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Fiscal Economic Instruments for the Sustainable Management of Natural Resources in Coastal Marine Areas of the Yucatan Peninsula

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Abstract: Fiscal economic instruments (FEI) are indirect regulation mechanisms that generate public revenue for the state through rights to use, charges, and concessions. In Mexico, some of these instruments can be used in the surveillance, administration, and preservation of the environment. In this paper, we analyze the changes in Federal and State growth rates of expenditure budgets in critical areas of the Yucatan Peninsula coast to describe their contribution to sustainable development during the last 12 years. We present an adaptation of the methodological guide of economic instruments for environmental management from CEPAL, with 2013 as the base year for the Gross Domestic Product (GDP) deflator and the use of the Protocol of Nagoya year as an international compromise signed by Mexico. The results obtained show that the expenditure budgets respond to economic, political, and short-term security attention without expectations for sustainability. However, alarming evidence of severe environmental deterioration in the coast is diminishing natural attraction, from tourism, for example, which is the main source of income in the region. The effective use of FEI by local governments may be useful to addressing environmental challenges from a decentralization process with better awareness of the importance of coastal areas for regional sustainability.

Keywords: economic instruments; Yucatan Peninsula; government budget; coastal sustainable management

1. Introduction

Indirect regulation mechanisms allow productive agents (businesses and families) to be involved in the governance of natural resources [1]. Among these indirect mechanisms, Economic Instruments (EI) stimulate the productive agents to change their behavior in the use of natural resources and the products that generate pollution, noise, or environmental degradation [2]. Thus, citizen, government, and productive sectors are encouraged to share the objective of implementing strategies focused on ensuring environmental sustainability and thereby ensuring national security, sovereignty, and the conservation of the natural capital (goods and environmental services) [3].

Fiscal economic instruments (FEI) for environmental protection, environmental taxes [4], or green fiscal instruments are a type of EI that relates to the use, enjoyment, and exploitation of natural resources, generating public revenue for the state, which can be partially or entirely used in the surveillance, administration, preservation, and recovery of the environment [5]. The tax implementation on environmental pressures such as energy, fragmentation of space, greenhouse gas emissions, and environmental degradation resulted in actions that enable the generation of employment and developmental efficiency of environmental policy objectives [6].

Diverse studies have analyzed the design, implementation processes, and the effectiveness of these EI, mainly in developed countries [7]. For developing countries with limited experience with FEI, additional challenges related to informational demands, institutional demands, and political acceptability have been analyzed [8].

One of the key aspects to describe the success of FEI is the measurement of the use of revenue, a process that plays a leading role in providing feedback on environmental management strategies [9]. An initial approach to the process of monitoring involves identifying the areas in which the budget is invested according to the objectives of the current public policies, the areas of analysis within the expenditures, and the public budgets [10].

FEI are fundamental in Mexican regulations (e.g., General Law on Ecological Balance and Environmental Protection) and form part of the environmental taxation that can be defined as the economic-environmental policy strategy, which uses the fiscal system and levies for the purpose of environmental protection, in the governance of natural zones [11]. Additionally, their implementation is applied for sustainable development [12]. Despite the economic and ecological importance of the coastal marine areas of Mexico and their contribution to the FEI [13], the financial resources for their management are limited, and they lack a coastal policy that prevents them from proper development and mitigation of environmental degradation [14,15]. However, there are few studies that have investigated how revenues generated by FEI are used or invested in coastal marine areas according to the objectives of the current public policies, especially when there are changes in development paradigms. Mexico's environmental policy changed with the incorporation of the Protocol of Nagoya that complements the Convention on Biological Diversity for conservation and sustainable use of biodiversity, which has channeled actions all around the country, including fiscal instruments to promote conservation [16,17].

This study focuses on how FEI are used for the sustainable management of the marine-coast area of the Yucatan Peninsula (YP) region. This region is of strategic importance in the National Development Plan of the country [18]. In addition, in the context of Mesoamerica, YP represents a strategic position for commercial interchange and port efficiency between central America, the Caribbean, and the south of the United States of America (USA) [19]. In addition, the region is threatened by exposure to extreme hydro-meteorological events [20].

We aim to contribute to this knowledge by describing the condition, and changes in the Federal and State Expenditure Budget applied to environmental challenges in the last two six-year terms (2007–2018) in the YP. We present an analysis referring to half of this time period, corresponding to the involvement of Mexico in the Protocol of Nagoya. Thus, we hypothesize that after 2014, there will be a change in the trend of the government expenditure budget that addresses the new development paradigm. This article intends to contribute to the coastal management literature of developing countries such as Mexico, particularly within budgetary governance when there is a paradigm shift. Thus, our theoretical contribution, according to Zhou et al. [5] criteria, will be in the practical utility of budgetary governance that uses FEI to achieve sustainability objectives in coastal areas [21].

In this way, the questions that led this investigation were: do federal expenditure budgets in critical areas of coastal regional development in YP show differences in the last two six-year terms of the federal government? Do state expenditure budgets show

differences between the three states of the YP in those critical areas of coastal regional development?

The second chapter of this article includes a theoretical framework and antecedents of the use of FEI; the third chapter describes the methodology used; the fourth chapter presents the results; the fifth chapter discusses our main findings; and the final chapter includes conclusions and some policy implications arising from the analysis.

