



Research article

Sustainable financing of marine protected areas: the case of the Martinique regional marine reserve of “Le Prêcheur”

Running title: Marine protected Areas sustainable financing: the case of the Martinique Regional Marine Reserve

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Abstract: Marine Protected Areas require sustainable funding for their effectiveness. This article aims to provide an analysis of the feasibility of financial possibilities for the support of a Regional Marine Protected Area in Martinique. It provides a valuation of the funding alternatives. The concept of payment for ecosystem services is introduced to seek the benefits that fishermen can get from their involvement in the management of the protected areas.

Keywords: Martinique; marine protected area; financing; payment for ecosystem services

JEL codes: Q51, Q57

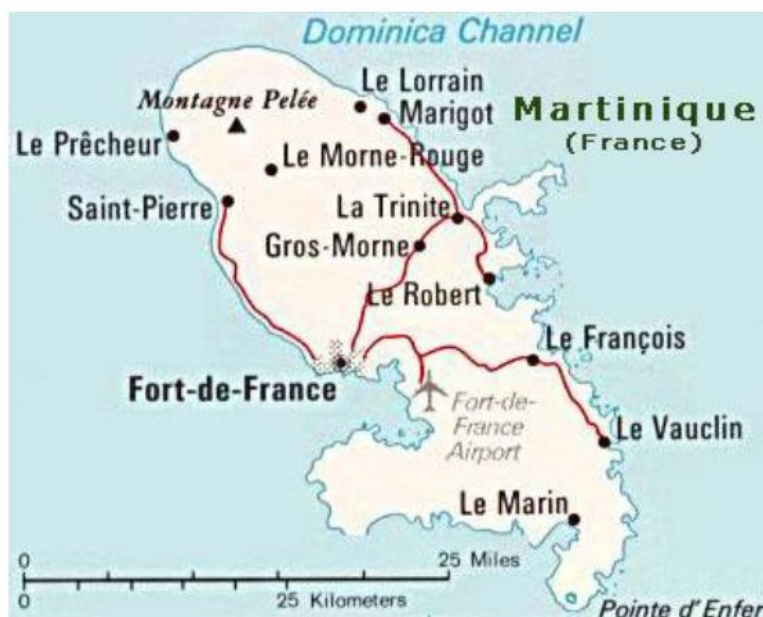
1. Introduction

Corals and their associated ecosystems are of great ecological and economic importance to Caribbean island nations and must be protected. Despite the Aichi target 11¹ that stipulated that by 2020 each country should have 10% of its maritime area devoted to protected areas, Marine protected areas (MPAs), both within the Caribbean and elsewhere, are all affected by the lack of funding to carry out conservation activities and enhancement of the existing ecological heritage. MPA funding takes on essentially four forms: (1) funding of state public funds or from local authorities, (2) self-financing, based on revenues generated by the sale of fees for entrance, activities and various services, (3) public-private partnership, achieved particularly with environmental foundations of large industrial groups and (4) research and development projects, which provide support to MPAs in a timely manner, and even more frequently when incurred by activities of research or ecological monitoring. The future Regional Nature Reserve (RNR) of “le Prêcheur”, located in the North-West of Martinique (see map below) must, as of today, include the financing of daily operations and investments on the agenda of priority actions. In addition to the financial support granted from the region, additional income modes should be considered.

The main objective of this article is to highlight the various possible additional funding sources for the sustainable functioning of the MPA of le Prêcheur. Several feasibility assessments of the implementation of funding of MPA mechanisms exist but each of them focus on a specific type of financing and its related feasibility, usually based on the willingness to pay (Reid-Grant and Bhat, 2009; Chen et al., 2014; Thur, 2010), while the contribution of this article is to present all possible options for complementary funding of MPAs and evaluate their feasibility in the context of Martinique. The options of taxes, royalties and entry fees that can be used to partially finance the future RNR of le Prêcheur are developed according to criteria of general framework for tax implementation and regimes. Of these options, only those that appear achievable are retained and their feasibility is analysed in more detail. This further analysis of the feasibility allows us to rank the options and thus evaluate which one to keep. The article also introduces the concept of “payment for ecosystem services” (PES) which, in the context of the RNR of le Prêcheur, could be used to compensate fishermen for their efforts towards the improvement of environmental services of the MPA of le Prêcheur (Failler, 2016). PES are not used directly to finance the operation of the reserve, but to compensate fishermen for their efforts towards the improvement of ecosystem services of MPAs, which compensates for the reduction of fishing activity while involving fishermen in the process of habitat conservation and sustainable use of fisheries resources.

The paper is structured in 3 parts. It starts by presenting an inventory of the volume and sources of public funding for natural areas in the French metropolitan area and in the French overseas territories. It then provides an analysis of main potential sources of income through the assessment of current options. It follows with a presentation of other funding options for which investigative work is required. Finally, the concept of payment for environmental services, and its applicability in the functioning of the RNR of le Prêcheur, is analysed. A conclusion gives the summary of key findings and some research and policy orientations.

