Diversification and rural livelihood resilience:

the case of wildlife hunting income for ranchers in Mexico

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Abstract

Diversification is the socioeconomic guided by pressures and opportunity factors, that makes household adopt livelihood strategies using different forms of capitals and access to them, as well as the household activities to reach them (Ellis, 2000). It has also been defined as a strategy to be less vulnerable and allows households an adaptation to different pressures to survive (Niehof A. 2004); (Rudie 1995). Rural households have a close relationship to ecosystems for their living, they transform them, they live within them, in synthesis they depend upon ecosystem health. Socio-ecological system is the result of this interaction and has been recognized as a complex system. In that sense, to study the socio-ecological systems and particularly livelihood resilience has been an interest for researchers. Thus, the aim of this research is to analyze if rural diversification can contribute to livelihood resilience. For that purpose, this paper analyzes the case of sustainable wildlife use as a strategy of diversification of income by northern (Sonora) ranchers in Mexico. Legal sustainable wildlife use in Mexico takes place by law, in the Management Units for the Conservation of Wildlife (UMA). This paper analyses the Pearson correlation index between the cow exportation and the number of permits for hunting in Sonora from 2003 to 2007. Results show a high correlation between data showing that an increase of *Ovis Canadensis* and *Odocoileus hemionus* hunting permits is correlated to a decrease in cow exports. Thus, ranchers diversify their income through wildlife hunting in order to be more resilient towards a decrease in income by exports. On the other hand, the UMA location, number, extension and land tenure at a national scale where related to changes on temperature and precipitation estimated by

the Mexican Institute of Water Technology (IMTA) in order to see the potential of UMA as livelihood strategy towards climate change. Sonora is one of the most vulnerable states due changes on precipitation and is one of the states with more number of UMA.

This paper explores the potential of UMA as a resilient strategy towards external pressures such as, economic crisis or climate change. Other external variables might explain the increase of UMA that are not taken into account in this work but it is a first approach linking non-agricultural income, specifically wildlife use as a strategy of livelihood resilience.

Keywords: Resilience, adaptation, livelihood, wildlife

1. Introduction:

Livelihood diversification is considered a rural strategy to face local, regional or national stress factors. It is defined as the process by which rural households construct different livelihood strategies using different goods and assets; it is a strategy to be less vulnerable to changes (Rudie 1995; Niehof A. 2004). Ellis (2000) define livelihood strategies as the goods, presented in different forms of capital (natural, human, physical, social, financial) and the access to them mediated by institutions and social relations, as well as the activities to reach them (Ellis F. 2000).

Income composition has been used as a diversification measure and it has been demonstrated in Latin America that 40% of the rural household income comes from non-agricultural activities, being services one of the most important sectors (De Janvry A. and E. Sadoulet 2001). However, Ellis (2000) indicates that income is an indicator of a complex phenomenon that depend on different variables, motivations and restrictions that varies upon time and households (Ellis, 2000:56). Thus, diversification is a complex process where the

interaction between different forms of capital (endogenous variables) and external factors, such as stress factors, determine the rural household decisions making to be less vulnerable.

Vulnerability in a livelihood context depends on the degree of exposure to risk, shocks and stress (Ellis, 2000). Similarly, in climate change, vulnerability is a function of exposure, sensitivity and adaptative capacity or resilience (Paavola J. 2008).

Resilience is defined as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedback” (Walker B. 2004; Walker B.H. 2006). Thus, resilience has emerged as a conceptual framework to understand changes implications in a multiple cross-scale interaction in socio-ecological systems (Plummer R. and D. Armitage 2007). Berkes et al (2003) has identified as central measurements of resilience, the ability to absorb or buffer stress, the ability to self organize and the capacity for learning (Berkes F. 2003).

Thus, resilient livelihoods are those that can buffer and recover from stress and shocks, maintain or arrange capabilities and assets, and ensure sustainable livelihood opportunities (Plummer R. and D. Armitage 2007).

The concept of sustainable livelihood has arise in the 90´s and defined as follow: “A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities, assets, and entitlements, while not undermining the natural base” (Marscheke M.J. and F. Berkes 2006). It can be argued that those sustainable livelihood are strategies to build resilience.

