UNIVERSITÉ DU QUÉBEC À MONTRÉAL

« DES CRÉDITS COMPENSATOIRES PLASTIQUE, C'EST POSSIBLE? » UNE PROPOSITION DE MODÈLE CONCEPTUEL POUR RÉDUIRE LA POLLUTION PLASTIQUE DES OCÉANS

MÉMOIRE

PRÉSENTÉ

COMME EXIGENCE PARTIELLE

DE LA MAÎTRISE ÈS SCIENCES DE LA GESTION

PAR

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MAI 2021

REMERCIEMENTS

La réalisation de ce mémoire a été un énorme défi pour moi. J'ai vécu des moments de bonheur, mais aussi de grandes périodes de découragement et de stress. Le dépôt de ce mémoire représente définitivement mon plus grand accomplissement académique, ainsi qu'un très grand accomplissement personnel. Je n'aurais pu y arriver seule, je tiens donc à remercier les nombreuses personnes qui ont participé à ma réussite.

D'emblée, je tiens à remercier ma directrice Cécile Bulle et mon co-directeur Mark Purdon pour leur disponibilité, leur bienveillance, et leur implication dans ce projet. Vos précieux conseils et les nombreuses rencontres que nous avons eues m'ont permis de retrouver mon chemin lorsque je m'égarais. J'ai appris énormément de vous et de votre générosité.

Merci au CIRAIG et à ses partenaires financiers qui m'ont permis de réaliser ce travail. La maîtrise m'aura permise de rencontrer des personnes inspirantes, qui resteront des ami·e·s pour toujours. À mes amies du CIRAIG, de l'AéMSG, et de RSE, sachez que vous m'inspirez par votre créativité et votre soif de défi. Je suis vraiment heureuse d'avoir pu partager cette aventure avec vous. Un merci tout spécial à Élizabeth, Cheryl et Sara qui m'ont particulièrement soutenues dans les derniers mois.

Un merci tout spécial à l'OBNL Thèsez-vous, qui m'a fait découvrir une technique de travail qui fonctionne à merveille. J'ai grandement bénéficié de rédiger dans votre espace, et avec vous à distance!

À ma famille, mes parents et ma sœur que j'aime plus que tout, merci de m'avoir réconfortée et encouragée dans les derniers mois. Merci aussi de m'avoir permis de déménager à Montréal et d'acquérir cette éducation. Votre amour et support est tellement précieux pour moi et je suis choyée de vous avoir dans ma vie. Je partage cette réussite avec vous.

Enfin, Gabriel, mon fiancé. Merci d'être l'homme que tu es et de m'aimer comme tu le fais. Tu as toujours trouvé le moyen de m'aider et de m'écouter, même si ce n'est pas facile de me faire parler lorsque je suis sous pression. T'avoir au quotidien dans ma vie (avec Bouille) m'apaise et rend ma vie simple et pleine d'amour.

DÉDICACE

À l'amour

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LISTE DES ABRÉVIATIONS, DES SIGLES ET DES ACRONYMES

CDM: *Clean Development Mechanism*
GES: Gaz à effet de serre
GMR: Gestion de matières résiduelles
LMIC: *Low- and middle-income countries*
MSW: *Municipal solid waste*
PRFI : Pays à revenu faible et intermédiaire
SWM: *Solid waste management*

RÉSUMÉ

La pollution plastique des océans est une problématique qui crée d'importants impacts environnementaux, sociaux et économiques. Plusieurs auteurs ont identifié le fait que, même si les pays à revenu élevé ont un rôle critique à jouer dans la résolution du problème, la plupart du plastique présent dans les océans provient plutôt des pays à revenu faible et intermédiaire (PRFI) en raison de leur manque de systèmes de gestion des matières résiduelles (GMR) appropriés. Pour résoudre ce problème, cette recherche exploratoire propose le modèle conceptuel d'un mécanisme de crédits compensatoires plastique, basé sur le concept de crédits compensatoires carbone. Un mécanisme de crédits compensatoires plastique a le potentiel de diminuer la pollution plastique des océans, et de permettre aux pays à haut revenu de compenser leur consommation de plastique non-durable. Pour répondre à l'objectif de recherche, cette étude fait, premièrement, ressortir les principaux risques et opportunités associés aux crédits compensatoires carbone. Deuxièmement, cette recherche compare les méthodologies actuellement utilisées par les mécanismes de crédits compensatoires carbone (approches par projet et par niveau de référence) à l'approche de système de gestion dans le but de déterminer laquelle d'entre elles serait la plus appropriée à ce mécanisme de crédits compensatoires plastique. Troisièmement, l'article identifie les principaux risques et opportunités de la GMR dans les PRFI, afin de créer un mécanisme efficient et durable, adapté à leur contexte. Suite à cette analyse, le modèle conceptuel de crédits compensatoires plastique est présenté. Les résultats de cette recherche démontrent que les crédits compensatoires carbone font face à trois principaux risques et opportunités : les risques d'intégrité, les risques d'effets pervers et les cobénéfices. L'analyse démontre également que l'utilisation d'une approche « integrated sustainable solid waste management » est essentielle au succès de l'implantation d'un système de GMR dans les PRFI. Finalement, l'analyse suggère qu'un mécanisme de crédits compensatoires plastique soit basé sur une approche de système de gestion, plutôt que sur l'une des méthodologies actuellement utilisées par les crédits compensatoires carbone.

Mots clés : Pollution plastique des océans; Gestion des matières résiduelles; Systèmes de gestion; Crédits compensatoires carbone; crédits plastique.

ABSTRACT

Ocean plastic pollution is a problem that creates important negative environmental, social and economic impacts. Several authors have identified the fact that, even if high-income countries have an important role to play in the resolution of the problem, the majority of the plastic ending up in the oceans rather comes from low- and middle-income countries (LIMC) due to improper solid waste management (SWM) systems. To solve this problem, this exploratory research puts forward a conceptual framework for a plastic offset mechanism, based on carbon offset schemes currently used. A plastic offset mechanism has the potential to reduce ocean plastic pollution, as well as to allow high-income countries to compensate for their non-sustainable plastic use. To do so, this research firstly highlights the key challenges and opportunities in creating a system of plastic credits, based on existing carbon offset schemes. Moreover, this research compares the methodologies used in these already-existing mechanisms, including the project-based and the standardized approaches, to a management system approach to determine which is best suited to implement a sustainable plastic credit mechanism. Finally, this research looks at the risks and opportunities of SWM in LIMCs. Following this analysis, a tangible framework for a plastic credits mechanism is proposed. The results show that carbon offset mechanisms hold three primary risks and opportunities, which are integrity risks, perverse impact risks and co-benefits opportunities. The analysis also shows that the use of an integrated sustainable solid waste management approach is critical to the implementation and operational success of a SWM system in LMICs. Finally, the analysis suggests that a plastic credit mechanism should be based on a management system approach rather than on the methodologies that are currently used for carbon offset methodologies.

Keywords : Ocean plastic pollution; Solid waste management systems; System management; Integrated sustainable waste management; Carbon offsets; Plastic credits

INTRODUCTION

La découverte des plastiques au 19ème siècle a permis aux êtres humains d'améliorer leur qualité de vie de nombreuses façons. En revanche, plus récemment, les plastiques ont fait mauvaise presse en raison des importantes conséquences négatives que la mauvaise gestion de leur fin de vie crée aux niveaux environnemental, social et économique, que ce soit sur la biodiversité, la santé humaine ou le tourisme, par exemple (Nelms et al., 2016; Oelz, 2015).

Bien que des initiatives visant à réduire la consommation de plastique aient été mises en place dans certains pays à haut revenu, celles-ci ont peu d'impact direct sur le problème de pollution plastique des océans. Plusieurs auteurs ont plutôt identifié que la majorité du plastique se retrouvant dans les océans provient de pays à revenu faible et intermédiaire (PRFI), en raison d'un manque de gestion des matières résiduelles (GMR) adéquat dans ces pays. Bien sûr, il est important de noter que des facteurs macroéconomiques tels que l'exportation de matières résiduelles de pays à haut revenu vers les PRFI jouent aussi un rôle important dans cette pollution. Or, ce mémoire se concentre sur l'enjeu du manque de systèmes de GMR adéquat dans les PRFI, ainsi que sur le manque de financement auquel font face ces pays afin de pouvoir implémenter des systèmes efficients (Jambeck et al., 2015; Stuchtey et al., 2019).