¹ See: <https://www.cbd.int/sp/targets/rationale/target-11/>.



Map 1. Martinique island and “Le Prêcheur” location on the North-West of the island. (source: <http://www.geographicguide.com/america-maps/martinique.htm>).

2. Public financing and taxation of French natural areas

The current system of public budget allocated to the protection of French natural areas in the mainland and French overseas aims to improve the quality of sites, landscapes, natural environments, as well safeguarding natural habitats. It also aims, when health status and vulnerability of natural areas allows it, to be used for spatial planning towards the opening to the people.

2.1. Public financing in favour of protected natural areas

According to the French Environmental Code, which applies in Martinique, protection and financing of protected natural areas is a shared jurisdiction between state and local authorities. The French protected natural areas are therefore currently funded almost exclusively by the public sector. Private funding through foundations and corporate sponsorship, is more uncommon, while self-financing from private operating revenue remains marginal.

State public financing assigned to protect the French marine and coastal environments are estimated at €74 million (see Table 1). These, however, are largely underestimated: State grants are supplemented by the budgets earmarked to policies in favour of environment conservation by local authorities (at nearly four times the state budget).

Table 1. State public budget (and operating organizations) for the protection of marine and coastal ecosystems.

Level	Budget (million €)	Notes
State	28.1	Allocated budget, program 113 action 7*
French Marine Protected Areas Agency	1	-
French Coastal Protection Agency	40	€2.4 million of which come from repayments of the state and €37.6 million come from an individual taxation regime
Other operators	5	-
Total State + operators	74.1	In comparison, the total state budget allocated to the conservation of natural areas and water management amounts to €2447 million

Source: Translated from Badré M and Duranthon JP, 2010. *Current financial resources allocated by the state to the budget for biodiversity policies are partly addressed by action 7 “management of environments and biodiversity” program 113 of the Ministry of Ecology, Energy, Sustainable Development and the Sea.

2.2. Taxes and royalties related to exploitation or use of natural areas

The state gets almost all of its income from compulsory levies (taxes, royalties, etc.). Those of regional authorities come from the state repayments or are induced by the individual tax system (e.g., the development tax, for which part of it is allocated to natural areas). The Environmental Code acknowledging the “polluter-payer” principle, taxation of the environment uses taxes and royalties to prevent or punish damaging behaviour to natural areas. Tax revenues are intended to pay for public services provided by the state or “collectivities” (local authorities). The revenues of royalties are used to pay for the services provided by private supplier or by common pool resources (here marine ecosystems) for a service provided to users. However, as some royalties work as eco-taxes, the distinction between both payments does not always fit to this definition (see Box 1).

The French law identifies three principles of taxation of natural areas, which meet three distinct objectives:

- a. To compensate exploitation of natural resources
- b. To compensate disturbances and damages to ecosystems
- c. To compensate use of the marine area

To get a better outlook of their relative relevance, the overview of taxes and royalties related to the use and exploitation of natural resources is structured below based on the amount of income they generate.

Box 1. Taxes versus royalties. Source: Extract from the final report of the Operational Committee n°5, Grenelle of the Sea.

The tax is levied from the provision of a service. It may be required not only from actual users but also from potential users and the amount is not strictly equivalent to the service provided (e.g. tax for household waste collection). The tax is provided by the law.

Royalties (or remuneration) for services rendered are received in return for a service, such as the use of a piece of work or a benefit provided by a public service to a user while bearing the cost, and therefore must match the value of the benefit or service. A royalty can be established through regulation. The amount of the royalty must be equivalent to the value of the benefit or proportional to the cost of the service rendered. Such is the case of the “institution of a royalty comprising of a fixed part and a variable part, provided that the calculation of the fee allows to ensure the proportionality with the cost of the service rendered” (EC No. 220803 of July 9 2009). ‘Respect for the rule of equivalence between the fare of a royalty and the value of the benefit or service can be ensured by withholding the cost of the latter, but also according to the characteristics of the service, by taking into account the economic value of the benefit to the recipient; that in all cases, the fare must be established according to objective and rational criteria, in full conformity with the principle of equality between the users of public services and the competition rules (EC No 309 499 of 7 October 2009) .

Environmental royalties can be defined as payment for environmental services: in return for their payment, the taxpayer receives an environmental service. As pollution could be interpreted as a particular use of a natural resource (right to pollute), a levy associated with a degradation of the environment can then be likened to a royalty.

The distinction between taxes and royalties is also based on the allocation of revenues. Into the general budget for the first case, revenues are earmarked for specific purposes in the case of royalties. Yet, in the field of environmental taxation, these two aspects of distinction between taxes and royalties are not systematically combined. This explains why these two terms are sometimes interchangeably used.

2.2.1. Royalties for the use or consumption of water resource

The majority of tax revenues related to natural areas are dependent on water management policies: more than nine tenths of the budget and total tax resources for natural areas originate from royalties and charges levied by the National Office for Water and Aquatic Environments (ONEMA) and water agencies and offices, representing €1.9 billion according to Badré and Duranthon (2010). In comparison, the marine environment, and to a lesser extent, terrestrial biodiversity, appear as the poor relation.