2. Theoretical Framework and Antecedents

2.1. Budgetary Governance

Budgetary governance refers to the processes, laws, structures, and institutions that are in place to ensure that the budgeting system meets conditions for action for the betterment of society (effective), engenders trust among citizens and government that use available resources to archive worthwhile objectives, such as sustainability [7]. Budgetary governance analysis is complicated since it encompasses all levels of government, national and subnational, where different mandates and levels of autonomy are different among the countries, but desirably will be coordinated, coherent, and consistent between them. The theory of budgetary governance has been analyzed from a planning or evaluation perspective in more detail for developed economies with coastal zones: Australia, New Zealand, USA, England, Portugal, for example [22–25].

For most coastal countries, most of these studies emphasize the rapid change and uncertainty that coastal regions have faced under climate change effects and urban development over the past two decades, the impacts on the communities living on the coast, and how coastal management could become more adaptative, socially fair, and effectively implemented [26,27]. In this way, Chandran et al. [28] examined Wagner and Keynesian views concerning the link between real government spending and real Gross Domestic Product (GDP).

2.2. FEI Design, Implementation, and Evaluation in the World

In the environmental economics context, the concept of Economic Instruments (EI) dates from the beginning of the 20th century, proposed by the English economist Arthur C. Pigou (1877–1959) to collect taxes on generators of pollution [29]. The arguments for putting a price on pollution include encouraging polluters to reduce their pollution as much as is economically feasible and internalizing negative externalities in the pricing [3,30]. In addition, in European countries, the application of environmental fiscal instruments has been strengthened over several decades. The implementation of taxes on certain environmental pressures such as noise, fragmentation of space, greenhouse gas emissions, environmental degradation, and transport, amongst others, has resulted in a 9% increase in GDP, which in turn has resulted in actions that enable the generation of employment and developmental efficiency [29]. In Latin-American countries, the process of incorporating EI as taxes and subsidies is part of the consolidation phase, whilst payment for environmental services or the reduction of emissions due to deforestation and the destruction of forests (REDD+) in environmental governance is still in its infancy [31].

In addition, effectiveness studies for developed countries show that different assumptions challenge their design but also, that market, cultural, legal, and administrative conditions play a critical role in their implementation, sometimes above the principal intention to optimize environmental policy cost-effectiveness [32–34]. For developing countries, O'connor [8] identified additional challenges related to informational demands, institutional demands, and political acceptability.

2.3. State of the FEI in Mexico and in the Marine-Coastal Areas

In Mexico, it was not until 2008 that revenue was evaluated using indicators for measuring performance through a short, medium, and long-term targeted impact and monitoring process [35]. Particularly, isolated studies of the FEI have been found to be related

to the measurement of performance, relevance, and consistency for environmental management mainly associated with soil, water, and air pollution [36,37]. Several authors have reviewed the environmental taxes in the country, and recent studies have addressed negotiable climate change levies, permits, and environmental taxes on carbon [11,38–40].

In general, the reports indicate that Mexico possesses a very low level of environmental tax collection, making up only 1.3% of national GDP. For example, in South Africa, 2.69% was collected in 2019, according to data from the OECD [7]. In Mexico, a lack in the performance of taxes was identified, arising from environmental damage, for the protection of human health and the ecosystem. This reality is represented by a low Environmental Performance Index (EPI) with a value of 55.03, which is much less than other countries such as Chile and the USA with EPIs of 69.93 and 67.52, respectively [40].

In Mexico, the Exclusive Economic Zone, which includes coastal and marine areas (3,149,920 km²) [27], constitutes almost 60% of the national territory and generates many economic, social, and ecological benefits: (a) almost half of the population of the country that inhabits coastal areas [41–43]; (b) nearly 43% of Mexico's protected areas preserve its valuable natural resources and cultural services [44–46]; (c) and its multiple ecosystem services [45]. In addition, marine-coastal vegetation has great economic potential due to its support and regulation services that allow entrance to national and global carbon markets [17,47,48], (d) the diversity of the oceanographic processes on both coastlines of the country, which may provide an alternative energy source to that generated by the extraction of hydrocarbons [49], (e) contributes approximately 43% to the national Gross Domestic Product (GDP) [50]; (f) generates employment in fisheries, port areas, and tourism services. Despite this, the knowledge of what and how the FEI is implemented currently appears to focus on the profits generated by Federal Land Maritime Zone (ZOFEMAT) concessions [14], which only consists of a narrow coastal strip approximately 20 m wide of the 11,220 km of coastline. Hence, the collection of FEI for the use and exploitation of natural resources of the marine-coastal zones could be clearly underrepresented in the national finances while not being entirely clear about how they are used for preservation.

However, the strategic importance of these areas is not always accompanied by management conditions that ensure their sustainability, which implies a degradation and loss of coastal ecosystems, a loss in the well-being of the local people associated with them, and an impact on coastal economic development [16,17]. This scenario would imply a greater impact on the countries that have a relatively more percentage of the population settled in coastal areas and is highly dependent economies of the coastal-marine areas, such as the nations of Latin America and the Caribbean [48,51]. As noted by de Alencar et al. [52], sustainability requires the interdependence of environmental, social, cultural, economic, political, and governance domains in a comprehensive vision at multiple scales. Fundamentally, it is necessary to identify the limits of economic growth for three reasons: to define a carrying capacity and mitigate the greatest source of stress in natural systems, to implement equitable economic models that generate sustainable well-being, and thus that the income derived from the development of infrastructure by urbanization and industry (e.g., tourism, ports) contribute to mitigating the socio-environmental impacts that they generate [49,51–53].

