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ORIGINAL ARTICLE

Effectiveness of the strategies to combat land degradation and drought

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Abstract This paper focuses on the determination of the most effective set of mitigation and adaptation strategies applied to combat land degradation and drought in a latitudinal gradient. This study was carried out in Chile, in a latitude gradient between 17° 30′S and 36° 33′S. The northern regions are mostly formed by desert and dry land, which can be considered as marginal areas for agriculture. On the other hand, the area formed by the southern regions has an industrialized agriculture where an increased use of technology takes place and where the climate and water availability are optimal for the development of agriculture. The period considered in this study was between 2000 and 2007. We calculated an Investment Effectiveness Index. Afterwards, and in order to assess the effectiveness of the financial support, we performed multiple regressions ($P \leq 0.05$), where the Index was considered as the independent variable, and the annual difference of the area affected by a high risk of desertification was considered as the dependent variable. Our findings suggest that the effectiveness of the different set of the strategies applied to fight against desertification and drought varies in a latitudinal gradient. Thus, in arid and hyper arid areas the promotion of modern irrigation systems seems to be effective in combating desertification, while in Mediterranean climates the reforestation strategies seem to play an important role. Our results suggest that in areas heavily degraded by overgrazing, the most effective strategies are those oriented to obtain a permanent vegetation cover on degraded soils.

Keywords Drought · Land degradation · Adaptation investments · Atacama Desert · Desertification · Mitigation strategies · Irrigation · Water scarcity

1 Introduction

Climate change will further increase the risk of desertification, which is already affecting large areas of the world. According to the definition of the United Nations Convention to Combat Desertification (UNCCD), desertification is the land degradation in arid, semiarid

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and sub-humid areas resulting from various factors, including climatic variations and human activities (UNCCD 1994). In that context, dry land degradation is a threat to forestry, agriculture and livestock, reducing intensely the ecosystem services (Gitay et al. 2001). At lower latitudes, especially in seasonally dry regions, crop productivity is projected to decrease for even small local temperature increases (1 to 2 °C), which would increase the risk of hunger (IPCC 2007).

It is estimated that 2.6 billion people are affected by land degradation and desertification in more than a hundred countries, influencing over 33 % of the earth's land surface (Adams and Eswaran 2000). Around 73 % of rangelands in dry lands are currently being degraded, together with 47 % of marginal rainfed croplands and a significant percentage of irrigated croplands (Gisladottir and Sttocking 2005).

Agricultural activity involves a close interaction between the socioeconomic activity and the environment itself. The use of land for agricultural purposes is managed to provide an appropriate and durable production capacity (Meeus et al. 1990). A healthy environment and a sustainable management of resources are essential to developing and maintaining the production capacity. In this context, the desertification processes are a threat to agriculture, livestock, and forestry and they dramatically reduce ecosystem services. Maintaining and enhancing healthy ecosystems are important elements in climate change mitigation and adaptation actions (Feehan et al. 2009). However, agricultural development cannot be intensified regardless of the bearing capacity of soils, ecosystems and socio-economic environment (Mueller et al. 2010). Qualitative and quantitative studies based on observations and modeling of the impacts of climate change on agricultural production systems are relatively numerous (e.g. Darwin 1999; Tubiello and Ewert 2002; Smit and Skinner 2002 and Jones et al. 2009). Under future climate and socio-economic pressures, land managers and farmers will be faced with challenges in regard to selecting those mitigation and adaptation strategies that together meet food, fiber and climate policy requirements (Smit and Skinner 2002; Rosenzweig and Tubiello 2007; Fobissie et al. 2008).

In the future, the strategies and policies for efficient use of water, especially for irrigation, will be a key issue in the fight against climate change and desertification. Water supplies stored in glaciers and snow cover are projected to decline in the course of the century, thus reducing water availability during warm and dry periods in regions which are supplied by melt water from major mountain ranges (IPCC 2008). Stress on water availability: drought related to La Niña created severe restrictions for the water supply and irrigation demands in central Chile, and any future reductions in rainfall in arid and semi-arid regions of Chile are likely to lead to severe water shortages (FAO 2007; IPCC 2008). In this regard, it is very important for decision makers to determine the level of efficiency of the strategies adopted for optimizing economic resources. Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas, such as the area of study (IPCC 2007).