The Water Office of Martinique, as well as other water agencies, collects a number of royalties for the use or consumption of water resources, which are devoted to actions to promote a better use of water in the territory².

2.2.2. Royalties for occupation or use of public ground

The state also draws royalties from the occupation or use of public ground. In the maritime area, this includes for example fishing and hunting rights, the product of exploitation of marine cultures,

² See Article L213-10 of the Environment Code.

products of extractions, rights of way for operators of telecommunication networks. The income amounted to almost €300 million in 2010.

2.2.3. Land planning tax

At the scale of local authorities, tax measures to raise funds in favour of protected natural areas mainly belong to the departments, through the development tax. Formerly Departmental Tax on Sensitive Natural Areas (TDENS), it is primarily intended to generate resources to finance actions in favour of biodiversity. Governed by the Urban Planning Code, it subdues the construction, reconstruction, expansion of buildings and other facilities projects subject to licence or declaration. Optional, it has nevertheless enabled significant financial reserve estimated at €269 million in 2010 (République Française, 2011). This net balance is due to under-utilization and a recurring postponement of a year on year revenue from this tax. Its rate varies according to the department, but it cannot exceed 2% of the value of the housing complexes. In 2009, of the 95 metropolitan departments and 4 overseas departments, nine departments had not implemented the TDENS, 20 had introduced a rate of 2%, 16 a rate between 1 and 2%, 34 a 1% rate, and 21 a rate lower than 1%. Among the chartered expenditures, the TDENS is used mainly for the development and maintenance of sensitive natural areas—the rest is devoted to the acquisition of these areas or is donated to another collectivity.

2.2.4. Visitor's tax

Some taxes are not directly associated to natural areas but their employment is linked through tourism depending on them. For municipalities and groups of collectivities with their individual tax, the visitor's tax³ is usually applied to expenses dedicated to promoting tourist visitation of the territory. However, some municipalities have instituted this tax for actions of protection and management of their natural areas, the revenue from the tax can be allocated⁴, to expenses to promote the protection and management of their natural areas for tourism purposes. The law provides that when these municipalities are situated in whole or in part on the territory of a national park or a regional park administered by a public administrative establishment, the product of the visitor's tax can be donated by the municipality or public establishment of inter-municipal cooperation to the park management organization as part of a convention. The visitor's tax has yielded €158 million for municipalities and €45 million for groups of collectivities of individual tax in 2010.

2.2.5. Other taxes

Other taxes on exploitation or use of natural areas exist, although they are less substantial. They are assigned to other legal entities than the state. In the area of environmental protection, those who have yielded the highest average tax revenue in 2010 (French Republic, 2011) are:

³ See Article L2333 - 26-46 of the General Code of territorial collectivities.

⁴ Subject to the provisions of Article L. 2231-14.

- a. The general tax on polluting activities TAGP5 for €489 million, part of which benefits the ADEME;
- b. The levy on the product of premiums or additional contributions relating to the guarantee against natural disasters risk (€158 million) intended for the Prevention of major natural disasters fund (FPRNM);
- c. The hunting royalties that benefit primarily the National Agency for Hunting and Wildlife (€70 million);
- d. The right to francization and navigation that benefits the Coastal and Lake Shore Conservation Authority in particular (€39 million);

Finally, some taxes reflect the compensation for inconvenience generated by the transport of passengers but generate far less income. For example, the tax on passengers departing to natural protected areas⁶ generated less than €1 million in revenue in 2010, revenue that shared the Conservatoire du Littoral, the marine park of Port-Cros, the National Forestry Office, affected collectivities, etc. For overseas territorial collectivities specifically, the tax due by air and maritime public transport companies on passengers (Article 285 ter of the Customs Code) is dedicated to classified or listed natural areas, national parks, natural reserves, CELRL sites or ports exclusively or mainly one of the protected areas mentioned above without being included. In 2010, Martinique, Guadeloupe, Guyana and Reunion have drawn together €8 million.

3. Usefulness and limitations of a tax as additional financing of the future RNR of le Prêcheur

RNRs are under the competence of the Region. From the ranking to the implementation of the management plan and organization of events, the Region therefore supports technically and financially the owner or organization managing the protected natural area (or in process of being ranked). According to the provisions prescribed by the regulations for intervention, it can subsidise a part of the operating and investment expenditures (actions of restoration, preservation and enhancement)—never all of the expenditures.

The region exclusively uses its budget, supplemented by the state, to finance the management of RNRs (unlike for example Departments that have the ability to use the revenues from the development tax). The use of taxation to complement the funding of the RNR of le Prêcheur includes the study of obstacles and opportunities for the establishment of such a design, as well as the definition of the base, geography or rate.