For marine-coastal areas, despite 20.6% of the ZOFEMAT (2292.74 km²) being concessional, it is uncertain how much of the budget expenses and also how the money is used [14]. An alternative for the financial sustainability of the coastal area could be a social assistance program called Temporary Employment Program (TEP), which could be implemented for the purpose of environmental recovery of the coastal communities following the occurrence of natural disasters [54]. This kind of alternative work can help to finance a sustainable economy to restore coastal systems, healing bodies of water, and conserve charismatic marine species, as well as building resilience capabilities of local governance to climate change [53]. Since both funds are of federal origin, they are inferred from the common home exchange. However, among various applicable taxes, duties,

tariffs, and subsidies, none are established for collection purposes only since they must be complemented by other tax provisions.

According to documents from the Centre for Public Finance studies [55], in the states of the YP region, the greatest economic boost is derived from secondary and tertiary activities associated with hydrocarbon extraction and tourism, such as manufacture, mining, construction, financial and commercial services, which coincide with services relevant to other states of the Gulf of Mexico.

2.4. FEI Generated in Marine-Coastal Areas

A study by the Federal Law of Rights [13] identified seven categories related to the rights to the use, charges, and concessions with respect to natural areas and resources of the coastal and marine zones of the country (Table 1). As established by the law, the collected amounts from the instruments will be directed to the Ministry of the Environment and Natural resources (SEMARNAT) and its decentralized bodies (National Commission of Water and National Commission of Protected Areas) or to the federal entities and their municipalities when they have entered into collaboration agreements with the Ministry of Finance and Public Credit. The quantity collected can be destined for surveillance, maintenance, preservation, or improvement of zones, species, or buildings in the coastal area.

Table 1. Rights and concessions are indicated in the Federal Law of Rights [13] with respect to the use of natural zones and resources of coastal and marine areas.

Sector	Use of Natural Zones and Resources of Coastal and Marine Areas
Ports and navigation	Use and exploitation of maritime port works (ports, terminals, and installations) and port services.
	Flagging or resignation of the flag of vessels for nautical tourism and fishing activities,
Fishing and aquaculture	Commercial fishing permits and concessions
	Commercial aquaculture permits
National Waters	Service rights related to the use of national waters (use of drinking water, aquaculture, recreation centers)
	Rights to discharge biodegradable and non-biodegradable wastewater to a receiving body for recreation and sport, fishing and hunting, mining, and industrial activities.
Wildlife	Export and import rights of specimens, products, and subproducts from wild species, sport hunting.
	Non-extractive use of wildlife in centers for conservation and investigation of wildlife.
	Extractive use of specimens of wild fauna in federal lands and zones (ducks, crocodiles).

	Use of natural marine and insular elements of the ANP of Federation competition for recreational, tourist, and sports activities.
Tourism	Use of elements and resources within ANP for touristic or urbanistic activities and tourist services.
	Rights to access museums, monuments and archaeological areas owned by the Federation.
Mining	Extraction of Stone materials (sand, among others)
	Exploitation rights of salts or saline by-products of marine waters and use of ZOFEMAT for that purpose.
Mixed	Rights environmental impact of works and activities.
	Exploitation of beaches, ZOFEMAT, land reclaimed from the sea, or any marine water.

The transparency of the fiscal budget derived from the use, exploitation, and enjoyment of the coastal-marine areas of the country represents a challenge for the planning and application of national public policy instruments [11,56]. This is not only for the reasons given above regarding their contribution to the national GDP, their socio-economical relevance, and their ecological value but also because in the coastal states of the country, the population has experienced an irregular growth of 39% in the last 20 years [14] and because there exists a significant industrial, touristic, urban and port growth with elevated demand for water and energy [14,56]. These are all situations that generate environmental, economic, social, and institutional tension in the coastal-marine areas [57–61].

The NPMCM document defines the use and protection of the coastal and oceanic zones of the country as crucial for national development. In addition, it includes a strategic goal of improving the local, regional and national economy by encouraging environmentally responsible productive activities [56]. Nevertheless, the NPMCM does not propose any specific strategy or line of action that involves the use of FEI to internalize the environmental costs of such activities. This reality does not correspond to the intention of national taxation, which, according to Ríos-Granados [60], it must correspond to the deterioration of the environment produced by the activity. Moreover, the author indicates that this environmental tax attempts to make anyone who uses or consumes environmental goods pay the real cost of the depletion of such goods. Other authors have argued that fiscal reform is required to contribute financially to coastal areas for the purposes of conservation and restoration of their natural resources [61]. Thereby, contributing to ecological and economic self-management [62] and, thus, to local governance.

3. Materials and Methods

3.1. Study Design

This study used the institutional expenditure evaluation methodology (EGI for Spanish acronym). The methodology is based on an ex-post evaluation alternative that centers the attention on the budget and on the strategic products or results of budget decisions according to institutional goals. This method has been part of the Ex-post Evaluation System of Budgets Directorate (DIPRES, for its acronym in Spanish) of the Ministry of Finance of the Government of Chile to ensure an effective allocation and use of public resources within the framework of the fiscal policy [63]. For this study, this methodology was conducted following the implementation of budgets in a time period prior to and following

an international compromise signed by Mexico (2014 as the reference year for the Protocol of Nagoya in Mexico) when the budget was audited according to the audit process described by [64]. For this analysis, quantitative data were used according to the 3 steps of the “methodological guide of economic instruments for environmental management” of the Economic Commission for Latin America and the Caribbean [65]: (1) compilation of the annual expenditure budget; (2) the analysis of the annual expenditure budget for each program of the Branches; (3) transformation of the data with a deflator for comparison objectives.