Socio-ecological systems resilience has been studied form different perspectives such as ecosystem services, institutions, watershed management, adaptative management and livelihood (Marschke M. y F. Berkes 2006; Osbahr H 2010) (Olsson P. 2006; Plummer R. and D. Armitage 2007)**.**

Livelihood diversification has been linked to resilience in few papers (Marschke M. y F. Berkes 2006) but livelihood adaptation has been a point of interest in a climate change context (Paavola J. 2008) (McDowell J.Z. and J.J. Hess 2012). The main strategies identified of livelihood adaptation are agriculture extensification and intensification, diversification, migration (Paavola J. 2008), as well as, informal institutions and collective land use (Osbahr H. 2008). On the other hand, stressors are changes on social, economic, political and environmental aspects that affect households. Mc Donwell and Hess (2012) has defined stressors as "events, trends, policies and processes that deplete resource stores or systematically alter resource access" (McDowell J.Z. and J.J. Hess 2012). Some of the stressors identified are climate change, land scarcity, market uncertainties in agriculture, labor markets and institutional construction or access (Paavola J. 2008; McDowell J.Z. and J.J. Hess 2012) as well as, violence or health (Marscheke M.J. and F. Berkes 2006).

The adaptation to multiple stressors remains poorly understood and more insight is needed to link livelihood strategies such as diversification and adaptation.

Thus the purpose of this research is to have a first approach to know the potential of sustainable diversification as an adaptation strategy, that is, if diversification might be a strategy to be more resilient.

A socio-ecological system resilience study requires defining the components of the system, the scale and the stress variables.

In that respect, our socio-ecological system is located in a micro scale and defined as the interaction between landowner and the ecosystem on its land, receiving stressors from a macroscale or national scale. Stressors in this case are changes on cattle export due to the agricultural crisis and climate change. Moreover, the vulnerability context is considered as a possible exposure to stressor where poverty and density population are measured.

For the purpose of this study, diversification is centered in non agricultural activities and particularly on sustainable wildlife use.

Wildlife use is a diversification source of income and several kind of activities has been studied such as non timber forest resources (Shone B. M. and J. L. Caviglia-Harris 2006) (Arnold J.E. M. and M. R. Pérez 2001; Mutenje M. J. 2011) wildlife ranching (Kreuter U.P. 1994), bush meat (Ambe Timah E. 2008; Morra W 2009) , hunting (Frost P.G. H. and I. Bond 2007), wildlife watching and environmental services payment (Kosoy N. 2008)

Wildlife use is then a source of revenue for many rural communities and has been recognized as a diversification strategy. Particularly, hunting has shown an important source of revenue for many countries such as Zimbabwe in the Campfire program (Frost P.G. H. and I. Bond 2007), in the United States (Wynveen C.J. 2005) (Munn I.A. 2010), and Mexico (Avila-Foucat V.S. 2008)

In México, wildlife use is regulated by the National Law of Wildlife where the Management Units for Wildlife Conservation (UMA) are the legal framework. UMA were created in 1997 in accordance to the Program of Wildlife Conservation and Rural Diversification and today a total of 9,531 covering more than 30 million of hectares exist. Hunting is one of the main activities developed in UMA. UMA has been increasing all over the country and the reasons have not been analyzed deeply. The aim of these units is to create an incentive for landowners to conserve the ecosystem through economics benefits obtained from a sustainable use. Thus, economic revenues are restricted to the conservation of the ecosystem and for that purpose it is required a management program and a permit.

Thus, the aim of this research is to make a first step on analyzing the potential of sustainable rural diversification in UMA to contribute to livelihood resilience where climate change and livestock crisis are the stressors.

2. Methods

2.1 UMA and livestock export in Sonora

The relationship between livestock export and UMA was done for the Sonora state which is located in the North of Mexico with a total area of 182 052 km², with a total population of 2 662 480 people and a growth population rate of 2.1%.

Sonora is one of the most important states of livestock production and exports mainly for cow (Fig.1).