3.1. Different options to implement taxes as partial financing

Options for the implementation of one (or more) tax(es) to partially finance the RNR of le Prêcheur fit into three distinct approaches:

- a. The introduction of a new tax/royalty;
- b. The assignment of an existing tax in whole or in part to the financing of the reserve;

⁵ Article 266 of the Customs Code.

⁶ Article 285 quater of the Customs Code.

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- c. Broadening the rate of an existing tax to include the financing of the reserve. These three approaches set the general framework of the tax implementation. For each approach, it is possible to consider various regimes of taxes and royalties, in terms of:
 - d. The subjected population: involved populations may include residential tourists, users of marine ecosystems, companies that pollute or have a negative impact on marine ecosystems;
 - e. The geographical scale: the intervention scale of the tax may be local and limited to the municipality of le Prêcheur (and potentially the neighbouring municipalities of Saint-Pierre and Trois-Rivières; see map 1 above) or regional and extended to the whole of Martinique. In the first case, taxes only apply to users of the marine environment and/or of the watershed of the municipality of le Prêcheur. It enables an effective reduction of marine and land pressures on the marine ecosystems of le Prêcheur. The second case extends the taxation regime to the users of the whole regional area. It calls for empowerment and awareness of environmental issues by all users on the island.

Using these criteria, 24 taxes, royalties and entry fees have been devised (Table 2). A part of these taxes seems a priori seldom enforceable in the case of the RNR of le Prêcheur (boxes highlighted in blue in Table 2). The decision to exclude these taxes a priori derives from the combination assessment of: social acceptability of the tax, legislative difficulties in the implementation of this tax, injustice or equity problems created by the tax, etc. For example, a new tax on polluting activities in Martinique that have impacts on marine ecosystems only to finance the reserve of le Prêcheur would result in a significant opposition from businesses located far from the northwest of Martinique and having no apparent negative impact on the area.

Ten other taxes seem more feasible and are worthy of a further analysis on their feasibility (boxes highlighted in green in Table 2 above). The strengths and weaknesses of the implementation of these taxes are presented in table 3 below.

Table 2. Taxes as partial financing of the future RNR of le Prêcheur.

		Introduction of a new tax or royalty	Assignment of an existing tax	Broadening of the rate of an existing tax
Regional scale	Residential tourists	Tax to finance regional reserves of Martinique (on the template of the tourist tax)	Share of the tourist tax of the municipalities of Martinique	Broadening of the airport tax; broadening of the transportation tax
	Inhabitants of Martinique	Tax to finance regional reserves of Martinique (on the template of the housing tax)	Share of dock dues	Broadening of the airport tax; broadening of the transportation tax
	Marine ecosystem users	Tax on uses of the ecosystems of Martinique (in addition to fishing licences for e.g.), tax on offshore recreational practices (surf, kitesurf, etc.) Taxes on polluting activities in Martinique that have impacts on marine ecosystems (urbanisation coastal fringe, granulate extraction, non-biological agricultural activities, etc.)	Share of revenue of fishing licences	Broadening of fishing licences
	Corporations that pollute		Share of the tax on marine polluting activities	Broadening of the tax on polluting activities
Local scale (area of the reserve and surrounding area)	Residential tourists	Tax to finance the RNR of le Prêcheur enforceable to tourist operators of the municipality (on the template of the tourist tax)	Share of the tourist tax of the municipality of le Prêcheur	Broadening of the transportation tax
	Inhabitants of Martinique	Tax to finance the RNR of le Prêcheur enforceable to the inhabitants of the municipality (on the template of the housing tax)	Share of the housing tax of the municipality of le Prêcheur	Broadening of the transportation tax
	Marine ecosystems users	Local tax on extracting and/or damaging of the RNR activities (fishing, spearfishing); royalty on diving activities; royalty on taxi-boats, recreational boats and private sailing boats	n.a.	n.a.
	Corporations that pollute	Tax on polluting activities of the watershed	n.a.	n.a.

Note: n.a. = not applicable; Source: authors own creation.

Table 3. Strengths and weaknesses relating to feasibility of implementation.

