

## El agotamiento de los recursos pesqueros y la emigración: el caso de la laguna de Tecomate, Guerrero, México

*The depletion of fish stocks and migration: the case of Tecomate Lagoon, Guerrero, Mexico*

*O esgotamento dos recursos haliêuticos e de migração: o caso do Lago Tecomate, Guerrero, México*

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### Resumen

Las lagunas costeras son importantes por ser refugios de especies acuáticas, terrestres y dar alimento a la población humana asentada en sus márgenes. El deterioro ambiental ha hecho que disminuyan los recursos pesqueros y, por tanto, ha afectado a las poblaciones ubicadas en el margen de la laguna de Tecomate, las cuales tienen un precario desarrollo socioeconómico, al igual que muchas otras localidades de México. Los hallazgos de esta investigación tienen que ver con la escasez de los recursos pesqueros ocasionados por la poca profundidad del lago, su alta concentración en sal y temperatura en la época estival, y lo contrario en la estación de lluvias. El ecosistema sufre radicales y opuestas alteraciones ambientales a lo largo del año, lo que afecta la

biodiversidad íctica, esencial para la subsistencia de la población asentada en la ribera de la laguna. Asimismo, los escasos recursos pesqueros ocasionan que la población joven migre en busca de trabajo para mejorar su nivel de vida. Se requieren estrategias de desarrollo desde un enfoque sustentable y la intervención de los actores locales para planificar el uso y conservación de los recursos pesqueros.

**Palabras clave:** agotamiento, recurso pesquero, migración, laguna de Tecomate.

### Abstract

The coastal lagoons are important as refuges for aquatic and terrestrial species and provide food to human population settled in its shores. Environmental degradation has decreased fish stocks and, therefore has affected populations located on the Tecomate lagoon shores, which have a precarious socio-economic development, just like many other towns in Mexico. The findings of this research have to do with the shortage of fish stocks due to the shallow depth of the Lake, its high salt concentration and temperature in the summer season, and otherwise in the rainy season. The ecosystem suffers radicals and opposing environmental alterations throughout the year, which affects the biodiversity of fish, essential for the subsistence of the population settled on the banks of the lagoon. Also scarce fishery resources cause young people to migrate in search of work to improve their standard of living. Strategies of development from a sustainable approach and the involvement of local actors is required to plan the use and conservation of fishery resources.

**Key Words:** depletion, exhaustion, fish stocks, fishery resources, migration, Tecomate Lagoon.

### Resumo

As lagoas costeiras são importantes por ser um refúgio de espécies aquáticas, terrestres e fornecer alimentos para a população humana vivendo em suas margens. A degradação ambiental tem causado o declínio dos recursos haliêuticos e, populações, portanto, tem afetado na margem da lagoa Tecomate, que têm um desenvolvimento sócio-económico pobres, como muitas outras cidades no México. Os resultados desta pesquisa têm a ver com a escassez dos recursos da pesca causados pela superficialidade do lago, alta concentração de sal e da temperatura no verão, eo oposto na estação chuvosa. O ecossistema sofre mudanças radicais e opostas ambientais ao longo

do ano, afetando a biodiversidade de peixes, essenciais para a sobrevivência da população que vive nas margens da lagoa. Também escassos recursos haliêuticos que causam os jovens a migrar em busca de trabalho para melhorar seu padrão de vida. estratégias de desenvolvimento são necessários a partir de uma abordagem sustentável e a participação dos agentes locais para planejar o uso e conservação dos recursos haliêuticos.

**Palavras-chave:** exaustão, os recursos haliêuticos, migração, Tecomate lagoa.

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## Introduction

The actions undertaken by the federal Government for the development and strengthening of water resources in irrigation districts were not based on environmental impact studies, but in decisions of rulers in turn taken from its vision of development and their particular form of Governing. At the time of make effective its initiatives only considered the number of people that would be "beneficiary", as opposed to the number of the "non-beneficiary", without pausing to think in the short and long term which could result in environmental effects, especially in the case of the Tecomate Lagoon, with the construction of the Mexican Revolution DAM at the beginning of the eighties, last century.