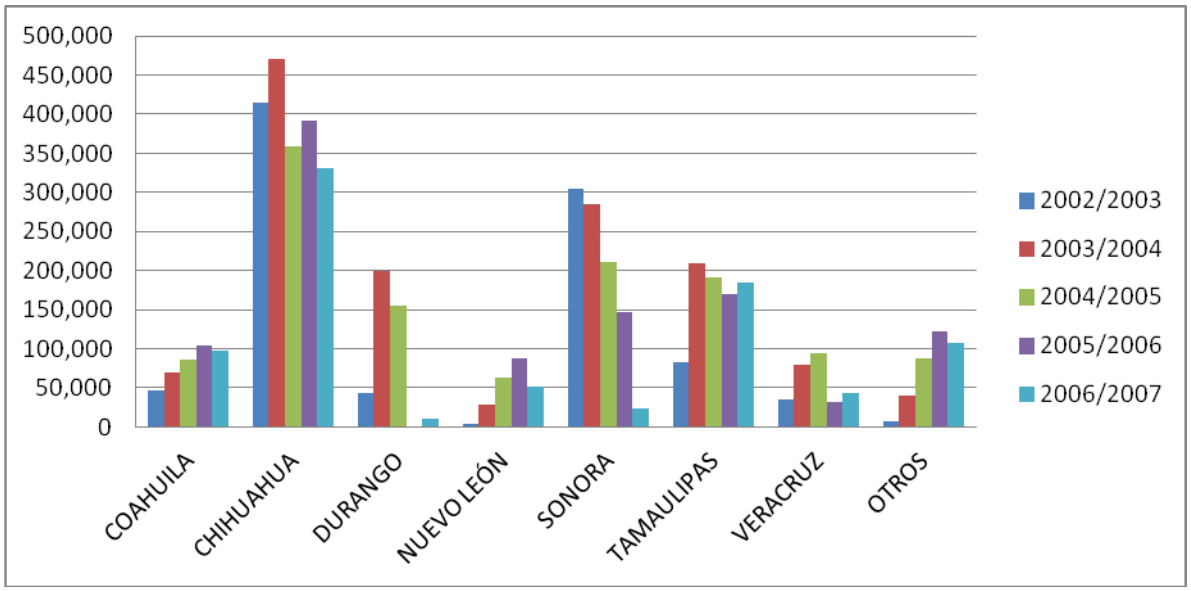

Fig. 1 Cattle export for the main livestock producers states of Mexico

In 2006, Sonora suffers from a decrease in the number of exports compared with other states such as, Chihuhua. On the other hand, it is one of the fourth state of importance in the number of UMA (550 up to 2010). Thus, it is interesting to analyze if there is a correlation between the decrease on exports and an increase on wildlife use in UMA. Livestock exports data were obtained from national statistics. UMA data are official data from the Wildlife General Direction (DGVS) from 1997 to 2010. Wildlife use permits are for the two main

species hunted in Sonora, the bighorn sheep O*vis Canadensis* and the deer *Odocoileus hemionus. They are also the species with the highest value in the market.*

A pearson correlation was carried out between cattle export and the number of individuals used hunting in Sonora from 2003 to 2007. A more detailed regression was not carried out since there are other variables influencing wildlife use, such as, a higher demand for hunting from tourists coming from the United States, or wildlife population increase defining the number of permits, variables that are not considered in this first approach.

2.2 Vulnerability context, UMA and Climate change

Firstly, the vulnerability context of UMA is described in terms of poverty and density population at a municipality scale. Then, at a state scale climate change and UMA location are related.

Vulnerability context at municipality scale

The number of UMA were obtained from the DGVS database and described for Mexico at a municipal. Data were transformed from Access to SPSS 2 and ARGIS 9.3.

Poverty is a variable of vulnerability since it leads to major risks and exposure to stressors and data were taken from the national census from CONAPO 2010.

On the other hand, density population is taken as a vulnerability variable since if UMA are closed to cities they might have more potential to receive tourists. Density population data were also from national statistics at a municipality level from CONAPO, 2010.

If those variables are coincident with UMA location thus, UMA can be an instrument used to be less vulnerable and be more resilient to stressors such as climate change.

Climate change and UMA

On the other hand, the number of UMA need to be where the localities are exposed to major climate variability in order to be considered as a strategy for coping to climate change or to plan adaptation strategies. At a national scale the percent of change on precipitation and on temperature were compared to location of UMA.