La pollution plastique des océans n'est pas la première problématique environnementale à laquelle l'humanité est confrontée. Les émissions de gaz à effet de serre (GES) ont été traitées en détail par les scientifiques et par différents instruments politiques environnementaux tels que des taxes et des charges. Or, l'un de ces instruments les plus discutés et controversés est les crédits compensatoires carbone. Les crédits compensatoires carbone permettent aux acheteurs, des individus ou des organisations, de compenser leurs émissions de GES en finançant des projets qui permettent la réduction ou la capture de GES. Le « Clean Development Mechanism », instrument développé dans le cadre du Protocole de Kyoto, permet aux pays à haut revenu d'acheter des crédits compensatoires pour financer des projets affirmant la réduction des émissions de GES dans le PRFI.

Les crédits compensatoires ont le potentiel d'être transférables à d'autres problématiques environnementales telle que la pollution plastique des océans. La création de crédits compensatoires plastique permettrait notamment de financer la création ou l'opération de projets de système de gestion des déchets dans les PRFI, réduisant donc la quantité de déchets plastiques émise dans les océans, tout en permettant aux acheteurs de ces crédits de compenser leur consommation de plastique.

À notre connaissance, aucune recherche scientifique ne s'est intéressée au potentiel de transfert que pourraient avoir les crédits compensatoires carbone à d'autres problématiques environnementales. Ce mémoire présente donc les résultats d'une recherche exploratoire visant à proposer le modèle conceptuel d'un mécanisme de crédits compensatoires plastique, inspiré des crédits compensatoires carbone, permettant l'atténuation du problème de pollution plastique des océans.

Afin de répondre à ces objectifs de recherche, ce mémoire, qui inclut un article scientifique soumis à un journal, est divisé en trois chapitres. Le premier chapitre élabore la problématique de recherche de ce mémoire. Une revue de littérature portant sur les plastiques, la pollution plastique des océans, la GMR dans les PRFI et sur les crédits compensatoires carbone est présentée. Cette revue est par la suite suivie des objectifs de recherche. Ce chapitre permet de démontrer la pertinence de ce travail de recherche.

Le deuxième chapitre est composé de l'article scientifique qui a été soumis au Journal of Cleaner Production, ainsi que de la déclaration des co-auteurs et de la lettre de soumission transmise au journal.

Finalement, le troisième chapitre de ce mémoire consiste en une discussion et une conclusion du travail élaboré où seront présentés les principales conclusions, ainsi que les force et limites de la présente recherche.

CHAPITRE I

PROBLÉMATIQUE DE RECHERCHE

Avant d'explorer cette recherche en profondeur, il s'avère avant tout important de situer ce mémoire dans le contexte dans lequel il s'insère. Partant du concept général de la production et consommation de plastique, ce premier chapitre explore par la suite les sujets des conséquences environnementales des émissions de plastiques, se concentrant ensuite plus précisément sur la pollution plastique dans les océans. Celle-ci étant très reliée à une GMR déficiente dans les PRFI, les divers enjeux de la GMR dans les PRFI seront explorés. Finalement, en vue d'explorer un potentiel mécanisme de crédits compensatoires plastiques permettant d'offrir une meilleure GMR dans les PFRI, les principes et les approches existantes de crédits compensatoires carbone seront présentées et analysées. Pour terminer, l'objectif de recherche ainsi que ses trois sous-objectifs seront présentés à la fin de ce chapitre.

1.1 La production et la consommation du plastique

C'est il y a un peu plus de 100 ans que le premier plastique synthétique a été découvert par Alexander Parkes, en 1862 (Harrison et Hester, 2019). Depuis, ces matériaux ont apporté de nombreux bénéfices à la vie humaine. En plus d'être peu coûteux, flexibles, stables, légers et résistants à la dégradation, les plastiques permettent de conserver des aliments de façon sécuritaire (Harrison et Hester, 2019). Il n'est donc pas surprenant que ce matériau se soit autant imposé dans nos vies, jusqu'à devenir le matériau le plus utilisé mondialement aujourd'hui.

Depuis sa création, la production et la consommation de plastique n'ont fait qu'augmenter de manière exponentielle (Harrison et Hester, 2019). En effet, PlasticsEurope évalue qu'en 2018, la production mondiale de plastique a atteint 359 millions de tonnes, comparativement à 348 millions de tonnes en 2018 (PlasticsEurope, 2019). Sa consommation est elle aussi en augmentation à travers le monde. En 2017, il était estimé qu'une personne jetait en moyenne 52 kg de plastique chaque année (Worm et al., 2017).

1.2 Les conséquences environnementales du plastique

Bien que le plastique offre des avantages considérables par rapport à d'autres matériaux, on ne peut nier les conséquences négatives qu'il crée sur l'environnement et la vie humaine. Premièrement, la production du plastique génère une importante quantité d'émission de GES annuellement. Il est notamment estimé que 90 % de la production mondiale de plastique provienne de sources fossiles vierges (Foundation, Ellen MacArthur, 2016; Harrison et Hester, 2019). Sa production actuelle représenterait 4 % de la consommation de pétrole globale et son processus de fabrication représenterait lui aussi 4 % de cette consommation (Dauvergne, 2018).

Deuxièmement, lors de sa fin de vie, le matériau n'est souvent pas collecté ni traité ou éliminé de manière adéquate, ce qui fait en sorte qu'une grande quantité s'échappe dans l'environnement annuellement. Plusieurs études réalisées dans les dernières années ont prouvé l'accumulation de plastique dans les milieux terrestres, dans les océans, sur les rivages marins ainsi que dans les eaux profondes (Jambeck, 2017). La présence de ce matériau dans les bassins crée d'importantes conséquences sur l'environnement, les animaux marins et même sur la santé humaine. Si rien ne change, la Ellen MacArthur Foundation (2017) estime même que les océans pourraient contenir davantage de plastique que de poissons, par poids, en 2050.

1.3 La pollution plastique des océans

Il est estimé que 80 % du plastique présent dans les océans provient de sources terrestres (Luttenberger, 2018). En effet, Jambeck et al. (2015) évaluent que de 4 à 12 millions de tonnes métriques de déchets plastiques sont entrées dans les océans à partir de sources terrestres en 2010. Il s'agit là d'une importante cause de la pollution plastique des océans.

Bien que les pays à haut revenu produisent des quantités exceptionnelles de déchets plastiques annuellement – ne pensons qu'aux États-Unis où sont produits 2,58 kg de déchets plastiques par personne chaque jour (Jambeck et al., 2015) –, les recherches effectuées dans les dernières années montrent que le plastique présent dans les océans ne provient pas directement de ces pays puisque ceux-ci possèdent des infrastructures de collecte et de traitement des déchets dites modernes. Dans leur étude, Jambeck et al (2015) présentent un modèle leur permettant de déterminer la masse de déchets plastique provenant de plusieurs pays pour l'année 2010 grâce à différents facteurs. Selon leur étude, plus de 80% du plastique total entrant dans les océans provenait de pays asiatiques. Parmi ceux-ci, la Chine serait la plus grande émettrice de débris marins plastique, avec entre 1,32 et 3,53 millions de tonnes émises en 2010 (Jambeck et al., 2015).

1.4 La gestion des matières résiduelles dans les PRFI

Le manque d'infrastructure dans les PRFI a été identifié par différents auteurs comme l'une des causes principales du problème de pollution plastique des océans (Jambeck et al., 2015; Stuchtey et al., 2019). Plusieurs facteurs participent à ce problème, dont le manque de financement identifié (Wilson, D. C. et al., 2013). En raison de leur contexte unique, une approche appropriée doit être utilisée afin d'en faire une bonne analyse de la GMR dans les PRFI. L'approche favorisés dans ces pays est le « integrated sustainable solid waste management » (ISSWM), qui favorise une approche de GMR intégrée et durable. Cette approche a premièrement été présentée dans le document du UN-Habitat (2010), et elle a rapidement été reprise par plusieurs auteurs.

En 2013, Wilson et al. (2013) ont repris cette approche, et ont proposé un modèle présentant deux catégories d'éléments essentiels à la GMR dans les PRFI : les aspects physiques et les aspects de gouvernance. Les aspects physiques sont composés de la santé publique (collection), de l'environnement (traitement et élimination), ainsi que du concept des 3R (relié à la valeur de la ressource). Les aspects de gouvernance du modèle sont quant à eux composés de l'inclusion, de la pérennité financière, et des institutions et politiques solides et proactives (Wilson, D. C. et al., 2013).

Bien qu'il soit impératif de traiter de ce problème, la pollution plastique des océans n'est pas la première problématique environnementale à laquelle l'humanité est confrontée. Au fil des années, la communauté internationale s'est mobilisée de différentes façons afin de développer des solutions permettant de faire face au problème important que sont les changements climatiques. Cette mobilisation a notamment permis la création d'instruments de politique environnementale, tel que les crédits compensatoires carbone.

