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West African science Service Center on Climate Change and Adapted Land Use (WASCAL)

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Presented by : Fama GUEYE

CARBON MARKET IN WEST AFRICAN ECONOMIC AND MONETARY (WAEMU) COUNTRIES

Supervisor: Pr Ahmadou Aly MBAYE

UCAD and WASCAL do not intend to give any approval or disapproval of the opinions expressed in this thesis. These opinions should be considered as the author's owns.

Acknowledgments

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ACRONYMS

ABREF: African Biofuels and Renewable Energy Fund

ACAD: African Carbon Asset Development

ACSP: African Carbon Support Programme

AEE: Afrique Energy Environnement

AFAT: Agriculture, Forestry and other land uses

AFDB: African Development Bank

AFIDEP: African Institute for Development Policy

AFULO: Agriculture, Foresty and other Land **Uses**

AGN: African Group of Negociators

AIJ: Activities Implemented Jointly

ARDL: Autoregressive Distributed Lag

ASER: Agence Sénégalaise d'électrification Rurale

BAU: Business As Usual

CCAP: Cheapest Cost Avoider Principle

CDCF: Community Development Carbon Fund

CDM: Clean Development Mechanism

CER: Certified Emission Reduction

CFC: chlorofluorocarbon

CIGI: Center for International Governance Innovation

CILSS: Permanent Interstate Committee for Drought Control in the Sahel

CMA: Conference of the Parties serving as the meeting of the Parties to the Paris Agreement

CMP: Conference of the Parties serving as the meeting of the Parties to Kyoto protocol

COMNACC: Comité National sur le Changement Climatique

CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation

CP2: Comitment Period 2

CSF: Climate Support Facility

DEEC: Direction de l'Environnement et des Etablissements Classés

DNA: Designated National Authority

DOE: Designated Operational Entity

EB: Executive Board

ECREEE: ECOWAS Center for Renewable Energy and Energy Efficiency

EU ETS: European Union Emission Trading Scheme

EU: European Union

FDI: Foreign Direct Investment

FE: Fixed Effects

FONSIS: Fonds Souverain d'Investissement Stratégiques

GCF: Green Climate Finance

GDP: Gross Domestic Product

GHGs: Greenhouse Gases

GWP: Gobal Warming Potential

HDI: Human Development Index

HFC : Hydrochlorofluorocarbon

ICAO: International Civil Aviation Organization

ICP: International Comparison Programme

IEA: Internation Energy Agency

IETA: International Emission Trading Association

IGES: Initial Graphics Exchange Specification

IMF: International Monetary Fund

IMR: Inverse Mill's Ratio

INDC: Intended Nationally Determined Contributions

IRENA: International Renewable Energy Agency

IRR: Internal Rate of Return

ITMO: Internationally Transferred Mitigation Outcomes

JI: Joint Implementation

KP: Kyoto Protocol

LDC: Least Developed Countries

LUCF: Land use change and forestry

LULUCF: Land use, Land-use change and forestry

MATA-CDM: Multi-Attributive Assessment of CDM projects

MAUT: Multi-Attributive Utility Theory

MDG: Millenium Development Goals

MG: Mean Group

MLR: Multiple Linear Model

MRV: Monitoring Reporting and Verification

NDC: Nationally Determined Contributions

NEMA: National Environmental Management Authority

NGO: Non-governmental Organization

NPV: Net Present Value

NSS: National Strategy Study

ODA: Official Development Assistance

OECD: Organisation for Economic Co-operation and Development

OHADA: Organization of Harmonization in Africa of Business Law

OPEC: Organization of Petroleum Exporting Countries

PAPEM: Programme d'eau potable et d'assainissement du Millénaire

PDD: Project Design Document

PMG: Pooled Mean Group

PoA: Programme of Activities

PPP: Polluter Pays Principle

QML: Quasi-Maximum Likelihood

R&D: Research and Development

RCCS: Regional Collaboration Centers

RE: Random Effects

REDD+: Reducing emissions from deforestation and forest degradation

RET: Renewable Energy Technology

SBI: Subsidiary Body for Implementation

SD: Sustainable Development

SDGs: Sustainable Development Goals

SFIT: Swiss Federal Institute of Technology

SF-SLM: National Durable Land-Management Strategy

SIDS: Small Island Developing States

SLM: Sustainable Land Management

SMM: Sustainable Mitigation Mechanism

SSN: SouthSouthNorth

SWOT: Strength, weakness, Opportunity and Threat analysis

UN: United Nations

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNESCO: United Nations Educational,Scientific and Cultural Organization

UNFCCC: United Nations Framework Convention on Climate Change

USD: US Dollar

WAEMU/UEMOA: West African Economic and Monetary Union

WBCSD: World Business Council for Sustainable Development

WEO: World Economic Outlook

WG: Within Group

WTO: World Trade Organization

Measure units and gases

CH4: Methane

CO2 : Dioxyde de Carbone

Gg : Gigagramme

GW: Gigawatt

MWh: Megawatt

N2O: Nitrous oxide

SF6: Sulfur hexafluoride

Abstract

Carbon trading mechanisms was introduced into the Kyoto protocol as a means to achieve emissions reductions in an efficient and cost-effective way. One of its principles that engaged developing countries in the formal carbon market is the Clean Development Mechanism (CDM). However, Africa has hosted a very few numbers of CDM projects especially in WAEMU countries where the participation is very low. In this thesis, we assess the factors responsible for the participation of these countries in the carbon market as well as analysing the contribution of CDM projects to sustainable development (economic, social and environmental) in West African countries and studying how carbon market interfere with the priorities of WAEMU countries' government. The panel regression demonstrates that Population size, human capital, infrastructure quality as well as GDP per capita are the variables which pull forward the CDM projects implementation in WAEMU countries. The multi-Attributive Assessment tool show that existing CDM project have a positive and slight impact on sustainable development in WAEMU countries. Compared with the benchmark scenario which give a utility of 0.995 (which should be the ideal score of a CDM project contribution on sustainable development), forestry CDM projects (with a utility of 0.407) still more profitable than solar projects (with a utility of 0.252) in these countries. Accompanying by international support, WAEMU countries will undertake more climate actions into their national programmes and policies.

Résumé

Les mécanismes d'échange de droits d'émission de carbone ont été introduits dans le Protocole de Kyoto comme moyen de réduire les émissions d'une manière efficace et rentable. L'un de ses principes qui engage les pays en développement dans le marché formel du carbone est le Mécanisme pour un développement propre (MDP). Cependant, l'Afrique a accueilli un très petit nombre de projets MDP, en particulier dans les pays de l'UEMOA où la participation est très faible. Dans cette thèse, nous évaluons les facteurs responsables de la participation de ces pays au marché du carbone ainsi que la contribution des projets MDP au développement durable (économique, social et environnemental) dans les pays d'Afrique de l'Ouest et étudions comment le marché du carbone interfère avec les priorités gouvernementales des pays de l'UEMOA. La régression du panel démontre que la taille de la population, le capital humain, la qualité des infrastructures ainsi que le PIB par habitant sont les variables qui font avancer la mise en œuvre des projets MDP dans les pays de l'UEMOA. L'outil d'évaluation multi-attributive montre que les projets MDP existants ont un impact positif et léger sur le développement durable dans les pays de l'UEMOA. Par rapport au scénario de référence qui donne une utilité de 0,995 (qui devrait être le score idéal de la contribution d'un projet MDP sur le développement durable), les projets MDP forestiers (avec une utilité de 0,407) sont encore plus rentables que les projets solaires (avec une utilité de 0,252) dans ces pays. Accompagnés d'un soutien international, les pays de l'UEMOA entreprendront davantage d'actions climatiques dans leurs programmes et politiques nationaux.

GENERAL INTRODUCTION

The carbon market refers to the selling and buying of reductions in greenhouse gases emissions, called carbon credits. The Kyoto Protocol design the carbon market allowing developed countries to have more facilities in how they meet their emission reduction goals. Developed countries can they buy emission reduction from developing countries or invest in emissions reduction projects in these countries and issue carbon credits. Since emissions reduction are cheaper in developing countries, developed countries will not need to reduce as much of greenhouse gases emissions in their countries. These emissions reduction projects also called the Clean Development Mechanism (CDM) are also supposed to allow developing countries to get clean technologies in a cost-effective way. The CDM is currently the leading means by which developing countries participate in the carbon market (Sey et al., 2009). The dual objective of the CDM is then to promote sustainable development in developing countries while allowing developed countries (Annex I countries) to participate to the global objective of reducing atmospheric concentrations of greenhouse gases (Olsen, 2007, Wooders & Nolet, 2008, Niemack & Chevallier, 2010; Karakosta, et al., 2013).

To better involve African countries in the carbon market through the CDM, several measures are taken at the international level: Preferences are given to carbon credits (Certified Emission Reduction) coming from Least Developed Countries and various financing and support opportunities for CDM projects in Africa are available. However, it is observed that the majority of CDM projects are still attracted by emerging markets. Except South Africa and Uganda to a lesser extent, Africa, particularly West African regions are slow in attracting enough CDM projects. At the present time, West African Economic and Monetary Union regions have hosted less than 20 CDM projects. The development of CDM activities in Africa is a means to promote clean energy in the country. So why, despite the available supports for African countries, the participation of WAEMU countries in the carbon market is so weak? What could explain this fact?

Empirical analysis showed mitigated results of CDM contribution on sustainable development. It is then often argued that the initial assumption of the synergy and win-win relationship between the dual aims of the CDM is in favour of developed countries through cost-effectiveness in CO2 reduction. Most of these studies do not draw conclusions on the CDM's actual contribution to sustainable development, they only estimate the 'potential',

’theoretical’ or ‘possible’ contribution to sustainable development, which tends to be positive. In addition, studies evaluating the benefit of CDM projects in Africa are very few and almost inexistent in West Africa. The win-win relationship of the CDM is then very unclear in West African countries. Number of studies argue that CDM has a substantial impact on the various character of sustainable development (economic, social, and environmental) in the host countries while some other state that the dual aims of the CDM does not hold for many projects, developed countries take advantage from CDM instead of developing countries. Then, do existing CDM projects fulfil the sustainable development criteria in West African countries? What are the real opportunities of these implemented projects? WAEMU countries as the other countries that have ratified the Paris Agreement, have submitted their different Nationally Determined Contribution (NDC) where they communicate their intentional climate actions and policies by 2020. Have governments taken the carbon market into account in their policies through the NDCs?

This dissertation has 3 objectives. Firstly, With a simple panel regression, whereby transparency index (control of corruption, governance effectiveness, etc.) and economic variables (GDP, FDI, etc.) are the main variables, this research intends to assess the factors responsible for the low participation of these countries in the carbon market as well as contribute to the understanding and awareness of such market in WAEMU countries. Secondly, this study aims also, by cases studies in Senegal, to assess the contribution of CDM projects to sustainable development in West African countries. Particularly, this second objective consist to conduct an ex-post analysis of CDM projects’ (a solar energy project and a reforestation project) contribution to the social, economic and environmental development in Senegal and generally in West African Economic and Monetary Union (WAEMU) countries. The Multi-Attributive Assessment tool (criteria and indicators) using surveys data, collected through questionnaire and checklist, constitute the approach of this second objective. Finally, with an analysis of the INDCs, this study analyses how carbon market interferes with the priorities of WAEMU countries’ government.

Three chapters forms our dissertation. The first chapter analyses the participation of WAEMU countries in the formal carbon market. The contribution of Clean Development Mechanism (CDM) to sustainable development in West African Economic and Monetary Union (WAEMU) countries through a case study of Senegal constitutes the second Chapter. With an exploitation of the NDCs, the last chapter examines if carbon market is among the priorities of the policies of WAEMU's governments.

I. Carbon market in the West African Economic and Monetary Union (WAEMU) countries

Introduction

It is recognized that climate change is one of the greatest environmental, social, and economic threats facing the world (Costantini & Sforna, 2014). Especially in Africa, climate change continue to threaten agricultural production, food security, health, water, energy security, which in turn undermine Africa's ability to grow and develop (CIGI, 2009).

An international treaty such as the Kyoto Protocol is a measure adopted in response to the threat of climate change. The Kyoto mechanisms operate in three principles: First is *the Emissions trading* which concerns the trading of allowance rights to emit greenhouse gases (GHGs). The emission trading exists between industrialised country governments, as they buy and sell the rights to pollute up to their own limits or assigned amounts. The second principle is *the Clean Development Mechanism* (CDM), the largest offset mechanism that allows emission-reduction projects in developing countries to earn Certified Emission Reduction (CER) credits, each equivalent to one tonne of carbon-dioxides (CO_2). These CERs can be sold and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol (CDM, 2016). The third one is the *Joint Implementation (JI*), which permits the same activity as CDM, but only between Annex 1 countries. Notwithstanding, a recent development of another mechanism, called the *Voluntary carbon market*, which follows a similar project cycle like the JI and CDM, with the main difference that the credits are not uniformly issued or regulated by the UN, and are typically sold in volumes that appeal to retail clients seeking a smaller number of reductions to offset their footprint (UNEP, n.d.). Currently, the Clean Development Mechanism (CDM) is the only mean to engage developing countries in the formal carbon market (Sanja, 2008). The CDM allows governments or private entities in industrialized countries to carry out emission reduction projects in non-Annex I countries (economies in transition and developing countries) (Fan et al, 2014) and receive Certified Emission Reductions (CERs) as credit, which they may count against their national reduction targets. Its dual goal is to promote sustainable development in developing countries while allowing developed countries (Annex I countries) to participate to the global objective of reducing atmospheric concentrations of greenhouse gases (UNFCCC, 1998, Olsen, 2007, Wooders & Nolet, 2008, Niemack & Chevallier, 2010; Karakosta, et al., 2013).

Several measures were taken to get a significant effect on Africa's role in the CDM which is a kind of premium for these countries since they undergo the worst effects of Climate Change while their pollution is often negligible. The European Union (EU) adopted a regulation on the use of Certified Emission Reductions (CERs) in the European Union Emission Trading Scheme (EU ETS) giving preference to CERs from LDC (Kreibich, et al., 2016). In addition, financing and support opportunities for CDM projects in Africa are available. For instance, UNFCCC's loan scheme for countries with fewer than 10 registered CDM projects; UNFCCC's regional collaboration centres (RCCS) in Lomé and Kampala; World Bank carbon funds and initiatives; the African development bank's (AFDB), African carbon support programme (ACSP); Africa carbon asset development initiative (ACAD); the intra-ACP climate support facility (CSF); African biofuels and renewable energy fund (ABREF); UNDP's millennium development goals (MDG) carbon; Germany's POA support facilities, etc. (unfccc-cdm, 2012). Despite the numerous opportunities of CDM projects for Africa such as multiple measures undertaken to give preferential treatment of CERs to Least Developed countries (Kreibich, et al., 2016), the several financing and support benefits available to CDM projects in Africa and so on, the majority of CDM projects are still attracted by emerging markets like China, India, Brazil and Mexico. The statistics showed that only very few Least Developed countries have hosted CDM projects (Winkelman & Moore, 2011). By the end of 2014, Africa hosted only 2.51% of all the registered projects while the part of LDCs is as low as 0.63% (Kreibich, Hermwille, Warnecke, & Arens, 2016). The only relatively good performer among African LDCs is Uganda with 14 registered projects. With the exception of South Africa that has been successful as host countries, Sub-Saharan Africa, have difficulties to attract CDM activities. To date, the West African Economic and Monetary Union (WAEMU) countries hosts only 17 CDM projects (of which 12 are registered) over 12 375 in the world and 242 in Africa (205 registered), (CDM, 2016). With an increase number of the CDM projects oriented on biogases, solar energy, wind energy and agro fuel, these projects can serve as opportunities for the development of clean energy in Africa. Because of the current situation of Africa in the carbon market, this research aims to investigate the issues surrounding the WAEMU countries participation, lessons that can be learnt from the handful of successful projects in Africa and other developing countries to help WAEMU countries to reap the benefits of carbon trading in the reduction of GHGs emission.