The communities Tecomate Pesquerías, Cerro la Pesquería and Las Ramaditas located on the shores of the lagoon, have been affected in fishing, their main activity, so have had to develop different strategies to survive. In addition to engaging in agriculture, as the temporary planting of corn, or the care of coconut orchards, they have migrated. These migratory processes are reflected in its population, because although the net population balance was positive during the period from 1970 to 2010, in one of these communities was negative. At first glance it seems that the construction of the dam and its impact on the environment caused the migration, but if the situation is analyzed in more detail it is possible to see that factors combine, factors related to the economic crisis of the 1980s and the facilities that back then had to migrate on a temporary basis. All this facilitated that migrants to be present on a regular basis, increasing the population and, subsequently, with the help of remittances, the development of the communities.

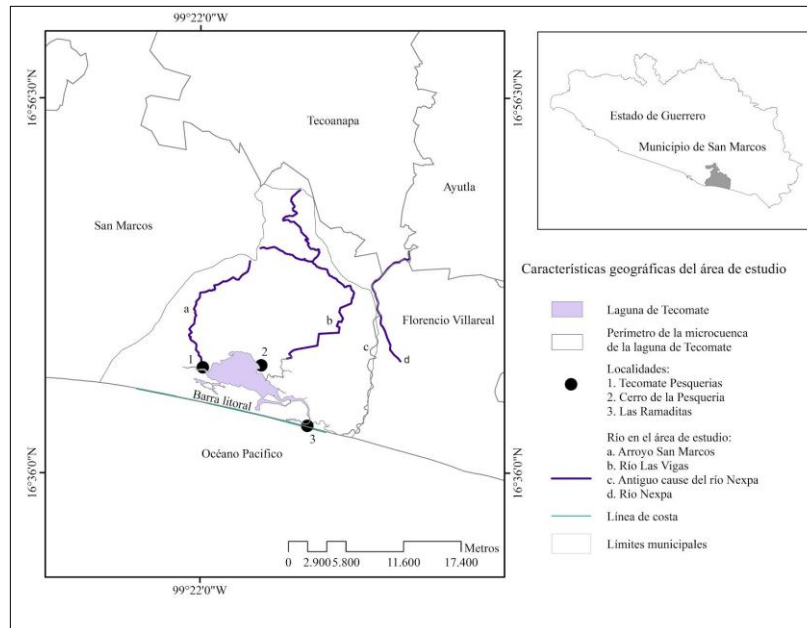
Cutting freshwater supply to the lagoon by the Nexpa River nowadays produces drastic changes in the conditions of the lagoon hydrological regime and in the catch levels of native species. The proximity to the municipal capital of San Marcos, as well as to the port of Acapulco, allows the inhabitants to develop, in addition to the aforementioned agricultural activities, economic activities that guarantee them the obtaining of the sustenance by temporary or definitive employment, as well as Of the remittances they receive from the migrant population and the assistance they receive from government programs.

### **Methodology**

The research work was carried out in three localities located at the edge of the Tecomate Lagoon, which has an area of 28 Km<sup>2</sup>, located at 16 ° 41 '28' N and 99 ° 19 '40' ' Longitude west, to 11 km of San Marcos, municipal head of the municipality of the same name. Tecomate Fisheries, Cerro la Pesquería and Las Ramaditas are located on the lagoon rim (Figure 1), whose settlements have a very close link with the lagoon because it provides them with resources (fish and crustaceans) to survive, although they also dedicate themselves to farm activities.

In order to observe the structure and organization of the communities, in particular the development of the fishing activity, tours were carried out in the lagoon environment and in the selected communities; In addition, surveys were conducted to know the type of catch and the approximate amounts of the catch, and semi-structured interviews to hear the actors' tendencies and behavior of production, as well as the population.

**Figure 1.** Tecamate Lagoon: location.



Source: trabajo de campo e INEGI (2016).

## Results

The fishing activity generates economic, social, alimentary and cultural production, also creates jobs and provides sustenance to several families that live in the surroundings of the lagoon of Tecamate; However, fishing has ceased to be its main economic activity.

In the Tecamate lagoon four species were identified: lisa (*Mugil* sp), malacapa (*Diapterus peruvianos*), flag (*Ariidae*), pijolín (*Centropomus robalito*), tilapia and crab. The commercial value of fishing depends on the supply and demand, in addition to the holiday seasons (Easter, December and bridges) (Table 1). Although there are fishing cooperatives, they do not record any of the catches, which made it difficult to estimate their volume. In an interview, fishermen said that after the construction of the Mexican Revolution dam and having closed the passage of the Nexpa River to the lagoon, fishing has declined and is very scarce. What little they catch only helps to supplement their income.