1.5 Les crédits compensatoires carbone

Le Protocole de Kyoto a établi le premier marché du carbone international en créant trois mécanismes. Parmi ceux-ci se trouve le Clean Development Mechanism (CDM) qui permet aux pays d'Annexe 1 de financer des projets de réduction d'émission de gaz à effet de serre dans des pays ne figurant pas à l'Annexe 1 (Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997).

Aujourd'hui, les crédits compensatoires sont connus à travers le monde et existent sous deux types de marché: obligatoire et les volontaire. Ces instruments de politique environnementaux permettent aux acheteurs de compenser leurs émissions de GES en finançant des projets affirmant la réduction ou la capture de GES (Macintosh, 2013).

Dans les dernières années, les crédits compensatoires ont été traités par plusieurs recherches scientifiques. En revanche, à notre connaissance, aucune d'entre elles ne semble traiter du potentiel de transfert des crédits compensatoires à d'autres problématiques environnementales

1.6 Objectif de recherche

Un système de crédits compensatoires plastique, inspiré des crédits compensatoires carbone, aurait le potentiel d'accélérer le financement de projets de GMR dans les PRFI, en plus de permettre aux acheteurs de compenser leur consommation non-durable de plastique. Cette recherche a donc comme objectif principal de proposer un modèle conceptuel de crédits compensatoires plastique, basé sur les crédits compensatoires carbone, afin de pouvoir réduire le problème de pollution plastique des océans. Sachant que la majorité du plastique qui se retrouve dans les océans provient du manque de GMR dans des PRFI, il était donc important pour nous d'explorer une possible piste de financement pouvant aider à diminuer cette problématique.

Trois sous-objectifs découlent de l'objectif principal de cette recherche. Dans un premier temps, cette recherche vise à faire ressortir les principaux risques et opportunités associés aux crédits compensatoires carbone. Deuxièmement, l'étude compare les méthodologies actuellement utilisées par les mécanismes de crédits compensatoires carbone (approches par projet et par niveau de référence) à l'approche de système de gestion dans le but de déterminer laquelle d'entre elles serait la plus appropriée à ce mécanisme de crédits compensatoires plastique. Finalement, l'article identifie les principaux risques et opportunités de la GMR dans les PRFI, afin de créer un mécanisme efficient et durable, adapté à leur contexte.

CHAPITRE II

ARTICLE SCIENTIFIQUE

Ce chapitre est consacré à l'article scientifique soumit au Journal of Cleaner Production. Celui-ci amène un apport important en proposant un modèle conceptuel de crédits compensatoires plastique, visant à réduire la problématique de pollution plastique des océans. Cet article est précédé de la déclaration des co-auteur(e)s, ainsi que de la lettre de présentation transmise au journal sicentifique lors de la soumission de l'article.

2.1 Déclaration des co-auteur(e)s

Chloé T. Bergeron est la première auteure de cet article scientifique. Elle a conduit seule les recherches nécessaires à la réalisation de ce mémoire. Elle a rédigé l'ensemble du mémoire seule, incluant l'article scientifique rédigé en anglais. Elle a préparé la figure de l'article ainsi que la liste de références. Elle a aussi pris en charge la soumission de l'article scientifique au Journal of Cleaner Production et a rédigé la lettre de présentation.

Cécile Bulle et Mark Purdon sont les seconds auteur(e)s de cette recherche. Ils ont accompagné Chloé T. Bergeron tout au long du processus de recherche, du cadrage jusqu'à la proposition du modèle conceptuel. Ils ont participé à structurer le mémoire, ont guidé la rédaction du mémoire et ont aussi révisé de façon significative l'ensemble du travail.

Fait à Montréal le 15/09/2020
Chloé T. Bergeron, Cécile Bulle et Mark Purdon.

2.2 Lettre de soumission du manuscrit

September 15, 2020
Dear Professors Klemeš, de Almeida and Wang**,**

I am pleased to submit this article titled "Financing Solid Waste Management Systems in Low- and Middle-Income Countries Using Plastic Credits" to the Journal of Cleaner Production. This original research is co-authored with Professors Cécile Bulle and Mark Purdon, and I am the first author.

This exploratory research aims to offer a solution to the problem of ocean plastic pollution by proposing a framework for a potential plastic offset mechanism, based on the currently used carbon offsets. To do so, this project highlights the key challenges and opportunities in creating a system of plastic credits. Moreover, through the analysis of the methodologies used in these already-existing mechanisms, including the project-based and the standardized approaches, this research determines that a management system approach is best suited to implement a sustainable plastic credit mechanism. Finally, this research looks at the risks and opportunities of solid waste management in low- and middle-income countries.

This manuscript has important theoretical contributions since it evaluates the potential for transferring carbon credits, by extrapolating parts of the carbon credit mechanism to that of a plastic offset mechanism. To our knowledge, no scientific study took an interest in the topic. The manuscript also brings practical implications, since it offers a potential solution to the critical environmental problem that ocean plastic pollution is.

This manuscript is unpublished and is our original research. It has not been submitted to any other journal and will not be submitted to any other journal during the review process. Also, we do not have any conflict of interests to disclose.

Thank you in advance for your consideration,
Sincerely,

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2.3 Page titre de la soumission

FINANCING SOLID WASTE MANAGEMENT SYSTEMS IN LOW- AND MIDDLE-INCOME COUNTRIES USING PLASTIC CREDITS: A FRAMEWORK PROPOSITION

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2.4 ARTICLE SCIENTIFIQUE

FINANCING SOLID WASTE MANAGEMENT SYSTEMS IN LOW- AND MIDDLE-INCOME COUNTRIES USING PLASTIC CREDITS: A FRAMEWORK PROPOSITION

1. INTRODUCTION

Plastic has since its creation helped improve human lives in numerous ways (Harrison et Hester, 2019), but much recent research has raised concerns about the material's danger to overall sustainability. This increased societal awareness of plastic's negative environmental, economic and social impacts, specifically as it relates to biodiversity, tourism, and human health, certainly fuels a desire to limit such consumption in some people (Nelms et al., 2016; Oelz, 2015). Indeed, while plastics only account for around 10% of global municipal solid wastes, they represent 85% of the marine litter today (Rhodes, 2018). Boucher and Friot (2017) found that almost 10 million tonnes of plastic waste enter the oceans every year, and this number is expected to increase greatly in the next years (Jambeck et al., 2015). However, it must be noted that while members of certain high-income countries are organizing actions to denounce and reduce unnecessary plastic use (e.g. the zero-waste movements, coercive regulations, etc.), these initiatives generally fail to reduce global marine litter. Most plastics pollution in water streams today is produced by low- and middle-income countries (LMIC)[1] (Jambeck et al., 2015). This research mainly focuses on microlevel plastic

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[1] For the purpose of this article, the term low- and middle-income (LMIC) refers to developing countries, while the term "high-income countries" refers to developed countries. The authors recognize that this income-based classification ignores the plurality of development ideals.

pollution in LMIC, but it is clear that macro factors such as industrial waste and plastic waste imports from high-income countries play significant roles in driving pollution rates.

The management of plastic waste is a part of solid waste management (SWM), which is a responsibility of local governments (Schübeler et al., 1996; Wilson, D. C. et al., 2013). Solid waste management is a challenge for local governments around the world, but it is especially harder for municipalities of LMIC. As population and income levels continue to rise in these countries, the amount of solid waste generated is doomed to climb too (Wilson, D. C. et al., 2013). Precisely, research suggests that by 2050, the total quantity of waste in low-income countries should increase by more than threefolds (Kaza et al., 2018). Facing pressure from exponentially growing rates of waste quantity, these SWM systems are crucial in providing a cleaner future. However, their structures, which require high capital investment and operation costs, constitute expenses that LMIC municipality budgets can rarely afford (Bogner et al., 2008; Wilson, D. C. et al., 2013). Various foreign-driven attempts to organize these systems in LMIC countries have failed, and these unfortunate outcomes are oftentimes direct results of a lack of consideration for regional needs. Consequently, several authors have stressed that the only way to achieve a sustainable reduction of plastic leakage in such countries is to ensure that the funding of SWM systems be adapted to regional specificities and needs, which is exactly what this project aims to do (Jambeck et al., 2015) through the creation of a plastic credit mechanism.