The most important greenhouse gas arising from human economic activity is carbon dioxide (CO_2). The issue of the greenhouse effect arises nowadays because human activities are

raising atmospheric concentrations of greenhouse gases and triggering a significant and undesirable climate change (Nordhaus, 1991). So regulatory measures to control GHGs emissions must directly address sectors that produce or rely on fossil fuels for their production, including coal, oil, automobiles, power generation and airlines (Kolk, Levy, & Pinkse, 2008). Powerful greenhouse gases, such as methane, HFCs and SF6, are emitted by agriculture, waste processing facilities, electric utilities and air-conditioning manufacturers in smaller quantities. Therefore, since emissions of carbon are a mixed pollutant, standard analysis mentions that introducing free trade in emission permits (emissions trade) will minimize global abatement costs and yield benefits to both buyers and sellers. And without a general participation in the treaty, it is expected that any agreement to reduce emissions will be undermined by the free rider problem as those countries outside the agreement increase their emissions in response to the reduction efforts of others (Copeland & Taylor, 1999). In fact, the idea of emissions trading mechanisms was introduced into the Kyoto process by the US delegation, asserting that only market mechanisms could achieve emissions reductions in an efficient and cost-effective way (Koch, 2014). So, carbon trading, in various forms, has emerged as the most important part of the outset global climate regime. Indeed, carbon trading has facilitated the concourse of business, governments, and key academic and professional constituencies around a slightly fragmented, decentralized and market oriented mode of carbon governance (Ascui & Lovell, 2011).

The objective of this study is to investigate factors influencing the participation of WAEMU countries in the carbon market through CDM projects. The remainder of this chapter is organized as follows: the second section lays out the literature review. The third section contains the data and methodology. The section forth states the results and section 5 conclude.

A. Literature review

Theoretical and empirical review

We expose here the theoretical review, which is mainly focused on the polluter-pays-principle and the empirical review which is an investigation on factors influencing the CDM projects distribution around the world.

A.1 Theoretical framework and review

It was proposed in equity attempt at the Rio meeting that in case where environmental harms arise, the costs will be inflicted to the responsible agents to pay for the rectification of these environmental damages. Since then, the Polluter-pays-Principle (PPP) has been seen as a

useful environmental management tool that makes provisions for innovative penalties seeking to place the burden of environmental pollution control on those that abuse the environment. So, monetary fines are compulsory for improper actions against the environment (Gondo et al.; 2010). Negative externalities and the external costs associated with them lead to socially inefficient levels of activities if they do not count the decision calculus of the polluters. External costs should be internalized in order to avoid this displeasing situation, meaning that polluters are to be retained responsible for the external costs they are assumed to have caused, which is the PPP (Wagner & Llerena, 2008), (Luppi, Parisi, & Rajagopalan, 2012).

The Polluter-Pays-Principle (PPP)

Through the international economic aspects of environmental policies in 1972, the OECD introduced the polluter-pays-principle (PPP) as a guiding principle (Lindhout & Den Broek, 2014). The document of the OECD states the recommendation as following: The "polluter-pays-principle" is the principle to be used for the cost's allocation of pollution prevention and control measures to stimulate rational use of scarce environmental resources and to avoid distortions in investment and international trade. This principle stands that the polluter should bear the costs of achieving the above-mentioned measures decided by the public authorities to ensure that the environment is in an acceptable state. It means that the cost of these measures should be reflected in the cost of goods and services that cause pollution in the production process or in the consumption. These measures should not be accompanied by subsidies that would bring about noticeable distortions in international trade and in investment (Khan, 2015). At the beginning, the PPP was a principle of economic policy. It intended that the market price of products reflects the cost of pollution and prevention and control measures (internalization of pollution cost). But finally, it shifted from the internalization of control and pollution costs to a higher level of internalization of environmental costs including for instance taxations possibilities, liability payments (a broad sense), (Lindhout & Den Broek, 2014).The core meaning of the PPP, cost internalization or negative externality, expresses efficient allocation of resources. This is also called *the full cost pricing*. The idea here is: once polluters are forced to internalize the costs, they will try to reduce the cost by reducing pollution, using emissions trading or better technology. Finally, a built-in incentive for R&D for new technology will be noticed. The adoption of the PPP in many of its varied forms is more and more on the agenda of many countries (including the major emitters) because of the emergency of addressing the climate change issues. So, it was formally adopted by the European Union in 1987 and was recognized by the United Nations Conference on the

Environment and Development delegates (Luppi et al., 2012). Since the related problem is a global common, the general contestation is about how to apply it globally, from an equitable point of view (Khan, 2015). After all, many countries have adopted the PPP has a regulation mechanism. It is also currently applied within and across the OECD countries through different versions of PPP (Khan, 2015). The formal implementation of the PPP in many countries is based on the use of environmental tax, which is proportionally determined by the amount of the emitted pollution (Glazyrina, Glazyrin, & Vinnichenko, 2006). To satisfy the PPP, the polluter entity should compensate those who suffer from its pollution. If a victim is not fully indemnified, then he or she pays part of the cost of someone else's pollution. Therefore, the polluter pays mechanism forces to the polluters, both, to pay for the damage they cause to the society and to entirely compensate the victims of these damages (Ambec & Ehlers, 2016) . The PPP mechanism has increasingly been adopted in treaties and international laws although the fact that the OECD recommendation was not binding. Few declarations and regimes have also internalized the PPP: the 1972 Stockholm declaration principle21, the 1992 Rio declaration principle 16, the Paris convention 1992 (the 1992 convention for protection of the marine environment of the North-East Atlantic, Bamako convention on the ban of the import into Africa and control of trans boundary movement and management of hazardous waste within Africa 1991 (article 12), etc. (Khan, 2015).

However, welfare economic look at how resources distribution affects an economy's overall sense of well-being. According to Pigou in the early 20th century in his book "Welfare Economics", the simplest idea to solve the environmental impact of negative externalities is to take the state's tax. For Pigou, an equalization of the gap between private and social costs can be obtained with a tax on polluters for the damage caused by the environmental pollution. So, to be able to change the situation where people ignore the damage of social pollution, one should make the negative external effects caused by market failures to the true costs of goods production (Long, Lei, Sijie, & Bo, 2012). Differently to Pigou, Coase denotes that there is no need for the Government to intervene the market. He advances that we should let the property or the market to fix the negative externality problem. He pointed out that if only the property rights are clearly defined, no matter how they are allocated, will be able to deal with the problem of low environmental efficiency of resource allocation. The new environmental-economic system which take into account the social and environmental value, the environmental ethics and the economic interests of the market players emerged in the 1990s and the theory of internalization of environmental costs has been largely expanded. Internalize

the environmental costs means to take the external costs of pollution as part of the producer costs and to make the environment as relevant as labor, capital, technology, resources and other factors of production. The translation of private costs into social costs leads to external diseconomies of environmental problems and the most adequate way to solve this issue is to make private costs of producers transformed into its own production costs, called the internalization of private costs. This is the best choice for the society to reduce the economic loss since the social costs exceed the private costs (Long et al., 2012). Both production and distribution are addressed in the Pigovian welfare economics. In the production side, the pigovian theory assumes that the optimal allocation of resources (welfare maximizing) is obtained if marginal social benefit and marginal private benefit are equivalent and marginal private cost and marginal social cost are also equivalent. For Pigou, the role of the government is to ensure that costs and benefits accrued to those who create them. For the distribution, it is assumed by the Pigovian approach that when marginal utilities of the final pound (or dollar) of income is the same across individuals, welfare is maximized (Hodgson, Samuels, & Tool, 1994). Economists tried to correct market failure (divergence of private and social costs and inefficiency of profit-maximizing decisions) by requiring internalization of externalities by private decisions makers, making the price of goods reflects the total economic and social costs of producing them, containing the pollution costs (Hodgson et al., 1994).

Application of the Polluter-Pays-Principle (PPP)

The Polluter-Pays Principle can be exploited for climate change solutions, both in mitigation and adaptation (Khan, 2015). The application of the PPP in many countries took different forms. The mechanism is applied through various economic instruments such as charges, taxes, emissions trading, deposit refund schemes, insurance and liability, *etc*.

To address climate change by mitigation or adaptation, the PPP can, internationally, be applied and it requires few conditions to be fulfilled:

- It is required to industrialized countries to make resources, financial and technology transfer in order to allow developing countries to apply PPP, improving then environmental standards in production;
- Arrangement on the specific year from which to assume historical responsibility by the industrial countries for the past GHGs emissions;

- A nation inducing damage to another one should undergo the problem and pay compensation for it.

In some cases, the PPP is implemented by the state governments via direct regulations which create economic incentives, leading the polluter to bear the cost of the environmental damage. The proponents of the liability rule focus also on cost internalization, which require to charge the social cost of an activity to the polluter. The liability ensures in addition that the commodity's price reflects the harm caused by important polluting activities, resulting in a more efficient resources allocation (Krier&Stewart,1978) cited by (Luppi et al., 2012).

Alterations from the Polluter-Pays-Principle

New departures from the PPP are noted. Some countries have created an obligation on local governments to furnish an immediate compensation to the victims of environmental harm. These legislative and legal re-apprehension of PPP hold local governments and states jointly-and-severally responsible for the environmental damage caused by private parties, conceding these public constitutions to act in subrogation against the individual polluters when possible (Luppi et al., 2012, Khan, 2015). Nowadays, developing countries like India, Malaysia, Taiwan, Chile, Costa Rica, Ecuador, Kenya, South Africa, etc. are shifting from the PPP to the Government-pays-principle. With this principle, governments and local agencies are obliged to provide prompt compensation to the victims of environmental harm and secondarily to recover costs from the responsible of the harm. This system executes reforms through judicial, legislative, and constitutional intervention in order to ensure victims' compensation when it is not possible to identify the polluters or when they are insolvent.

Kenya and South Africa illustrate two similar developments from African countries. The shifting from the Polluter-Pays-Principle to the government-pays-principle led to legislative intervention in South Africa in late 1980s. The Environmental Conservation Act argues that the government has to take the necessary steps to adjust the devastation and to regain the cost from the polluter for its defeat to take adequate measures. In 2002, from the high court in its draft Constitution, Kenya outlined a provision for citizen redress facing pollution. The provision confers extensive powers to the court to oblige the government to take retroactive measures and to compensate any victim of pollution for the lost use of natural resources.

It is fund that the Government-pays-principle may be better than the PPP in situations of widespread poverty, high interest rates, and judicial delays and uncertainty. But this alternative mechanism of environmental liabilities does not fully internalize the costs as well as the benefits of the agents' care (Wagner & Llerena, 2008).

Despite the apparent appeal of the polluter pays principle, it is said to be flawed. The PPP, different from the cheapest cost avoider principle (CCAP) which states that a cost benefit analysis must be conducted and the stakeholder who can prevent external costs at the lowest cost for the aggregate economy will pay, faces tree deficits which are slightly related, that can cause avoidable welfare losses. Firstly, the role of government and pollutees are neglected when focus is only made on polluters as the only consignees of regulatory measures. Secondly, the PPP is ineffective of dealing with second best problems that may emerge from government as an additional investor, inefficient behaviour of the pollutees or the existence of monopolies. Thirdly, in the situation of multiple equilibria, the guidance offered by the PPP is poor, corner solutions and administration costs (Wagner & Llerena, 2008) .

It is also said that the application of this principle is not adequate in the real negative impact if the pollutant compiles to a stock in the environment. If the PPP is conventionally implemented, it will lead to a potential conflict of interests between the society and private business (Glazyrina et al., 2006). Therefore, in modern societies, environmental settlements emerge from negotiation among stakeholders. And public authorities, firms, NGOs are now involving in the debates on the design of regulations (Ambec & Ehlers, 2016).

Is it possible than the polluter principle mechanism be preferred to any possible coalition of agents? Meaning that if a group of agents can be better-off by agreeing on another way to regulate externalities among them and leaving out the other agents? For example in international agreements, a group of countries can refuse to agree to apply the polluter pays strategy if these countries can achieve a higher welfare with another agreement (Ambec & Ehlers, 2016).

A.2.Empirical review: Factors influencing the distribution of CDM projects across hosting countries

Empirical evidence shows numerous factors that influence the distribution of CDM projects in various countries. These factors differ from one country to another.

The implementation of CDM projects in Least Developed Countries (LDC) leaves to be desired. This lack of projects is now worrying. Researches are being conducted in order to understand this situation. But a luck of empirical evidences focusing on LDCs is noted.

Fay (2013) mentioned four challenges for CDM development in South Africa: awareness, capacity, eligibility and finance (Fay, 2013). A general lack of public awareness is noted in South Africa. The complexity of CDM market is a hurdle of CDM engagement in the country. In Zambia, the complexity of CDM market makes also the communication of its potential

benefits very difficult. The implementation of a CDM project requires extensive expertise for the registration and the monitoring. The capacity to identify the CDM's benefits leaves to be desired in South Africa. As result, the critical mass required to propel CDM projects is not expended. Within the Zambia, the technical capacity for CDM methodologies, procedures, and scientific analysis is very limited. Projects developers of South Africa had uncertainty about the CDM projects eligibility because of the fact that the European regulation restricted projects registered post 2012 from being eligible for the European Union Emissions Trading Scheme (EU ETS). Being restricted from accessing the EU ETS has hindered the development of projects in South Africa. The bigger impediment in Zambia is the fact that the applicable projects types by CDM guidelines and the EU ETS are very restricted. A major bottleneck of CDM projects development is the high costs of projects validation. Developing the required documents as the Project Design Document (PDD), reports and associated survey is also very expensive. The required time to develop a new methodology may also jeopardize the development of CDM market in South Africa and Zambia. And usually the projects are not financially profitable. The author has used a qualitative method, which is a simple experiences comparison of South Africa and Zambia. The probability of hosting a CDM project is seeing to be a function of CDM potential, profitability and feasibility. Flues has set hypotheses on factors which are expected to affect these three dimensions. It is fund that all these dimensions influence positively the probability to host CDM project (Flues, 2010) . The possibility to host projects is expected to be influenced by the level of *economic activities* and the *growth rate of the countries*. The *energy structure of the countries* may be expected to matter. The more fossil fuels are used to produce energy, the more there are CO2 emissions which can potentially be mitigated through CDM projects (renewable energy). We can also expect more CDM projects in developing countries that have strong *links with developed countries.* Availability of *infrastructure*, *capital for investment*, *democratic governance or political freedom* may be significant factors. In fact, democracy may help to raise the awareness of climate change and available options like CDM project to fight against it. So, the expected explanatory variables on CDM capacity and profitability in this analysis are: *economic development and growth, fossil fuel use, renewable energy generation, as well as links to developed countries and institutional quality, political freedom.* In this study, the number of projects by country is used as the dependant variable. *Population*, *country's security for investors* and *FDI inflows* are used as control variables. Count regression models were applied for the empirical analysis of the determinants of CDM hosting. When data are aggregated, it is seen that *larger countries* have more possibilities to host CDM projects.

Additionally, hurdle models were also estimated as the processes generating zero counts (hosting projects or not). Likelihood-ratio test were performed to see if the number of projects and hosting at least one project matter in the determinants. Negative binomial models for unobserved heterogeneity account are estimated and compared to Quasi-Maximum Likelihood (QML) models. Likelihood ratio tests are also used to single out between models. Unrelated variance-covariance matrix is used to evaluate differences in coefficients. As results positive effects of *GDP* level, economic and political freedom, growth, are detected in both bilateral and unilateral projects. Trade is more significant for bilateral projects while aid is for unilateral ones. The poison hurdle models fit the data better than both the single equation models and the binomial negative models. The count data models shown that political freedom, population as well as growth and economic development, trade and fossil fuel energy generation have positive impact for hosting at least one bilateral project. *Economic development, growth, population and aids flow, political freedom, renewable energy generation, colonial status, the early ratification of the Kyoto protocol,* are significant determinants with positive effect in the case of hosting at least one unilateral project. The preparation of methodologies, and the lack of national technical capacity to develop methodologies without reliance on expensive international technical support ;lack of adequate international institutional capacity for the various steps in a CDM project from mobilization of resources to certification and validation for the diversity of situations; difficulties in identifying eligible projects ; etc. are challenges for CDM projects development (Desanker, 2005). For Silayan, the different factors influencing the inequitable distribution projects are extensive and diverged. They can be recapitulated as following:

-The patterns of the investor's project choice can lead the choice in the same countries for the CDM projects. In fact, the fund placements are to be devoted as close as possible to the top level of quality, delivery risk and asset cost. These three criteria are used by the Prototype Carbon Fund (PCF).