3. Results

3.1 UMA and cattle export

The Person correlation index shows a negative and significant relationship between the cattle export decrease and the number of deer and bighorn sheep use for hunting (Table 1). Results suggest that if the number of cattle exports decrease ranchers might diversify their income with hunting revenues.

Table 1. Pearson correlation index between cattle export and hunting

Year	Cattle exports	Number of Deer	Number of Bighorn sheep
2003	*289,490*	982	52
2004	*265,885*	1179	176
2005	*159,727*	1465	198
2006	*102,881*	1551	142
2007	*52,391*	1704	348
		Pearson= -0.98	Pearson= -0.75

3.2 Climate change, vulnerability context and UMA

Vulnerability context at municipal scale

The number of UMA in municipalities is dominant in the north of Mexico as shown in previous national studies (Avila-Foucat V.S. 2008) (FIG. 1). Specifically, the municipalities in the north east closed to the US frontier have a high number of UMA. This might be due to the demand for hunting coming from US. It is also interesting to see that a coastal municipality in Sonora more than 135 UMA, also in Baja California but this states have only few municipalities It is interesting to note that the center of Mexico, south pacific and Gulf of Mexico are the regions with less municipalities with UMA.

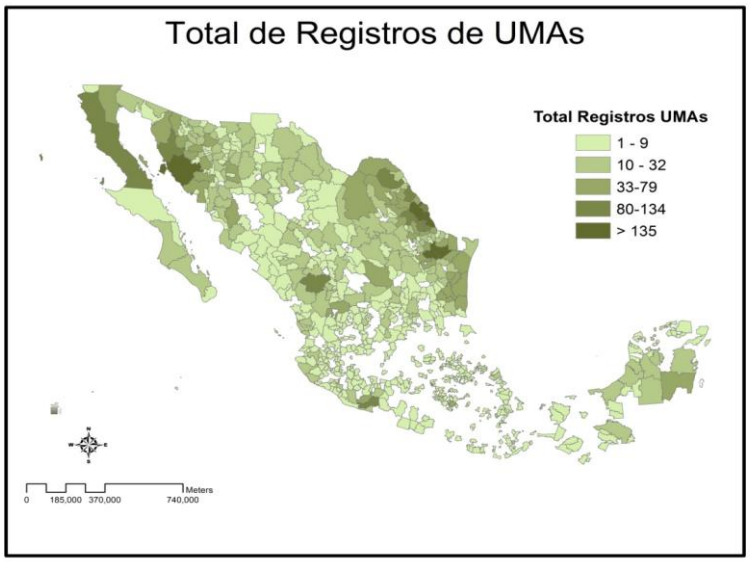

Fig. 2. UMA in municipalities of Mexico

Vulnerability context where UMA exist, measured in terms of poverty at a municipality scale show that a major number of UMA are located in the municipalities with less poverty and (Fig.3) that most municipalities have less than 50 UMA.