Ocean plastic pollution is not the only environmental challenge confronting humanity. Greenhouse gas emissions is a problem that has been discussed at lengths and for which different mechanisms have been implemented around the world. An example of such mechanisms includes carbon credits, which allow buyers, either individuals or organizations, to "compensate" for their gas emissions by financing projects that work towards reducing the latter. A comparable offset mechanism could potentially be applied to the plastic litter issue, where compensations would be used to fund the creation and/or operation of SWM systems in LMIC, thus reducing land-based plastic leakage. The case of the Clean Development Mechanism (CDM), which was implemented under the Kyoto Protocol, provides a great starting point. Criticized for its sole focus on the reduction of GHG emissions (Siebel et al., 2013), this program offers high-income countries the possibility to buy carbon credits from LMIC, and the funds raised go towards project that promote the reduction of greenhouse gas emissions (Wilson, D. C., 2007). Similarly to this, a system of plastic credits would allow buyers to “compensate” for their unnecessary plastic production and/or consumption as well as offer them opportunity to finance actions that work towards reducing ocean plastic pollution.

Little is known about the carbon offset mechanism’s applicability to other environmental issues. This research however works to provide a potential framework for a plastic credit mechanism that could directly inform decision-makers as well as local and international stakeholders who operate in the sphere of sustainability. More specifically, by extrapolating parts of the carbon credit system to that of a plastic offset system, this research anticipates and answers potential drawbacks while addressing possible benefits. To do so, based on already-existing carbon credit mechanisms, this project highlights the key challenges and opportunities in creating a system of plastic credits. Moreover, through the analysis of the methodologies used in these alreadyexisting mechanisms, which include the project-based and the standardized approach, the research determines that a management system approach is best suited to implement a sustainable plastic credit mechanism. Finally, this research looks at the risks and opportunities of the SWM in LIMC. Following this analysis, a tangible framework proposal for a plastic credit mechanism is put forward.

2. MATERIAL AND METHODS

The research article provides a framework for a potential plastic credit mechanism that could inform decision-makers and stakeholders operating in the sphere of sustainability. To propose such a framework, it is imperative that already-existing mechanisms, including their risks and opportunities, be critically looked at. Consequently, this literature review focuses on carbon credits, more precisely, it looks at their basic principles, risks and opportunities as well as at the conditions necessary for their sustainable implementation. When it comes to this compensation system, two existing approaches exist, that is a project-based and a standardized methodology. To evaluate the carbon credit system's applicability to the issue of plastic pollution, these existing methodologies will be compared to a management system approach on the basis of their advantages, limits and conditions. The goal here is to identify the most appropriated option for the case of a plastic credit mechanism specifically.

The issue of plastic emissions will also be analyzed to understand the extent to which a solution inspired by carbon credits could be useful to offset the issue of plastic pollution. As mentioned earlier, the main source of plastic emissions into the environment is linked to the poor management of solid waste. A good understanding of waste management issues in LMIC is thus key when assessing the potential use of plastic credits to create and enforce better waste management practices in LMIC. That is, a systemic analysis of waste management structures in such locations will be provided, and the conclusions drawn will establish key recommendations for the implementation of a plastic credit mechanism. Combined with the analysis of the basic principles, risks and opportunities of the carbon offset mechanism as well as the study of existing methodologies, the analysis of waste management structures in LMIC will be integrated to detail a conceptual framework for a potential plastic credit system.

3. RESULTS AND DISCUSSION

This section introduces a literature analysis on the carbon offset mechanism, its methodologies and management systems as well as on overall waste management in LMIC. These topics will be reviewed and the key elements to build the necessary conceptual framework, will be highlighted in section 3.1.4.

3.1 Literature analysis

3.1.1 Carbon offsets

Carbon offsets refer to the "reductions in emissions, or the maintenance or enhancement of carbon sinks, relative to a counterfactual reference case, which can be used to compensate for emissions from another source" (Macintosh, 2013). They exist under voluntary and mandatory carbon markets and are used extensively throughout the world. A carbon offset represents one ton of equivalent cabon dioxide and its price depends on many factors, such as the offset's quality. The most well-known carbon offset program exists under the Clean Development Mechanism (CDM), which is a mandatory scheme established by the Kyoto Protocol. The CDM was created to allow high-income countries to cost-effectively reach their emission reduction targets while simultaneously promoting sustainable development in LMIC by ways of financing (UNFCC, 1997).

While carbon offsets were mainly designed to generate net climate benefits (Broekhoff et al., 2019), the environmental instrument has been criticized for many reasons. At the heart of these criticisms is the concern that some of them do not actually produce the volume of emission reduction they claim to do (Bushnell, J. B., 2011; Kollmuss, A et al., 2008).

Researchers such as Macintosh (2013) have identified the two principal risks and the one opportunity related to carbon credits: integrity risks, perverse impacts risks and the creation of co-benefits.

The first risk associated with carbon offsets are integrity risks, which specifically refer to the offset "quality". The principal integrity risks associated with carbon offsets schemes are additionality, leakage and permanence (Macintosh, 2013). Additionality addresses the need of carbon credits to only be given to projects that would otherwise not have occurred (Raymond, 2010). That is, such projects constitute direct results of the financing generated by carbon offset schemes. A project's additionality can be tested using a project-based or a standardized approach. These methodologies will be presented and analyzed in details in section 3.1.2. Leakage refers to the idea that a project could lead to an increase in GHG emissions or to the reduction of a carbon sink outside the project (Macintosh, 2013), thus leading to the overestimation of emission reductions. The permanence issue, which is considered an integrity risk by only some authors, will not here be analyzed because it applies specifically to forestry projects. Shortly put, this risk deals with the assumption that carbon credits should be used to support projects that ensure carbon storage in a long-term perspective (Macintosh, 2013).

The second category of carbon offset risks are perverse impact risks, which refer to the negative social and environmental impact that often result from carbon offset projects. One controversial perverse impact examples is the funding of HFC-23 mitigation projects under the CDM (Bushnell, 2011). In this case, some authors argued that high carbon credits revenues, and low GHG abatement costs caused more HFC-23 production by plants when carbon credits could be claimed (Schneider, L. R., 2011).

Finally, other than their promise to reduce GHG emissions, carbon credits offer the opportunity of co-benefits (Broekhoff et al., 2019). These co-benefits can include "improvements to community employment opportunities; enhanced air or water quality; biodiversity and habitat conservation; improved energy access; and better access to community health and education services (Broekhoff et al., 2019)." That is, carbon offsets can promote the acceleration of sustainability by generating positive social, environmental and economic impacts. Credits of higher "quality", such as the Gold Standard, promise the maximization of positive impacts of their projects, but this comes with a premium price.

3.1.2 Carbon offsets methodologies and management systems

Additionality is considered to be the most important aspect of a carbon offset "quality". Depending on the offset mechanism, additionality can be tested using either a project-based or a standardized approach. A carbon offset program's methodology choice will directly determine how GHG emissions reduction are calculated for a specific project (Kollmuss et Fussler, 2015). An analysis of a different methodology, in this case of the management systems approach, is needed to generate a more complex understanding of current methods' benefits and disadvantages. This plan-do-check-act approach is used by organizations around the world and it grants systems with a chance at better performing specific functions such as quality, environment, occupational health and safety, and corporate social responsibility (Jonker et Karapetrovic, 2004). In the next section, these three methodologies will be discussed, and their possible use in a plastic credit mechanism will be determined

3.1.2.1 Project-based methodologies

One of the earliest apparition of carbon offsets was through the Clean Development Mechanism, established under the Kyoto Protocol. The CDM, like other important offset mechanisms, was initially designed as a project-based mechanism (Presicce, 2011). To assess their carbon credits, project developers estimate a baseline scenario (in a “business-as-usual scenario”) as well as the expected carbon emission reductions linked to their project’s activities (WBCSD, 2004). This assessment is then submitted to and reviewed by the accrediting body. The additionality aspect of a project is granted when the project’s emission reductions are higher than the determined baseline.

The project-based approach was first used officially used in the CDM credit offset mechanism. To this day, and following this first example, this approach is maintained by various credit offset schemes around the world. Shortly put, this approach takes into account local specificities, and it may be used in cases where a data set is too limited to develop a standardized baseline. Indeed, the project-based approach only requires data on a specific project in a specific geographical area (WBCSD, 2004).

With that in mind, this methodology is criticized in scientific and grey literature. Some researchers consider that to compare a project’s emission to an “hypothetical” baseline is an inefficient way of proving additionality (Drew and Drew, 2010). Indeed, considering that the baseline is hypothetical, the comparison is then rooted in some level of uncertainty, which can lead to the over-crediting or under-crediting of carbon credits (European Investment Bank, 2020). While the baseline is considered an “if all stays the same” scenario, the reality is that factors such as political environments, which are sometimes not even considered by project developers in the baseline setting process, are most likely changing.