**Table 1.** Laguna de Tecomate: species and value of the catch, 2014.

Nombre común	Nombre científico	Valor de la captura por kilogramo (pesos)
Lisa	<i>Mugil cephalus</i> (Linnaeus, 17589)	20.00
Malacapa	<i>Diapterus peruvianos</i> (Cuvier, 1830)	25.00
Cuatete	<i>Ariopsis guatemalensis</i> (Günther, 1864)	30.00
Pijolín	<i>Centropomus robalito</i> (Jordan y Gilbert, 1882)	40.00
Jaiba	<i>Callinectes arcuatus</i> (Orday, 1863)	25.00
Camarón	<i>Penaeus vannamei</i> (Boone, 1931)	80.00
Langostino	<i>Macrobrachium americanum</i> (Bowman y Abele, 1882)	60.00

Source: trabajo de campo (2014).

The people consider that the Tecomate lagoon is dying because it has little water, besides that in dry season the water gets too hot and its level drops a lot.

### Organization for fisheries

Fishing in the lagoon as a "common catch area" is carried out by organizations located in Tecomate Fisheries, Cerro de la Pesquería and Las Ramaditas. Of a population that had 884 inhabitants in 2010 in the three localities, 274 are engaged in fishing (99.63% of the EAP). The fishery is distributed as follows: 60% is located in Tecomate Fisheries, 26% in Cerro de la Pesquería and 14% in Las Ramaditas. This important fisher population is very high compared to the surface of the water body of the lagoon (1: 0.10 km<sup>2</sup>); There is a great fishing pressure, another probable cause of the exhaustion of the fishing resource.

The fishermen are natives of the three localities and those who have emigrated come from neighboring communities; It is deduced then that the people dedicated to the fishing have a great rooting and identification with its locality. On the other hand, in the microregion the individualistic behavior persists in coastal fishermen, who are indifferent to the economic and social development of their localities and, consequently, apathy to associate and to face in a combined, organized and efficient way the productive function that they play . This scenario is presented in the fishing entities of the South Pacific, as mentioned by Villaseñor and García

(1990) and therefore on the coast of Jalisco, where they found many cooperatives disorganized and with deficiencies regarding the registration of the fishery product.

However, the fishermen of this microregion do not totally oppose technical change. Apparently, their lack of interest in change is due to lack of knowledge about the opportunities or possibilities of accessing support programs implemented by the government, or the scarcity of financial resources or other reserves, prerequisites for accepting the risk of entering in something new. It is also clear the disinterest of the three levels of government (federal, state and municipal), to resolve or alleviate the situation of socio-environmental deterioration in the lagoon. Only in electoral campaigns are promises to solve this problem.

**The behavior of the population**

In addition to analyzing the impact on the natural conditions of the lagoon, the reproduction of its ecosystem and the fishing activity, it was important to consider the behavior of the population in the communities that surround it. For that, the period 1970 - 2010 was analyzed, when there were four censuses and two counts of population by the National Institute of Statistics Geography and Informatics (table 2).

In 1970, there were no data on the population of the Las Ramaditas community, which suggests that their size was not significant or had not yet been established, while the communities of Tecomate Pesquerías and Cerro de la Pesquería were already included in the censuses of population.

Table 2. Laguna de Tecomate: total population of the communities, 1970-2010.

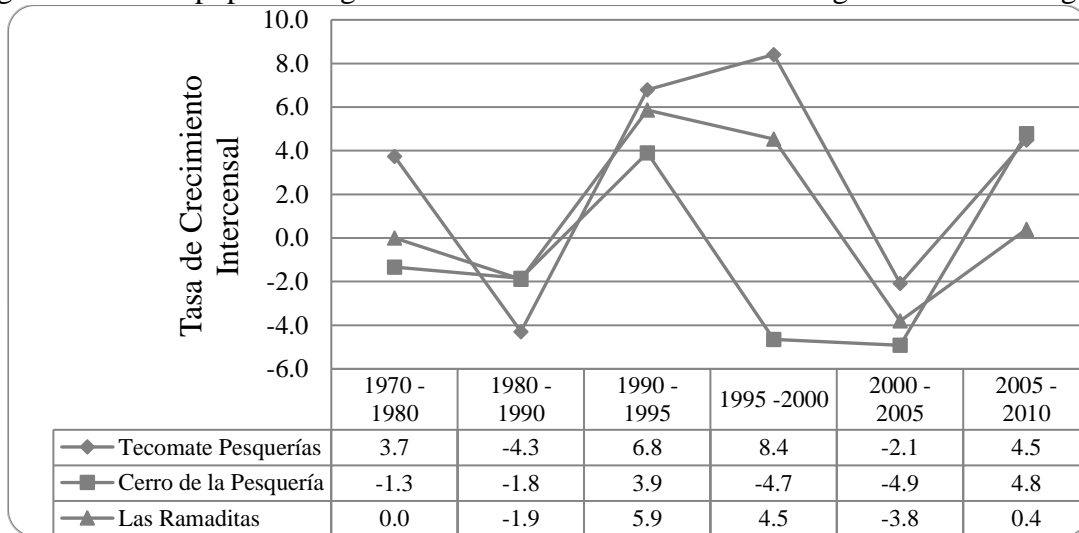
Localidades	Años						
	1970	1980	1990	1995	2000	2005	2010
Tecomate Pesquerías	353	485	277	371	527	472	578
Cerro de la Pesquería	188	163	133	159	122	92	114
Las Ramaditas		143	116	150	184	149	152
Total	541	791	526	680	883	713	844