Desertification is a global issue, which threatens development, sparking an exodus from the affected regions because when land becomes uneconomic to farm, people are often forced into internal or cross-border migration. This can further strain the environment and cause social and political tensions and conflicts (UNCCD 2011). Therefore, making agriculture less susceptible to climate change and desertification implies development of irrigation, establishment of conservation-effective techniques, making fertilizers and soil amendments available to farmers, and development of farming/cropping systems which are less vulnerable to declining effective rains and warming temperatures (Lal 2009; Lal et al. 2011).

Many countries are implementing policies and making investments and efforts to mitigate arid land degradation and desertification through the National Action Programs (NAP), which are one of the key instruments in the implementation of the UNCCD (UNCCD 1994). These improvements require financing, especially on degraded lands with arid and semi-arid features, and land users should receive direct benefits for preventing or mitigating land degradation (Salinas and Mendieta 2012b). Empirical evidence shows that land users are more likely to prevent or mitigate land degradation when they benefit directly from the necessary investments and when those benefits outweigh the benefits of continuing current practices that degrade the land (Nkonya et al. 2011).

Recent studies demonstrate the relevance of these mitigation strategies in combating desertification and land degradation trough a numerical model using real data (Salinas and Mendieta 2012a). The long term implementation and effectiveness of these mitigation and adaptation strategies require a socio-economic return for its sustainability (Salinas and Mendieta 2012b, 2012c), in a context where climate change constitutes an additional pressure that could change or endanger ecosystems and the many goods and services they provide (Gitay et al. 2001; Zilberman et al. 2004). Thus, the sustainability of the financial support to fight against desertification lies on the socio-economic benefit and on the environmental sustainability of the investments.

Considering that there is consensus in seeing the desertification a global environmental problem with political and socioeconomic implications (UNCOD 1977; UNCCD 1994; Yang et al. 2005; Reynolds et al. 2007), the knowledge about the environmental effectiveness of different strategies to fight against drought is a key issue in order to address the best mitigation policies and strategies. In this context this paper focuses on the determination of the most effective set of mitigation and adaptation strategies applied to combat land degradation and drought in a latitudinal gradient.

1.1 Case study

The control of land degradation and mitigation of the effects of drought and desertification have a long history in Chile. Since January of 1998, with the approval and ratification of the UNCCD, the environmental policies for the recovery of degraded soils, started to be effective in coordination with diverse national organizations in charge of this environmental issue. The Chilean National Action Program (PAN 2000) was created within this context. The 78 % of productive soils in the country, showed degrees of erosion, ranging from moderate to very severe (CONAF 1999), and in the period 1997–2007, the country has lost 32 % of fertile land.

1.1.1 Area of study

This work takes place in north-central Chile, between latitudes 17° 30′S and 36° 33′S. The Regions between these latitudes are the administrative units affected to greater erosion and drought in the country. The total surface area of study represents the 50.2 % of the country, which corresponds to 37,935,970 ha.

The climatologic characteristic of the area of study fluctuates between hyper arid and semiarid zones, and the use of agricultural land increases from north to south. Table 1 shows the environmental characteristics of the regions under study, according to INE (2009). Figure 1 shows the area of study.

The critical areas or priority areas for combating desertification are Regions I, II, III, IV and V, the Andean plateau of the Regions I, II and III, and rain fed areas of Regions VI and VII. The Fig. 2 shows the desertification status by Region according to CONAF (1999).

Table 1 Summary of the main environmental characteristics of the regions under study

Characteristics	Regions						
	I	II	III	IV	V	VI	VII
Average Temperature (°C)	18	16.4	15.2	13.6	14	13.7	13.8
Precipitation (mm/year)	1	2	12	150	350	701	689
Land devoid of vegetation (%)	66	66	58	18	18	16	18
Bush and grasslands (%)	13	9	11	42	52	16	5
Agricultural land use (%)	0.5	0.5	2.3	4.6	1.45	27	25

1.2 Mitigation and adaptation strategies supported by government institutions

We consider both mitigation and both mitigation and adaptation strategies as a whole, because one complements the other, the evaluation of the effectiveness was made taking into account the set of the strategies employed by each agency, i.e., which is the most effective agency combating land degradation and drought by region.

The Chilean government annually assigns funds to support the mitigation and land reclamation programs of its main public Agriculture, Livestock and Forestry (ALF) promotion agencies. The support mechanisms under study are the Agriculture and Livestock Service (SAG), the National Forestry Corporation (CONAF), and the National Irrigation Commission (CNR). The promotion of agriculture, livestock and forestry lies mainly on these three agencies.