Moreover, since the baseline is here determined by project developers themselves, these results allow for subjectivity. Indeed, researchers have identified that lack of transparency and that baseline manipulation can happen (Drew and Drew, 2010, Presicce, 2011) in this type of methodology. It is up to the project developer to determine “what constitutes a significant set of barriers for a project, whether barriers are insurmountable, and ultimately how to weigh and compare the cumulative significance of barriers for different alternatives” (WBCSD, 2004). Once this assessment is realized by the project developer, it is reviewed by auditors. However, it has been argued that the quality of the project's assessment, being established by auditors who influenced by their own subjectivity, varies considerably and is unclear in many cases (Schneider, 2007).

Finally, since it is designed to evaluate carbon credits for a project in particular, project-based metholodology requires extensive data on the latter (Ellis and Bosi, 2000, Kollmuss and Fussler, 2015). Indeed, before being able to set a baseline, project developers must be sure that the data needed is available, and more importantly, that it is relevant, reliable, and verifiable (WBCSD, 2004). Considering that the development of the baseline scenario demands great amounts of time and resources, one must note that transaction costs for this methodology are usually high (Macintosh, 2013, Presicce, 2011).

3.1.2.2 Standardized approaches

Standardized approaches have been implemented by different offset programs around the world, and the Western Climate Initiative accounts for one example. Unlike project-based methodologies, standardized approaches are established at higher level of aggregation and overtly specify the eligibility criteria for projects (Haya et al., 2019). If a project fulfills the additionality requirement, it is automatically considered to be additional (Haya et al., 2019). This approach is applicable under certain conditions and for certain project types only (Presicce, 2011). The baseline determination of a standardized method requires that some degree of uniformity of practices as well as of technology be used across a project type, and it also calls for easy access to data and readily available resources (Presicce, 2011). However, once the methodology is determined, it simplifies project developers job in many ways.

Two well-known standardized methods are performance benchmarks and positive lists. Performance benchmarks, which include the emission or energy intensity methods, calculate the GHG emission rates of all project in one set category to construct this said GHG performance benchmark (WBCSD, 2004). Consequently, it holds an advantage in that once the performance benchmark set, any similar project can be compared to it. Positive lists offer a simple answer to additionality testing. These lists, set by the carbon offset program, compile the various types of projects that are known and considered to hold a notable performance rate. Here, a technology's existence on a positive list in itself validates its granting of the additionality criterion (Presicce, 2011). Similarly to performance benchmarks, positive lists simplify the process of assessing additionality in that they offer a direct and binary answer to questions of expected project performance (Presicce, 2011).

Standardized approaches shift the cost of the methodology development and data collection from the project developers to the centralized body that governs it (Hayashi and Michaelowa, 2013), thus reducing transaction costs and simplifying the overall process of the former. As established earlier, baseline setting can be a quite time and resource consuming and again, it generates high costs for project developers. Here, standardization provides a solution to this shortcoming as it lowers costs, thus improving projects' success opportunities. In other words, the standardized method's relative simplicity and inferior costs, especially when compared to the project-based method, facilitates project developers' access to carbon credits. Project developers, who can predict their rate of success at the additionality testing with more ease and certainty, are more likely to invest and direct funding towards sustainable projects (Presicce, 2011).

The standardized method addresses another shortcoming of the project-based approach, as it reduces the risk of under-crediting or over-crediting. Indeed, being determined by the aggregation of important amounts of periodically-updated data, this method is less subjective (WBCSD, 2004). The overall chance of uncertainty is reduced in cases where baselines are determined conservatively (WBCSD, 2004, Presicce, 2011). Moreover, it can also help with the leakage and permanence since the analysis is more objective (Daviet, 2009).

While standardized methods enjoy the benefit of being applicable to several projects, they by doing so ignore project specificities. Assuming that some projects demand that conditions such as culture, political atmosphere, geographical location and economic state to name a few be taken into consideration, this inflexibility certainly comes at a disadvantage.

Finally, data availability is essential to the standardized approach, which is why this method may not be appropriated where data is not precise enough or readily available. Consequently, this heavily data-based process often discourages project developers, who are often too skeptical to invest in the development of a methodology that would facilitate the work of their competitors and that would also rid them of many methodology costs (Presicce, 2011).

3.1.2.3 Management systems

Over the last thirty years, standard organizations such as the International Organization for Standardization (ISO), have developed management systems standards for the quality, environment, occupational health and safety and corporate social responsibility functions of organizations (To et al., 2012, Nunhes et al., 2019). The ISO defines a management system as “the way in which an organization manages the interrelated parts of its business in order to achieve its objective” (ISO, n.d.). Its goal is to improve organizational performance for a specific function—such as SWM—by establishing a management system.

The benefits of implementing management systems are both economic and "non-economic". Alberti et al. (2000) identified several economic benefits of implementing environmental management systems, which include raw material conservation, productivity improvement and energy conservation. The same researchers also detail "non-economic" benefits, or benefits that bring value to an organization without being economically quantifiable, and examples such as workers' better knowledge of their job, a reduction of site contamination risks and human risk reduction are cited.

While management systems share some similarities with the systems perspective, the former is based on a the plan-do-check-act approach, that is one that provides a means for continual improvements (Jonker and Karapetrovic, 2004). Current management standards look at function separately, and in cases where functions are simultaneously implemented, organizations may find it difficult to facilitate their integration. To avoid the more complex and costly management of such multiple functions, they should be integrated rather than dealt with separately (Jonker and Karapetrovic, 2004).

Management standards are currently mostly used in high-income countries. Indeed, standards such as ISO are known to be costly, to require extensive resources, and to generate a lengthy accreditation process that is paper-driven and dependent on bureaucracy. These reasons certainly acts as deterrent against their implementation in LMIC (Alberti et al., 2000).

3.1.3 Solid waste management in low- and middle-income countries

As mentioned earlier, the principal cause of ocean plastic pollution is directly linked to the inappropriate management of solid wastes in LMIC. An analysis of municipal solid waste management is provided below through the use of an integrated sustainable solid waste management (ISSWM) approach .

The ISSWM approach was discussed by several authors. However, for this specific research, Wilson et al. (2013)'s framework is prioritized for the analysis of SWM in LMIC. This specific framework proposes two triangles, one representing the physical and the other the 'soft'-governance elements of SWM systems in LMIC. As for the first triangle, Wilson (2007) concurrently identifies these physical aspects as the first key drivers of SWM development, that is, public health, environment and 3Rs (resource value). The second triangle focuses on the governance aspects of a well-functioning SWM system, and features aspects such as inclusivity, sound institutions and proactive policies as well as financial sustainability. For a SWM system to be deemed efficient, it is expected to consider and integrate these six elements, which will be further detailed in the next section (Wilson et al., 2013).

3.1.3.1 Public health (waste collection)

The issue of uncollected waste induces a number of serious environmental, economic and human health problems (Un, 2010, Kassim et al., 2006, Wilson et al., 2015). While the improper handling of solid waste can create direct health hazards to workers, it can also create majors consequences for the general population. Indeed, if uncollected, waste can block drains, causing flooding and the apparition of diseases (Wilson et al., 2013; Zohoori and Ghani, 2017). These negative outcomes highlight the importance of collecting solid waste, and this latter activity is both the main driver of SWM systems development in LMIC as well as to be the most basic indicator of their performance (Un-Habitat, 2010; Wilson, D. C., 2007).

One must note that waste collection rates are influenced by income levels as well as geographic location. That is, as a country rises in income per capita, its solid waste collection coverage usually follows the same trajectory. Kaza et al. (2018) estimate that the coverage rate for low-income countries coverage represents of 39%, while that of high-income countries amounts to 96%. Such rates are not independent from the urban/rural binary. Indeed, Kaza et al. (2018) state that "in lower-middle-income countries, waste collection rates are more than twice as high in cities as in rural areas". Moreover, solid waste collection rates also tend to be higher in richer area (Un, 2010), reinforcing the already existing inequitable connection between the urban/rural binary and socioeconomic classes.

Waste content in LMIC differs from that of higher income countries. For instance, food and green waste constitute more than 50% of LMIC's waste (Wilson et al., 2013, Kaza et al., 2018), while this data decreases to 34% in high-income countries (Kaza et al., 2018). According to Kaza *et al.* (2018), recyclables, which include materials such as paper, cardboard, plastic, metal, and glass, make up for about 16% of low-income countries' waste, and these rates increase as countries' income levels rise. Many technology transfers from high-income countries to LMIC over the years have failed to account for these major differences in waste contents. More precisely, many foreign donor-funded attempts have failed to avoid improper waste management precisely because they ignored context-specific factors such population density, waste generation patterns, waste composition, financial ability, culture and the presence of informal waste management systems (Un, 2010; Mader 2011). The possibly inappropriate transfer of collection vehicles from high-income countries to LMIC exemplifies this failure, as factors such as waste density and workers' inability to linguistically understand the technology were ignored. Going forward, the development of waste-disposal technologies in LMIC should be rooted in an understanding of these differences, and it is imperative that collection methods, technologies, and design choices depend on local conditions.

