENTRAL: CASE OF BENI MESKINE, PROVINCE OF SETTAT.

Maadid Hanane^{1,3}, Koulali Yahya¹, Mabrouk Achraf^{2,3} and El Mzouri El Houssine³.

1. Laboratory of Ecodesign, energy, environment and innovation, University Hassan 1st, Faculty of Sciences and Technologies, Settati, Morocco.
2. Laboratory of Food and Health, University Hassan 1st, Faculty of Sciences and Technologies, Settati, Morocco.
3. Department of Agronomy, Regional Center for Agricultural Research, Settati, Morocco.

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Abstract

Fluorosis is a major constraint for the sheep "Sardi" in the region of Beni Meskine in Morocco. The objective of this study is to explore the local knowledge of farmers for fluorosis, its causes, impacts, spatial distribution, and strategies for mitigation. To meet these objectives, workshops and surveys were conducted with the breeders of the study area. The results of this study indicates that the local population is very aware of the distribution and mapping of its territory on the soil to fluorosis. Most of the population is aware that the soil and the drinking water cause the problem of fluorosis. Two cards based on local expertise were established for the first time to this area and that concern: a) a Fluorosis distribution map and b) a card that summarizes the main mitigation strategy. This information can be used for action plans to set up to target the mitigation of fluorosis by the departments concerned. It also used to establish a research program on soil mapping according to their fluoride content to a confrontation of approaches / scientific methods with those of the local knowledge of farmers.

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Introduction:-

Beni Meskine is a region on the Chaouia region of Morocco known by its sheep of the race "Sardi" which is known for its best quality meat and is very popular nationwide. Approximately 250,000 sheep heads is the main economic pillar in this area of Central Western Morocco (RGA, 1994).

Beni Meskine breeders have accumulated over time a very substantial expertise in the conduct of this breeding and constraints that may limit its performance. Thus, their knowledge about fluorosis, ecological niches and the strategy adopted to mitigate it, are well understood by farmers of different ages. This disease (fluorosis) spread from an endemic way in these phosphate regions rich in fluorine (Mountadar et al., 2000). In this area, fluorosis is hydro telluric, it has long been known as the "Darghmous". The Darghmous is a chronic pathology of fluorine consumption of excess or its derivatives for a long period of life (Aajouj, 1982). It causes abnormal bone formation and tooth development.

Corresponding Author:-Maadid Hanane.

Address:-Laboratory of Ecodesign, energy, environment and innovation, University Hassan 1st, Faculty of Sciences and Technologies, Settati, Morocco.

This poisoning affects both human and animals. After ingestion of fluoride products at high doses appear abdominal pain, alleviates diarrhea and vomiting with thirst, sweating (OMS, 1972).

In phosphate regions of Morocco, particularly in Beni Meskine, fluorosis has become a dominant pathological compulsion that inhibit the development of systems of farms and therefore on their economies causing interesting losses.

Ranchers and farmers in the study area have local knowledge and cumulative beliefs with a long history of interaction with their natural environment and the scourge of fluorosis. A lot of research has been reported on the usefulness and interest of the local expertise of farmers who are the best experts of their land for the direction and operation of research on aspects related to soil (Aquino et al., 2002; Busquet, 2006; Suehoueto, 2002). The objective of this study is to explore the local knowledge of farmers of Beni Meskine for fluorosis, its causes, impacts, spatial distribution, and strategies of mitigation to map depending on their local knowledge the spatial distribution of fluorosis.

Materials and methods:-

Presentation of the study area:-

Beni Meskine is administratively represented by the circle of El Borouj, covers an area of approximately 200 Km² (latitude: 32.50397 / 32 ° 30'14, longitude: -7.18917 / -7 ° 11'21 "and altitude: 300 and 500 m). This study area was selected as part of this study to the importance of its livestock and the presence of fluorosis as a constraint to their herd. Territory of Beni Meskine is dominated by limestone formation of Cretaceous and tertiary age, which is an extension to the south of the phosphate area. The soils are generally shallow, stony, and poor in organic matter and very eroded. They belong to the class of calcimagnesian of carbonate soils and limestone brown group (DPA, 1996).