Fuente: elaboración propia con base en información de la Secretaría de Industria y Comercio, 1973 e INEGI, 1983, 1991, 2001 y 2011.

The behavior of the population in the three communities was atypical due to abrupt variations in population increase and decrease. Failure to do a proper analysis can result in a priori assessments, leading to inadequate conclusions. It is important to consider that the studies on migratory processes in the fishing communities of the coasts of Mexico are scarce, both in the Gulf and Pacific slopes.

When considering the behavior of the intercensal growth rates of the population, it is observed that the communities under study have alternately had positive and negative population growths. During the 1980s to 1990, all communities had negative growth rates, a situation that was repeated in the five-year period 2000-2005; While in the five-year periods 1990 to 1995 and 2005 to 2010, all communities had positive growth rates (figure 2).

Figure 2. Rate of population growth of the communities surrounding the Tecamate lagoon.



Source: elaboración propia con base en la tabla 1.

García et al. (2007) Indicate that Mexico is currently the world's largest exporter of migrants and the third recipient of remittances, making Mexican migrants the largest population group of foreigners in the United States. For its part, Madera (2010) indicates that the reasons and reasons that lead to migration are: curiosity motivated by listening to stories by the inhabitants of the locality; Seeking income from lack of means of subsistence in the locality or region; Inability to get a good job or continue with higher education; Accompany the spouse in their migration.

Other points of interest are natural catastrophes, scarcity of natural resources and environmental degradation, as they can also generate migration. Gradual or unforeseen environmental changes



in the short or long term cause the mobility and displacement of people, which affects living conditions and the obtaining of livelihoods. In addition, increased migration can contribute to further environmental degradation, but it can also make it possible to cope with economic hardship, making it a survival strategy for those who move.

Based on the above, we speak of migrants due to environmental causes (Cassels et al., 2005, Black et al., 2011). They are people or groups of people who, because of sudden or progressive changes in the environment, are negatively affected their living conditions and thus are forced to leave their places of habitual residence, either temporarily or permanently, to move to other Areas in your country or abroad.

After considering the intercensal growth rates of the population, as well as the definition of migrants due to environmental causes, the communities surrounding the Tecomate lagoon, during the decade of 1980 to 1990, were reduced in the three localities. The construction of the Mexican Revolution dam and the reduction of freshwater feed negatively impacted on fishing, also within a framework of economic crisis. Mexico, like the rest of the developing countries, did not escape the provisions established by the international financial organisms, and to face its crises had to adapt its economic policy to the prevailing economic model.

Consequently, during the decade 1980-1990, changes in the population of the communities under study were more than the result of the construction of the dam and economic policies linked to the development of irrigation districts - which affected fishing activities -, it was the impact of the economic crisis. In addition, as traveling to the United States was easier than now that allowed the mobility of the population, that is to say, migration relapsed mainly in the men, who when visiting the community used to beget a new member.

In recent years, particularly in the five-year period 2005-2010, population growth in the communities of Cerro de la Pesquería and Las Ramaditas was not very high. In the first community was 22 and in the second of 2 inhabitants, which contrasts with that of Tecomate Fisheries which was 106 (Table 1). The increase in the number of dwelling houses, as well as the number of inhabitants, is related to the arrival of people from other localities attracted by the natural beauty of the surroundings, as well as the arrival of remittances by the relatives of migrants. The growth of families makes it necessary to build more homes.

This, together with the natural conditions of the environment, particularly the lagoon, as a result of the recovery of population levels and growth in the number of dwellings, will increase the

demand for public services: light, piped water, drainage and paving; Which will have a negative effect due to the lack of adequate means to guarantee the sustainability of the lagoon environment.