CONAF, through its Decree Law No. 701 on forestry development, includes mitigation investments for reforestation of lands with the purpose of encouraging the recovery of degraded forest lands. SAG through Supreme Decree No. 202 incorporates the recovery of soils in agricultural use of land through conservation, reclamation and rehabilitation. Similarly, Law No. 18,450 of the CNR aims to increase the irrigated area of the country by encouraging the modern irrigation of dry land, and by incorporating new land to farming, to improve productivity, in order to raise the income of the producers and to benefit the quality of life of rural likelihood.

The Table 2 summarizes the mitigation and adaptation strategies supported by the Agriculture and Livestock Service (SAG), the National Forestry Corporation (CONAF), and the National Irrigation Commission (CNR).

In this context this paper focuses on the determination of the most effective set of mitigation and adaptation strategies applied by the promotion of the agriculture, forestry and livestock in a latitudinal gradient of arid and semiarid lands.

2 Material and methods

The assessment of the environmental effectiveness of the financial support was made in a latitudinal gradient between the period 2000 and 2007. In this sense, the country represents an extraordinary advantage for such studies because its political-administrative division matches, from north to south, with a latitudinal gradient.

The data of the financial support and the data of the surface intervened by the promotion agencies were collected in 2008 from the data base of CONAF, SAG and CNR in Santiago, Chile.