-The inherent implementation scheme of CDM project which are the conditions for joining in.

-Redundant flow capacity building funds to countries are apprehended to have the greatest potential for CDM projects.

This author mentioned that if the parties were honest with the Kyoto protocol's vigour, the CDM projects should be better distributed among developing countries. To correct that, we must critically contribute to the current procedures and structures in the implementation of the CDM. Originality and newness are needed to reinforce the spreading of CDM projects to countries with relatively high potential (Silayan, 2005). Another research shown that three

dimensions affect CDM projects. These dimensions with their associated variables in bracket are: *mitigation potential* (expected greenhouse gas emissions), *institutional CDM capacity* (Kyoto ratification, Activities Implemented Jointly (AIJ) experience, CDM authority (DNA) installed timely, National Strategy Study (NSS) completed) and *general investment climate* (index based on political stability, regulatory quality and rule of law). The analysis proved that high greenhouse gas emissions affect positively the construction of institutional CDM capacity. In the short term, capacity building can contribute to mitigate greenhouse gases, without solving the problem thoroughly (Jung, 2006). As methodology, one hundred and fourteen host countries are included in the analysis. The cluster (k-means method) analysis method is used in this study. The single-linkage algorithm is applied to determine outliers and then the squared euclidian distance was needed for the comparison of cases. If a case is fund to be closer to a cluster, it is moved to this cluster as far as all the cases are into clusters. In order to test the homogeneity of the clusters, F-values are computed for each variable and each cluster. In two different specifications, the probit regression shown that electricity capacity growth, log emissions, education index and CDM capacity building are significant determinant for CDM projects implementation. The specification 2 has demonstrated that OPEC countries are significantly not interested in hosting CDM projects (Winkelman & Moore, 2011). The truncated regression indicated that log emissions and years since first project have significant positive effects in both specifications. *Carbon intensity of economy*, *education index* and *electricity capacity growth* are also positively significant. Small Island Developing States (SIDS) and landlocked countries are negatively correlated with CERs issuance. Institutional index, CDM capacity building and FDI inflows are not significant determinants. In summary, human capital and greenhouse gas emission levels, growing markets for CDM co-products, such as electricity are important determinants of CDM project in this study (Winkelman & Moore, 2011). Only countries which have ratified the Kyoto protocol and set their DNA are included in this analysis. A probit regression model with a binary dependent variable is estimated to assess the determinants. In addition, a truncated regression model with a dependent variable for the number of CERs is also estimated to analyse the determinants of Certified Emissions Reduction (CERs). For the choice of explanatory variables, a conceptual model, based on the net revenue produced by a CDM project is developed. Others empirical results shown that bilateral export flows from Annex I economies toward non-Annex I countries explain a large portion of the geographical Distribution of CDM projects. Bilateral export flows, GDP per capita, CO2 emissions, and energy structure, commercial bilateral relationships, quality of institutions, electricity

production from renewable energy direct also investments in CDM projects. The higher the installed capacity for the production of renewable energy in a country, the higher the probability for this country to attract an important investor for CDM project. So, countries with high renewable energy production are more competitive in CDM projects implementation. Cost-effectiveness is also a criterion for abatement efforts.

Enhancing the institutional framework in developing countries that host CDM projects and reinforcing compulsory rules for CDM destinations in the least-developed economies could be solutions for the uneven distribution of CDM investment through countries (Costantini & Sforna, 2014). A gravity model is applied to a panel dataset in this analysis. With secondary data, Wang and Firestone (2012) used also a gravity model which shown that for both host and credit countries, domestic GHG emission is the first factor for the spreading of CDM projects, positively and consistently. *Infrastructure* in terms of roads, rail line, airports, electricity supply, telephone, internet connexion etc., *international trade*, *technical support, oversees development assistance* are important factors as well. The project size may also affect the distribution of CDM; it is directly related to the *country's natural endowment*. Well-endowed countries earn more CERs from projects, other things being equal (H. Wang & Firestone, 2012) . The research question of Wang and al. (2015) is if investment and economic conditions affect the CDM performance in China as they do at the international level? The main results are: *investment* is the most significant factor in CDM performance in China. *General economic* and *investment conditions* have a compiled effect. And finally it is fund that the sub-national uneven CDM performance in China is identical to the unbalanced performance at the international level (Zhu, Yao, Tang, & Wang, 2015). Empirical analytical approach is adopted in this study. The MLR model was applied. It is a relevant method to deal geographically with uneven CDM performance. Secondary data from the Project Design Document are mostly used here. Dinar & Ambrosi (2008) demonstrated that *energy structure of economies*, the vulnerability level to climate change effects, institutional development, economic development, the international relationship between the investor and host countries are good forecasters of the cooperation level in CDM projects. It is worth noting that the level of governance is another variable which has comparable impact in other studies of international cooperation (Dinar & Ambrosi, 2008). Poison regression model is estimated to measure the level of cooperation by the number of CDM projects. And a dichotomous variable is used to measure the countries' involvement in CDM projects. Glachant and al. describe the international transfer of climate change mitigation technologies generated by the Clean Development Mechanism in China, India, Mexico and Brazil. The international

technology transfer diverges across countries. The transfer ranges from 12 % in India to 68% in Mexico. Diverse technologies are involved in this transfer. In Mexico and Brazil, the most important transfer is on biogas in breeding farms projects. In Brazil, Mexico and China, wind turbines import is very current while India meanly relies on regional suppliers. HFC, N_2O elimination technologies, landfill gas capture and flaring are nevertheless imported by all the considered countries. Factors driving these transfers are also investigated. In Brazil and Mexico, the factors are the same and they are: good technological capabilities and strong involvement of foreign partners. However, the international transfers linked to the investment opportunities generated by the rapid growing economy seems to be more relevant in China and India (Glachant Matthieu, Antoine Dechezlepretre, 2009). Dataset from 644 PDD's projects is used. A logit equation, where technology transfer is a binary variable is applied. In 2014, Grote and Rottgers have analysed the motivations of CDM project investment in Africa. The relationship between the Foreign Direct Investment (FDI), the Official Development Assistance (ODA-proxy for aid) and the CDM is described by the authors. An augmented gravity model is used for their analysis. The regression computations adopt a 2-stage Heckman solution. In this approach, a first regression named selection equation resolves the likelihood of having at worst one project started by a couple of partners. The selection regression allowed forming a statement about the first project initiation by countering the zero-inflation bias of the selection regression. The function of this selection equation is to admit data for the computation of the inverse Mill's ration (IMR). In a second regression called the outcome equation, this IMR is used in order to counter the zero-inflation bias. A panel data from 2005 to 2012 is used for the estimation of the gravity model. The panel data consists of all available developed financier countries and all eligible developing projects host countries. In the selection models, results shown that the emissions of both partners of the project, FDI flows, ODA flows, governance, trade, literacy, infrastructure as well as the three cultural factors: common language, colonial relationship and genetic distance, have usually an impact statically significant on project installation. GDP per capital is the only variable which stays regularly insignificant in the selection models. Results show that the opportunity to find a partner for a first project decreases when the host country is in Africa. This fact is correlated with *governance*. So, we can argue that it is more appropriate and easier for financiers to invest in countries with a high quality of governance. African countries have then an impediment to overcome to success in the CDM business. Strangely, China which has bad governance remains one of the bigger players in the carbon trading. Findings show that business relationship through FDI and trade is also important (Grote and Rottgers , 2014).

Based on these results, the general recommendation to increase African CDM projects is to support African countries to attract initial CDM investment (first project) (Grote and Rottgers , 2014) . 'The most direct criterion for CDM investment attraction is the volume of carbon emissions. This is the hypothesis of Hwang and Kim (2011). An agency establishment for legal procedures supervision is important to have in the host country and also the government has to designate sectors for reduction according to the country's situation (Hwang & Kim, 2011). For the verification of the hypothesis, several sources of primary data were collected and analysed. An issue is that countries with raising GHG emissions are more likely to captivate CDM projects investment. This is due by the fact that the goal of CDM financing is carbon emissions reduction.

Then, basic institutional infrastructure and political support should be implemented by the host country in order to support CDM attractiveness. The Asian region (the study area), has an important amount of GHG emissions and after 1990, CDM projects keep increasing in proportion to the CO_2 emissions raising. In 2010, the region captured approximatively 80% of CDM investment. This fact can be seen as the impressive performance of China and India where the minimal level of political stability and institutional infrastructure is satisfactory. In the case of CDM investment, many factors can explain why a weak FDI does not attract investment. Transaction costs, rather than labour market or market opportunities, are more likely to lead investment. So, in order to attract more CDM investment, the CO2 emissions levels or the increase rate of CO2 as the transaction costs of the investment should be took into account.

In short, factors influencing CDM attraction are diverse: economic, social, environmental, geographical, and cultural. More effort has to be made by African countries in order to host more CDM project.

B. CDM in WAEMU Countries

Created on January 10^{th,} 1994 in Dakar, the West African Economic and Monetary Union (WAEMU/UEMOA) aims to build, in West Africa, an harmonized and integrated economic space, in which is assured a total free movement of persons, capital, goods, services and factors of production, as well as the effective enjoyment of the right of exercise and establishment for the liberal professions of residence for the citizens on the territory community (UEMOA, 2017). The region experiences strong growth led by the continued economic expansion in Cote d'Ivoire (IMF, 2015). Eight costal and Sahelian countries, bound by the use of a common currency, the FCFA and profiting from common cultural traditions,

form the WAEMU: Benin, Burkina Faso, Cote d'ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. The WAEMU covers a surface of 3 506 126 km2 and counts 112 million inhabitants. The growth rate of the GDP, at constant price, is 7% in 2015 (*NS/C. UEMOA: RSM June 2016).*

B.1. West African (WAEMU) countries in climate negotiations

A regional roadmap was adopted by three institutions: WAEMU, ECOWAS and CILSS (Permanent Interstate committee for Drought Control in the Sahel) in order to support the member states in the process of climate negotiation (ECOWAS,CILSS,UEMOA, 2015) . These institutions have jointly coordinated the third workshop for preparation of the negotiators and regional actors involved in climate negotiations from 7th to 9th May 2015 in Abidjan (Cote d'ivoire). This meeting gathered 40 focal points negotiators from Benin, Burkina Faso, Cote d'ivoire, Guinea, Guinea Bissau, Gambia, Liberia, Mali, Niger, Ghana, Senegal, Sierra Leone, Chad and Togo. During the workshop, the group highlighted their priorities in the climate negotiations. These are: technologies transfer, financing, mitigation, agriculture, losses and damages and adaptation, between others.

For the field of finance, the greatest importance was:

- Developed countries must clear up the actions to $100 billion by the COP21, with intermediate objectives, and insure that an important part is public and dedicated to adaptation;
- Increase the amount of climate finance through the UNFCCC funds, including adaptation funds and the Green Fund;
- Support a system for monitoring and evaluation of financial flows and the needs in the agreement of Paris at the states level.
- Assess and review the needs and financial commitments of climate founded on the trajectory of mitigation;
- The public financial agencies have to reorient their fund toward the development of low-carbon / resilient with positive social and environmental impacts;
- Simplify the access to funding devoted to Africa, mainly in consolidating the institutional framework, the national entities, national strategies, capabilities and financing bankable projects in African states;
- Climate budgets must be incorporated in communal, local and national planning;
- At least 50% of the funding should be assigned to adaptation, in form of grants;

B.2. CDM negotiations in Africa

The AGN negotiators began debating about the best way to approach the CDM discussions because many issues of institutional design were not settled after the Kyoto

protocol. So many of the key scheme issues were the focal point of regional workshops hosted at this time by agencies like UNFCCC, UNEP, etc.

In relation to the CDM, a number of objectives were found by African through a common position:

- ✓ The CDM should function in a market-based mechanisms principle and the projects equitably distributed;
- ✓ An equivalent geographical representation on the CDM executive board and capacity-building programs;
- ✓ Priority on both developmental and environmental benefits of CDM projects;
- ✓ Start an adaptation fund that would be financed by modest fine on CDM transactions.

Despite the common position adopted by African negotiators, their influence on the CDM's scheme was very limited. However, sustainable development, capacity building programs as well as adaptation find were adopted as objectives of the CDM and not the equitable distribution of projects (Roger & Belliethathan, 2014). At this point, arrangements on the demand for an adaptation fund and measures to ensure equitable representation on the CDM Executive Board, supported by non-Africans states, were the only fine successes for Africa.

At this point, arrangements on the demand for an **adaptation fund and measures to ensure equitable representation on the CDM Executive Board**, supported by non-Africans states, were the only fine successes for Africa.

Africans negotiators encountered several obstacles since the opening of the UNFCCC negotiations (Roger & Belliethathan, 2014).

- ✓ Participating in climate change negotiations (travel, accommodations, support staff, etc.) was high-priced. In addition, delegations were not important and these limited delegates were overwhelmed by the number of meetings which needed to be attended and the huge number of documents that had to be read.

So African states were not considerable players in the conception of key dimensions of the CDM proposal at Kyoto, which was mainly settled after the official meeting period when several AGN negotiators had left, principally because UNFCCC covered only the funds for the formal meeting or because visa requirements did not allow expanding the stay.

- ✓ Lack of information expertise and skills. The AGN was composed by many inexperienced delegates and they had to rely on information provided by Annex I countries. And especially, in the prior negotiations, African countries used to send

climatologists who commonly do not have the negotiating and training skills for an effective bargaining in political settings.

- ✓ An unclear directive from African bureaucracies has a tendency to constrain individual negotiators and impeded collectively the AGN's bargaining. The main problem is due to the fact that for lot of governments, the UNFCCC negotiations were not a priority. Finally, these negotiators who were generally coming from low ranking ministries instead of ministries of foreign affairs, finance or development, negotiated without understanding of what their governments would consider acceptable, making them to lean on opposing positions and to shy away from any innovative ideas that can turn out to be disputable later on. It is why it was certain during the CDM negotiations that the ministerial level did not have enough clear instructions (Roger & Belliethathan, 2014).

However, since the early 2000s, African states start becoming more proactive in the UNFCCC negotiations. In spite of the progress made, many barriers continue to hamper the liberty of Africa in the global climate change negotiations. Climate changes negotiations can have more important consequences for incomes of poor countries than others negotiations such as the World Trade Organization (WTO) (Cantore, Peskett, & Willem, 2009).

B.3. The GCF and the CDM

Beyond its initial role of generating transferable mitigation outcome, the CDM has begun to serve as a framework for results-based climate finance. It is the first international crediting scheme which has received important amount of money for the financing of emission reduction projects in developing countries. Indeed, the CDM's system gave experience on mitigation activities implementation in developing countries in an internationally recognized, testable and transparent way (Mikolajczyk et al., 2016).

Comparison between the two institutions

Both the GCF and the CDM are governed by the UNFCCC and both share the goal to encourage GHG mitigation action in developing countries while contributing to sustainable development. However, the CDM is a crediting scheme and a baseline while the GCF is a funding method through which the climate finance agreements are disbursed and accounted for. Regarding the funding tools, the GCF offers equity finance, concessional debts, grants and price guarantees while the CDM does not furnish any eligibility criteria on finance and particular guidance. Concerning the institutional design, the GCF and CDM share similarities and are both ruled by boards that make the final funding decisions**.**

Support between the CDM and GCF

The CDM mechanism can support the GCF to quicken actions implementation through the CDM established and familiar infrastructure. A workshop on the utilization and financing of the CDM by international climate finance organizations was held through the 44th session of the Subsidiary Body for Implementation (SBI 44) and how connecting the GCF to the CDM was explicitly debated in this workshop. The potential for the CDM to support climate financing activities was also noticed (Mikolajczyk et al., 2016).