Project developers of SWM in LMIC should understand that economically poorer regions are often underserved, and that the creation of SWM projects that ignore these above-mentioned local specificities work to reinforce existing inequalities.

3.1.3.2 Environment (waste treatment and disposal)

While waste treatment and disposal have significantly improved in LMIC, they still constitute a significant challenge in LMIC. Indeed, the most prevalent practice in such locations remains open dumping, which represents 93% of the waste disposal (Kaza et al., 2018), while landfill disposal and recycling respectively represents 3% and 4% of current practices (Kaza et al., 2018). Some challenges associated with waste treatment and disposal include the rapid urbanization of LMIC. This urbanization contributes to the exacerbating urban land scarcity, a space that is otherwise essential for the establishment of landfills (Banerjee and Sarkhel, 2020). Moreover, waste treatment and disposal methods often depend on income levels, and practices such as open dumping tend to be more endemic to regions of lower socioeconomic levels while places associated with higher income levels often see the rise of other methods, such as incineration (The World Bank, 2018). Unfortunately, due to landslides in uncontrolled dumpsites, several LMICs have seen the death of hundreds of people, and as already established, these incident are particularly relevant to economically poorer regions (Wilson et al., 2013).

The treatment of recyclables in LMIC also constitutes an important challenge. A lack of waste segregation at the source and a lack of compliance from the users, geographic specificities, users' socioeconomic status and well as their possible unwillingness to pay for such services and the important amount of organic content is waste all contribute to making this task a difficult one to manage for local governments in LMIC (Ferronato et al., 2019). Factors such as regional population growth and income levels should play an important role in determining waste treatment and disposal choices. Indeed, SWM projects developers should take into consideration that recycling can be greatly improved by a better waste segregation at the source as well as with a more effective user compliance.

3.1.3.3 Three Rs – reduce, reuse, recycle

The concept of the Three Rs addresses the need to prioritize waste reduction at the source rather to solely focus on reusing or recycling a product. Indeed, waste generation is expected to grow exponentially in the next years, and that is especially true for LMIC. With this concept in mind, it is expected that local governments in such locations focus both on improving their SWM systems and on working towards reducing waste at the source. As it relates to the aspect of reusing, it is important to note that the management of repair systems in LMIC often falls into the hands of the informal sector (Wilson et al., 2013).

In LMIC specifically, recycling and composting processes are mostly performed by informal workers, which sometimes include children (Medina, 2008), and such activities are mostly driven by the financial value of the materials. In fact, the separation of waste from materials worthy of reselling constitutes a known financial activity. In some LMIC, it is estimated that about 2% of the population depend on waste picking as means of financial survival (Medina, 2007). The treatment of recyclables also demands important, and often impossible to reach, economic capacities, which provides another justification for the relatively high-involvement of the informal sector in waste management. Indeed, the latter allows municipalities to lower their waste management costs, and it is estimated that around 20% of municipal SWM budgets are saved due to the indirect involvement of the informal sector. As mentioned in Wilson et al. (2013), there are important benefits to building on the existing informal sectors in LMIC. Integrating them into the more formal SWM system can not only increase recycling rates and lower municipal SWM systems' costs, but it can also protect and develop citizens' livelihoods, address perceived problems (such as child labor), create employment and reduce poverty (Wilson et al., 2013, Nemadire et al., 2017).

The different actors involved in SWM in LMIC are expected to consider these above-analyzed socioeconomic and systemic specificities. Precisely, local governments should promote and support initiatives that respect the concept of Three Rs, while project developers should understand, value and support the work the informal sector, especially as it relates to recycling and composting practices. As established earlier, including these workers, who often depend on this specific income to survive, in the more formal sector can bring various added benefits to SWM projects.

3.1.3.4 Inclusivity

Local governments are responsible for the management of their municipal solid waste, and the inclusion of users, providers, especially from the informal sector has been identified as a critical aspect of the implementation success of a SWM system (Wilson et al., 2013).

As suggested by Mader (2011) in her thesis, "the success of recycling collection programs depends on the level of public knowledge about their existence and how to use them". That is, one cannot expect a SWM system to be implemented successfully without it being adopted by its users first. Some value should be placed upon understanding user participation or the lack thereof, and other aspects such as convenience, users' knowledge on the pertinence, functioning or appropriate costs of SWM systems as well as their involvement in the planning and day-to-day organization of such services (Mader, 2011). Moreover, it should be noted that since women in LMIC often take on a more active role than men when it comes to SWM, special attention should be reserved for their inclusion (Mader, 2011, Wilson et al., 2013).

Providers, being part of the formal and/or informal sector, should also take part in the SWM system design and day-to-day operations. While the inclusion of the formal sector in SWM seems to be clear, the inclusion of the informal sector is not. This challenge might be explained by the fact that in high-income country, material recovery is realized by the formal sector, while "in the low-income countries, the activity is predominantly in the informal sector; [and] the middle-income cities are between these two extremes" (Wilson et al., 2013). Without project developers' understanding of these specificities, a successful SWM system cannot be guaranteed. Indeed, authors such as Matter, Dietschi, & Zurbrugg (2013) suggest that the inclusion, involvement and acceptance of the informal sector within a formal recycling system is the main challenge for working towards sustainability in megacities. The inclusion of the informal sector starts with its acknowledgement by their respective governments (Nzeadibe and Ejike-Alieji, 2020).

The inclusion of stakeholders should be considered as a critical aspect to the success of a SWM implementation. Project developers should make sure that the users, providers and other stakeholders are consulted and involved from the start. While users are expected to understand, and to be educated on, if needed, the workings of SWM system, project developers are expected grasp the key role of the informal sector and thus to include them in their definition of service providers.

3.1.3.5 Financial sustainability

As it relates to the sustaining of SWM, lack of capital is one of the most important challenges faced by LMIC (Bogner et al., 2008, Wilson et al., 2013). With waste generation growing rapidly, it is therefore critical that LMIC increase their revenue sources and secure significant amounts of financing (Wilson et al., 2013).

The proper treatment and disposal of solid waste demand much funding. This high capital requirement is not only crucial to the establishment infrastructures, but also to ensure the smooth operation and maintenance of the latter (Ferronato et al., 2019). Current financial aid allocated to the improvement of SWM in LMIC generally goes directly to the construction of sites, while the substantial funds needed to sustain these operations are often ignored (Wilson et al., 2013). Consequently, an overall lack of funding of SWM systems constitutes an important cause of failure, as such infrastructures are often unable to finance their long-term services (Un-habitat, 2010).

Brunner and Fellner (2007) recommend that regions determine their economic capacity before designing their SWM systems. Costs and revenue sources should carefully be evaluated to ensure that the appropriate solid waste management budget be set up (Un, 2010). While the issue of data availability might burden the careful planning of cost and revenue sources in LMIC especially, it should be noted that readily available data such as the total budget and total number of tonnes handled by the formal sector can indicate an average cost per tonne of pwaste (Un, 2010). Moreover, since not all LMIC can rely on user fees to finance their SWM systems, local governments are expected to identify different revenue sources (Un, 2010).

Shortly put, it is crucial that LMIC increase their revenue sources to finance their SWM systems. Since the waste generation numbers are expected to grow exponentially, it is even more vital that, as suggested by the current research, the design phase of any SWM system carefully examine the sustainability of a project. To do so, project developers should evaluate infrastructure and operation costs as well as possible revenue sources.

3.1.3.6 Sound institutions and proactive policies

Since local LMIC governments are responsible for the management of their municipal solid waste, a strong and transparent framework within the national and local tiers is essential to the efficiency of SWM systems (Wilson et al., 2013, Un, 2010). Aiming for a stable system even when political shifts occur, the organization of waste management should be strategically planned, and clear commitments should be agreed upon (Un, 2010).

Governments should identify management elements, that is inefficient labour and accounting practices, poverty, and corruption, as the main hindrance to SWM systems' productivity (Un, 2010, Wilson et al., 2013). Authorities should also be mindful that regulations, or regulations under development, do not represent barriers to the performance of their SWM system, but that they rather safeguard the sustainability of such projects.