3.2. Study Area

The marine-coast of the YP region represents 12% of the total area of the country and 30% of the total Mexican coast [66]. Its extension of 39,612.15 km² corresponds to the emerging continental shelf of the States of Campeche, Quintana Roo, and Yucatan [66] (Figure 1), which forms part of the great marine ecosystem of the Gulf of Mexico and the Caribbean Sea. Its highly permeable limestone karst soil formed from fine and medium sand with shell deposits does not allow water runoff at the surface level and facilitates its infiltration into the mantle. Along the coastline, there are sand dune formations originating from the deposition of sand grains by the action of the wind and from calcareous deposits, of biological origin, as a product of the disintegration of the coral reefs and mollusks’ shells [67]. An outcrop on the continental slope, an anticyclonic gyre, a cyclonic current of the continental shelf of the peninsula, and a thermic front in the region allows the presence of an abundance of species of tropical oceanic phytoplankton and zooplankton that have maintained a high level of production in the marine zone, sustaining diverse commercial fisheries [68–70].

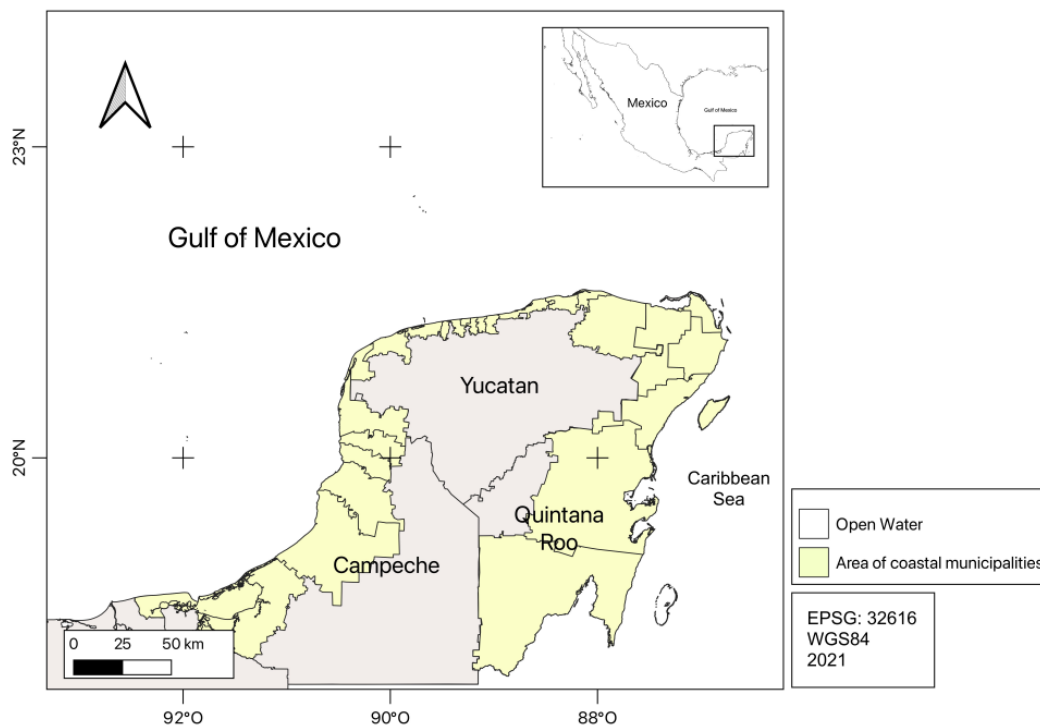


Figure 1. The geographical location of the Yucatan Peninsula region (20° N, −90° E).

The YP region is increasingly exposed to natural threats resulting from climate change and the warming of the ocean [20]. These include hurricanes, intense tropical storms, and fires that cause variable damage each year due to wind, rainfall, and excessive burning of grasslands that challenge the adaptive capacity of the social, productive, and

environmental sectors of the region [71]. Its coastal ecosystems are the final destination of underground drainage basins charges with agrochemicals, fertilizers, waste from pig and poultry farms, and increasing water discarded from domestic and industrial use [72–74]. In addition to this, there were other problems that were similar or shared within the 3 States of the Peninsula, such as rapid urbanization, destruction of wetlands (including salt marshes, sandy beaches, coral reefs, and mangroves) [75]. Erosion is present in most sandy beaches in the Peninsula, especially in Sabancuy, Campeche; Cancun, Quintana Roo; and in Progreso, Yucatan; extreme weather events cause flood risk and damage in the coastal zones of the YP [76]. Other problems were salinization and pollution of aquifers, siltation, and hindrance navigation, increasing muddiness of waters, and decreased biological productivity [77].

3.3. Data Collection

Qualitative information was obtained through secondary sources. The information about the Federation expenditure budget was downloaded from the Federation's Official Gazette portal, and for Campeche, Quintana Roo, and Yucatan, the pages for the state government (Supplementary materials, Table S1. The expenditure budget categories analyzed were for: fisheries, aquaculture, port infrastructure, transportation and communication infrastructure, and tourism (Table 2). These categories and the budgeting branch for the prevention of natural disasters derived from the effects of climate change were considered critical for YP coastal regional development [20,78]. The analyzed period included the fiscal years from 2007 to 2018, which covers the last 2 6-year terms of the federal government, the last 2 for Yucatan (2007–2018), the last 3 for Quintana Roo (2005–2022), and Campeche (2003–2021).

Table 2. Categories for which the analysis of the expenditure budget was conducted.