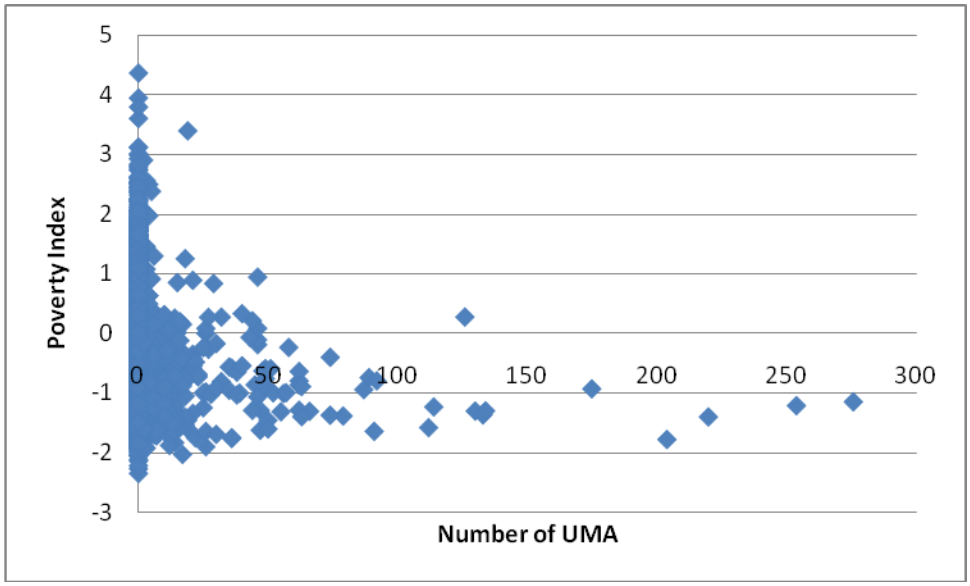

Fig. 3 Number of UMa and poverty index at municipality scale

Thus, looking closely to the municipalities with less than 50 UMA we can observe that the ones with higher levels of poverty have less number of UMA (Fig 4)

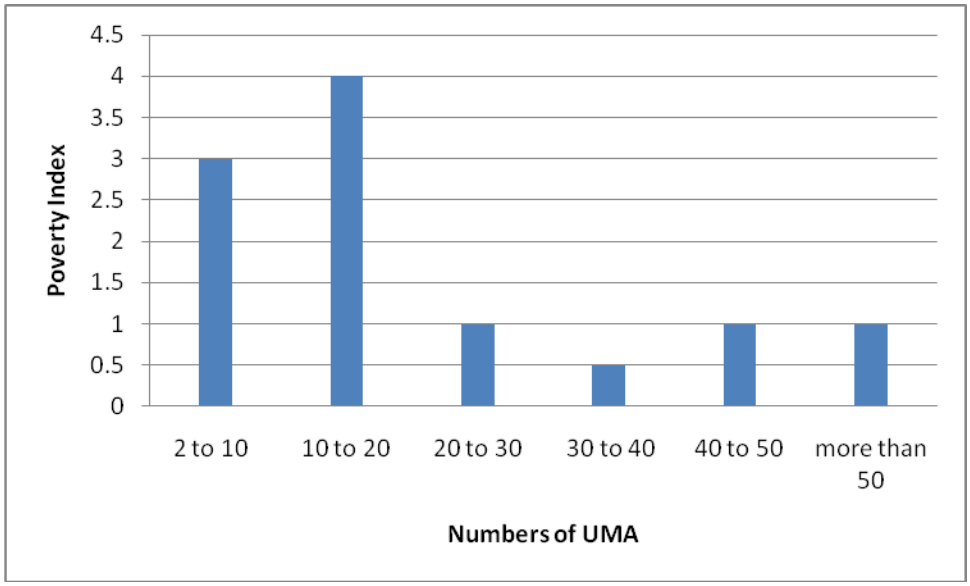

Fig. 4. UMA per ranges and poverty index

The vulnerability context related to population density show that UMA are located in municipalities with low density population (Fig5).

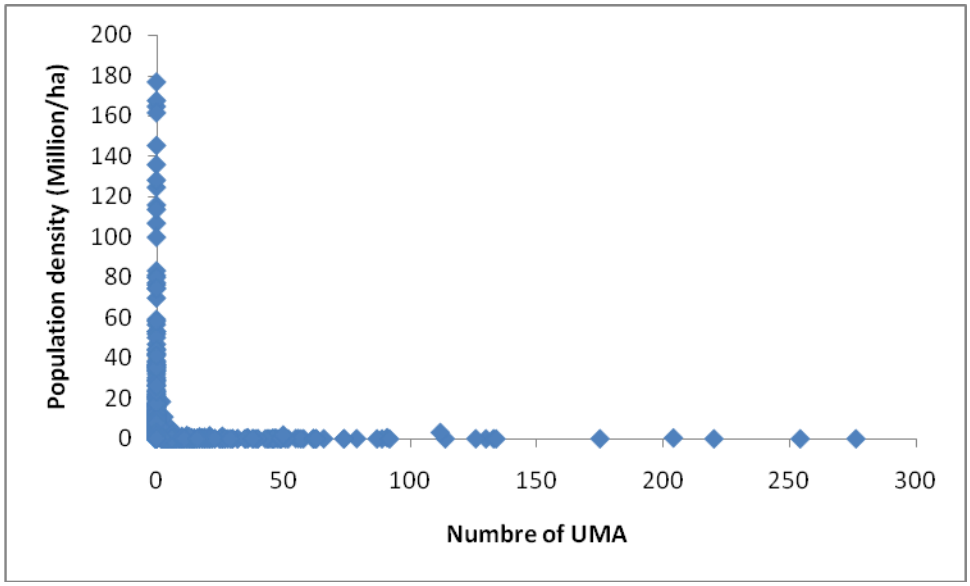

Fig. 5. UMA and population density at municipality scale

Results show that UMA are located in areas with less poverty index and away from cities. Thus, if government would like to consider UMA as a diversification and adaptation strategy to be more resilient a specific policy for that purpose would be needed. UMA municipalities are vulnerable to stress factors, but in what extend this determine their resilience is difficult to say.