The most dominant soils according to local classification are of four types (Maatougui et al., 2000):

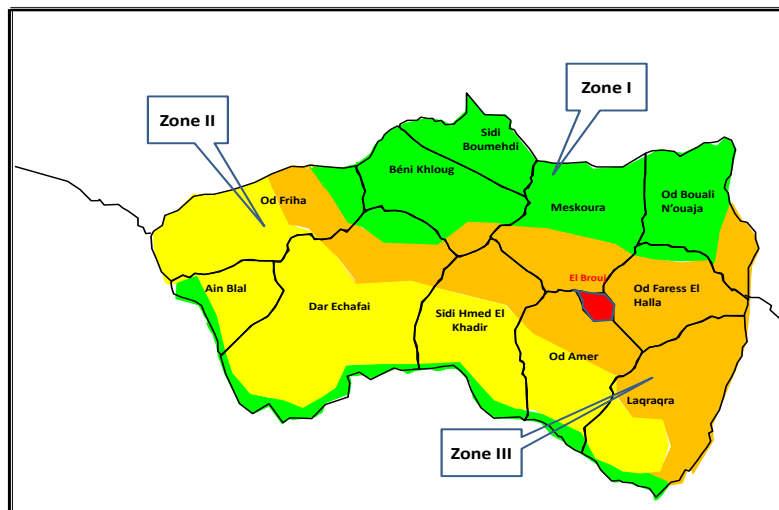
- ❖ Hrach (dominant): stony, shallow ability to very low water retention.
- ❖ Tirs: a large production capacity when water is available, clay land is deep enough. Hard and compact when dry and sticky when wet, these soils are difficult to work.
- ❖ Biad: have a high proportion of clay, limestone soils and shallow. They capture enough moisture well and have an average production potential. They occupy large areas in arid and semi-arid in Morocco.
- ❖ Hamri: red loam land. These soils have a good production potential and good soil, with holding capacity, which are deep or moderately deep. The soils are generally low in organic matter.

Collection of secondary data:-

The collected secondary data is to better guide the field study concerned: a) the biophysical data (soil, climate and vegetation) from existing documents that can be used at first in zoning of Beni Meskine, b) basic documentation of consultation on socio-economic data (ethnic composition, systems of farming, sheep production constraints, etc ...) and c) the consultation of the database available on the problem of fluorosis, and the ways of its mitigation whatsoever by the competent authorities or the local population.

Prospecting and zoning of the area of Beni Meskine:-

Multidisciplinary and institutional team realized multi zoning and for exploration of the territory of Beni Meskine. Three distinguished enough areas have been identified given the climate, the soil, the type of crop systems, and types of farms. These three areas are Zone I: favorable, Zone II: moderately favorable and zone III: unfavorable (Figure 1).

Figure 1:- Homogeneous agro-ecological zones of the area of Beni Meskine.**Choice of information collection method on local knowledge related to fluorosis:-****Participatory workshops:-**

Five workshops were conducted in different areas of Beni Meskine with pastoralist groups ranging from 15 to 45 people. Discussions have been initiated with breeders using visualization tools (sketch map, resource maps and time line). It is a tool that invites farmers to make a sketch of their land and aspects they consider important (resources, soil / contaminated areas by fluorosis, zones, solutions, etc.). In our case, we focused this tool to identify grazing areas throughout the year. These participatory workshops were supplemented by field trips along transects designed by breeders and in which direct observations were conducted with farmers on soil type, existing forage species, and the degree of contamination caused fluorosis. As informal interviews were conducted with farmers, shepherds and agricultural technicians.

The product of these workshops was to map the degree of contamination by fluorosis caused by the soil resource and maps resource and space utilization to mitigate the disease. These organizational space and maps of local perception of space cards are a tool for collective use, useful to upgrade the participants, looking for ideas and views communes, the learning, editing, storing, development of ideas of the actors concerned by the problem of fluorosis.

Formal Investigation:-**Questionnaire:-**

To complement the information collected by the informal survey, a questionnaire was developed and validated in the presence of the team of researchers and then filled with at least thirty farmers from each zone. A total of 200 farmers were surveyed among them some that contributed to participatory workshops mentioned above. The main areas covered in the questionnaire are:

- ❖ Local definition of fluorosis,
- ❖ Symptoms,
- ❖ The sources of contamination,
- ❖ Its impact,
- ❖ The strategies adopted by farmers to mitigate the impact.