Expenditure Budget Category	Federal	Campeche	Quintana Roo	Yucatan
Fishery and Aquaculture (08)	x	x	x	x
Communication and transport (09)	x	x	x	x
Environment and natural resources (16)	x	x	x	x
Energy (18)	-	x	-	-
Tourism (21)	-	x	x	x
Programmable spending in natural disasters (23)	x	-	-	-

It is necessary to clarify that although the federal budget includes energy and tourism sectors, these were not included in our analysis since the contribution to coastal municipalities was not entirely clear and was mostly focused on inland municipalities. Particularly, the Ramo 13 budget, which corresponds to the specific enhancement of seas and coasts at the federal level, was not included in the analysis since it was only in existence since 2007; and the fund destined for ZOFEMAT was not included due to a lack of information for this category by state throughout the analyzed period. Finally, the analysis includes the description of changes for the Disaster fund budget, assuming that its use was mostly associated with extreme hydrometeorological events that hit the coasts, for the reasons given above.

3.4. Data Processing and Statistical Analysis

The data of the expenditure budgets were deflated using GDP deflator 2013. In order to analyze the changes in the Federal and State expenditure budgets in the critical areas of regional coastal development of the federal government in Mexico, the budget growth rates were calculated throughout the last 2 6-year terms, and the results were plotted by sector and by state. Subsequently, a bibliographic analysis was performed to describe the rising or falling peaks in the observed changes.

With the purpose of describing that after 2014, there will be a change in the trend of government expenditure budget addressing the new development paradigm following Mexico's involvement in the Protocol of Nagoya, we performed 2 statistical comparisons: (a) an analysis of variance (ANOVA) in order to identify the differences between the means of the budgets among the 3 states for the critical areas; (b) Student and Wilcoxon test for comparing government expenditure budgets from 2007 to 2012 and from 2013 to 2018 according to normally distributed data. First, the normality of the data was determined using the Kolmogorov–Smirnov test. For normally distributed data, the student's test was performed for a sample and for those data that were not normally distributed, the Wilcoxon test was performed for 1 sample. In order to know if the average budget decreased or increased from one period to another, the means of both periods were compared for these 3 states (Supplementary material, Table S2–S4). Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26 software.

4. Results

4.1. Federal Expenditure Budgets in the YP (2007–2018)

Analyzed in detail, there was evidence that showed that federal expenditure budgets only changed drastically when special events occurred. In the environment and natural resource sector, there was a growth rate increase of 1276% that concurred with the 13a Conference of the Parties on Biodiversity (COP) in Cancun, Quintana Roo in 2016. During that conference, more than 196 countries met to discuss various conservation issues related to natural resources [79]. Thus, the Mexican government increased public spending on personnel, infrastructure, promotion, and security. In the fishery sector in 2014 and 2015, the Direct Fisheries Support Program (PROPESCA) was implemented. Finally, in the FONDEN, the rate of growth from 2009 to 2010 was 6199%, which coincides with the most chaotic year in terms of natural disasters (rains, mudslides, earthquakes, and floods) that affected the country [80] (Figure S1).

4.2. State Expenditure Budgets in the YP (2007–2018)

Statistical descriptives of central tendency (media, median, standard deviation, and outlier values) of state expenditure budgets are shown in Figure 2. These values were presented for state and for critical areas of coastal regional development (programs). Quintana Roo is the state with the greatest variation among its budget in the analyzed period, while highway and port infrastructure programs also showed the greatest variations. On the other hand, tourism and FONDEN showed evident outliers, which extreme values correspond to Tourism in Quintana Roo state, that was modified for visualization purposes, but its real value was 32,954 million MX pesos.

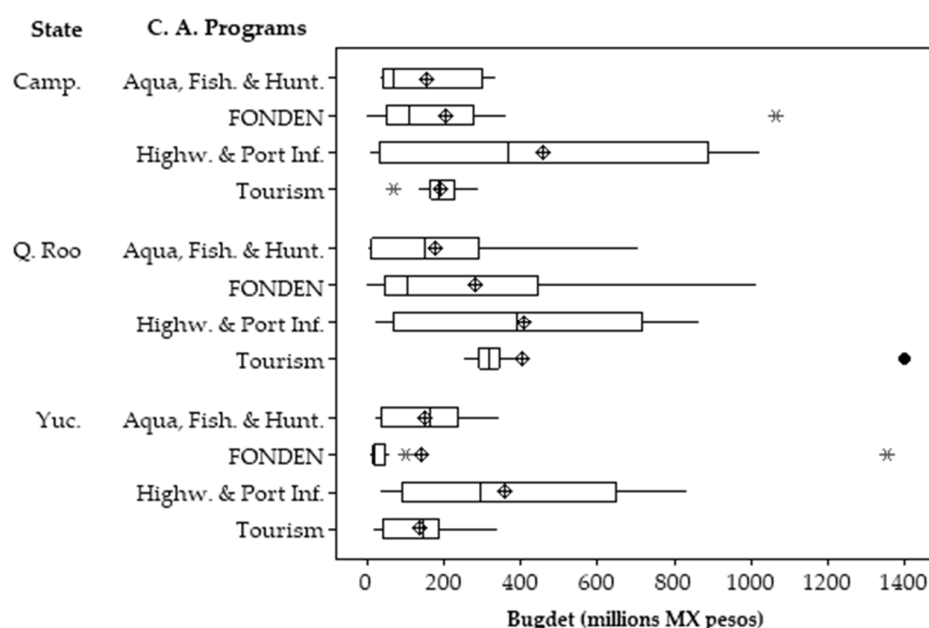


Figure 2. Budget expenditures in critical areas of coastal regional development in YP states (2007–2018). Crossed white diamond represents the media value; vertical line represents the median value; asterisk represents outlier values; black dot represents an extreme outlier, which was modified for visualization purposes. Horizontal line represents standard deviation. Aqua, Fish. & Hunt. refers to Aquaculture, fishing and hunting program; Highw. & Port Inf. refers to the highway and port infrastructure program. Camp. refers to Campeche; Q. Roo refers to Quintana Roo and Yuc. refers to Yucatan. C.A. Programs refers to critical areas of coastal regional development.