Strengths		Weaknesses
Introduction of a new tax/royalty		
Tax for the financing of the RNR of le Prêcheur enforceable to tourist operators of the municipality	Tourism figures increasing, potential source of growing incomes Potential modulation of the rate based on the environmental impact of the operator	Penalises supply of tourism services of the municipality of le Prêcheur only, already seldom developed Potentially penalises visitors that are non-users of marine ecosystems (e.g. Hikers)
Tax for the financing of the RNR of le Prêcheur enforceable to inhabitants of the municipality	Empowers inhabitants on the impact of their everyday practices on the ecosystem Potential modulation of the rate based on the environmental impact of the building	Penalises the inhabitants of the municipality of le Prêcheur only, potentially making the area less attractive Potentially penalises the inhabitants that are non-users of marine ecosystems (e.g. Hikers)
Local tax on extractive and/or damaging of the RNR activities (fishing, spearfishing)	Reduces through a fiscal leverage the extractive activities and other damaging practices while producing revenues for the reserve Enables guidance by incentives for reorientation of fishermen or discontinuing of damaging practices (frequent use of beach-seine for example)	Low acceptability upon populations of fishermen and underwater hunters already affected by management actions Difficult to weigh the burden of a tax only on fishermen and underwater hunters Revenues of this tax are destined to decrease, thus jeopardizing the financing Penalises operators who take measures voluntarily (eco-responsible construction, choice of a fishing net with larger mesh, etc.)
Tax on polluting activities of the watershed	Polluter-payer principle: polluting activities must be subjected to financial compensation; to go further, it is possible to implement a payment for ecosystem services: polluting activities fund the reserve for improvement of the treatment of waste produce by these activities; enables to give a tax preference to non-polluting local activities (idea of a partial exemption from tax for the reduction of pollutants)	Seldom educational, as it can be interpreted as a “right to pollute” Concerning the development of the tourism sector, operators are already subject to obligation to avoid, reduce and compensate damages to the environment
Royalty on diving activities	Positive image from alerted and sensitized persons, usually willing to pay extra if their participation in the reserve is transparent Widely favourable view of diving operators in the area, willing to raise the average price per dive	Cannot be the only measure because: i) little profitable and ii) it shows a taxation disparity of one activity without taxing the others (fishing, swimming on beaches, access, etc.)
Royalty on taxi-boats, recreational and private sailing boats	Taxation affects primary beneficiaries of the reserve (through tourism increase), the acceptability of such a tax should be good Can be done through various taxes and lead to development (tax for the access to mooring buoys in the reserve)	Cannot be the only measure because: i) little profitable and ii) it shows a taxation disparity of one activity without taxing the others (fishing, swimming on beaches, access, etc.)

Continued on next page

		Strengths	Weaknesses
Assignment of an existing tax			
Share of the tourist tax of the municipality of le Prêcheur	<p>Tourism in the area is closely related to visitation of natural resources, particularly marine resources</p> <p>Figures of tourism increasing, potential source of growing incomes</p> <p>Highlight the willingness of local authorities to participate in the implementing of the reserve</p> <p>Opportunity for neighbouring municipalities (Saint-Pierre, Grand Rivière, Cabaret, etc.) to devote part of their tourist tax to the reserve</p>	<p>Little profitable as long as visitation and supply of accommodation are limited in capacity</p> <p>Difficult to arbitrate for the reallocation of a share of the tax to the reserve</p> <p>Participation of neighbouring municipalities to the reserve presumably difficult</p>	
Share of dock dues	<p>Taxation of all products sold in French overseas – modulation of the rate based on environmental impact of products</p>	<p>Difficult to justify the financing when dock dues ought to help in economic development</p> <p>Advocacy work needed for an arbitration in favour of the reserve and at the expense of the financing item which loses the income of the tax</p>	
Share of the tax on marine polluting activities	<p>Polluter-payer principle extended to the region: polluting activities must be subject to financial compensation</p> <p>Gives a fiscal preference to non-polluting regional activities (idea of a partial tax exemption for reduction of pollutants)</p>	<p>Lack of acceptability of activities not directly linked with le Prêcheur (e.g. Intensive agriculture of southern Martinique)</p>	
Broadening of the rate of an existing tax			
Broadening of the airport tax	<p>Can generate very high revenues at a low cost per person</p> <p>Attachment to marine ecosystems of airport passengers, tourists or inhabitants</p>	<p>Airport taxes usually intended to upgrade safety and comfort of passengers; can pose problems of arbitration of tax revenues thus needs an expansion and not a modification of assignment</p>	
Broadening of the transportation tax	<p>The possibility of a justification of an environmental approach of transport helps social acceptance of the broadening of the tax</p>	<p>Political and legislative difficulties of broadening the rate of an existing tax</p>	

Source: authors own creation.

3.2. Comparative analysis of the implementation feasibility

To compare them, the ten selected options are quantitatively analysed through these six criteria:

- a. Ease of implementation: this criterion depends on the conditions of establishment of the tax, from the easiest (broadening the tax base or the rate of an existing tax for the management of future MPA of le Prêcheur) to the most constraining (introducing a new tax, the proceeds of which will be donated to the managing organization for the management of future MPA of le Prêcheur);

- b. Acceptability: this criterion reflects the reaction of users and non-users to the implementation of the tax. It is strongly related to the legibility of the tax objective. It also calls for a higher level in communication and information which should accompany the implementation of the tax (the lower the acceptability, the more communication activities must be well crafted, targeted);
- c. Income generation: this criterion expresses the potential of the tax to generate revenues for the RNR; depending on the choice of tax base and subject population; the wider the base and population, the higher the contribution of the tax to partial financing of the RNR;
- d. Sustainability: this criterion evaluates the life expectancy of the considered tax; taxes may be transient or permanent, depending especially on their purpose, for instance a tax on destructive fishing practices aims at eliminating these practices on the medium-term and not to sustain them in order to continue taxing these activities;
- e. Resilience to the economic context: this criterion foresees the consequences of the risks related to economic uncertainties on the collection of tax revenues and provides better transparency on the stability of the RNR's financing;
- f. Selectivity of the subjects: this criterion reflects the number and diversity of people subject to tax; the considered tax should not, as far as possible, be restricted to a single occupational category, or there will be poor social acceptability and economic risk.