Sampling:-

We have adopted a structured and oriented sampling in this area, depending on, age of farmers, the herd size, the type of farming (extensive, intensive), and membership of the breeder local / national NGO (association, local cooperative, ANOC), and gender. Data collected whether the informal survey / participatory workshops or formal survey were processed and compiled as a map of the spatial distribution of fluorosis.

Results and Discussion:-

Local definition of fluorosis:-

According to the information collected, over 70% of the population of Beni Meskine stated suffer from fluorosis and agrees that fluorosis locally called " *Darghmous* " is a disease that weakens the body's animals (ruminants and equines) and Human. It is not contagious and known for a long time in the area.

Sources of contamination:-

According to various testimonies, fluorosis is caused by environmental factors linked primarily to the following resources: soil, and water. For most of the population, the soil remains the main cause of this disease and secondly the drinking water.

For the latter, some wells (shallow, less than 30 meters) can contain harmful elements that over time affect the teeth of young animals and their performance. As for the soil resource, two causes are attributed to him: the first is the direct grazing crop residues sheep in summer or young herbs in the winter and the second is the abode of the herds (Zriba). As for harmful elements reported by the majority of the population, the various interviews indicate that the farmers are unable to identify the fluorine as causal agent of this disease. Herders speak of "infected" areas instead of contaminated areas. This collected information has not yet been written documentation or scientific research article in the study area. The drinking water (Brindha et Elango, 2011; El Jaoudi et al., 2014; Ibrahim et al., 1995) mainly causes however, most of the literature showed that fluorosis.

Symptoms of fluorosis:-

According to information collected by farmers, this disease was characterized by various general symptoms: loss of appetite, weight loss, brown and black spots on the incisors and molars. In addition to these symptoms, usually bones become thin and fragile. Effectively the same symptoms were described previously from the beginning of the century in Naples (Eager, 1901). The black coloring of the dental enamel reflects the same symptoms described in Colorado Springs (Black et Mackay, 1916). Fluorosis is first manifested in the gingival third of the second primary molars (Warren et al., 2001).

The impact of fluorosis:-

This mineral disease (excessive fluoride or its derivatives) arrived, according to the local population, to cause sizeable losses in Beni Meskine. Indeed, it has a direct impact on:

- ❖ The health and performance of sheep (loss of teeth, poor appetite, weakness and even death)
- ❖ The shortfall of breeding ewes (farmers are forced to sell yearling replacing them with older ewes over 4 years)
- ❖ The selling price: farmers report that the price of the animal with dental fluorosis lesions undergoes 30 to 45% reduction.
- ❖ The economics of sheep production (transportation to other uncontaminated areas, food shopping, etc).

Spatial distribution of fluorosis as local knowledge of farmers:-

The confrontation of different information and viewpoints were used to develop a final map describing the zones called " *Slalam* " in the local language, and areas contaminated with fluoride " *Darghmous* " using a GPS "Global Positioning System "Garmin" with an accuracy of 2.9 m. This is a network of satellites that continuously transmit coded information. This information helps to precisely identify locations on earth by measuring distance from the satellites, exploiting the ArcGIS 9.3 software for the development of a map of the distribution of fluorosis in Beni Meskine knowledge breeders (Figure 2).

Figure 2:- Map of the distribution of fluorosis as local knowledge of farmers in Beni Meskine.



The analysis of the above map showed that fluorosis affects the majority of the area of Beni Meskine. Of the eleven rural districts, eight towns were affected by fluorosis: BeniKhoulouf, Dar Chafai, Meskoura, OuledBoualiNouaja, Ouled Fares, Laqraqra, OuledAmer, and Sidi Ahmed khader. On the other side, only the town of AinBlal is unscathed. Some others like OuledFreiha and Dar Chafai, which are partly free in addition to the surrounding communities of the river of Oum Rbia.

Our investigation revealed that such a severity of fluorosis in Beni Meskine could be explained by certain factors, including:

- ❖ The geological aspect of the aquifer: the possibility of the release of fluoride from geological substrate (Caudan et al., 1982).
- ❖ In arid area characterized by a warm climate forcing animals to drink more water which can contain high levels of fluoride, which becomes toxic when the temperature is high (Del piero et al., 2014).