In Table 3, ANOVA results are shown. At a 95% confidence level, there was not a significant difference in the means of aquaculture, fishing and hunting, highway and port infrastructure, tourism, and FONDEN program budgets among the three states. In this way, the null hypothesis of equality of means was accepted for all critical areas of coastal regional development.

Table 3. ANOVA results for critical areas of coastal regional development between the three states of the YP.

Critical Areas Programs	ANOVA	
	F	p
Aquaculture, fishing and hunting	0.023	0.977
Highway and port infrastructure program	0.247	0.782
FONDEN	0.174	0.841
Tourism	1.114	0.340

In the comparison of the means of the highway and port infrastructure program category of Quintana Roo, a statistical significance was observed, with a p -value of 0.000 ($p < 0.05$) (Table 4). Likewise, a significant difference in the comparison of means of the highway and port infrastructure program of Yucatan was observed, corresponding to a p -value of 0.001 ($p < 0.05$). Finally, in the comparison of means of the tourism program of Campeche, a significant difference corresponding to a p -value of 0.032 ($p < 0.05$) was observed.

Only in the categories of tourism in Quintana Roo and Yucatan, was the difference between the means of both periods statistically significant (p -value < 0.05) (Table 4). Finally, in the comparison of the means of the tourism Category of Yucatan, a significant difference was observed corresponding to a p -value of 0.046 ($p < 0.05$).

Table 4. Student and Wilcoxon t-test for a sample.

	t/z	gl	Sig. (Bilateral)	Average Budgets Increased (↑) or Decreased (↓)
Aquaculture, fishing and hunting of Campeche (2007–2012) vs. (2013–2018) (**)	−0.314		0.753	↓
Aquaculture, fishing and hunting of Quintana Roo (2007–2012) vs. (2013–2018) (**)	−0.314		0.753	↓
Aquaculture, hunting and fishing of Yucatan (2007–2012) vs. (2013–2018) (**)	−1.363		0.173	↓
Highway and port infrastructure of Campeche (2007–2012) vs. (2013–2018) (**)	−1.572		0.116	↓
Highway and port infrastructure of Quintana Roo (2007–2012) vs. (2013–2018) (*)	11.525	5	0.000	↓
Highway and port infrastructure of Yucatan (2007–2012) vs. (2013–2018) (*)	6.505	5	0.001	↓
Natural Disaster Fund of Campeche (2007–2012) vs. (2013–2018) (**)	−0.105		0.917	↑
Natural Disaster Fund of Quintana Roo (2007–2012) vs. (2013–2018) (**)	−0.734		0.463	↑
Natural Disaster Fund of Yucatan (2007–2012) vs. (2013–2018) (**)	−1.572		0.116	↓
Tourism of Campeche (2007–2012) vs. (2013–2018) (*)	2.941	5	0.032	↓
Tourism of Quintana Roo (2007–2012) vs. (2013–2018) (**)	−1.992		0.046	↑
Tourism of Yucatan (2007–2012) vs. (2013–2018) (**)	−1.992		0.046	↑

* For these data with normal distribution, a student's *t*-test was performed. ** For these data with non-normal distribution, a Wilcoxon test was performed.

5. Discussion

Our findings contribute empirically based knowledge to practical questions that challenge coastal needs in budgetary governance, which include environmental protection and sustainable development in agreement with critical areas of coastal regional development and some international compromises.

5.1. Changes in the Spending of the Federal Budget on Critical Areas of Coastal Regional Development

Regarding our first research question, do federal expenditure budgets in critical areas of coastal regional development in YP show differences in the last two six-year terms of the federal government? We found that budgets used during the past 20 years are aligned with medium-term strategic priorities of the government related to tourism development, as it was defined 70 years ago with the impulse of the Riviera Maya, particularly for Quintana Roo and Yucatan. Additionally, our results indicate that although aquaculture and fisheries are still important sources of income and well-being for coastal communities in the region, government budgets for this sector are decreasing, without capital investment plans for infrastructure needs and sectoral or social priorities. The same trend was observed for the highway and port infrastructure program of Quintana Roo and Yucatan. This last trend is in contrast with the information provided in the Numeralia of the Mexican coast [81], which identified that the coastal transportation infrastructure represents 63% of the national road infrastructure. However, it does not necessarily include the roads of the coastal municipalities or the roads that connect the coasts with the rest of the territory.

Regarding the Federal budget for the Environment and Natural Resources category which, except for the year 2016, the trend in the data did not exhibit marked fluctuations that could be identified as warning that the budget does not correspond to the environmental degradation exhibited by the coastal resources of the region. For example, the coastal water and the environmental quality distributed to 10 coastal cities of the region, show severely deteriorating environmental conditions due to industrial development, water discharge, habitat, port, tourism, and recreation, which has been documented since the 90s [82]. Many of the activities include those with FEI listed in Table 2. This is particularly alarming if tourism is the main source of income in the region and 78% of the business operates in spaces of federal, state, or reserved conservation (municipal or private) whose main attractions depend on the maintenance of their natural conditions [83]. There are other reasons for alarm within the environmental sector, one is the lack of biological [70] and economic [84] characterization of the natural areas of the region that had made the implementation of the FEI in the management of marine-coast resources slow, partial, and unstable [85]. This has permitted the loss of the natural conditions and processes and, with that, the loss of ecosystem services, which result in more recovery costs in the medium and long term [86]. Possibly as a reflection on the population growth that has led marine-coastal areas to change the use of land for tourism and real estate purposes. The economic spillover generated encourages public policies to continue with practices and uses where the mechanisms of fiscal, financial, and market regulation do not compensate for the environmental impact [49,87,88].