The taxes considered for having a good potential to complete the financing of the future RNR of le Prêcheur are qualitatively analysed according to these six criteria. The results are displayed in Table 4 below: one star means “little” or “low”; two stars mean “a lot” or “strong”. Red means “negative” and the blue “positive”.

3.3. Which option(s) to consider?

From the elements of the previous analysis, it is possible to rank the ten selected options. By assigning a score by ranking the criteria of the comparative analysis of Table 4 (+1 for a blue star and -1 for a red star), the feasibility of each option is relatively estimated (see Table 5).

The overall feasibility valuation shows a definite relevance to weigh the burden of taxation on local leisure activities, through the establishment of a new royalty. The two options that cumulate the most points are the royalty on recreational and sailing activities (8 points) and the royalty on diving activities (7 points). Besides the financial contribution to the management of RNR of le Prêcheur, these options also have the virtue of offering a tool to regulate the use of marine ecosystems. In this respect, they function as an entrance fee (Voltaire et al., 2011). With the difference that they are better accepted in France, the principle of the entrance fee faces legal (see right of the public domain) and social (tradition of free access to nature) constraints (Vourc'h and Natali, 2000). However, possible difficulties of introducing a new royalty in the currently depressed economic environment must be noted.

Table 4. Comparative analysis of tax options for partial financing of the RNR of le Prêcheur.

	Ease of implementation	Acceptability	Income generation	Sustainability	Resilience to the economic context	Selectivity of the subjects
Introduction of a new tax/royalty						
Tax for the financing of the RNR of le Prêcheur enforceable to tourist operators of the municipality	★	★	★	★	★	★
Tax for the financing of the RNR of le Prêcheur enforceable to inhabitants of the municipality	★	★ ★	★	★	★	★
Local tax on extractive and/or damaging of the RNR activities (fishing, spearfishing)	★	★	★	★ ★	★	★
Tax on polluting activities of the watershed	★	★	★	★	★	★ ★
Royalty on diving activities	☆ ☆	☆ ☆	★	☆ ☆	★	★
Royalty on taxi-boats, recreational and private sailing boats	☆ ☆	★	★	☆ ☆	★	★
Assignment of an existing tax						
Share of dock dues	★	★	★	★	★ ★	☆ ☆
Share of the tourist tax of the municipality of le Prêcheur	★	☆ ☆	☆ ☆	☆ ☆	★	☆ ☆
Share of the tax on marine polluting activities	★	★	★	★	★	★
Broadening of the rate of an existing tax						
Broadening of the airport tax	★	★	☆ ☆	☆ ☆	★	☆ ☆
Broadening of the transportation tax	★ ★	★	☆ ☆	★	★	★

Source: authors own creation.

Table 5. Overall valuation of the feasibility of the ten considered taxes.

	General valuation
Introduction of a new tax/royalty	
Tax for the financing of the RNR of le Prêcheur enforceable to tourist operators of the municipality	0
Tax for the financing of the RNR of le Prêcheur enforceable to inhabitants of the municipality	-1
Tax on extractive and/or damaging of the reserve activities (fishing, spearfishing)	-3
Tax on polluting activities of the watershed	1
Royalty on diving activities	7
Royalty on taxi boats, recreational and private sailing boats	8
Assignment of an existing tax	
Share of dock dues	2
Share of the tourist tax	6
Share of the tax on polluting activities	2
Broadening of the rate of an existing tax	
Broadening of the airport tax	7
Broadening of the transportation tax	2

Source: authors own creation.

The expansion of the airport tax seems to also be an interesting option (7 points). Its implementation can be difficult because it is a broadening of the tax that does not directly benefit to the management of the airport. But the revenue generated can be very large in view of visitation of the airport Aimé Césaire.

The allocation of part of the tourist tax levied on all hosts of Martinique also proves relevant, with a score of 6 points. This option provides a better distribution of the tax burden than a strictly local royalty, which could penalize the attractiveness of the municipality of le Prêcheur.

Less interesting are the options that suggest the introduction of a tax on polluting activities of the watershed and at regional scale, to allocate part of the dock dues or to expand the transportation tax (1 or 2 points). The introduction of a tax on extractive activities in the area, or taxes to explicitly finance the RNR with tourists or inhabitants of the municipality, prove to be among the least favourable of the selected options. Yet these low scores, with regard to the complementary revenue generation target for the RNR, should not mask the advantage in terms of management of marine ecosystems and associated activities of the latter options. Thus, a tax on polluting or damaging activities reduces pressures on ecosystems of the reserve and encourage virtuous practices for the environment (Binet et al., 2013; Failler et al., 2015).