The CDM provides an MRV (Monitoring, Reporting and Verification) framework that can help the GCF to track the mitigation impact of invested funds over time.

By motivating the project implementers and the accredited entities to the GCF to use the framework provided by the CDM, the following goals could be achieved by the GCF:

1. Appeal new sources of private climate finance containing institutional investors which see importance in tracking GHG mitigation
2. Reinforce the results-based approach to climate finance by applying the CDM's MRV framework to measure, in a verifiable and transparent way, the impacts of mitigation funded by the GCF
3. Leverage the current CDM pipeline in order to mobilize mitigation action by encouraging reproduction and scale up of registered projects as well as giving help to additional, high quality CDM activities which face risks.
4. To produce a pipeline of projects which could serve to provide mitigation outcomes by allowing CER price guarantees and bridging the period until compliance demand motivated by the Paris agreement become real.

However, several preliminary remarks were made but more ideas will be needed to put any of them in practice

1. The GCF can exploit the CDM's MRV structure to establish the GHG mitigation impacts of funded activities, both in terms of underlining funding terms and conditions as well as performance-based payments;
2. The CDM commitment with the GCF should not be limited to only one funding miniature. Equity finance, grants, debts and price guarantees should be assessed and tested in order that adapted solutions and maximize learning are provided.
3. The purchased credits should be cancelled by the involvement of GCF with the CDM and then this fact will meanly contribute to overall global GHG mitigation.
4. Formal debate should be initiated between the GCF boards and the CDM Executive board where each party state its engagement to progress on this front and raising confidence to market participants and project developers.

5. Distinction can be made between the existing CDM activities which require revenue report to assist operations and new activities that need help in their financial capital expenditures.
6. Individual CDM activities requiring GCF funding directly through an Accredited Entity should be differentiated with the pools of CDM activities that are combined by specialised investment tools.
7. By providing price guarantees on CERs from high-quality projects and programmes, the GCF could start its commitment with the CDM. The resources' cost-effectiveness can be maximised by adopting auctions as a price exploration system.

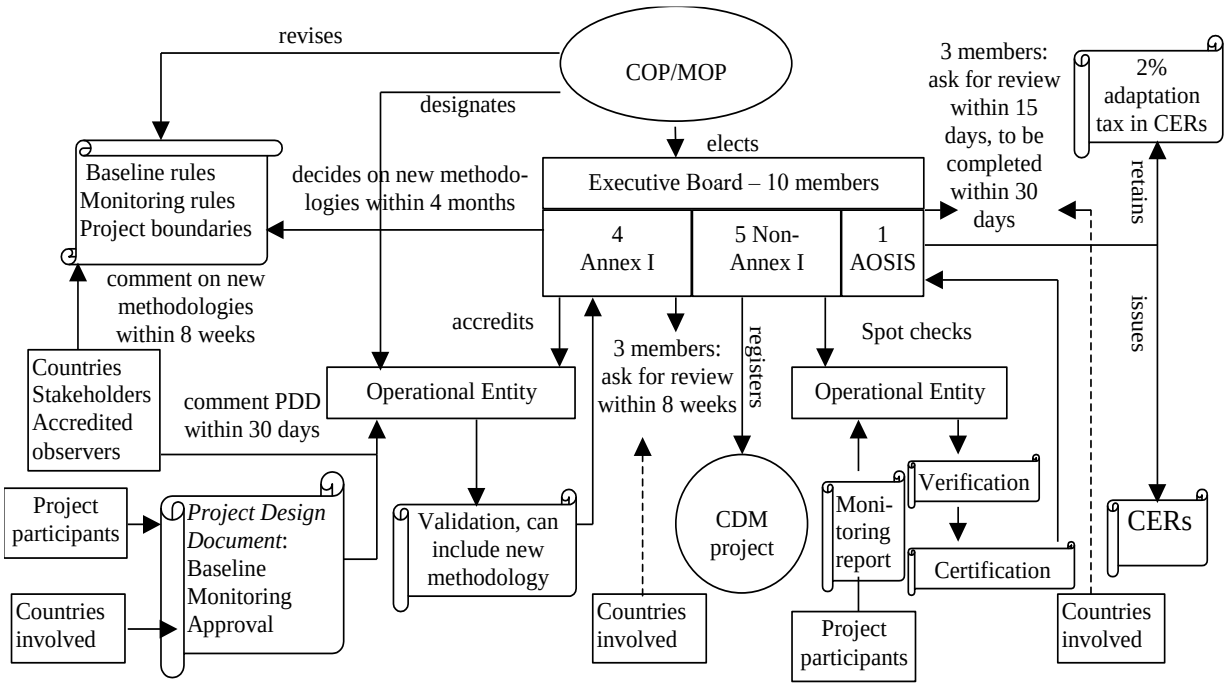
B.4. Conditions to implement CDM projects

A developing country wishing to undertake the CDM strategy has to take into account these following contexts. It has to check

- If it could offer an attractive supply of cheap CDM projects;
- Whether it has enough capacity to guarantee a CDM strategy;

How the synergy between national development aims and the CO2 emission reduction can be maximized (Michaelowa, 2003).

Figure 1: Institutions in the CDM labyrinth



Host country's requirements

The institutions of the host country have to complete these tasks:

- Approval

The principal advantage a host country has in the CDM context is the approval of a project that has to be done by the Designed National Authority (DNA). The different criteria the DNA has to specify are: Sustainable development criteria, technological and sectorial priorities, sharing of CERs, additionally requirements, foreign currency requirements and job loss prevention.

- Capacity building and marketing

In order to persuade investors about the national CDM programme and to sustain the competitiveness of CDM projects at the local level, the national institutions should grow several services: project development support, policy development support, operational entity support, crediting sharing support, marketing, information database, information dissemination and training.

- Reporting

Under the Marrakech agreement, national CDM programmes are required to report details. They have to provide the progress for CDM projects in their countries through annual reports.

Participation requirements

- Countries should fulfil the three following preconditions in order to participate in CDM programmes (Silayan, 2005).

1. The participation is free-willed
2. The participant shall have ratified the Kyoto protocol
3. The participant parties have to designate a national authority (DNA), also known as the CDM focal point

B.5. CDM Project cycle

Different stakeholders are required in a CDM implementation. The steps described in the figure from below are the ones a project needs to go through in order to get registered, receive and sell carbon credits. In the PDD development phase, the project participants, using the CDM-PDD, have to determine the methodology process by providing tools and standards to develop the project. After the project participants have written the PDD, the Designated National Authority (DNA) of the host country issues a letter of approval for the proposed project after approving the project against national sustainable development goals. UN-approval third-party auditor called Designated Operational Entities (DOEs) conduct the project approval. The CDM project validation includes 4 steps:

-A desk review of the CDM, the letter of approval and other documents;

-On-site visit and follow-up interviews with project stakeholders;

-A 30-day public comment period after the PDD has been released;

-Issue of the final validation report; (Carbon Market Watch, 2019)

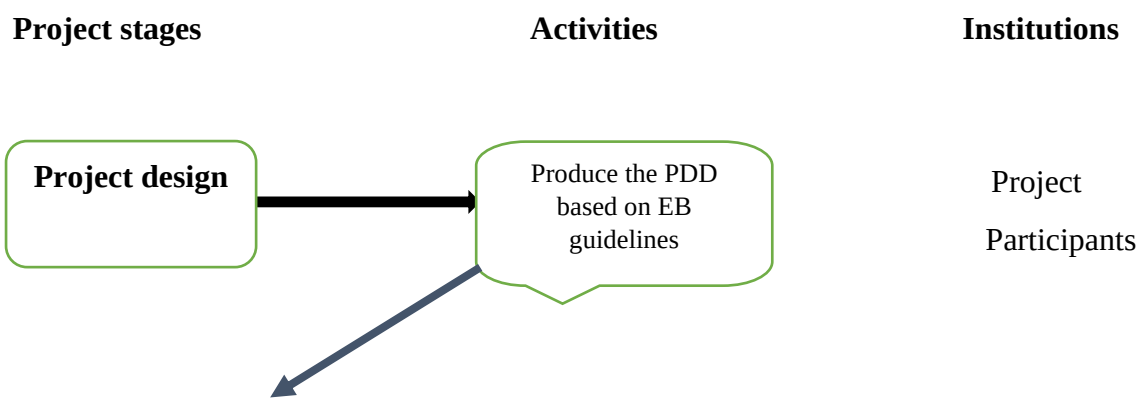
The registration is the formal acknowledgment of the project as a CDM activity by the Executive Board. At the stage, the UNFCCC secretariat check the completeness and a review of the project requested by the EB or a party involved in the project (Word Bank and Carbon Finance Assit, 2008)

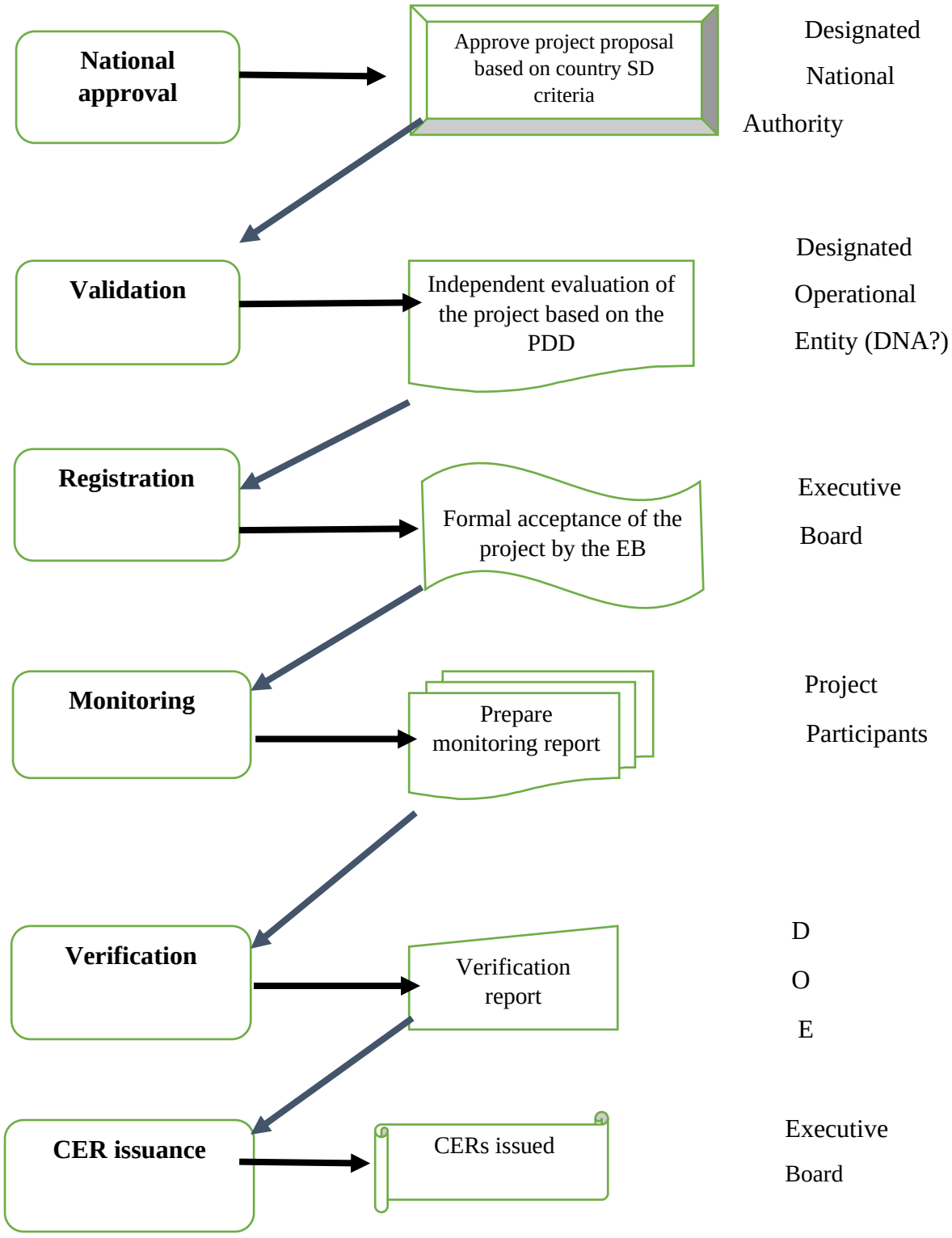
A project can reapply for registration if it is rejected.

The monitoring plan is a part of the PDD. All relevant data (like the records measuring the emissions reduction) during the crediting period are collected and archived during this phase. So, the monitoring document allows to issue the project's emissions reductions (Carbon Market Watch, 2019). The monitoring plan is a requirement for verification, the certification and the issuance of CERs (Yamin F., 2005). The verification is done by the DOE (auditor different to the validating auditor) with the monitoring report use. It is a periodic review of ex post measurement of GHG emissions reductions. This auditor should ensure that the monitoring has been completed in accordance with the PDD procedures. The DOE will conduct on-site visits, prepare a draft verification report, and highlight issues in the process, prepares the final verification (and make it publicly available) and certification report (Yamin F. 2005, Carbon Market Watch,2019). The time interval verification is freely chosen by the project owner or the project developer. The certification is the affirmation that the project activity has achieved the reductions in anthropogenic emissions as verified.

For certification and issuance of CERs, the verification report is submitted to the CDM EB. And two weeks after submission of request for issuance, the issuance is normally conclusive. The project developer will provide a letter on how the CERs will be issued. The indicated quantity of CERs will be issued through the CDM registry instructed by the EB. 2% of the total CERs will be subtracted as fee for adaptation fund.

Figure 2: CDM project steps





Source: Author

- Nevertheless, unofficial conditions, such as the existence of a baseline data, exist also: For a project to be validated and registered, it had to be additional (Silayan, 2005). It means that the existence of the project is in line with the incentives offered by the CDM.

A CDM project is additional if the emission reduction would not occur without registration of the CDM project (Schneider, 2011). *But actually, the additionality is not anymore verified for projects from least developed countries in order to implicate them more in the business of CDM.*

A baseline scenario had to be established in order to justify the additionally of a project. This baseline scenario had to show what may happen to emission trends if the CDM project is not pursued. Some rules: the average of similar project activities undertaken in the prior five years, the amount of emissions from a technology which is economically attractive and the historical or actual emissions, supposed that participating countries possessed such baseline data available. Inopportunely, such data were not available in many developing countries.

In addition of these official and unofficial conditions, some less developed countries are not able to implement CDM projects simply because they are not disposed to make the necessary structures for participation (Silayan, 2005).

B.6. New guidance related to the CDM

In November 2016, the Conference of the Parties serving as the meeting of the Parties to the Kyoto protocol (CMA) noted that today, the CDM is liable to (UNFCCC, 2017) :

- ✓ Over USD 300 billion invested;
- ✓ Over 7,700 CDM projects being registered in over 95 countries;
- ✓ Over 1.7 billion Certified Emission Reductions (CERs) issued;
- ✓ Over 15 million CERs voluntary cancelled;
- ✓ Over 195 million of revenue for the Adaptation fund from the sale of the Certified Emission Reductions;
- ✓ A total of 78 loans under the CDM loan scheme accepted and over USD 6.2 million of total promise;
- ✓ 37 sustainable development co-benefit description reports published employing the voluntary sustainable development mechanism

In their report, the CMA encourages the Executive Board to keep simplifying the clean development mechanism, particularly the registration and issuance processes, and the methodologies, although maintaining the environmental integrity.

It was asking to the Executive Board to examine the global cost for Designated Operational Entities (DOE) and to report back to the conference of the parties serving as

the meeting of the parties to the Kyoto protocol at its coming thirteenth formal meeting in November 2017.

It was also requested to the Executive Board to continue ensuring the CDM resources management and its capacity to execute its mission by developing and maintaining the mechanism up to the end of the true-up period of the second commitment period of the Kyoto Protocol.