According to the data from SEMARNAT from 2006, the number of inspection and verification visits of the use and exploitation of the ZOFEMAT have decreased and could result in the modification of Annex 1 of the Administrative Collaboration Agreement in Federal Tax Matters [89]. This trend has made us believe that to reserve funds for surveillance, maintenance, and preservation or improvement of natural areas, species, or real estate in the coastal area is not a priority, even when it is indicated in the Law of Federal Rights and are under intense demand, are suffering the effects of climate change, and the growing discharge of contaminants [41,42,90].

Regarding the communication and transport category, the construction of coastal infrastructure such as ports and communication routes that facilitate their mobility has been carried out despite the environmental impact on the coast, such as the fragmentation of the connectivity of ecosystems, the decrease in the environmental services, and the often-irreversible environmental alterations due to the installation of communication routes on bodies of water [83,91–93].

The trend of budget expenditure of the FONDEN indicates the need to construct local and regional planning capacities to generate financial sources in the face of environmental contingencies. Several international agencies emphasize the need for financial sources for the recovery and reconstruction in the case of disasters with the intersectoral collaboration of local governments, civil society, and the business sector, which if necessary could request resources from the federal government once the budget of the federative entities are exhausted [94,95]. An interesting observation that needs further explanation is the rate of growth from 2009 to 2010 of 6199% in the FONDEN that corresponds to public work (repair of street and poles, street cleaning) after disaster events in the region (personal communication of former state secretariat) and the Cancun Climate Change Conference in 2010 (COP16).

Finally, the dynamism of the budget year in the touristic sector is remarkable [96–98]. Clearly, this coincides with the appreciation that this sector is the axis of regional transformation that has been a trigger for the investment in the highway and port infrastructure sector [99] and with the common development model of developing countries where the government sees touristic activities as the main currency source [100,101]. In Mexico, as in other coastal countries, coastal areas are dominated by mass tourism that have many disadvantages in terms of environmental changes [102,103].

5.2. Changes in the Spending of the State Budget in the Critical Areas of Coastal Regional Development

Regarding our second research question, do state expenditure budgets show differences between the three states of the YP in those critical areas of coastal regional development? It should be clarified that although the YP has an ecological corridor formed by coastal wetlands with high hydrological importance and essential habitats for bird conservation, it has not shown consistent management strategies that ensure their connectivity and ecological preservation, as was documented by Vidal et al. [104] and despite 62% of the territory of the YP region being under the conservation status and their marine-coastal area forming part of the Mesoamerican Biological Corridor [105]. Federal budgets are allocated to each state according to their lobbying in the House of Representatives, and each state allocates its federal budget according to what is perceived as their own most pressing needs and environmental challenges, clearly coastal degradation is not one of them. However, federal government compromises with conservation and sustainable use of biodiversity (e.g., Protocol of Nagoya) was not evident for any of the three states of the YP. This is shown by ANOVA results where any significant differences among average budgets in aquaculture, fishing and hunting, highway and port infrastructure, tourism and FONDEN programs for the three states were found.

At the state level, the budget assigned by each sector presents changes with slightly pronounced increases and decreases, except for some specific periods that are indicated below. In aquaculture, fishing and hunting (Figure S2), the increase in the budget at the start of the analyzed period could be due to the momentum generated by the federal government in the National Development Plan 2007–2012 [18] in which the need to address the stagnation of sustainable production of the sector and the low income of the producers that participate were considered a political priority. The modernization of the fishing fleet was encouraged in order to elevate sustainable and profitable production to maximize the income of the producers and it was decided that subsidies would be kept to buy fuel. However, the document also highlights that the productive potential of the federal entities must continue with a decentralization process that locally serves the regulatory, socio-

economic, and environmental policy causes that promote stagnation [106]. For the YP region, this financial injection became evident during some years when the Food and Agriculture Organization of the United Nations (FAO) boosted the aquaculture sector [107].

Other financial sources for the agriculture and fishery sector for natural disasters include one specifically for the sector and the FONDEN. These funds were increased following the passage of hydrometeorological events that took place in 2002, 2005, 2007, 2009, and 2010 (Karl, Dean, and Felix) that caused extraordinary draught in the sector [81,108–110]. Moreover, after the creation of the Special Program against Climate Change in the State of Yucatan and a Climate Change Fund for the YP [109,110] (Figures S3 and S4). The highway and port infrastructure program includes expansion and modernization of highway infrastructure and port installations, temporary employment programs for conservation, and reconstruction of rural roads. These programs are documented in official web pages [111–113] (Figure S5).

Financing in the tourism sector is more dynamic than in the fishing sector. It was observed that from 2007 to 2018, the national policy had placed emphasis on the economic growth of the country through boosting tourism that coincides with the declaration of being an international tourism pole in the PND 2012–2018 and implementation of the highway and port infrastructure program [18,99]. The general trend of change in the YP region corresponds to alternating periods of investment to enable touristic attractions and facilities, followed by periods of no investment when the sector reported extraordinary profits. (Figure S6).

The relative proportion of each one of the five categories analyzed as a subtotal value of the sum of the five programs specific to the coastal zones is shown in Figure S7. The importance of the highway and infrastructure, and tourism sectors is highlighted, which coincide with the productive activities indicated with the greatest contribution to the state's GDP presented in Table 2.