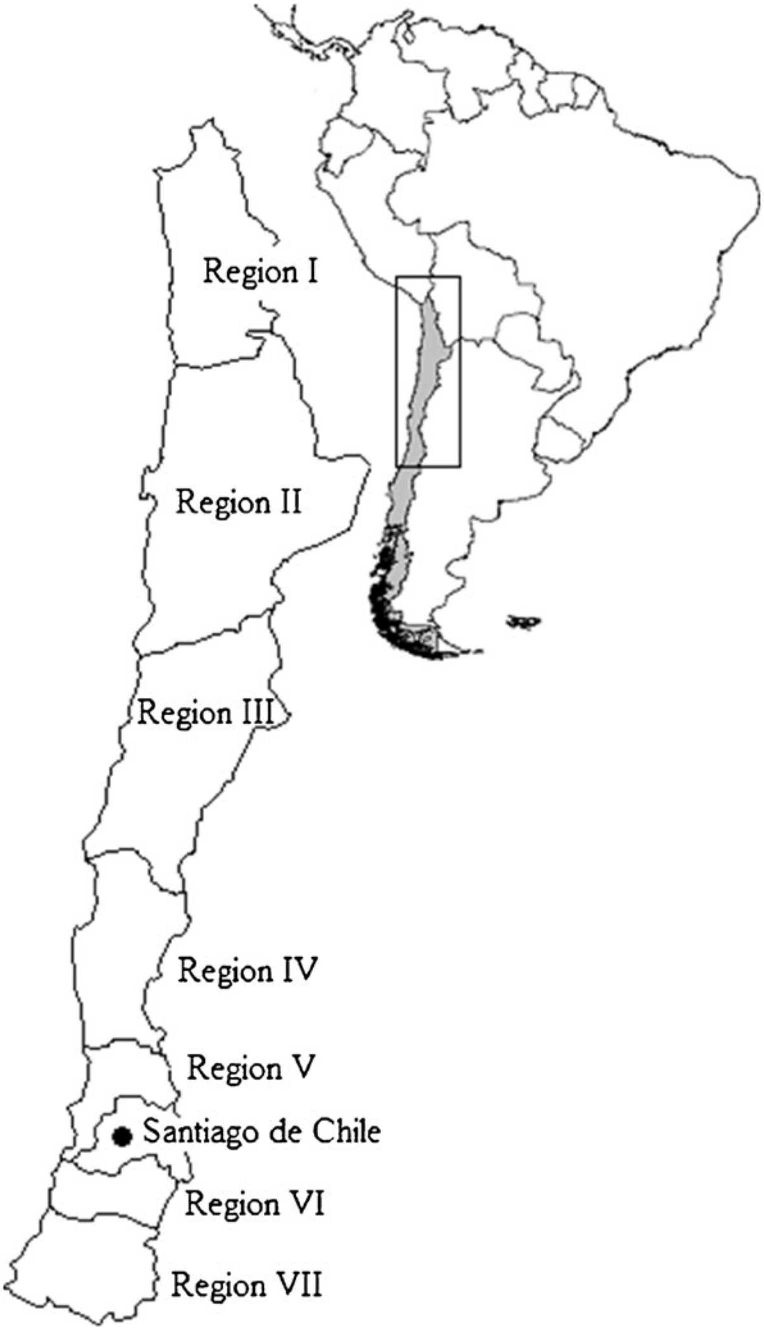

Fig. 1 Area of study in Chile

In a first step, we have calculated an inter annual effectiveness index of the financial support. This Investment Effectiveness Index (IE) was calculated by the quotient $IE =$

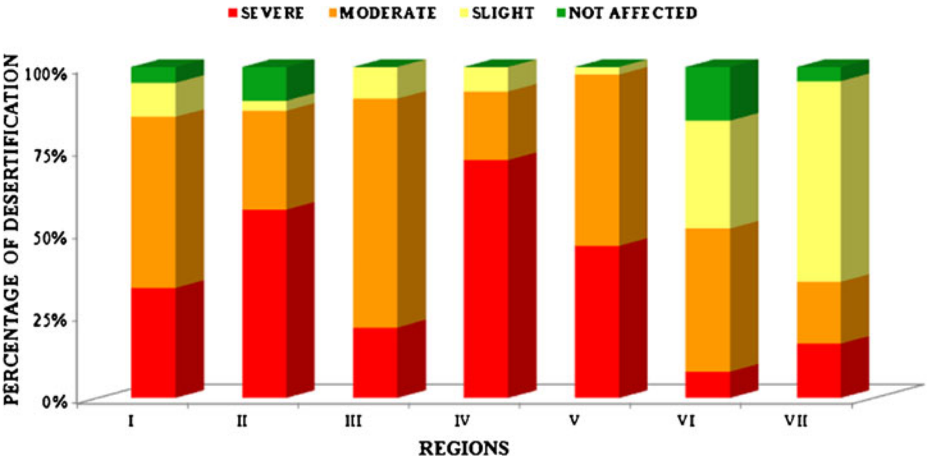

Fig. 2 Areas affected by different desertification conditions, given as the percentage related to the total surface of each region (Salinas and Mendieta 2012c)

FS/TOA for each region, where: FS is the Financial Support given in US$, and TOA is the Total Operated Area (ha) by each agency.

In a second step, and in order to assess the effectiveness of the financial support, we have performed multiple regressions to a significance level of $P \leq 0.05$. This statistical analysis allows the use of more than one explanatory variable; this will give us the advantage of using more information in the construction of the model and, consequently, more precise estimates (Novales 1996).

The multiple regressions were performed by each Region. In the regressions, the Investment Effectiveness Index of each agency, i.e. SAG, CONAF and CNR, were considered as independent variables, and the inter annual difference of the area affected by a high risk of desertification was considered as the dependent variable. Thus, low values of the dependent variable indicate a lower degree of desertification, and high values indicate a severe degree of desertification. The restrictions of the model were associated to the risks described by (Pukkala 1998; Schmitz et al. 2003).

3 Results and discussion

Our results suggest that the effectiveness of the investments varies by region from north to south, and also by each of the promotion agencies. The model has significant values ($p \leq 0.05$) on the correlation between the investment effectiveness index and the reduction of the desertification for the CNR in the Region II, for the SAG in Regions IV and VII, and for the CONAF in Regions V, VI and VII (Table 3).

3.1 Regions I, II and III

In the northernmost regions of the country, i.e. the most arid regions of the studied area, the CNR is the only agency whose effectiveness is significantly correlated to the decrease of the land affected by desertification in the Region II ($p \leq 0.05$). The negative value of the slope ($t = -3.29$) for the CNR indicates that the effectiveness and the reclaimed land areas are in an

Table 2 Summary of the mitigation and adaptation strategies supported by SAG, CONAF, and CNR