It should also be taken into account that the closeness to the municipal head allows the mobility of the inhabitants of the communities to develop complementary activities or take a definitive employment in activities outside the ones that are developed in the community, which allows to indicate that during forty Mobility has been presented for economic rather than environmental reasons.

### **Discussion**

The Tecomate lagoon is located within the hydrological region No. 20, which includes from the Papagayo River to the Verde River in Oaxaca. The study area is part of the Nexpa river basin. At present, the Tecomate lagoon receives only a basin of 384 km<sup>2</sup> and two streams that drain directly; These are the ones that nourish the system and are influenced by the characteristics of the climate regime prevailing in the region. However, the lagoon hydrological system is limited by the input of fresh water and incoming seawater.

The construction of the Mexican Revolution Dam is a result of the efforts made by the League of Agricultural Communities (now the National Peasant Confederation). This hydraulic work is located in the channel of the Nexpa River, 1 km northwest of the town of El Guineo and Las Vigas, in the municipality of San Marcos, Costa Chica region of the state of Guerrero. In 1984, construction of the Mexican Revolution Dam (with a capacity of 260 million m<sup>3</sup>) was completed to generate electricity and irrigation for an area of 14 983 ha in the municipalities of Florencio Villareal, Cuautepec and San Marcos. Irrigation district 105 (SEMARNAT, sf).

Once the dam and the irrigation system came into operation, the water from the main channel of the Nexpa River was reduced. The channel of the Nexpa river in the coastal plain is located in Florencio Villareal and the little water that escurria was sent to the lagoon of Chautengo, located in Florencio Villareal. Consequently, the connection to the Tecomate lagoon was deprived of the main contribution of fresh water, and its flood regime was decimated, as were hydrological phases, according to Bayley and Petrere (1986). For Novoa (1986), when the main channel of the river ceased to be running, the lagoon tended to maintain a low water level for 32 years. In the

summer, in the months of June to September, the lagoon temporarily receives an influx of fresh water that surpasses the feeding of the rest of the year, reason why the level of flood is exceeded. The physicochemical parameters (temperature and salinity), besides the low depth, have contributed to the instability and to the process of environmental deterioration of the lagoon (Villerías et al., 2016).

It should not be forgotten that the coastal lagoons were born in the last glaciation, which occurred approximately 18,000 years ago, and that sea level rise caused the ocean to invade coastal depressions, valleys and river deltas, thus generating the current Coastline, which includes bays and sea entrances. In areas where there was water from the continental drainage, estuaries and coastal lagoons were formed.

An outstanding feature is the formation of a sandy cord parallel to the coast, which reveals the accumulation of sand as a result of marine and wind processes, in formations of irregular size in width, which are important because they help to protect the coastal lagoons ; In addition, in these bars the exchange of subsurface and groundwater of fresh and marine water takes place.

The local hydrological and geological processes in the lagoon, as well as the development policies of the irrigation districts from the construction of the dam, have been determining factors for this body of water to be in a process of watering. In addition, sedimentary transport of the marine environment from north to south and the proximity of the mouth of the Papagayo River as the main tributary of sediments of continental origin should be considered, producing formation in the lagoon of a sedimentary bar (Figure 1) that separates the Sea of the lagoon Its maximum width is 2.9 km and it is located in front of the community of Tecomate Fisheries and its smaller amplitude is of 1.3 km. Located near the community of Las Ramaditas. This process of marine accumulation (lagoon bar) is of natural origin by effects of marginal marine currents.

In the same way it must be considered that there is an erosion of the soil as a consequence of the anthropogenic activities that take place in the upper part of the basin, which cause the deterioration of the natural resources (socio-environmental deterioration); Degradation that has effects in the lagoon (shortage of runoff and increase of sediment). Consequently, the fish resources that are developed in this body of water are negatively affected. This has transcended the economic activity of fishing, which is located in the three localities located on the lagoon edge, so it is important to comment on some of the population that lives there.

An important factor considered in the present spatial analysis is the participation of the local economically active population (EAP) and that related to fishing activity. It should be noted that the EAP is closely related to the gross domestic product of any region as a result of the activities taking place in the territory, which in turn involves the population that is employed in them.