UMA and climate change

Climate change is a stress factor. The figure X shows per state the number of UMA and the percent variation on precipitation. There is no clear relationship between those variables, that is, some state where precipitation will decrease importantly can have a high number of UMA or not, such as Nayarit or Nuevo León. Similar results are found when comparing with the states with high increase in temperature. Thus, UMA are not necessarily located in the most vulnerable states in terms of climate change Fig. 6.

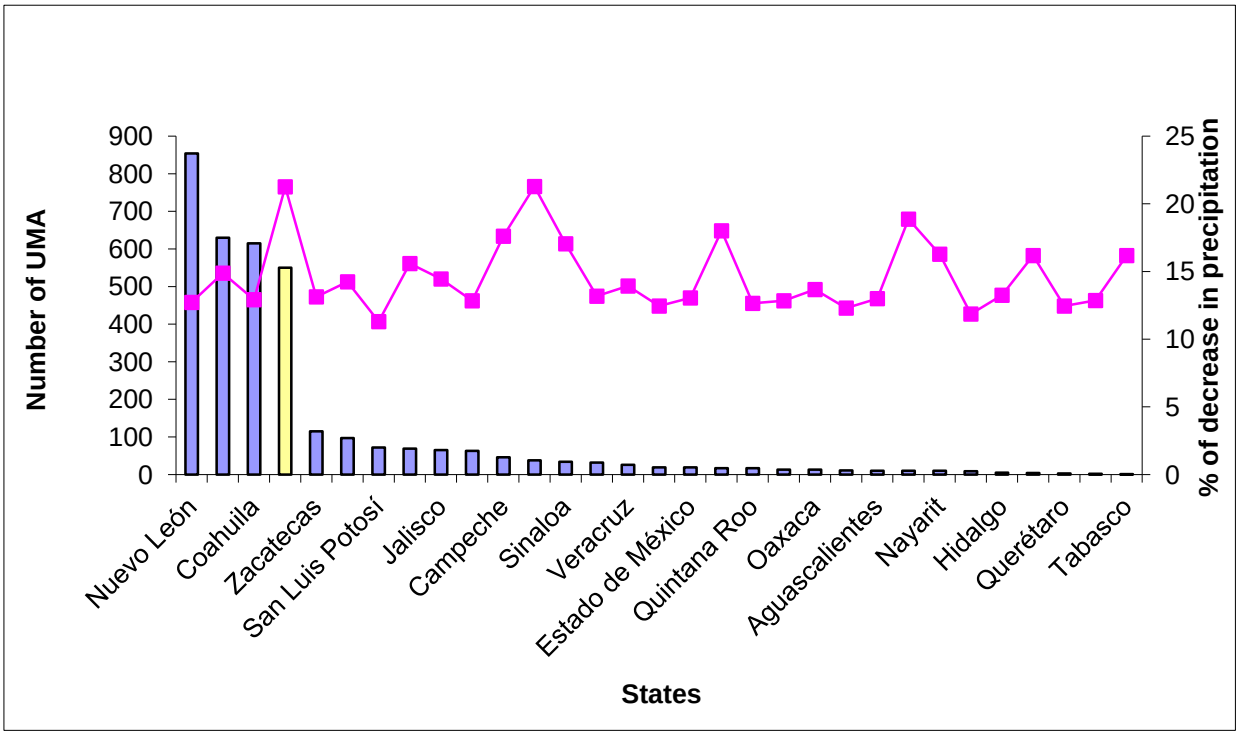

Fig. 6 UMA and Precipitation by State for 2010 Data from DGVS and IMTA 2010

However, Sonora is the Sate with a high number of UMA and high decrease on precipitation and higher increase on temperature (Fig 7.).