Local and national governments should value the efficiency of their SWM system, as failing infrastructures generate various social, economic and environmental impacts. To do so, proactive policies that address both the need for clear commitments and management challenges should be put in place.

3.1.4 Lessons learned

The transferability of the concept of carbon offsets to the ocean plastic problematic is innovative and has a potential to reduce plastic emissions in the environment. This research highlights a few lessons that should be considered for the creation of a plastic offset mechanism:

- Carbon offset mechanisms function because carbon markets were implemented. Similarly, a plastic market would be a prerequisite for the creation of a plastic offset mechanism. For now, plastic markets do not exist. As such, their creation should be the first step in the implementation of a plastic offset mechanism.

- Importance should be placed on taking into account local specificities in the design phase of a plastic offset project. As seen in the previous section, many factors differ from region to region in LMIC, such as waste characteristics or the role that the informal sector plays in the SWM's system. Plastic offset projects cannot ignore these factors.

- Governments should aim for waste reduction first, but shoud also work to improve SWM's systems. The volume of solid waste, which includes plastic waste, is expected to grow in LMIC. Consequently, efforts to solve the ocean plastic pollution problem cannot solely rely on the creation of a plastic offset mechanism.

- Stakeholders shoud be included in all SWM projects' phases. The social acceptance of a plastic offset project by its stakeholders, such as informal workers or citizens, is critical to its success since they all play a crucial role in its proper functioning.

- A plastic credit price should include the infrastructure and operation cost into its cost structure. As previously seen, many donor-funded projects have failed over the years because once SWM infrastructures were put into place, resources were not able to sustain the long-term financing of these systems.

- Carbon offsets risks and opportunities could be transferable to the case of a plastic offset mechanism. To ensure a plastic offset project's integrity, plastic offsets should only be given to projets proving to be additional, not leaking, and permanent. They should also limit perverse impacts outside the scope of the SWM project. Finally, opportunities for co-benefits should be identified during the project's design phase, again reitering the need for stakeholders' inclusion in all projects' phases.

- Finally, the analysis of project-based, standardized and management system approaches reveals that the management system approach constitutes the most compatible one with ISSWM. Unlike the result-driven project-based and standardized approaches, the management systems approach focuses on its components and their interrelation as a way to achieve its objectives. Moreover, a management system approach offers the possibility to take into account context specific factors since it focuses on the management side of a project. Moreover, even if it were possible to acquire the required data to set a baseline, which again is a very difficult task to achieve especially in LMIC, project-based and standardized approaches would still present important integrity risks.

3.2 Framework proposal

Based on the critical review offered in section 3.1, a Plastic credit mechanism should strive to reduce plastic leakage in the oceans, while also maximizing the creation co-benefits in LMIC. Following the theory proposed by the ISSWM, the chosen approach should focus on the interrelation between various SWM system components.

3.2.1 A Plastic credit mechanism - Conceptual framework

A Plastic credit mechanism should be composed of three key elements: the plastic credit buyers who purchase credits in exchange of being assured of the latter's quality, an accrediting body that overlooks the management system integrity, and a management system that ensures the efficient operation of SWM systems.

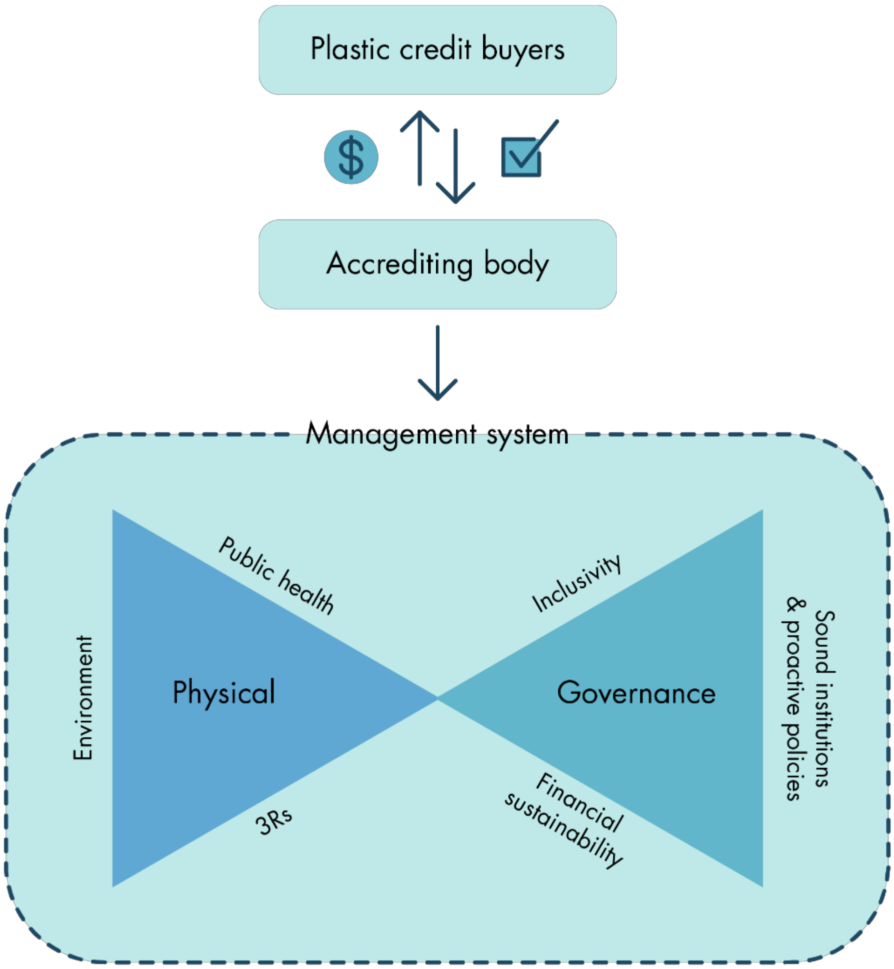

Fig. 3.1. Framework proposal of a Plastic credit mechanism

Plastic credit buyers

Plastic credits could be bought by anyone, but it is expected that buyers would consist mainly of individuals or organizations from high-income countries mainly. Buyers could be motivated by the opportunity to "compensate" for their non-sustainable plastic use, or by the chance to financially participate in the resolution or reduction of ocean plastic pollution in the ocean.

As already argued, unlike the current methodologies used by carbon offset mechanisms, the management system approach does not solely focus on results. However, to obtain long-term tangible results, plastic credits should ensure that buyers properly compensate their non-sustainable plastic use, thus such credits need to match a clear amount. The use of one tonne of plastic waste per plastic credit should be prioritized since this same unit is already being successfully used for carbon credits.

The plastic credit price should include the accreditation cost to avoid having to be supported by the project developer. Project developers, who are expected to carefully evaluate total costs and possible revenue sources, should be allowed to direct finances towards the different stages of a SWM system, for instance to provide infrastructures while also covering subsequent operation costs. Researchers suggest that the evaluation of a project's potential plastic emission reduction should be estimated by the accrediting body by aggregation to prevent both issues of subjectivity and the over or under crediting. Moreover, using such an approach would reduce developers' transaction costs, bringing added benefits such as the improvement of the project's rate of success.

To ensure the integrity of those purchasing plastic credits, an accrediting body put in place should ensure that proper implementation of the management system is adopted and maintained through time.

Accrediting body

The first role of the accrediting body should be to validate the integrity of the SWM system and to make sure that this same system does not create any perverse impacts as discussed previously. To do so, it would first provide guidelines to project developers. These guidelines would help the latter implement an integrated sustainable solid waste management system that considers the 6 elements presented in section 3.1.3: the physical elements, that is public health, environment and three Rs as well as the aspects of governance, that is inclusivity, financial sustainability and sound institutions and proactive policies.

This accrediting body should also support project developers and stakeholders in the design and implementation process. The accrediting body could for instance provide project developers with support in the identification of the new system's possible perverse impacts and in the listing of co-benefits opportunities. It could also help developers determine the ways in which they could facilitate the integration of the informal sector within the formal SWM system, or provide them with educational tools directed towards users of waste management systems.

Finally, the accrediting body should serve to validate or audit the management systems implemented by SWM projects in LMIC through time. As mentioned in section 3.1.2.3, the auditing process can be quite bureaucratic and resource-driven. However, in the case of a SWM project in LMIC, a management system framework should avoid unnecessary bureaucratic and resource-driven practices. The accrediting body should prioritize a collaborative approach over a merely compliance once, so that factors such as local specificities of the project are truly taken into account.

Management system

The management system should ensure buyers that the SWM system has integrated the best practices, and that the financed projects value objectives of collecting, treating, and most importantly preventing waste. Considering that part of this said waste includes plastic waste, the buyers would then also be ensured that their investments go towards the prevention of plastic leakage into the oceans.