B.7. Potential of WAEMU countries to play an important role in the carbon market

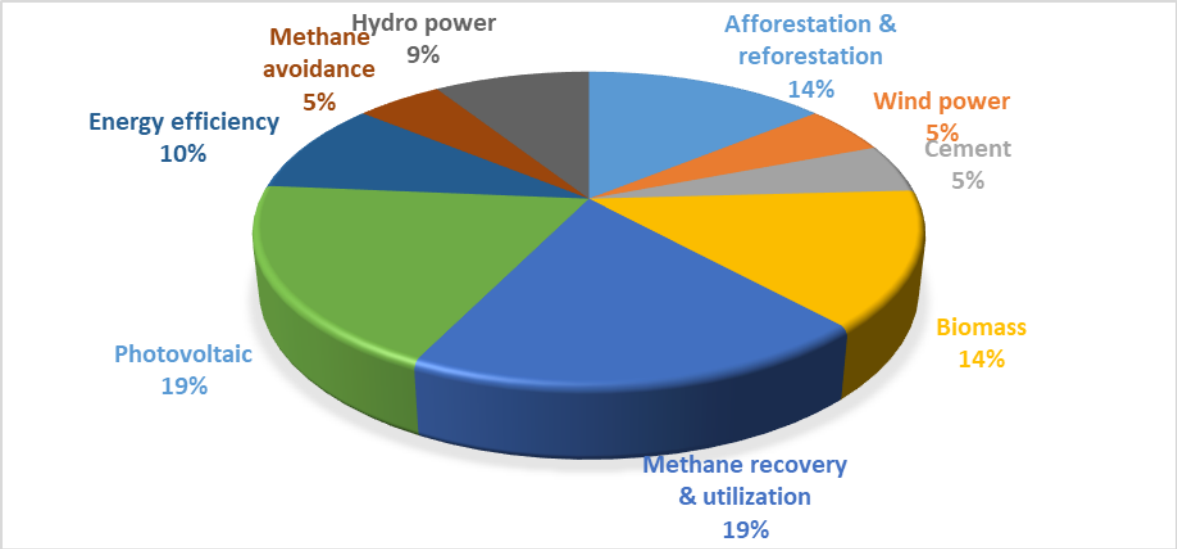
Carbon market could be profitable for African countries and especially for WAEMU countries by CDM projects in power sector. Indeed, the potential for CDM projects in the power sector seems significant in Sub-Saharan Africa where the actual two main challenges are: access to electricity and climate change effects (Avila, Carvallo, Shaw, & Kammen, 2017). The World Bank has calculated that the 47 countries in sub-Saharan Africa, with a combined population of 800 million people, use as much power as Spain, with a population of 45 million. These powers generated by these African countries are from fossils fuel and renewable sources: solar, natural gas, hydroelectricity, etc. (Avila et al., 2017). The potential technical production capacity of this zone is estimated to 11.000 Gigawatts (GW), mainly from renewable sources.

In WAEMU countries, the potentials solar layer gives:

- An annual sunning ranging between 1600 and 2200 kWh/m2
- A daily average radiation average ranging between 4.5 and 6 kWh/m2/day

While WAEMU countries participation in the carbon market is low, CDM projects centred on solar energy, wind energy, etc., are very valuable in the carbon market and are opportunities for Africa to develop clean energy system.

Figure 3: CDM distribution by project type in West African Economic and Monetary Union (WAEMU) countries



Source: author, using IGES database

C.Data and method

C.1. Data

Six WAEMU countries are considered in this study: Burkina Faso, Cote d'ivoire, Mali, Niger, Senegal and Togo. Benin and Guinea-Bissau are excluded because they do not produce CERs (no CDM projects) presently. Pooled cross-sectional time series data, often described as Panel data are used. The data is for a period starting from 2005 to 2016. 2005 is the starting date because the first CDM project in WAEMU is hosted in 2005 in Niger. Combination of datasets from IGES CDM projects database (2016), QoG standard dataset (2017) and World Bank (2017) are used for our analysis. The QoG standard dataset is a compilation of several datasets from 105 data sources, consisting of approximately 2,000 variables. The datasets include several categories of variables: quality of governance, civil society population and culture, conflict and military services, education, energy and infrastructure, environment, health, history, judicial, labour market, media, migration, political parties and election, political system, public and private economy, religion and welfare. The CERs values and the CDM related data are gotten from IGES CDM projects database (2016). This CDM pipeline includes 12,368 CDM projects from the validation stage to the CERs issuance through registration, with 7,447 registered projects. The remaining is composed of rejected, withdrawn, and registered in 2nd period projects. Based on our literature review and the features of WAEMU, the following variables and index are expected to influence CDM implementation in WAEMU countries: the **transparency index** (as a proxy of governance), CO_2 **emissions**, **GDP per capita**, **ease of doing business** (business regulatory environment;

investment conditions), **Renewable energy consumption**, **Quality of overall infrastructure**, **human capital index**, **population** as well as Foreign Direct Investment (FDI).

C.2. Variable description

The transparency index

It is a combined index of Information Transparency Index and Accountability Transparency Index. For the Information Transparency, sub-indicators are constructed to measure the differences of this type of transparency. Three sub-components are established: 1- the existence of a free and independent media, 2-fiscal (budgetary) Transparency, 3-political constraints. There are 13 separate indicators for the Information Transparency Index (six for the information quantity, four for the processes which generate that information, and three for the required infrastructure to circulate that information. The considered base year is 1980 and the ITI has scores for initially 153 countries in 1980, increasing over time to 191 countries by the year 2010 (Dahlberg and al., 2017). For the accountability transparency, there are 16 separate indicators (six for the measurement of free media, four for the fiscal transparency and six for political constraints). 1980 is also considered as the base year. The Accountability Transparency Index has 115 countries in 1980 and rise to up to 189 countries in 2010(Dahlberg and al., 2017). Revealing openly public resources expenditures is critical for any African economy which attempt to grow (Aidara, n.d.). The fact that public spending addresses the essential and most appropriate developmental opportunities and barriers is even more important. It is shown that the investments of West African governments are not having the appropriate impact on poverty and stopping the inequality gap in education, health and agriculture. Poverty is persisting in the larger part of West African countries despite the granted efforts in public resource transparency. Transparency is a positive starting point but it is not sufficient to lead to substantial development and accountability. Despite the unprecedented growth in West African regions, it remains amongst the poorest regions in the world (the GINI index remains high in all member countries). Better governance is fundamental for sustainable development strategies and poverty reduction in Africa. Policies of poverty reduction defect are assigned in a part to a lack of clarity on how governments are spending budgetary resources. It is generally assumed that there is a positive and linear correlation between transparency and efficiency (Aidara, n.d.).

CO2 emissions (metric tons per capita)

These carbon dioxide emissions are those from cement manufacture and fossil fuels burning. These emissions include also the carbon dioxide produced during liquid, solid, gas flaring and gas fuels consumption (Dahlberg and al., 2017).

The GHG production in Africa meagre compared to the emissions at the planetary scale. Indeed, the African continent is responsible of only 136 carbon gigatons in the atmosphere, which remains lower than the emissions produced alone by certain countries like China the United States, India Russia and Japan. The third of these emissions is from deforestation, impoverishment of soils and erosion. These factors lead to the release of billions of tons of carbon in the atmosphere. The comparative data of per capita GHG emissions reveal that Europeans and Americans emit respectively approximately 50 to 100 times and 100 to 200 times more than Africans. On average, Africa generates less than 4% of the worldwide produced GHG. However, the consequences of climate change are projected to be disastrous for Africa resulting mainly from two principal elements: on the one hand, the existence of multiple constraints and on the other hand its low adaptive capacity. In West Africa, the vulnerability is due to extreme poverty. Indeed, the statistics reveal that: 14 out of 30 countries with the weakest human development index (HDI) are located in West Africa. Among the 49 countries considered as the least developed in the world (LDC), 14 are located in West Africa. The average GDP of 340 USD in West Africa is also less than half of the average GDP in Africa (700 USD) (Performance MC, 2009). The emissions from fuels have increased in Africa, the liquid and solid fuels represent 35% and gaseous fuels for 17% of the total fossil fuel of the region. The main part of these emissions from fossil fuels and the production from cement comes from few countries. South Africa account for 38% and 46% are from the group formed by Egypt, Algeria, Nigeria, Libya and Morocco. These six countries are the only ones in the continent to have annual CO2 emissions which exceed 10 million tons of carbon. Only four African countries have CO2 emissions per capita higher than the world's mean (1.3 ton of carbon per year): Libya (2.53), South Africa (2.39), Seychelles (2.22) and Equatorial Guinea (1.99). According to the emission rates per capital of 2008, 28 of the 55 African countries have emissions rates per capital lower than 0.1 ton per capita and per year (UNESCO, 2014). Yet, it shows a positive relationship between CO2 emissions and economic growth. In their study, Holtz-Eakin and Selden (1995) attest that the source of sustainable growth will be due by the fact that economic and population growth will be most accelerated in the middle-to lower-income nations that have the highest Marginal Propensity to emit (MPE). So, responsibility must be taken to avoid disagreements between

policies to control GHG emissions and those to improve the distribution of income. (Holtz-Eakin & Selden, 1995).

GDP per capita PPP (current international dollar)

GDP per capita based on Purchasing Power Parity (PPP) is the Gross Domestic Product converted to international dollars using PPP rates. An international dollar has the same purchasing power over GDP. GDP at purchaser's price is the sum of gross value added by all resident producers in the economy augmented to any product taxes and minus any subsidies not included in the value of the products. It is measured without making deductions for depreciation of manufactured assets or for depletion and degradation of natural resources. Data are in current international dollars based on the 2011 International Comparison Program (ICP) round (Dahlberg and al., 2017).

In its simplest form, the PPPs are relative prices, or in other words price ratios in national currency of the same good or service in various countries. One of the most common application of PPP is in the computation of GDP and GDP per capita of a country. Although GDP per capita is often criticized as being an incomplete measurement of economic welfare, it remains an essential indicator of countries' economic performance. The increasing use of this indicator in economic and political analysis explains for much the importance of PPP as a statistical tool (Schreyer & Koechlin, 2002). Exchange rates PPP are above all used in international comparisons of standard of living. The international comparison of GDP leads to not take into account the price differences existing between countries. The differences between real exchange rates and PPP exchange rates can be significant. For instance, when the Yen, the Japanese currency, is overestimated in 1999, the GDP per capita appears much higher than its American equivalent but when measured in PPP, it is actually much lower. In 2016, the economic growth of the WAEMU is estimated at 6.8% compared to 6.6% in 2015. It is also indicated that during 2016, the financial transactions of the governments showed a deficit of 4% of the GDP. The evolution of the public finances of the Member States of the union in 2016 remains symbolize by a rise in current expenditure and by the continuation of investment efforts in infrastructure and social sectors in a context of poor mobilization of external resources and stagnation of the tax ratio (Le point Afrique, 2017).

Business regulatory environment

This criterion estimates the length to which the regulatory, legal, and policy environment helps or impedes private business investment, creation of jobs, and getting more productive.

The emphasis here is on direct regulations of business activity and goods regulation and factor markets. Three sub elements are measured: a- the regulations affecting entry, exist and competition; b-regulations of ongoing business operations and c- regulations of factor markets (labour and market) (Dahlberg and al., 2017).

Institutional requirements use to hamper the development of business. Case studies in cross-country survey have shown that regulations, laws and uncertainty about policies have hampered private sector development in many developing countries. Businesspersons worldwide believe that the cost of doing business is considerably increased by damage and theft. Relatedly, entrepreneurs postulate that authorities do not appropriately guarantee their personal safety and do not support their property rights in many developing countries. In Sub-Saharan Africa, the greatest problems are high taxes, tax regulations, corruption, inadequate infrastructure, inflation, theft, crime and financing (Brunetti et al., 1997). Even if Africa had the lowest Business reform intensity in 2004 and that businesspersons experience more regulatory obstacles in Africa than in other regions, Rwanda was an exception and a good example of success stories. In 2004, Nigeria proposed 3 reforms easing business, credit information and labour practices. Mauritius introduced 2 reforms and become the 23rd easiest places to do business, while South Africa ranks 28 and Namibia 33. (World Bank, 2006). There are equally good success stories especially is Asian countries, Japan for instance, that can inspire SSA. The business climate in the WAEMU countries is one of the less motivating in the world, being always in the last quartile of the 189 classified countries. The report of Doing Business 2016 revealed that Cote d'Ivoire is the best performing country among the WAEMU countries, but the country was placed in the 142nd position of the world classification and the 17th position in SSA. However, to handle this inefficiency of the business climate in WAEMU countries, a plan is adopted by the commission since 2012. This plan is to implement a federator framework of the actions of the member states, communal institutions and technical and financial partners for business climate enhancement. Finally, a regional initiative was created through this reflection for the improvement of the business climate. This initiative is based on a capitalization of good practices between the member states and sets reasonable communal objectives, in terms of indicators in order to maintain internal dynamics of regular improvement (UEMOA, 2017). In the new annual report of the World Bank group (2017) on the ease of doing business, Mali is doing better and gains two places compared to the last year ranking, moving from 143rd place to the 141st place out of 190 economies. By this improvement, Mali passes, in SSA zone, in front of Cote d'ivoire and

Senegal. This advancement in Mali is due to several measures initiated by Mali's authorities to enhance the climate of business and to attract foreign investors. Cote d'Ivoire occupies the 142nd place, Burkina Faso 146th, Senegal 147th and Niger 150th. Rwanda remains one of the most effective economies on the topics studied by doing business such as property transfer and loans procurement. Land conservation is very impressive in Rwanda where only 12 days is necessary for a mutation in comparison to OECD high income economies where 22 days on average is needed. In terms of reforms, during 2016, thirty-seven of the 47 economies in Sub-Saharan Africa have implemented at least one reform facilitating the climate of business, in total 80 reforms, meaning a boost of 14% compared to the number of listed reforms. Half of these reforms were engaged by the 17 members of Organization of Harmonization in Africa of Business Law (OHADA). For 2018, it is shown that Sub-Saharan Africa is the region with more important number of reforms (83 in total). East Asia and the pacific occupy the second place (45 reforms), Europe and the central Asia are at the third position (44 reforms). (World Bank, 2018). For 2018, the ease of doing business is ranked for WAEMU countries in the World Bank report ranking of 190 countries as follow: Cote d'ivoire 139th place (+2.04 percentage points), Senegal 140th place (+3.75 percentage points), Mali 143rd place (+0.30 percentage points), Niger 144th place (+2.26 percentage points), Burkina Faso 148th place (+0.20 percentage points), Benin 151st place (+1.85 percentage points), Guinea 153rd place (+0.32 percentage points) and Togo 156th place (+0.64percentage points) (World Bank, 2018). The best performance is however noted in Senegal who gains more points (+3.75). Indeed, a one point enhancement to the distance to frontier score (difference between an economy's current performance and the practice across the whole sample of 41 indicators across 10 Doing Business indicators group) is associated with 0.02 percentage point decrease in unemployment growth rate. Since few years most WAEMU's countries have made considerable progress of business climate improvement. One-stop shops common to several countries were set up for companies' registration, the procedures were simplified and commercial courts established. Thus, many countries of the area went up over years in the Doing Business ranking, and attract now important flows of FDI has been underlined by IMF services. The authorities have the desire to continue improving the business climate by reducing again the financial and administrative costs of commercial activities in their countries, by satisfying the deficits of infrastructures and by developing the human capital more. They subscribe to the recommendations of the IMF's services which recommend to continue promoting the reforms and to invest in human capital (FMI, 2016).