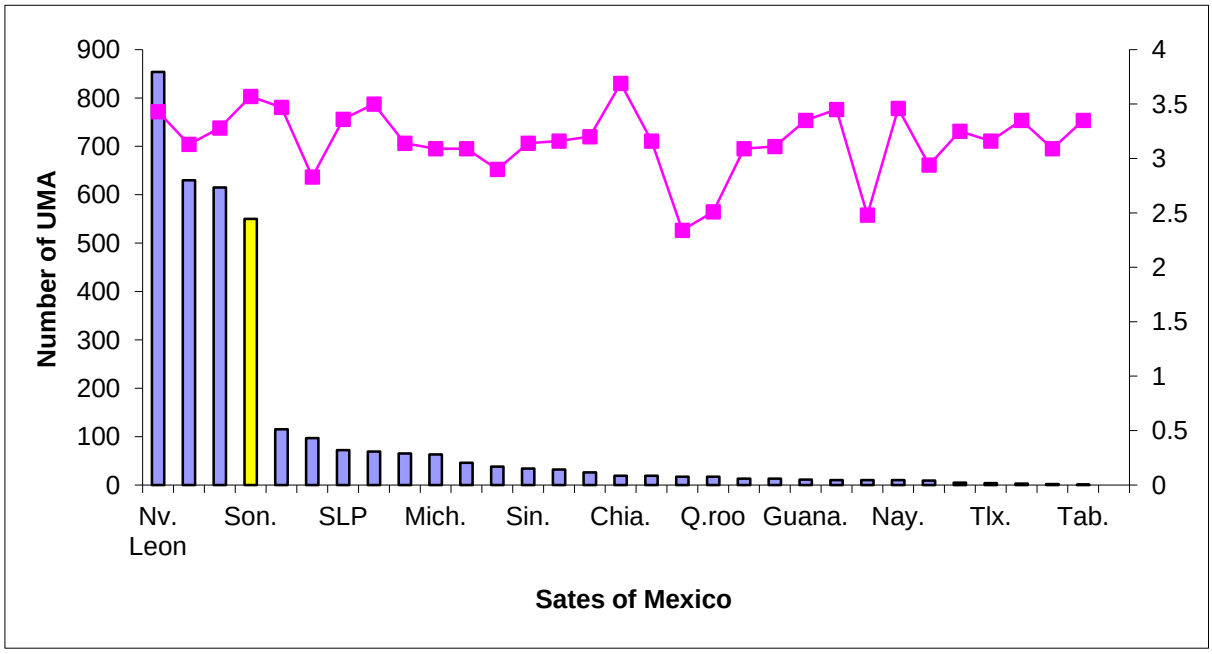

Fig. 7. UMA and temperature increase Data from DGVS and IMTA 2010

4. Discussion

Livestock export and UMA relationship showed that UMA as a diversification strategy might contribute to the resilience of the socio-ecological system towards economic stress or livestock crisis. It is important to mention that UMA is not the only adaptation to livestock crisis or decrease on exports that is why, only a correlation between variables was done. Ranchers generate other strategies such as, changes on species production, migration, diversification to other sources of income. However, the correlation shows that the increase on the use of

deer and highborn sheep might be due to the decrease on cattle export. UMA was created after NAFTA because ranchers were looking a diversification strategy (Avila-Foucat V.S. 2008) because the import of cattle was affecting national production and export. In 2000, an economic crisis affected Mexico and after 2003 a decrease on export is notorious in northern states of Mexico (Fig 1). Thus, it appears possible that recreation hunting is an income diversification strategy to be more resilient towards economic stressors.

UMA location and socioeconomic context at a municipality scale has not been described in the literature. Thus, this first approach is useful since adaptation strategies need to be built in a micro scale in order to be more specific to local characteristics. It is interesting to note that municipalities with higher number of UMA are located closed to the frontier which might be due to the US demand for hunting and also due to species location. In the center of Mexico, wildlife use is mainly done in captivity and manufacture and services are the economic sectors in the region rather than agriculture. However, it is interesting to note that in the south of Mexico some municipalities have more than 80 UMA.