Support mechanisms	Mitigation and adaptation strategies
CONAF: mitigation investments for reforestation of lands with the purpose of encouraging the recovery of degraded forest lands	Afforestation, land reclamation and/or stabilization of dunes on fragile soils, and in lands in process of desertification, or in degraded soils with great slopes.
	Afforestation and sand dune stabilization in soils suitable for forestry.
	Management of forests planted on land suitable for forestry.
	Supporting smallholders for afforestation and forest management of stands planted on soils suitable for forestry.
SAG: recovery of soils in agricultural use of land through conservation, reclamation and rehabilitation	Phosphate fertilization to encourage the use of a fertilization correction dosage in deficient soils.
	Reduction of the acidity of the soils and the neutralization of the toxicity of the aluminum through liming. It is considered the incorporation of calcium carbonate or equivalent products to the soil.
	Soil conservation to encourage practices to prevent or reduce physical loss of soil.
	Establishment and regeneration of pastures oriented to obtain a permanent vegetation cover on degraded soils.
	Soil rehabilitation by elimination and reduction of physical and/or chemical impediments in soils suitable for agriculture.
CNR: to increase the irrigated area of the country by encouraging the modern irrigation of dry land, and by incorporating new land to farming	Increase the irrigated area of the country, improving the water supply to water scarce areas.
	Encouragement of more efficient water technologies for irrigation.
	Improvement of the drainage works and facilitation of the conversion of deficient irrigation systems to more efficient ones.
	Facilitation of the conversion of deficient irrigation systems to more efficient ones.

indirectly proportional situation. That suggests that the effectiveness index found for the CNR, is significantly correlated with the decrease of land degradation.

Dry lands are areas of the globe where the Index of Aridity (IA)—defined as the ratio of mean annual Precipitation (P) to mean annual Potential Evapotranspiration (PET)—is less than 0.65 (Maestre et al. 2006). This definition excludes hyper-arid areas of the globe where IA<0.05, such as the Atacama Desert. The Atacama Desert is hyper arid but in its Chilean area, it is crossed by several rivers fed by the melting snow of the Andes such as the rivers Lluta, San José, Loa, Copiapo, Huasco and Salado, which make its valleys suitable for agriculture and livestock since ancient times. The flow rate of these rivers is restricted to the snowmelt of the Andes and to the influence of the occasional rainfalls coming from the Amazon basin (IGM 2005). This fact makes this part of the desert unique, and gives it an

Table 3 Multiple regression model results for the strategies applied by the Agriculture and Livestock Service (SAG), the National Forestry Corporation (CONAF), and the National Irrigation Commission (CNR) in the regions analyzed

Region	Agency	t	R	R^2	ANOVA F
I	SAG	−2,127	0,716	0,512	2,623
	CNR	−1,277			
II	SAG	0,949	0,848	0,719	6,407*
	CNR	−3,29*			
III	CONAF	0,161	0,561	0,315	0,612
	CNR	−0,818			
	SAG	1,035			
IV	CONAF	−0,34	0,908	0,825	6,297*
	CNR	0,418			
	SAG	3,135*			
V	CONAF	−3,652*	0,946	0,895	11,425*
	CNR	1,301			
	SAG	0,812			
VI	CONAF	−4,134*	0,957	0,917	14,659*
	CNR	0,322			
	SAG	−0,499			
VII	CONAF	−6,031*	0,957	0,916	14,448*
	CNR	−1,608			
	SAG	−3,218*			

*Indicates significant values for $p<0,05$

extra portion of complexity to the analysis. The area of the river basins is where the CNR makes its efforts in combating drought. Thus, the water availability is a key resource for sustainable development in this area. Our results suggest that the effectiveness of the investments made in modern irrigation and in irrigation infrastructure in the areas of the Region II are environmentally significant.

The significant result of the correlation between the effectiveness of the investments and the improvement of land in this Region is a very important one, because it takes place in areas of the Atacama Desert, and could be indicating that it is possible to involve a fewer number of hectares to ensure the efficiency of the investments. That agrees with the results of Salinas (2011) and Salinas and Mendieta (2012c) who found out that the recovery and improvement costs per hectare in these regions are much higher than in the southern regions.

Desertification is usually associated with land degradation in rangelands under drought; however, desertification combines many land degradation processes and can be exacerbated by climate change (Gitay et al. 2001). In that sense, the mitigation investments made by CNR to incorporate land to farming by high technology irrigation seem to have a high degree of effectiveness. This fact is consistent in an indirect way with the documented by Zou et al. (2011) for China, where Water Saving Irrigation was demonstrated to play a role in climate change adaptation.