FDI (net inflows, % of GDP)

The foreign Direct Investment are the inflows of investment to get a permanent management interest (10 % or more of choosing stock) in a company (or business) operating in an economy other than that of the investor. It is the sum of equity capital, earnings reinvestment, other short-term capital and long-term capital. This series shows net inflows (net investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP (Dahlberg and al., 2017). Yameogo N. & Anyanwu J., N.D) results', demonstrated that FDI are positively attracted by natural resources (oil and metal), domestic investment, trade openness, real per capita GDP, first year lag of FDI, monetary integration, endowment and exports in West Africa and it exists a negative relationship between FDI inflows and life-expectancy, economic growth and second-year lag of FDI. However (Loris, 2016) found that FDI do not have an appreciable impact on African countries' industrialization. The world FDI displayed a strong recovery in 2015. The world flows of FDI leaped of 38% to reach 1,760 billion dollars, their higher level since the world economic and financial crisis of 2008-2009. This world rise is mainly explained by the strong progression of international fusion-acquisitions which amounted to 721 billion dollars against 432 billion dollars in 2014. The value of the investments of capability building announced remained raised to 766 billion dollars. The flows of FDI towards developing countries have increased to reach a new record of 765 billion dollars, an enhancement of 9% compared to 2014. With inflows of more than 500 billion dollars, under developed Asia remained the first FDI beneficiary region in the world. Flows towards Africa as well as Latin America and the Caribbean fell. Half of the 10 first host countries were always developing countries. The weakness of staple foods' prices discourages the FDI in Africa. In 2015 the Foreign Direct Investments in Africa represented 54 billon dollars, showing a falling of 7% compared to the preceding year. In West Africa, the FDI inflows dropped to 18%, 9.9 billion dollars, mainly because of a FDI collapse in Nigeria (CNUCED, 2016). Analysing the impact of FDI on economic growth in WAEMU countries from 1990 to 2012, Ndiaye and Xu (2016) shown that there is an increase trend of FDI flows in WAEMU although there is a constant trend in some countries during some years. Niger is the one which receive most of the FDI inflows indicating a rising trend from 2008 to 2012. It is followed by Mali with an enhancement of USD 1,900,000 to USD 80,000,000 from 2004 to 2010. In third position, come Cote d'ivoire, Burkina Faso and Senegal. The recent wars in Cote d'ivoire cause FDI loses in the country. Benin has shown a stable trend and Togo receives less FDI inflows because of the lack of resources which attract investors. The

econometric results demonstrated a positive impact of FDI on economic growth in seven WAEMU countries. It exists in these countries a strong and positive relationship between economic growth and FDI which is often the main passage through which advanced technology is transferred to developing countries (Ndiaye & Xu, 2016).

Renewable energy consumption (% of total final energy consumption)

It is the share of renewable energy in total final energy consumption (Dahlberg and al., 2017).It is stated that only 30% of the population have access to electricity in West Africa. The access rates of electricity vary in the region, from 20% in countries like Niger and Burkina Faso to 50% in countries like Senegal (WEO, 2017). According to IEA (2015), the national electrification rates are: Benin (29%), Burkina Faso (17%), Cote d'ivoire (26%), Guinea Bissau (21%), Mali (26%), Niger (15%), Senegal (55%), and Togo (27%) (IEA, 2015). More than 500 million people in SSA do not benefit from a reliable access to electricity (UNESCO, 2014). Traditional energy represents 54% of total energy demand in SSA and 27% oil, 14% solid fuel, 3% hydropower and 2% gas (Karekezi & Kithyoma, 2003). The major constraints of electricity access in the region include the lack of adequate financing, weak generation of electricity, transmission and distribution capacity inducing losses, lack of pro-energy efficiency policies, population growth and inadequate regulatory frameworks (Dramé, 2014). Karekezi & Kithyoma (2003) also highlighted the lack of skilled manpower, weak baseline information, poor services of maintenance and infrastructure which limit the electrification potential of the region(Karekezi & Kithyoma, 2003)(Karekezi & Kithyoma, 2003)(Karekezi & Kithyoma, 2003)(Karekezi & Kithyoma, 2003) (Karekezi & Kithyoma, 2003). In addition, the legal, regulatory, institutional, tariff structure and schemes for renewable energy are weakly implemented in the region (ECREEE and Casa Africa, 2012). The insufficiency of access to electricity has severe implications for poverty alleviation in West African regions. For Vilar (ECREEE, 2012), the social and economic consequences of energy poverty will continue to be a challenge for West African countries in 2030. Nevertheless, there are electrification potentials for the region. On renewable energy potential, wind energy in Senegal and Mali are under exploitation, micro-hydro schemes in Cote d'ivoire, Guinea-Bissau and Togo; solar and biomass resources are widely available in Burkina Faso, Niger and Mali (Dramé, 2014). Only 7% of Africa's hydro potential has been exploited (Karekezi & Kithyoma, 2003).

Therefore renewable energies represent a diverse energy resources: wind, solar, hydro, biomass, geothermal, etc. and it can also contribute to the domestic energy security (ECREEE

and Casa Africa, 2012). It is considered that modern energy is capital of ensuring sustainable development and the achievement of the SDGs. In spite of the enormous potential of natural resources in the African continent, most of its countries suffer from an increased lack of electricity. This reality is more accentuated in certain zones of the continent such as the WAEMU countries. To reverse the situation, the WAEMU countries, through several energetics projects, intend to reach 82% of green energy by 2030 (La tribune Afrique, 2017). It is generally demonstrated that, energy consumption is positively linked to economic growth even if there is no agreement either on the existence of this relationship or the causality direction between electricity consumption and economic growth. The empirical results of Ozturk et al. (2010) inform that energy consumption and GDP are cointegrated for three income groups: low income, lower middle income and upper middle-income countries. His panel causality tests results prove that, from 1971 to 2005, there is a long-run Granger causality moving from GDP to electricity consumption for the low income group and in middle income countries, bidirectional causality exists between GDP and energy consumption (Ozturk and al., 2010). In 25 OECD countries, from 1981 to 2007, it existed a price-inelasticity of energy consumption. A causality tests demonstrated a presence of bi-directional causal relationship between economic growth and energy consumption (Belke and al., 2011). Ouedraogo (2013) found that energy consumption and economic growth moved together in a long-term, from 1980 to 2008 in fifteen African countries including the WAEMU ones. A unidirectional long-run and short-run causality is found in his investigations. The causality moves from economic growth (GDP) to energy consumption in the short term and from energy consumption to economic growth in the long-run. An evidence of unidirectional causality moving from electricity consumption to GDP is also found in the long-term (Ouedraogo,2013). All these empirical proves advance that a lack or limited access to modern energy services can impede economic growth and jeopardize the development. Considering the importance of energy in economic growth, the energy consumption per capita stagnates in Africa during these last decades while the world's one raised somewhat. The consumption of electricity per capita in SSA (South Arica excluded) dropped, moving from 132.6 kWh in 1980 to 112.8 kWh in 2000. The consumption of electricity in WAEMU countries is largely confined to intensive energy use sectors like trade and industry, and to lesser extent households with high income. The sharpness with which the difficulties of access to electrical energy justifies certainly the definition of a policy and strategy of energy taking into account the strong correlation which would exist between a country's development and the energy it

employs, and at the same time the limited financial resources of African countries (Diandy, 2007).

Quality of overall infrastructure

Dahlberg and al., (2017) used a scale of 1 (extremely underdeveloped) to 7 (extensive and efficient by international standard) to assess the general infrastructure (transport, telephony, etc.) (Dahlberg et al., 2017)(Dahlberg et al., 2017). Their analysis shows that Africa is largely lagging behind other developing countries in terms of quantity and quality of infrastructure services and Africa's infrastructure deficiency is more advanced in the energy sector (dependency on traditional biomass, low purchasing power, low energy efficiency, lack of access by rural populations). The indicators swayed by this observation include household access to electricity, per capita capacity to generate electricity, frequency of roads system, paved roads, sanitation and water. Important efforts are now consecrated to empirical and theoretical evaluation of infrastructure contribution to growth and economic development. More attention has also been moving to the impact of infrastructure on inequality and poverty in recent past (Jerome, 2011).

Jerome (2011) found that electricity is accessible to only 18 percent of Sub-Saharan Africa's population, relatively to 44 percent in South Asia, the next lowest region. Improved water and sanitation access are respectively 58 percent and 31 percent compared to 87 percent and 33 percent in South Asia. Access to flush water is however only 6 percent in SSA. In developing countries, more than 1.3 billion people do not have access to electricity and 590 million of them live in Africa (Peters, 2016). 32 out of 39 studies of OECD countries found a positive effect of infrastructure on some mixture of private investment, employment, productivity, efficiency and output. In the microeconomic side, because of the judgment that they naturally lead to income generation and poverty reduction, substantial attention has been devoted to roads, principally in rural areas. Poor public capital (inadequate and unreliable power supply) reduce substantially productive private investment. So, poor public capital evicts private investment (Reinikka and Svensson 2002 cited by Jerome 2011). Calderon (2008, cited by Jerome) have estimated that in Africa, infrastructure proffered 99 basis points to per capita economic growth over the period 1990-2005 compared to 68 basis points for alternative structural policies. The results of Calderon demonstrated that if all African countries caught up with Mauritius in infrastructure, their per capita economic growth could raise by 2.2 percentage points. It is often argued that lack of access to infrastructure services is a huge obstacle to sustainable human development and it hampers economic development (Peters,

2016). Based on Asian and Latin American experiences, electrification has three socio-economic benefits on different dimensions: decline in respiratory sicknesses because of decrease in kerosene usage, academic benefits because of increase in study time and enhancement in income because of increased non-agricultural activities (Peters, 2016). This last point is particularly important for our analysis because we suppose that the improvements of infrastructure like electricity will increase economic development through business progresses. Besides, based on the World Bank Enterprise Surveys, it is proven that indirect charges related to infrastructure and services represent a relatively high share of firms' charges in poor African regions and then cause a competitive burden on firms in Africa. Also, appeasing the infrastructure limitations contribute to high indirect costs and then major investments are required to do business (Eifert and al., 2008).

Human capital index: based on years of schooling (Barro/ Lee, 2010) and assumed returns (Dahlberg and al., 2017). In the *Oxford English dictionary*, human capital is defined as "the skills, knowledge and experience possessed by an individual or population, viewed in terms of their value or cost to an organization or country". These investments in people (for instance training, education, health) increase their productivity. The magnitude of the residual (share of the economic growth which cannot be explained by the raise in physical productive factors such as capital stock, number of workers and their hours of work) during much of the twentieth century associated with the economic growth per capita or per worker terms shown that physical capital combination did not explain very much growth and that something else did. That something else is knowledge production and the enhancement of the labour input via education and training, meaning that much of the residual resulted to the human capital increase. Approaches are formulated by some researchers in order to close the "residual" gap by completing the Solow model by the human capital growth (Mankiw, Romer & Weil 1992 cited by Goldin, 2014). In addition, incomes can rise through modest technological change and lead parents to allocate some of their revenues to school their children. So the education's enhancement induces technological, population and income reform. At a certain level of profound growth, it will be possible to have a demographic transition and durable growth per capita and the world breaks the Malthus trap. (Goldin, 2014). Nevertheless, the results of the study of Quenum (2011) show that the human capital of post-primary education levels produces a significant and negative effect on the economic growth o WAEMU countries. He thus advances that the problems of quality of education or area of competence of the capital human can explain these against-intuitive effects (Miningou, 2012). The results of Miningou

(2012) join those of Quenum. In fact, he found that the human capital in the WAEMU countries is less productive than in CEMAC (Central Africa) countries during the period 1980-2010. Moreover, it seems not to have had a positive evolution in productivity during this period. Results also show that has a whole, the returns to scale of capital human are decreasing in all the considered countries (Miningou, 2012). And since it was shown that the weakness of education affect negatively the total productivity of factors in the countries of SSA (Binam, Njikam et Tachi, 2006 cited by Miningou 2012) and that SSA countries are more inefficient in the transformation of capital human by the population than in the accumulation of human capital through public investments in education and healthcare (for instance In Senegal, the literacy rate of adults increased approximately 56% between 1990 and 2006 while in the same period, the increase of GDP per capita is only 16% (Miningou, 2012). Education systems have to target developing skills required in the job market and on vigorous public-private partnerships in order to meet the needs of Africa's young which represent over 20% (between the ages of 15 and 24, (Williams, 2012)) of the population. Africa needs to do something now by providing both quality primary education and better vocational and high education to all. Africa is receiving support from the World Bank for youth employment, broaden learning and training opportunities (The World Bank, 2005). It is shown that qualitative characteristics and diminishing returns of human capital engender a positive and significant relationship between human capital and economic growth in 22 African economies (including Benin, Guinea-Bissau, Mali, Niger, Senegal and Togo) over the period 1970 to 2000. Investigation on human capital estimate that education raises productivity and returns mainly by furnishing skills, knowledge and a way of analysing problems. However, some other researchers have an alternative view: schooling do not improve productivity. It is demonstrated that all countries which have constant economic growth have had important increase in the training and schooling of their labour forces (Becker, 1994).

Population

It is based on the facto definition of population, considering all residents regardless of citizenship or legal status. Sub-Saharan Africa experiences an explosive demographic transition. Higher fertility rate despite long intervals between births, number of desired children are high, early weddings, poor contraceptive practice, are leading to high population in the region. (Leridon, 2015). The French-speaking SSA continue to have high performances with a growth of 3.7% in 2016. The population density varies greatly between WAEMU

countries: Togo: 140, Senegal: 80, Niger: 16, Mali: 15, Cote d'ivoire: 75, Burkina Faso: 68 and Benin: 96 (World Bank, 2016). However, this situation of rapid growth population could lead to an increase in migratory pressure from the rest of the continent. The population of African countries is currently young. The pressure to support young dependents and older persons jeopardize savings and investment in economic and social development. Adequate economic and social policies have to be developed for a satisfactory economic and social development (Kay & Nagesha, 2016). Although being the fastest urbanizing region, African countries remain the least urbanized ones in the world, with only 40.4% percentage of its population residing in urban areas by 2015. The vulnerability to climate change impacts is emphasized by the population growth, undermining then sustainable development. The rapid population growth of SSA region inhibits efforts to preserve environment and well-being. The relationship between sustainable development and population is critical in SSA since the largest share of its population lives in areas which are exposed to climate variability. Many countries are then experiencing dual challenges of population growth and climate change negatives impacts. This twin challenges have negative implications on the availability of natural resources as water and agricultural land (AFIDEP, 2012).