The strategies adopted by farmers to mitigate the impact of fluorosis:-

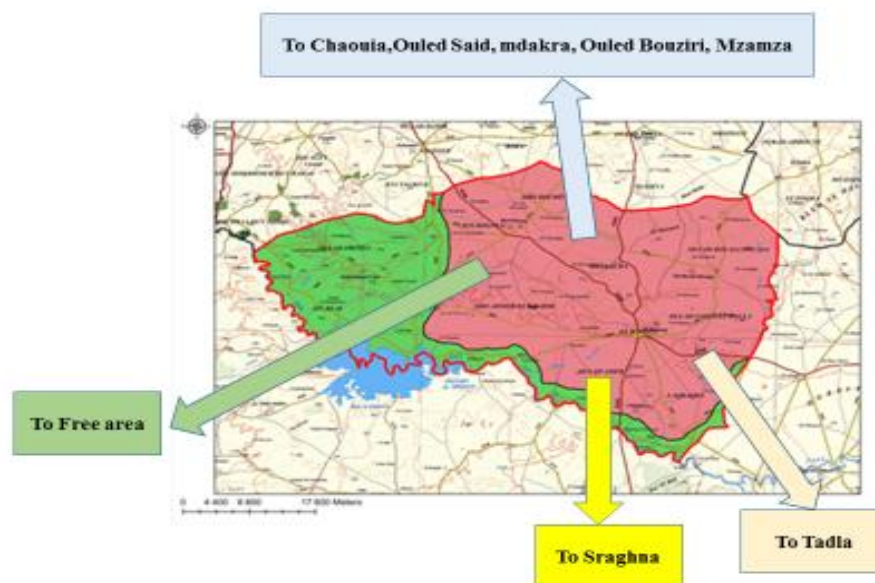
Faced with this environmental disease, farmers have adopted several strategies tailored to their socio-economic context and knowledge in the field to alleviate it.

Limiting itself only to mitigation strategies related to soil resources, we quote: seasonal transhumance, the contribution of non-contaminated soil in place stalls, and buying ewes aged from non-contaminated areas with fluoride.

The seasonal transhumance was practiced between contaminated areas (infected) to other areas whose soils are free. It is a practice quite old since the 50s, which was based on tribal, family, social and neighborhood (Figure 3). However, during the last decades (since 1990) this solution is more common given the pressure on agricultural land and the deterioration of social relations. This transhumance took place during the winter to the summer, which coincided with the period of change of youth sheep's teeth in autumn and to avoid grazing during winter and grazing of crop residues in summer on soil contaminated with fluoride.

This transhumance was done to Chaouia north (Ouled Said, ouladBouziri and Lamdakra), and the SgharnaRhamna south and Tadla in the East, particularly for pastoralists with large herds. For most small farmers, transhumance was done within Beni Meskine to free zones (AinBlal, OuledFreiha, DarChafai).

Figure 3:- The seasonal transhumance of *Sardi* sheep s' herds of fluorosis areas to the free areas in Beni Meskine



Regarding the contribution of non-contaminated soil in place stalls, which is a new adaptation strategy to the problem of fluorosis that emerged over the past decade. It is about spreading soil from other areas "*Slalam*" as Tansift and AinBlal to minimize direct contact between animals and the soil rich in fluoride in their environment to live. Recently some farmers are going to build slabs in these places for sheep (*Zriba*). For the last adaptation strategy, it is to renew the ewes and rams by buying other adults coming from free regions as AinBlal the Sraghna, and Tadla.

Conclusion:-

The use of local knowledge to delimit free and contaminated areas by fluorosis, allowed us to understand the perception of the breeders in Beni Meskine for this disease, its causes, and impacts. It is obvious that the population of farmers combined the causes and severity of this disease with the soil resource in the first place and with the water resource, secondly, and consequently, it is a disease related to the biophysical environment in which it exists. In connection with the characterization of the content of fluoride in ground. We were able to create the map delineating the zones "*Slalam*" which represent less than one third of contaminated areas in Beni Meskine. As it was pointed out adaptation strategies / mitigation adopted by farmers, using their knowledge to the solutions related to the fluorosis such as: seasonal transhumance, contribution of free soil of fluoride, and replacement of livestock from free areas of fluorosis.

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