3.4. *What incomes to expect?*

With approximately 18,000 dives per year for around fifteen dive centres in the area of le Prêcheur (Failler et al., 2010), the implementation of a royalty could generate between 36,000 and 90,000 euros per year. For reference, an investigation undertaken with the visitors of Martinique had shown the possibility to increase prices of 2 to 5 euros per dive as long as spectacular fish or marine areas can be

observed, for a dive of an average price of 40 euros (Borot Battisti et al., 2011). This range is equivalent to the introduction of a tax with a rate between 5 and 12.5%.

The implementation of an enlargement of the airport tax of 1 euro to finance regional marine reserves would allow, with a passenger flow of 1.6 million on average for the last three years, generation of an income of 1.6 million euros.

With a yearly average of 1500 excursionists visiting the area of le Prêcheur by taxi-boat or sailing boat, the introduction of a royalty on tours could yield about 3,000 euros a year (for a willingness to pay estimated at €2 per tour). This relatively low estimate does not take into account, for a lack of assessment of their number, visitors on boats in the area. This is a potentially significant income, as they are estimated at about 40,000 a year on all of Martinique.

With 19,000 residential tourists each year in the territory of the municipality of le Prêcheur, the allocation of part of the tourist tax levied on all hosts of the municipality would generate an income of 3,800 euros per year for €0.20 and €7600 per year for €0.40. The neighbouring municipalities (Saint-Pierre, Grand Rivière, le Carbet, etc.) may also earmark a share of their tourist tax to fund the reserve. This solidarity contribution of neighbouring municipalities could generate tens of thousands of euros.

4. Payments for environmental services

The implementation of an MPA results in a decrease in fishing activities, little or not compensated (Binet et al., 2013). To maintain their activity, fishermen tend to increase fishing efforts in the unprotected territory, which goes against the MPA's conservation efforts. It is therefore essential to find a way to compensate for this loss of territory without increasing fishing efforts. In addition, the ousting of the fishermen for the MPA results in a loss of knowledge for society in general, as fishermen have empirical knowledge of the marine ecosystem transmitted in an ancestral way. This knowledge is crucial to anticipate the consequences of global change on marine and coastal ecosystems of the Caribbean islands. The traditional knowledge of the fishermen can also be harnessed for the maintenance or improvement of coastal environments. This can be done simultaneously to fishing activities. The point is not to convert fishermen to conservationists; no, it is much more about involving them in the process of habitat conservation and sustainable use of fisheries resources. Thus the two functions, fishing and protection, become inseparable.

The goal is therefore to develop a simple mechanism where fishermen can be rewarded for their efforts towards the improvement of ecosystem services of marine protected areas. This realization warrants a reflection on "payments for environmental services" or PES. The PES concept emerged in the 1990s (Meral, 2010), notably with the establishment of the PES program in Costa Rica that protects to this day 25,000 hectares of forest. But it was not until 2002 that the PES experienced a real increase of interest thanks to two books published by Landell-Mills and Porras, and Pagiola, Bishop and Landell-Mills. Although the definition of PES is still controversial, the one established by Wunder (2005) is widely accepted. It defines a PSE as a voluntary transaction where a particular ecosystem service is 'purchased' by (at least) one individual consumer from (at least) one individual supplier, if and only if the supplier guarantees the production of this service. Designed in a market-driven, voluntary exchanges between providers and consumers of services can thus be subject to negotiations, nonetheless forcing

suppliers to engage in activities of specific use and to consider the demand to set the price. Moreover, the compensation is carried out in a ‘logic of additionality’, as the presence of service must provide a benefit to biodiversity, and in a ‘logic of conditionality’ ensuring the effectiveness of the service, its supply becoming mandatory to obtain the payment (Froger et al., 2012).

Several PES programs similar to that of Costa Rica have been implemented, including in Mexico (protection of about 2 million hectares of forest). However, the vast majority of PES initiatives are implemented on a smaller scale. Thus, many PES program projects are being implemented or prepared at national scale or the scale of a watershed (Pagiola, 2008). As of today, no PES program has been established for marine and coastal ecosystems. The establishment of PES in le Prêcheur would be a pioneering action that may, if successful, be replicated in other MPAs.

Behind the name of PES stands a simple mechanism that is to reward the actions of those that enhance (or do not cause a decrease in) the quality of ecosystem services; the contributors being the users. In other words, the fishermen can be paid for efficient actions in favour of biodiversity and for the knowledge they provide to the governance of MPAs. In the first case, it is the direct users (divers, boaters, hikers, swimmers, etc.) that will contribute to the remuneration of the actions of fishermen, in the second, it is the society in general that is indebted (through the MPA) as protected areas act as places with higher resistance to global change than non-protected areas, and with greater resilience. The PES mechanism is all the more relevant as it generates funding for activities towards biodiversity that would not exist otherwise. It is also sustainable because it is based on self-interest of fishermen and users and not on the good will of the government or non-governmental organizations. It is all the more sustainable as it has a net positive toll for both individuals and society as a whole.