Our findings do not suggest that the investments of the promotion agencies analyzed are effective to combat desertification in the Regions I and III. However, there is evidence that the mitigation investments made by the ALF promotion agencies in combating desertification in the northernmost regions of the country allow the agricultural activity in these areas, having a positive impact in the ALF GDP and in the employment in the agricultural sector (Salinas and Mendieta 2012b). These regions are located in the area of the Atacama Desert. The agriculture in these Regions is characterized by small properties, family farming, and traditional subsistence farming, with a low rate of industrialization (FAO 2009). In relation to production, these areas can be considered as marginal areas for agriculture, understanding, that the designation of marginal, indicates that the productivity level in the concerned land is situated close to the margin beyond which management expenses and risks are not compensated by the profit obtained with production (Correia 1993). Usually marginal agricultural land is abandoned. That agrees with Schmitz et al. (2003), who argue that the availability of water for agricultural purposes would mean better living conditions, which would slow the migration to urban areas and as a result it would preserve the rural environment.

As many other parts of the world (Fedoroff et al. 2010), water scarcity is a critical concern in northern Chile. Furthermore the demand of water for non-agricultural uses could endanger the availability of water for irrigation. Therefore strategies that ensure sustainable use of the limited water resources are of absolute necessity (Zou et al. 2011).

3.2 Region IV

In the region IV, the effectiveness of the SAG has significant correlation with the reduction of desertification ($p \leq 0.05$) and a positive slope (t=3.135). This result suggests that the investment effectiveness and recovered area are in a directly proportional position. Thus, the higher the degree of desertification, the higher the value of the effectiveness index. That suggests that the recovery cost is higher and that there is a greater difficulty in recovering land in this region.

The region IV is characterized by intensive agricultural use of land, where the most critical and eroded areas correspond to dry lands, resulting in low productivity of the environment. In these areas, an extensive grazing goat livestock has been developed that exceeds the Animal Carrying Capacity, i.e. the number of animals per hectare and year that a given area can sustain for a long period without causing a loss of a significant plant cover (Quiroz 2007). Approximately the 90 % of goat livestock in Chile is owned by family farming. The goats are exploited in terms of low production efficiency, and in extensive operating systems, taking advantage of the low cost of the natural resources (FAO 2009). Agreeing with the definition given by Correia (1993) to the marginal agriculture, we can consider the situation of the Region IV as a marginal livestock management. Overgrazing is the predominant indicator pointing out to an increase in desertification in the Region IV (Salinas and Mendieta 2012a). About the 50 % of the total number of goats in the regions under study are located in Region IV. The erosive impact caused by goats and sheeps is not only associated with the arid lands, but it also affects the Andean plateau pastures used as summer pastures (Quiroz 2007). With the intensification of grazing and under long lasting drought conditions, the land has been degraded, being now most of the surface of the Region IV at serious risk of desertification (Fernandez 1997; CONAF 1999; Nuñez et al. 2002). The described situation explains one of the main causes of the desertification in the Region IV. The significant correlation of the SAG indicates that the improvements made in the Region IV are effective, being its limiting factor the high cost that they imply.

Worldwide, managed grazing is the most extensive form of land use, with dry lands supporting 78 % of grazing on the planet (Asner et al. 2004). Grazing alters vegetation properties, water availability, soil erosion and compaction, carbon cycling, and many other ecological processes in dry lands (Asner and Heidebrecht 2005). Desertification, due to overgrazing, is also documented for other areas of the world (FAO 1964; Huss 1972; Le Houérou et al. 1981). On the other hand, goat breeding is an economic activity and a source of income for the population of the Region IV, which shows a high rate of poverty (Quiroz 2007). The SAG is competent not only for the promotion of agriculture, but also for the promotion of livestock. In that sense, the sustainable management of the goats could help to mitigate desertification.

Although the strategies applied by SAG in this Region helps recovering degraded land (Salinas and Mendieta 2012a), our results indicates that the land recovery is not very effective. In that sense, and according to (Mitchell and Csillag 2001; Tubiello et al. 2007) one adaptation strategy for drylands would be to change the cutting and grazing regime for grassland. As stated by Iglesias et al. (2011) wetter winters and an increased likelihood of fields remaining waterlogged into spring mean that the housing period of livestock may need to be increased, with the animals remaining inside for longer in the spring. Hotter summers may also mean that ruminants need to be housed in summer to reduce problems from heat stress or because pastures may not remain productive during the summer months.