C.3. Methodology

A simple panel regression with $i = 1 \dots \dots N$ and $t = 1 \dots \dots . T$ will be used:

$$Y_{it} = \alpha_i + X'_{it}\,\beta + Z'_{it}\,\mu + \varepsilon_{it} \qquad (1)$$

Where $Y_i$the number of CERs per capita, X_{it}, a vector of exogenous or explanatory variables that can determine the CERs per capita and Z_{it} a vector of control variables, are $K_1 \times 1$ and $K_2 \times 1$ vectors. $\alpha, \beta \; and \; \mu$ are 1 ×1, $1XK_1$ and $1XK_2$ vectors of constants respectively. ε_{it} is the error term, it is independently, identically distributed over i and t, with mean equals to zero and variance σ_ε^2(constant). We have N=6 and T=12, implying that $n = N * T = 6 * 12 = 72$

Specification tests

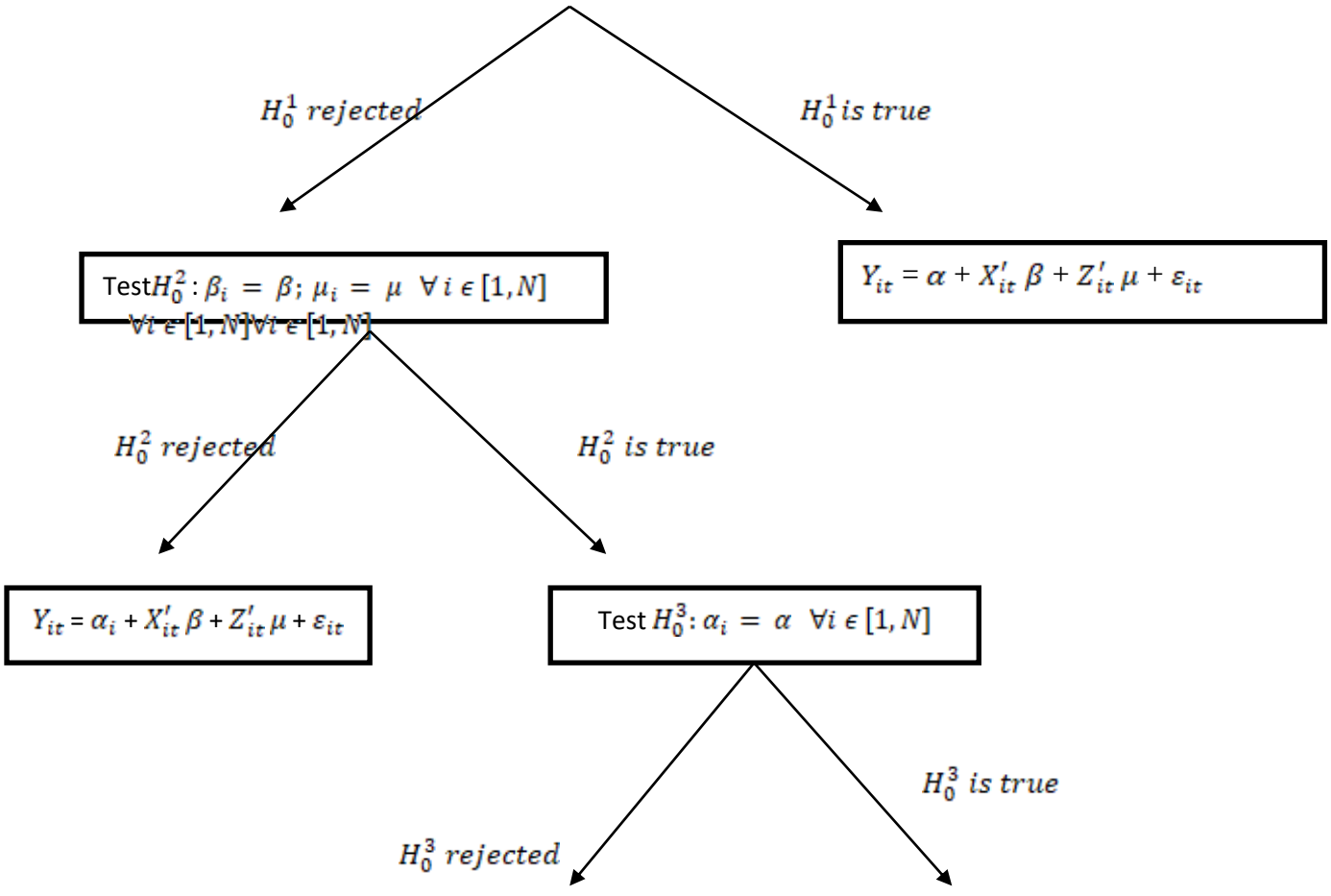
Homogeneity test

When working with panel data, the first thing to check is the homogeneous or heterogeneous specification of the generating process of the data. Econometrically, it means to test the equality of the studied model's coefficients in the individual dimension. Economically, it is to determine if it is possible to presume that the studied theoretical model is perfectly identical

for all the countries (pooled models; in this case,α, β and μ are identical to all the countries $\beta_i = \beta, \mu_i = \mu$ and $\alpha_i = \alpha$), or if there are proper specificities to each countries (the panel structure is rejected if α, β and μ are different for all countries). If the expectation of total homogeneity is rejected, it is advisable to test if the different constants are identical to all countries. If it is not the case, the model cannot be the same for all countries. In this case, estimations should be done country by country. If it turns out that there exists an identical relationship between the dependent and independent variables for all the countries, the constants α_i may then be the source of the heterogeneity of the model. It is therefore necessary to test the hypothesis of a common constant to all countries. And if this hypothesis is rejected, we obtain a model with individual effects of this form:

$$Y_{it} = \alpha_i + X'_{it}\,\beta + Z'_{it}\,\mu + \varepsilon_{it}$$

In summary, the general process of the homogeneity test (Hsiao test) is:



$$Y_{it} = \alpha + X'_{it}\beta + Z'_{it}\mu + \varepsilon_{it}$$

$$Y_{it} = \alpha_i + X'_{it}\beta + Z'_{it}\mu + \varepsilon_{it}$$

- The likelihood ratio test (Fisher test)

Model 1: $Y_{it} = \alpha + X'_{it}\beta + Z'_{it}\mu + \varepsilon_{it}$

Model 2: $Y_{it} = \alpha_i + X'_{it}\beta + Z'_{it}\mu + \varepsilon_{it}$

The following null hypothesis will be tested: $H_0 = \alpha_1 = \alpha_2 = \ldots\ldots = \alpha_n = \alpha$

The test is:

H_0 : Lack of effects (model1)

H_1 : Presence of fixed effects (model 2)

- Breusch and Pagan test (Lagrangian multiplier test for random effects)

Model 1: $Y_{it} = \alpha + X'_{it}\beta + Z'_{it}\mu + \varepsilon_{it}$

Model 3: $Y_{it} = \alpha + X'_{it}\beta + Z'_{it}\mu + \alpha_i\,\varepsilon_{it}$

A Lagrangian multiplier test will be done:

The test hypotheses are:

H_0 : Lack of effects (model1)

H_1 : Presence of random effects (model 3)

- The Hausman specification test

This test is widely used for specification tests of individual effects on panel data. Then, it allows discriminating the fixed and the random effects.

The test hypotheses are:

H_0 : Presence of random effects

H_1 : Presence of fixed effects

The autocorrelation problem will be check. If the model has autocorrelation problem, dynamic model will be used, if not, we will check whether Y_{t-1} has impact on Y_t and will decide to choose dynamic or static model.

As econometric technic, the GMM is excluded since T (<30) and N are not large enough. And if we specify a Least Squares Dummy Variable estimator, the estimations of the fixed effects will be inconsistent. Pooled OLS approach will be applied for the estimation with STATA. In

the static case, we will also use a standard within estimator to capture fixed effects and it will also provide consistent and unbiased estimates. If there is an unobserved heterogeneity, the POLS will be inconsistent, whereas fixed effects are consistent and will be used. If there is no observed heterogeneity, all these two approaches will be used since they will be consistent.

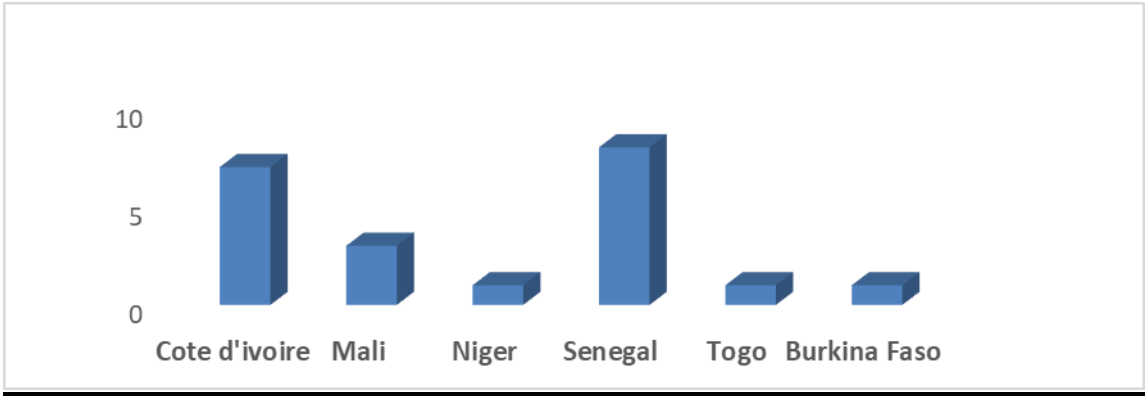
D. Results

Table 1: First CDM year in WAEMU countries

Country name	Kyoto ratification date	First CDM year	Number of CDM projects[1]
Cote d'ivoire	23 April 2007	2007	7
Mali	27 January 1999	2007	3
Niger	23 October 1998	2005	1
Senegal	20 July 2001	2007	8
Togo	2 July 2004	2011	1
Burkina Faso	31 March 2005	2014	1

This table lists the CDM host countries considered in our analysis. The first CDM year in WAEUMU is in 2005 in Niger followed by Cote d'ivoire, Mali and Senegal in 2007. Burkina Faso is the one which lastly host a project in 2014. Half de the considered countries host only one CDM project presently. The CDM mechanism is launched in 2001.

Figure 4: Number of CDM project per country



[1] These projects have the following status: RD(Registered), VA (public validation), VT (validation terminated-inactive projects) and CC (undergoing completeness check)

Among WAEMU countries, Senegal hosts most CDM projects (8 projects) followed by Cote d'ivoire where there are 7 projects. Niger Togo and Burkina Faso are at the same level with only one project per country.

Table 2: Data summary

Countries (N= 6)	**Mean**	**Stand. Dev.**	**Min**	**Max**
Annual-CERs	357646.2	633189.7	752.1288	2857521
Transp_index	50	6.45	39	59
GDP/capita	550.66	210.80	263.81	983.48
Business_environ	3.3	0.37	2.5	4
CO2 emission/capita	0.23	0.17	0.06	0.64
Renewener_cons	19.8	7.19	9.4	25.97
FDI	3.78	3.91	0.32	19.37
Quality_infrastr	3.21	0.55	2.10	4.03
HCI	1.40	0.22	1.12	1.78
Population	1.43e+07	4449974	5578219	2.22e+07

Variable's units of measure

Annual CERs: total CERs for all the country; **Transparency index**: 0 (highly unclean) to 100 (very clean); **GDP per capita**: Current international dollars (per capita); **Business regulatory environment:** from 1(extremely poor) to 7 (extensive and efficient by international standards); **CO2 emission per capita**: Metrics ton per capita; **Renewable energy consumption**: % of total final energy consumption; **FDI**: percentage of the GDP; **Quality of infrastructure**: from 1(extremely underdeveloped) to 7 (extensive and efficient by international standards); **HCI**: based on years of schooling and assumed returns; **Population**: all residents regardless of legal status or citizenship.

Hsiao test

Global Homogeneity

F-stat	1.02
P-value	0.50

Homogeneity of coefficients B

F-stat	0.98
P-value	0.54

Homogeneity of coefficients A

F-stat	1.35
P-value	0.26

P-values are > to alpha (5%), Ho is not rejected, the panel structure is accepted. We have a homogeneous panel (pooled). We have a global homogeneity, and homogeneity of the coefficient and homogeneity of the constant.

The Hausman test showed that a fixed effects model is recommended (P value < α)

Table 3: Autocorrelation test of Wooldridge

Wooldridge autocorrelation test	
Ho: no first order autocorrelation	
F (1, 11)	2.362
Prob > F	0.1526

The test shown no autocorrelation

Table 4: The random effects estimation

Variables	Estimates	Std-errors	t-statistic	p-value
LogCER				
ltransp	-2.165	1.900	-1.14	0.254
lgdp	1.353**	0.649	2.08	0.037
lbusiness_env	-0.678	1.335	-0.51	0.611
lCO2	-1.290***	0.259	-4.98	0.000
lrenew_energ	-4.029***	0.718	-5.60	0.000
lfdi	-0.464***	0.118	-3.91	0.000
lhci	11.348***	2.420	4.69	0.000
lpop	4.356***	0.819	5.31	0.000
R-square	Within: 0.2659 Between: 0.9964 Overall: 0.8741			
Wald chi2(9)	416.65			
Prob > chi2	0.0000			
Corr (u_i, x)	0			
Number of observations	70			

Source: estimations by the author

(*) (**) (***) significative respectively at 10%, 5% and 1%

D.1. Justification of random effects use instead of fixed effects

A model choice is principally a trade-off between bias and precision. The first explanation can be the fact that the countries are randomly included in our analysis. Among the 8 countries of WAEMU, 6 are took into account and 2 countries are excluded because of lack of data (no CDM projects in these countries). Hausman test is not accurate in all cases, RE is choosing because of the characteristics of the data (we have larger between variation than within variation, in this case, it is not correct to use FE (which assume homogeneity between units) even if Hausman test suggests it. If the standard deviation of the random coefficient is statistically different from zero, RE is preferred to FE (see table A). A test of residue normality is performed to verify the estimations validation. The test showed a P-value equal to 0.0291 (>0.1) implying that the residu follows normality at 10% threshold.

D.2. Interpretation of the estimated results

The probability value is near to zero (0.000), which mean a global convenience of the used model. The retained variables explain well the CERs per capita (number of carbon credit per capita which is the proxy of CDM implementation) in the different countries of WAEMU. Among the considered variables, only two of them are not significant: the transparency index and business facility.

On the other hand, coefficients associated with GDP, CO2 emissions, renewable energy use, Foreign Direct Investment (FDI), Quality of overall infrastructure, Human Capital Index (HCI) and population are significative. Our estimations show that Population size, HCI, infrastructure quality as well as GDP per capita are the variables which pull forward the CDM projects implementation in WAEMU countries. So, countries which higher level of economic development, infrastructure quality, human capacity and population size are most likely to engage in CDM development.

An increase of 1% of **GDP** in WAEMU countries implies an increase of 1.353% of the CERs per capita and then an increase in expected CDM projects. This is possibly due to the fact that economic activities are likely increased with an enhancement of GDP which is an indicator of a country's economic performance; and that can rise the number of projects in the economy. This result is in line with the one of Flues (2010).

An increase in 1% in the overall **quality of infrastructure** allows an increase of 1.464 % of CERs per capita in WAEMU countries. In fact, infrastructure in terms of telephone, internet, roads, rail lines, sanitation access as well as electricity availability are supposed to increased economic growth through business development. It is often argued that lack of access to infrastructure services is a huge obstacle to sustainable human development and it hampers economic development (Peters, 2016).

An increase in 1% in **human capital (literacy**) allows an increase of 11.348 % of CERs per capita in WAEMU countries. This may simply be explained by the fact that human capital is necessary for CDM implementation. This replicates the findings of Grote and Rottgers (2014).

An increase in 1% in the **population size** allows an increase of 4.356 % of CERs per capita in WAEMU countries. Countries with more individuals are more likely to host CDM projects.

The coefficient associated with **FDI** investment is negative and significant at 1% level. This may suggest that CDM projects investment could be substituted for FDI. This result is similar with the one of Winkelman & Moore (2011) and it also joins the findings of Loris (2016) which states that FDI do not have an appreciable impact on African countries' industrialization. However it is different from the result of (H. Wang & Firestone, 2012), Grote and Rottgers (2014), etc.

Our estimations shown a negative link between **CO2** emissions and the number of carbon credit. It is fund that an increase of 1% of CO2 emissions is associated with a reduction of 1.29% CERs per capita. This finding is contrary to the ones of some researchers as (H. Wang & Firestone, 2012) who found that CO2 emission is positively linked to CDM projects implementation. Countries with high emissions (most 'dirty' countries) are more likely to host CDM project. In fact, they have more opportunities to replace CO2 emissions sources by renewable sources through CDM projects implementation. Our result may be due to the fact that the fundamental aim of the CDM is to reduce GHG (in a cost-effective way) while GHG emissions are weak in West African countries, impeding them to get the better opportunities for CDM implementation. Moreover, CO_2 emissions, distinctly, move upwards in selected countries before they have CDM projects in the pipeline (Huang & Barker, 2009), meaning that CDM projects could lead to CO_2 emissions reductions in the long-run.

The coefficient associated with **renewable energy** was expected to be negative. A country with a larger part of fossil energy in the overall energy consumption is likely to host CDM projects since its potential is higher. The more the part of renewable energy in the total energy consumption is low, the higher the CDM expectation. Renewable energy consumption is negatively linked to the CDM implementation. Among the 12 registered projects in WAEMU, only 2 concern renewable energy project. Most of the projects in WAEMU are forestry projects. This result is in accordance with chapter 2 results where forestry project is negatively linked with the indicator: reduction of fossil energy use. So, forestry projects in WAEMU increase the utilization of fossil energy and therefore decrease the use of renewable energy.