A survey was conducted among the fishermen of le Prêcheur in 2015 and 2016 (Thirot et al., 2017). The study sample, composed of 16 fishermen, represents about 50% of the fishermen declared in activity. It is characterized by an ethnic diversity, ensuring a wide spectrum of responses and access to the various existing categories in the professional group⁷. The fishermen's knowledge on the marine environment originates from a daily presence at sea and the data transmission by peers during the apprenticeship. They are presented very synthetically in Table 6 below. They can be promoted in the context of ecotourism, where it is direct users who contribute to the payment of fishermen's actions, or in scientific monitoring and more generally the MPA management.

⁷ However, some fishermen fiercely opposed to the creation of the MPA refused to be interviewed.

Table 6. Knowledge of fishermen and their appreciation.

Knowledge of fishermen	Ecotourism	Scientific monitoring and MPA management
Physical characteristics, behaviour and habits (feeding, habitat, spawning grounds) of fish (ethology)	X	X
Spawning grounds		X
Fish life cycles (breeding and migration seasons)	X	
Impact of abiotic factors (hydraulic, oceanographic, climatic) on fish life cycle		X
Adaptive and resiliency capabilities of the marine environment to climate change		X
Endangered species	X	X
Health status of the marine environment (coral bleaching or algal invasion for example)		X
Evolution of the fishery resource with notably species rotation, disappearance or appearance (lion fish), etc.		X
Rhythm, temporality et cycle of fishing seasons and species presence	X	
Interconnections between species (between fish species but also between fish and plants)		X
Impact of human activities on the marine environment		X

Source: authors own creation.

The knowledge of fishermen encompasses both elements of local (nursery places for example) and global (including climate change) knowledge, observed on a long timescale since some have been working for over 30 years. With this sharp empirical knowledge, they are able to interpret ecological processes at work in the marine environment by making hypotheses they can later test in situ. This exercise is essential for those who wish to appreciate the evolution of the marine environment, its adaptability and resilience to climate change. This integrated vision of the marine ecosystem can thus be useful to the scientific monitoring and generally the management of the MPA of le Prêcheur and for any type of action beneficial to the restoration, maintenance and improvement of biodiversity in general (through awareness-raising of the educational world).

Although the MPA of le Prêcheur was formally created by deliberation of the Regional Council of Martinique on October 14, 2014, no management structure exists at this time to make it run. The PES therefore cannot be implemented. However, when an effective management is established, their implementation should allow fishermen to contribute to the preservation of a common asset. Thus, PES can act as catalysts and promote the MPA as means to add value to the fishing profession.

5. Conclusion

The feasibility analysis of taxation as an additional income for the RNR of le Prêcheur demonstrates the relevance of the enlargement of the airport tax to finance the RNR. This analysis also demonstrates the benefits of the introduction of a new royalty on tourism activities related to the enjoyment of the marine ecosystems of the area: the recreation and sailing on the one hand and on the other hand diving. The allocation of part of the tourist tax, collected for the benefit of the management of RNRs of Martinique, also appears an attractive option.

The estimation of the financial benefits of the four selected taxes is approximately €1.6 to 1.7 million. This income will probably be destined to increase for taxes levied locally with the establishment of the RNR, the label of which will function as a guarantee of quality and therefore of attractiveness to visitors. For regional taxes on the other hand (primarily the airport tax), this participation will be reduced with the possible creation of other regional marine reserves in Martinique.

However, the final selection of the preferred option requires a thorough operational analysis, including in particular the implementation schedule, costs and results associated with the collection of taxes and forecasted financials. In particular, the reality of the institutional context, fiscally constrained, forces to reckon with limited resources and no guarantee of sustainability. It requires in all cases to fully optimize the effectiveness and efficiency of resource use. For this, a detailed analysis of the starting funds needed for the future reserve and then for the medium-term management seems essential, in parallel of the study of potential sources. Finally, we must remember that, regardless of the option selected, no action can succeed without first involving all stakeholders for concertation.

Finally, the implementation of a sustainable management of marine resources requires the development of specific systems of gratification, such as payments for environmental services, ensuring the recognition and enhancement of knowledge and actors who hold them, here the fishermen. These compensation mechanisms need to take into account two types of environmental services provided by fishermen. The first is based on the commitment to protect the marine environment and requires a change in practices. The direct beneficiary is biodiversity. The second service is to exploit the knowledge held by engaging in sustainable resource management operations, in the short and medium term. The beneficiary is the society (more generally humanity) and specifically the services recipients that are institutional players, other sea users and the local population. In all cases, these bonuses must meet requirements of justice and fair redistribution.

Acknowledgements

This paper has been produced with the financial support of the European Commission, under the BEST Scheme and within the Project CARIPES (Payments for Ecosystem Services in the Caribbean). Opinions expressed in this article do not necessarily reflect the ones of the European Commission and don't anticipate the Policy of the Commission in this area.

Conflict of interest

The authors declare no conflict of interest.

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