3.3 Regions V, VI and VII

Table 1 show that the model has significant values ($p \leq 0.05$) on the correlation between the investment effectiveness index and the reduction of the desertification for the CONAF in the Regions V, VI and VII. The regression has a negative slope for the CONAF in the three regions ($t=-3.652$, $t=-4.134$ and $t=-6.031$, respectively for Regions V, VI and VII). These results suggest that the effectiveness indexes found for CONAF in these regions are significantly correlated to the decrease of land degradation. This situation suggests that the strategies carried out by the CONAF could help effectively in combating desertification in these regions.

Our results reveal that afforestation strategies to fight desertification and drought are effective in regions with a Mediterranean climate, but not in arid lands. Considering that this is a problem that concerns many countries in all regions of the world, it would be better to use native species of bushes or types of vegetation that even maintaining soil humidity and soil cohesion, do not demand large amounts of water consumption.

In the Region VII the model indicates that the regression is also significant ($p \leq 0.05$) for SAG, with a negative regression slope ($t=-3.218$). This result indicates that the effectiveness index is significantly correlated to the decrease of land degradation and that the variables are in an indirectly proportional situation. Thus, the higher the value of the effectiveness index, the lower the degree of desertification for SAG's intervened area. The greatest efficiency of SAG's investment is related to the fact that the main economic activity in the region is linked to agriculture. This activity has a high degree of development in this region, which is favored by the Mediterranean climatic condition of the Region VII.

These results are in accordance to the statement of Wall and Smit (2005) who concludes that the mutually supportive relationship between sustainable agriculture and climate change adaptation could be used to justify more government support for sustainable agriculture policies and programs. In that sense, the strategies applied for the recovery of soils in agricultural use of land through conservation, reclamation and rehabilitation are effective tools in areas suitable for agriculture.

4 Conclusions

Many potential agricultural adaptation options have been suggested, representing measures or practices that might be adopted to alleviate expected adverse impacts (Smit and Skinner

2002). Climate and weather conditions are a good example of factors that require on-going adaptation (Wall and Smit 2005). In that sense and in order to optimize the investments for adaptation and mitigation, our analysis is a contribution to reveal which type of strategies are more effective in different environmental conditions in strict terms of combating desertification and drought. Our findings suggest that the effectiveness of the different mitigation and adaptation strategies to fight against desertification and drought varies depending on the different climatic conditions, on the agricultural, forestry and livestock activities developed in the land and on the type of strategies carried out.

In arid and hyper arid areas, the strategies to increase the irrigated areas are to encourage the modern irrigation of dry lands, and to incorporate new land to farming, these actions seem to be effective strategies to combat desertification and drought. Moreover these strategies improve the productivity in marginal areas for agriculture, in order to raise the income of the producers and to benefit the quality of life of rural likelihood. Thus our results reveal that the promotion of the technical irrigation is a key issue in arid regions.

The strategies for the recovery of soils for agricultural use of land through conservation, reclamation and rehabilitation seem to be effective in Mediterranean climate areas, such as the Region VII, where winter rains and spring snowmelts are present, i.e. where there is water availability in some period of the year. For the other hand, in areas affected by severe land degradation, as a result of long lasting droughts and the overexploitation of land cover by overgrazing, such as the Region IV, the mitigation strategies applied for the recovery of soils for agricultural use of land through conservation, reclamation and rehabilitation do not seem to be effective. Thus, there is necessary the implementation of strategies leading to a sustainable management of cattle, such as those described by Wall and Smit (2005) and Iglesias et al. (2011). These strategies could be oriented to the re-introduction of native grasses for pasturing that are drought resistant when rotational grazing is practiced on them, and strategies that facilitate the producers the cattle housing in periods of severe droughts to reduce overgrazing problems in very weakened pastures. All this should be done with strict control of the Animal Carrying Capacity of the land.

The reforestation of lands with the purpose of encouraging the recovery of degraded forest lands seems to be effective in areas of Mediterranean climate, where water availability is present at least in winter months. In arid and hyper arid areas, where water availability is unclear, there would be desirable to focus the efforts in native bush improvement strategies.

The collection of data for the development of this work has been one of the biggest difficulties we have faced. The data were widely dispersed in different Institutions depending on the characteristics of each indicator. In this regard, and for systematic assessments of the land degradation processes and subsequent evaluations of the effectiveness of the mitigation and adaptation strategies, it would be desirable to incorporate the creation of specific databases into the discussion context of the desertification.

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