On the other hand, poverty index show that high number of UMA are located in the municipalities with low poverty index suggesting that to create a UMA a minimum of assets and access to them is needed. Thus, wildlife use as a livelihood strategy requires a minimum infrastructure (physical capital), wildlife management capacities and other human capacities to lead with government institutions, social capital to obtain the community agreement to have a UMA, financial capital to pay the management program, infrastructure and natural capital with good condition species population. The previous has been shown for other source of non-agricultural incomes in other parts of Mexico and the world (Yunez-Naude A. y J. E. Taylor 2001). In particular, natural and human capital are important for UMA since species populations need to be in a good condition to be used which is many times related to habitat

quality; and wildlife management as well as tourism management requires human capacities. As mentioned by MCDonewell (2010) human capital is important for adaptation including labor and the capacity to make it meaningful and fruitful" (McDowell J.Z. and J.J. Hess 2012).

Population density is another variable that was measured as part of the vulnerability context, since access to a city might influence the commercialization of a specie managed or tourism access to UMA. However, results show that the majority of UMA are in the municipalities with in less population. It is important to mention that in the north of Mexico a UMA extension can be much bigger than in the south due to land tenure and topography (Avila-Foucat and Ramírez, 2008). Moreover, some species require in the wild higher extensions than others and hunting tourists prefer sometimes to be far from civilization. Wynveen et al 2005 analyze the determinants of wild turkey hunting showing that wildlife interaction, education, being away social interaction and hunting skills are dominant attributes (Wynner C. J. 2005). Similarly, Hammitt et al (1990) mentions for deer hunting that past experience, wildlife characteristics, harvest amount, hunter crowding, hunter behavior and environmental conditions are important (Hammitt W.E. 1990). Therefore, UMA in Mexico have been growing in municipalities where population density is low, thus, with low regional infrastructure (physic capital) and high natural capital. In terms, of climate change adaptation and mitigation, it is good to diversify activities with low energy consumption and high natural capital. However, in order to encourage and promote this instrument as an adaptation strategy, it is recommended to provide economic incentives to build cabanas or accommodation in UMA as well as, improve connection to terrestrial and aerial transportation.

Temperature and precipitation variation is not clearly correlated with UMA location. This paper doas not aim to explain UMA location due to climate variability, the intention is to see if UMA are located in the states with more climate variation in order to observe if it can be an

instrument to cope to climate variation. However, only Sonora state has a variation on climate and a high number of UMA. A more detailed analysis is needed, per region and specie used. But, in general terms if government would consider UMA as a diversification strategy to copy to climate change states such as Sonora, Campeche, Yucatan, Baja California (precipitation decrease) Chihuahua, Durango (temperature increase) can be a starting point of analysis. Thus, it is recommended to start a pilot program in Sonora analyzing vulnerability context and ecosystem vulnerability in order to analyze UMA as an adaptation strategy to climate change. Moreover, institutional cross-scale dynamics, forms of livelihood diversification and collective land –use systems need to be assessed since they allow reciprocity, flexibility and resilience in coping and adaptation processes (Osbahr H. 2008).

Sustainable diversification need to be promoted as a resilience and adaptation strategy to face stressors looking assets use, relation between choices, and market oriented livelihood (McDowell J.Z. and J.J. Hess 2012) to make sure activities does not increase sensitivity to later climatic or economic stress

It is important to build or modify rural policies for planned adaptation (Badjeck M-C. 2010), oriented to assets, response mechanisms, recognizing the opportunities that climate change and other stressors can bring to planning for rural development, and multi-sector perspective.

5. Conclusion

Sustainable livelihood diversification, such as wildlife sustainable use in UMA is a rural strategy that can support resilience toward economic stressors. However, a more detailed analysis is needed at local scale to relate UMA to climate change and some states of Mexico can be identified as a priority. UMA are less resilient towards stressors if they are located in vulnerable contexts measured as a proxy in this paper as poverty and population density in municipalities. UMA are located in less poor municipalities thus might be less vulnerable. On

the other hand, they are located in municipalities with less population density but this is not necessarily a vulnerable condition as mentioned in the discussion. Thus, if government would be interested to promote UMA as an adaptation strategy to be more resilient to stressors, a specific policy to promote them would be needed.

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