The management system to be integrated should focus on the interrelation of the system's elements, as described in section 3.1.3. Again, these elements constitute the physical elements, that is public health, environment and three Rs as well as governance aspects, that is inclusivity, financial sustainability and sound institutions and proactive policies. The management system is expected to frame these 6 elements. Using this type of approach rather than a result-focused approach would ensure that the accredited SWM system is as efficient as it can be, while also mitigating the potential risks and creating co-benefits.

4. CONCLUSIONS

This study responds to a need to provide the necessary framework for a potential plastic credit mechanism that would help to reduce ocean plastic emissions. Resulting from the above-conducted analysis, a program regulating SWM projects using a management system approach is valued.

The literature analysis reveals that carbon offset mechanisms hold three principal risks and opportunities, which are integrity risks, perverse impact risks and co-benefits opportunities. The analysis also shows that the use of an integrated sustainable solid waste management approach is critical to the implementation and operational success of a SWM system in LMIC. Finally, the analysis suggests that a plastic credit mechanism should be based on a management system approach rather than on the methodologies that are currently used for carbon offset methodologies.

This project, which aims for the reduction of plastic leakage into the oceans, specifically addresses decision-makers and stakeholders who operate in the sustainability sphere while also contributing to general sustainability theory and practices. Further studies focusing on the implementation aspects of the mechanism, which should include case studies, are needed.

CHAPITRE III

DISCUSSION ET CONCLUSION

Cette recherche visait à proposer un modèle conceptuel pour un mécanisme de crédits compensatoires plastique permettant la réduction du problème de pollution plastique des océans. Pour y arriver, une analyse de la littérature scientifique et grise a été réalisée, permettant de faire ressortir les points essentiels à prendre en considération pour la création d'un tel mécanisme. Ce mémoire visait aussi à répondre aux trois sous-objectifs identifiés dans la problématique de recherche. Dans un premier temps, cette recherche visait à faire ressortir les principaux risques et opportunités associés aux crédits compensatoires carbone. Dans un deuxième temps, l'étude cherchait à comparer les méthodologies actuellement utilisées par les mécanismes de crédits compensatoires carbone (approches par projet et par niveau de référence) à l'approche de système de gestion dans le but de déterminer laquelle d'entre elles serait la plus appropriée au mécanisme de crédits plastiques. Finalement, l'article visait à identifier les principaux risques et opportunités de la GMR dans les PRFI, afin de créer un mécanisme efficient et adapté à leur contexte.

Cette recherche répond à un besoin identifié dans la revue de littérature, c'est-à-dire d'évaluer le potentiel de transfert que pourraient avoir les crédits compensatoires carbone à d'autres problématiques environnementales. À notre connaissance, aucune recherche ne s'était intéressée à ce sujet jusqu'à présent. Cette recherche répond aussi à un besoin pratique criant. La pollution plastique des océans est une problématique environnementale qui cause d'importantes conséquences environnementales, sociales et économiques négatives. Plusieurs recherches avaient identifié la nécessité d'améliorer les systèmes de GMR dans les PRFI, ainsi que le manque de financement associé à ce service. Cette recherche offre un cadre méthodologique conceptuel répondant à ces besoins aux décideurs publics ainsi qu'aux parties prenantes de la sphère du développement durable.

Tout d'abord, cette recherche a su relever les principaux risques et opportunités des crédits compensatoires carbone, en identifiant deux catégories de risques et une catégorie d'opportunités : les risques d'intégrité, les risques d'effets pervers et les cobénéfices. Le principal défi auquel les crédits compensatoires carbone font face sont les risques d'intégrité. L'intégrité d'un crédit assure la « qualité » de ce dernier. Cette première catégorie est composée de l'additionalité, des risques de fuites et de la permanence. Les enjeux d'additionalité constituent la principale raison pour laquelle les crédits compensatoires sont aussi controversés. Certaines études ont mis de l'avant qu'un grand pourcentage des crédits compensatoires carbone qui avaient été attribués par le Clean Development Mechanism n'étaient pas additionnels, c'est-à-dire que les projets associés n'allaient pas réellement au-delà des pratiques courantes (Haya, 2009; Raymond, 2010). Les risques de fuite, dans leur cas, se réfèrent au fait que le projet crédité doit éviter d'entraîner une augmentation des émissions de GES en dehors des limites du projet. Finalement, la permanence n'a pas été analysée puisque ce risque est associé aux projets forestiers. La deuxième catégorie de risque à laquelle font face les crédits compensatoires est le risque d'effets pervers. Si mal évalué, un crédit compensatoire carbone peut entraîner la création d'effets négatifs aux niveaux environnemental, social ou économique. Finalement, la principale opportunité identifiée pour les crédits compensatoires est la création de cobénéfices. En finançant des projets permettant la réduction d'émissions de GES, les crédits compensatoires ont aussi le potentiel de créer des impacts positifs encore plus larges sur une communauté, accélérant l'implantation de projets durable. Des études proposent d'évaluer le potentiel de cobénéfices d'un projet lors de sa phase de conception.

Cette analyse des crédits compensatoires carbone est suivie d'une analyse plus précise sur les méthodologies utilisées par les crédits compensatoires, ainsi que sur l'approche de système de gestion. Leurs avantages et limites ainsi que les conditions pour leur implémentation ont été discutés. Cette analyse a mis de l'avant le fait que les méthodologies actuellement utilisées par les mécanismes de crédits compensatoires se concentrent sur les résultats du projet, tandis que l'approche de système de gestion se concentre davantage sur la relation entre les différentes unités d'une organisation pour atteindre l'objectif du système.

Ensuite, la gestion des déchets plastiques et plus globalement la GMR dans les PRFI a été évaluée. L'approche systémique de gestion intégrée et durable des déchets solides (integrated sustainable solid waste management) proposée par plusieurs auteurs, dont Wilson et al (2013), a été identifiée comme étant le paradigme actuel. Cette approche a donc été utilisée pour analyser le sujet. Il a été noté que pour qu'un système de gestion des déchets soit efficient, une attention particulière doit être portée aux six dimensions du modèle proposé par Wilson et al (2013). Ces dimensions se présentent en deux catégories : les aspects physiques et les aspects de gouvernance. La première catégorie est composée de la santé publique (collection), l'environnement (traitement et élimination) et le concept des 3R (valorisation). Les trois derniers éléments de ce modèle composent les aspects de gouvernance et sont l'inclusion, la pérennité inancière et des institutions et politiques solides et proactives. Pour être bien géré, un système de GMR dans les PRFI doit veiller à prendre en compte ces six éléments, mais aussi à faire en sorte qu'ils soient gérés de manière intégrée.

Finalement, cette recherche propose le modèle conceptuel d'un mécanisme de crédits compensatoires plastique qui s'adresse aux décideurs publics ainsi qu'aux parties prenantes de la sphère du développement durable. Ce modèle est basé sur les conclusions de l'analyse de la littérature et utilise l'approche de système de gestion. L'objectif du mécanisme de crédits compensatoires plastique devrait être de réduire les pertes de plastique dans les océans provenant des PRFI, mais aussi de maximiser la création de cobénéfices tant économiques qu'environnementaux et sociaux dans les régions où les projets sont développés.

Le mécanisme est présenté dans la section 3.2 et est composé de trois principaux éléments : les acheteurs, l'organisme d'accréditation et le système de gestion. Les acheteurs achètent des crédits compensatoires et permettent par le fait même d'améliorer la gestion des déchets dans ces pays. L'organisme d'accréditation assure l'intégrité et l'efficience du système de gestion par différents moyens. Finalement, le système de gestion permet aux développeurs de projets de gérer leur projet de façon efficiente en prenant en compte l'entièreté des éléments importants et en impliquant l'ensemble des parties prenantes essentielles à la réussite d'un projet de GMR.

Cette recherche a permis de démontrer qu'un système de crédits compensatoires peut être transféré à d'autres problématiques environnementales telles que la pollution plastique des océans dans le cadre de cette étude. Toutefois, cette recherche exploratoire est basée sur l'analyse de recherches scientifiques ainsi que sur de la littérature grise, et n'a donc pas été testée de manière pratique. D'autres recherches, telles que des études de cas étudiant l'implémentation d'un tel système sur une région spécifique seront nécessaires pour démontrer le potentiel réel du modèle conceptuel proposé. Néanmoins, cette recherche a contribué à l'exploration d'un mécanisme environnemental non traité dans la littérature scientifique et a donc des apports théoriques et pratiques importants.

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