The Guerrero economy presents deep structural problems: state GDP is below the national average, there is a delay and decapitalization of the field, a high percentage of the EAP located in the informal sector or in agricultural activities of low productivity and a poor development of the sector secondary. Evidence shows this: three out of five people can not meet their basic needs, and two out of five do not have enough to eat; They do not have access to the minimum necessary for their development and survive below the "official poverty limit". In rural areas, this problem is more acute and the most lacerating expressions of extreme poverty occur in indigenous peoples and in some areas where basic services do not exist. Nearly 68% of the population of Guerrero and 46% of the population of the municipality of San Marcos, where the study area is located, are in a situation of poverty (CONEVAL, 2012).

For the year 2010, in the communities located to the side of the Tecomate lagoon were settled 844 inhabitants: Tecomate Fisheries had 68%, Las Ramaditas 18% and Cerro de la Pesquería 14% of that population. They are small localities that between the years of 1970 and 2010, as a whole they had a net increase of population of 53 inhabitants. The case of the community of Cerro de la Pesquería stands out, which had a net decrease of 49 inhabitants, although in the whole they show a typical population behavior of all rural community. According to INEGI (2011), the EAP occupied in these localities ranged from 32.89% to 34.21% relative to the total population, and considering that the entire EAP was occupied, this can also be taken as the range of the dependency index Economic; However, it should not be forgotten that the EAP employed in all three communities is mainly self-employed in the primary sector (agriculture and fisheries). The concept of income is closely related to that of salary and can be understood in different ways: as a price or as an inflow of capital, for being a fee for a job rendered; As well as a cost, since it is a remuneration of a factor of production. However, the concept of salary has evolved with progress and today is one of the most complex problems for the analysis of the economic and social organization of peoples. Wage imbalances are capable of provoking social mobilization, because incomes are disparate, and for the majority of the population are insufficient and employment is scarce, fostering the development of informal activities.

Throughout the time different theses have arisen around the wages, each with its contributions like: the theory of the Income of Adam Smith, that considers wages dependent on the wealth. The most important factor, however, is the fact that the rise in wages does not necessarily constitute an increase in the amount of national wealth, the steady increase in that wealth depends on increased production and the sale of Whether in the interior or in the country (Tsoulfidis, 2010, p.26).

On the other hand, income plays a very important role because it expresses how families define their consumption strategies over time, in the way they spend (Torres and Gasca, 2001). Also, in situations of crisis, he develops skills to counteract the effects of loss of income, such as: using his workforce more intensively, increasing the working day and incorporating new family members into the various activities. At the same time, it introduces changes in the structure of its expenditure of non-basic and basic goods.

The different levels of rural and urban poverty are associated with low incomes, which makes it possible to determine which groups of the population, as well as their location, are in a situation of vulnerability, which is reflected in their level of well-being. In rural areas, the situation is worrying since it is mentioned that in Mexico 80% of the population does not manage to cover food minimums according to the characteristics of their income; Is a population that develops subsistence activities in the primary sector (agriculture, fishing), or that has migrated and is located in the peripheral areas of large and medium cities, without having a permanent job, living in overcrowded conditions and sometimes Public charity.

In the settlements located on the banks of the Tecomate lagoon, on average only 30% of the employed EAP receive a salary, the rest are unemployed and self-employment activities, or they move to San Marcos, the nearest urban community, to Temporarily engaging in various activities. Some receive economic support from government programs (temporary employment, sixty or more, single mothers, head of household), or migrants in other entities or abroad. In these fisheries, income is a function of the fishing season and the prices that the intermediaries allocate to the catch product. Undoubtedly, the income of the population that is engaged in fishing are not the most adequate. It is necessary to encourage this activity to generate new forms of production and organization of fishermen, with the purpose of diversifying their activities and can obtain complementary income that help to alleviate the poverty in which they live.

## CONCLUSIONS

In the case of the inhabitants of the localities located on the verge of the Tecomate lagoon, although they do not show intentions and willingness to organize collectively in the development of fishing and agricultural activities, consideration should be given to the development of institutional proposals that To maintain the ecological balance, to promote activities that tend to strengthen the fishing activity, to seek that through the imprisonment of the dam in the dry season allows the feeding of fresh water and encourages the reproduction of species, as well as the diversification of The agricultural activity, since one of the major challenges facing the region and the country is that of food production.

As mentioned before, the participation of the federal, state and municipal governments, as well as local organizations, is required to implement development strategies as Rozas (2000) and Albuquerque (2004) point out. These actions of local organization will strategically allow to propose development initiatives in the search to improve the living conditions of the population settled in the edge of the lagoon of Tecomate.

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