Overall, results show that the effects of climate change in the region are underestimated in the three states. Thus, government budget use for this sector is only available when a disaster has occurred, and there are no financial sources for adaptive governance. Finally, the importance of ZOFEMAT use and exploitation has decreased, thus funds are reserved for surveillance and maintenance, and preservation or improvement of natural areas, their ecosystem services, species, or real estate in the coastal area are not a priority.

6. Conclusions and Policy Implications

This study presents an advance in the generation of information and knowledge of the budget applied to environmental challenges facing the YP region after an international political compromise, and it allows understanding of the general use of the budget that represents the priorities of the nation [114]. This is relevant in a context in which the natural resources of the marine coastal area are subjected to intense pressures due to port, industrial, urban, and touristic development. Therefore, it is necessary to have funding oriented to conservation and restoration. The collections that were obtained by the FEI could be used for environmental purposes and contribute to environmental governance of the coastal localities and their sustainable development but knowing what these resources have been used for requires monitoring. However, this study describes that after 2014, there is no evidence of a change in the trend of the government expenditure budget to address the new development paradigm regarding conservation and sustainable use of biodiversity in the YP. The federal compromise seems not to be addressed coordinately by the three PY states neither by critical areas of regional coastal development.

The authors of this study maintain that the environmental, social, and economic changes facing the development initiatives should be accompanied by process of discussion and preventive action of the use of the budget, especially in the coastal municipalities where such development is concentrated. However, coastal countries must achieve their established environmental policy objectives, which also require mobilization of resources and good management, not only the implementation of economic instruments [85].

This investigation also helps to recognize that the process of decentralization of the budget would drive local governments to decide on their usage priorities according to the context and to assume their responsibilities in sustainable coastal governance management. However, the analysis of other issues are still pending, such as local administrative reforms and financial strength that facilitate budget use, the exercise of political discussion that promotes causes or defines public spending priorities, the participation of multilateral and international agencies (e.g., World Bank, OCDE) that induce attention to international agendas and the participation of non-governmental organizations. For example, there is a growth in the number of academic publications related to the region that evidences the quality and quantity of knowledge that is generated to make sustainable development possible and meet the objectives of agendas 2030 and 2050 [115], another of the eight key conditions required to evolve for adaptative coastal governance [116]. In particular, it is relevant to address the effects of climate change and pressures on resources and ecosystem services in the marine-coast areas for the sustainable development of economic activities therein, but political will is needed to do so.

For policymakers and practitioners, the results suggest that a stronger environmental and social identity is needed to define YP regional and state budgetary governance in general. First, the results indicate that the federal budget defined by the environmental tax system and the federal view of development should not be the only source of budget use. Each state should design a fiscal system that aligns industry contractors and host government interests to create an incentive for any social and environmental impact derived from their operations, such as the hydrocarbon benefit-sharing system for the Gulf of Mexico and particularly in Campeche [60].

It is necessary to implement an environmental tax reform that includes the use of natural coastal resources by tourism, urban, and industry development, such as land adjacent to beaches, springs of underground water, wind and solar energy, and coastal dunes and wetlands. Among the evaluation criteria to implement them, the environmental effects should be of priority and should be suited to improving environmental outcomes. Fuel subsidies for marine fisheries need to be eliminated, and alternative methods need to be evaluated, and a tax credit system could be used for major fishing products exporters [7] since their activities contribute to national GDP but also sustain important parts of the coastal population in the region (Marine Protected Areas: economics, management and effective policy mixes, OECD). Subsidies from the drinking water, drainage and treatment program in charge of the national water commission within the YP for industrial, touristic, and urban use should be conscientiously revised to avoid underground water quality and quantity degradation. To expand local governance initiatives to promote blue carbon rights and climate change mitigation services from the coastal ecosystem (e.g., mangrove and seagrass), alternatives that include ejidal and private owners of wetlands should be promoted and tested. In addition, under extreme events, tax for collars should also consider damages from other stressors such as tourism activities, pollution, stranding, and climate change effects. We think that without these recommendations, FEI will poorly contribute to the sustainable management of coastal marine areas of the Yucatan Peninsula.

To reinforce research in fiscal economic instruments for sustainable management is needed to increase the period of analysis, that will depend on the presence of standard, reliable, and disponible data from national and local government institutions. However, in Mexico, there are still problems with transparency and accountability in the management and results of public resources [117], which makes it difficult to obtain reliable data to carry out analyzes regarding the budgets exercised by the different levels of government. It is necessary to clarify that in Mexico, the states have poor fiscal autonomy [118] since they do not collect the majority of taxes, particularly those related to the coastal environment as was shown in Table 1 and, those derived from ports, touristic and fisheries development and environmental contingencies. Some collaboration agreements between the federal government and the states can be developed to use those taxes, but it will be necessary to strengthen the local capacities to administer them.

Supplementary Materials: The following are available online at www.mdpi.com/article/10.3390/su131911103/s1, Table S1: Official government sources of information, Table S2: Paired Sampled Statistics, Table S3: Results of the t-test for paired samples, Table S4: Wilcoxon signed ranked test, Figure S1: Changes in coastal programs (2007–2018), Figure S2: Growth rates of sector 08: Aquaculture, fishing and hunting, Figure S3: Changes in growth rates in natural disasters in the agriculture and fishing sector (2007–2018), Figure S4: Changes in growth rates in the Natural Disaster Fund (2007–2018), Figure S5: Change in growth rates in the highway and port infrastructure program (2007–2018), Figure S6: Change in growth rates in the Tourism Category (2007–2018), Figure S7: Changes in growth rates in the category of aquaculture, hunting and fishing, and natural disaster in the agriculture and fishery sector, highway program and port infrastructure, tourism and FONDEN of the 3 states of the sum total of the 5 categories of the 3 states.

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