Table 5: Robustness check: pooled OLS estimation

LCER	Coefficient	St. Error	t-statistic	P>|t|
Transparency Index	-6.120	2.102	-2.91	0.005
GDP	3.315***	0.642	5.16	0.000
Business	-2.685*	1.540	-1.74	0.086
CO2	-1.213***	0.311	-3.90	0.000
Renewable-energy	-4.552***	0.855	-5.32	0.000
FDI	-0.627***	0.138	-4.54	0.000
Infrastructure	5.011***	0.566	8.85	0.000
HCI	0.837	1.678	0.50	0.620
Constant	26.223	7.338	3.57	0.001
Prob > F	0.000			
R-squared	0.815			
Adjusted R-squared	0.790			

Source: estimations by the author

(*) (**) (***) significative respectively at 10%, 5% and 1%

To check the robustness of our estimations, we remake it using the pooled OLS estimation technic. This second estimate confirms the positive impact of GDP on the development of CDM projects. This latter estimates also showed that the quality of infrastructure (transportation, telephony, paved roads, sanitation, water, etc.) has an important role in the implementation of CDM projects. The negative impact of variables such as CO2 emission levels, renewable energy consumption and FDI on the promotion of CDM projects is confirmed by this pooled OLS estimates.

E. Comparison of WAEMU's CDM implementation with Southeast Asian developing countries:

The situation of CDM in WAEMU is compared with the one of some other developing countries, in Asia particularity where most of CDM projects are implemented (~ 80%). The same regression for WAEMU countries has been done also for the selected Asian developing countries. The aim here is to see which variables seem to make the differences between the 2 groups of countries. The selected countries are: Malaysia, Laos, Philippines, Vietnam and Indonesia.

Table 6: Random effect estimation with Asian developing countries

LCER	Coefficient	St. Error	t-statistic	P>|t|
Transparency Index	0.374	0.752	0.5	0.618
GDP	-0.545	0.220	-2.47	0.013***
Business	5.347	5.735	0.93	0.351
CO2	-0.228	0.345	-0.66	0.509
Renewable-energy	-0.423	0.332	-1.27	0.203
FDI	0.160	0.138	1.16	0.245
Infrastructure	2.281	0.711	3.21	0.001***
HCI	-5.372	1.678	-3.20	0.001***
pop	-0.314	0.315	-1.00	0.318
Constant	-5.726	6.760	-0.85	0.397
Prob > F	0.000			
R-squared	0.6682			

Source: author

The estimate shows that the only variable that has the same impact on both groups of countries is the **quality of infrastructure**. Indeed, if West African countries had the same infrastructure qualities as countries such as Malaysia, Laos, Philippines, Vietnam and Indonesia, they would have attracted as many CDM projects as these countries.

Conclusion

The Clean Development Mechanism allows governments or private entities in industrialized countries to implement emission reduction projects in developing countries. However, Africa has hosted a very few numbers of CDM projects especially in WAEMU countries where the participation is very low. This research intends to assess the factors responsible of the low participation of these countries in the carbon market.

The regression model indicates that Population size, HCI (human capital), infrastructure quality as well as GDP per capita are the variables which pull forward the CDM projects implementation in WAEMU countries. So, countries which higher level of economic development, infrastructure quality, human capacity and population size are most likely to engage in CDM development.

GDP affects positively the implementation of CDM projects probably because of the fact that economic activities are likely increased with an enhancement of GDP which is an indicator of a country's economic performance; and that can rise the number of projects in the economy. The results suggest also that infrastructure can play an important role on CDM distribution. In fact, infrastructure in terms of telephone, internet, roads, rail lines, sanitation access as well as electricity availability are supposed to increased economic growth through business development. Human capital and population size are likely important too CDM attractiveness. Indeed, most populated countries with more educated citizens can expect to attract more CDM projects.

The regression attests a negative connexion between CO2 emissions, the Foreign Direct Investment (FDI), the part of renewable energy in energy consumption and CDM implementation in West African regions. Dirty (most polluted) countries then more likely to succeed in the CDM by generating more CERs. Foreign Direct Investment also may not play an admirable role on the process of industrialisation in West African countries. Countries with a high part of renewable energy in their energy consumption may have less opportunities to issue carbon credits through CDM projects.

Helping developing countries like West African countries to develop the quality of infrastructure and the human capital can help them to gain new economic benefits through the Clean Development Mechanism.

Necessary institutions should be developed in West Africans regions to promote CDM.

II. Contribution of Clean Development Mechanism (CDM) to sustainable development in West African Economic and Monetary Union (WAEMU) countries: a case study of Senegal

Introduction

The Clean Development Mechanism (CDM) is one of the three flexible market mechanisms of the Kyoto protocol. Through emissions reduction projects, CDM allows developing countries to earn certified emissions reductions (CERs), each equivalent to one tonne. These CERs can be commercialized and used by developed countries to satisfy a part of their emission reduction targets under the Kyoto protocol (UNFCCC, 2018). The Clean Development Mechanism (CDM) is currently the only approach to engage developing countries in the formal carbon market (Sanja, 2008). Its dual goal is to promote sustainable development in developing countries while allowing developed countries to participate to the global objective of reducing atmospheric concentrations of greenhouse gases (UNFCCC, 1998, Olsen, 2007, Wooders & Nolet, 2008, Niemack & Chevallier, 2010; Karakosta, et al., 2013). It allows industrialized countries to accomplish their greenhouse gas emission reduction engagements under the Kyoto protocol in a cost-effective way (Anagnostopoulos and al., 2004). The promotion of sustainable development in developing countries by industrialized countries has to be done via capacity building, technology transfer, financial resources, social justice, and natural resources protection. Sustainable development and environmental integrity are one of the key issues discussed in the Paris agreement during the CoP21. It was stated that the parties engaged in the Internationally Transferred Mitigation Outcomes (ITMOs, it allows non-Annex I countries to finance domestic mitigation beyond what can be achieved with their own resources while allowing industrialized countries to be more ambitious by keeping environmental integrity and transparency) have to promote sustainable development and environmental integrity. And most of defined articles of the agreement are based in the context of sustainable development.

The greater number of studies on the impact of the CDM agree that the CDM has a substantial impact on the various character of sustainable development (economic, social, and

environmental) in the host countries. In the other side, some authors argue that the CDM has not significantly contributed to Sustainable Development and the initial assumption of the synergy and win-win relationship between the dual aims of the CDM does not hold for many projects (Olsen, 2007). The trade-offs which exist between the two objectives of the CDM is in favour of cost-effectiveness (Colchis et al. 2001; Markandya and Halsnæs 2002; Sutter 2003, Karen, Olsen and Risø 2005), meaning that developed countries take advantage from CDM instead of developing countries. Most of these studies do not draw conclusions on the CDM's actual contribution to SD, only estimate the 'potential', 'theoretical' or 'possible' contribution to SD, which tend to be positive. Studies evaluating the benefaction of CDM projects in Africa are very few in Africa and almost inexistent in West Africa. The win-win relationship of the CDM is then very unclear in West African countries, which leads us to set the following questions: do CDM projects fulfil the sustainable development criteria in West African countries? What are the real opportunities of the implemented projects? What are their challenges? **The aim of this empirical study is, by cases studies in Senegal, to assess the contribution of CDM projects to sustainable development in West African countries through households' surveys and interviews.**

A. Actual debate around carbon trading

The proponents of the Clean Development Mechanism (CDM) regard it as an opportunity of development funds for developing countries. They argue that it provides a flexible and profitable mechanism for combating climate change and helps developing countries reach their sustainable development goals while reducing the financial burdens on their public sector (Promethium, 2014).

The greater number of studies on the impact of the CDM agree that the CDM has a substantial impact on the various character of sustainable development (economic, social, and environmental) in the host countries. CDM projects contribute to clean and sustainable development in developing countries while having the potential to achieve poverty alleviation (Michael, Antônio, & Gustavo, 2015). The technology transfer is often considered as a key component of promoting sustainable development. Many studies which examined CDM projects found that these projects allow equipment and knowledge transfer, job creation, economic benefits and so on. Besides these proponents of carbon trading, there are opponents of carbon markets who exposed its ineffectiveness. Based on research findings, Olsen argues that, by 2006, the CDM has not significantly contributed to Sustainable Development (Olsen,

2007). A general finding from applying any of the sustainability assessment tools to case studies of CDM projects is that trade-offs exist between the two objectives of the CDM in favour of cost-effectiveness (Colchis et al. 2001; Markandya and Halsnæs 2002; Sutter 2003, Karen, Olsen and Risø 2005), meaning that developed countries take advantage from CDM projects instead of developing countries. As Sustainable Development's benefits are not monetised in the carbon market, the Sustainable Development (SD) objective tends to be given a lower priority than the cost-effective reduction of GHGs. So, the initial assumption of the synergy and win-win relationship between the dual aims of the CDM does not hold for many projects (Olsen, 2007).The literature has then shown that the win-win relationship between the two aims of the CDM does not exist in many analysed projects (Karen, Olsen, Risø, 2005). Gupta et al. (2008), Wittman and Caron (2009) and Martinez and Bowen (2012) have also found meagre contributions of CDM projects to sustainable development. Sutter and Parreno advance that this trade-off is evident, and is strongly in favour of the cost-efficient emission reduction objective and the SD objective is being neglected (Sutter and Parreno, 2005). In addition, Pearson, Luvbrand et al (2009) and Alexeew et al (2010) argue even that the dual objectives of low-cost abatement and sustainable development is at least partially incompatible. Common to most of the forward-looking and sustainability impact studies is the fact that **they do not draw conclusions on the CDM's actual contribution to SD, only on the 'potential', 'theoretical' or 'possible' contribution to SD, which tend to be positive.** In the early, forward-looking studies, no data on CDM projects yet existed. Without empirical data against which to critically assess the CDM's objectives, the conclusions tend to be in line with the initial assumptions about synergies and win-win opportunities. Between the dual goals of carbon market, to the detriment of development criteria, carbon sequestration is generally prioritized in project design and implementation. It is found that stakeholders have different priorities of environmental, development and carbon criteria of sustainable development (Brown and Corbera, 2003). Left to the market mechanism, existing institutions for CDM projects management are not likely to fulfil the objectives of local equity and sustainable development. Then, Brown, Adger et al. (2004) assumed that the carbon market may worsen the social inequalities. Furthermore, it is feared that the CDM will be used to harvest the 'low-hanging fruit,' i.e. exhaust the cheapest and easiest means of reducing emissions, and leave the more expensive options for later when developing countries might have to commit to emission reduction targets (Kim,2003). In terms of poverty reduction, studies by Michaelowa (2011), Martinez and Bowen (2012) and Crowe (2013) find that projects have not delivered significant pro-poor benefits. Presently, the carbon market is

widely regarded as being in crisis (Promethium, 2014, Kreibich et al., 2016). The global carbon markets crashed and CER prices plummeted to near zero: the lack of ambitious emission reduction targets in Annex-I countries together with a decline of industrial emissions in the wake of the global financial crisis of 2008/2009 resulted in a large oversupply of emission permits, shrinking demand for CERs to historical low levels (Kreibich et al., 2016). The carbon market is also criticised for creating unjustified property rights by commodifying air, a common resource. It is further criticised for creating and perpetuating power differentials between the global North and South because of its market-oriented nature, as it provided disproportionate benefits to wealthy and high-polluting industries (Promethium, 2014). The strongest critique against carbon market is that it is currently leading to an increase in emissions, because the offsetting mechanism allows corporations and countries to simply transfer responsibility for their emissions reductions to the developing world (Promethium, 2014). For the World Bank, countries in sub-Saharan Africa are not dirty enough, or do not consume enough, to compete successfully for carbon-offsetting opportunities. In other words, Africa has to get dirty to be admitted as a serious player in the CDM-type carbon business. Another important critic to take into account is that the nature of the development benefits from a CDM project is left to the developing country to define, while the contribution towards offsetting a developed country's emissions is assessed and verified at the international level (Desanker, 2005). The process to register a CDM project is widely seen as complex and costly for many developing countries.

B. Empirical review: Contribution of CDM projects to sustainable development

During the negotiations of the CDM's structure, most parties agreed that the parties hosting the projects are in the best position to assess the projects' contribution to sustainable development. Therefore, the global market price for emissions abatements cannot be controlled by individual countries which will lack market power. The competition between non-Annex I countries in capturing more CDM projects may be a reason to establish low sustainability standards for more project's attraction with abatements costs (Sutter, 2003).

Forward-looking of CDM's contribution to SD

Before the Marrakech accord, some authors tried to estimate the future contribution of CDM on sustainable development without CDM project data. Austin and Faeth (2000), by using literature reviews from possible CDM projects in China, India and Brazil, have tried to see how far the CDM will boost the sustainable development goals. Assessing the CDM impact

on SD by using different economic methodologies, Banuri and Gupta (2000) have analysed if the CDM will promote or impede sustainable development and Mathy, Hourcade et al. (2001) tested whether the CDM can be leverage for development, by employing modelling and simulation of the leverage effect of CDM on development.

The risky findings of these studies are likely to be positive by displaying possible CDM projects benefits for developing countries: technology transfer, investments, environmental solving problem, and social goals achievement. Afterwards, studies have shown mixed results. In the analysis of Watson and Fankauser (2009), the terms economic growth and development are used to point to immediate project benefits. More lasting benefits which are often not captured by conventional economic analysis are identified. These sustainable development gains are then organized as contributions to natural, social and physical capital (Watson and Fankhauser , 2009). The co-benefits of CDM projects which are claimed in PDDs are examined. The authors consider that the PDDs are the most widely-available and complete source of project by project information. This study considers the affirmation of the CDM projects co-benefits stated in their PDDs. To assess the Sustainable Development, the authors constituted eight practical indicators to evaluate the sustainable development and the economic growth. Since negative impacts do not appear in the project documents, they are not counted in this study. The indicators are scored 'yes'- if the project has real potential contributions to sustainable development, or 'no' otherwise. The key considered indicators for the economic growth and development are: employment and livelihood; concerning sustainable development, the main indicators are physical (infrastructure and technology transfer), natural (environment and pollution) and social (education and training). The study covers all the countries. A **standard logit model** is used to estimate the determinants of the principal co-benefits of CDM projects. In this model, the probability of discovering a particular co-benefit p_i is a function of a set of independent variablesX_i. Several models are used. With model 1, it is found that bigger projects forecast more significant employment gains than the smaller ones at 5% level of significance.

Results make know that employment (82%) and training (87%) are absolutely the more important development benefits. Despite the fact that 96% of all the considered projects asserted sustainable development contribution, 33% of the projects asserted technology transfer, followed by livelihood services (23%), pollution reduction (21%), infrastructure (21%), literacy (5%) and environmental benefits (4%). 84% of the projects claimed economic growth. In consideration of the sustainable development only, CDM projects confer mainly social capital (50%) and natural capital (24%). It is also found that renewables energy,

CH_4 reduction, cement and coal mine bed, energy efficiency composed the full complement of sustainable development benefits. The results shown also that forest carbon projects contribute more to sustainable development than projects in the other sectors even if they do not deliver technology transfer (Watson and Fankhauser , 2009). A study is conducted with an analysis of 202 registered project design documents (PDDs) to assess the reported contribution to sustainable development. The results of the PDDs analysis show that almost all PDDs (99%) reported sustainable development benefits. 96 % of them mentioned economic benefits, 86% mentioned social benefits and 74% mentioned environmental benefits. According to previous empirical studies, 27% to 39% of CDM projects announce technology transfer as a component of the project design. According to the PDD analysis carried out for this study, 27% of registered projects analysed reported some form of technology transfer (Spalding-fecher et al., 2012, P.147). For Taylor and al. (2014), the Sustainable development benefits distribution is very different in Kenya following the environmental, social and economic dimension. In the analysis, several criteria are considered for each dimension. Air quality, conservation, land and water criteria for the environmental benefits assessment. Balance of payments, energy and growth for the economic benefits assessment and employment, health, learning and welfare for the social assessment (Taylor, Karakosta, Marinakis, Letsou, & Psarras, 2014). The considered approach in this paper includes several steps: *Short description of the host country*: narration of the needs, key priorities and the host country's actions toward climate chance and sustainable development. The achieved purposes are also stated. *Sustainable Development benefits identification:* a set of SD benefits is considered and a conceptual framework is developed for the evaluation of the sustainable development benefits delivered by the CDM projects. *Data collection*: the data are collected from the PDDs' projects. *The CDM projects' sustainable development profile*: information from the Project Design Document (PDDs) is used to assess the contribution to projects to the priorities of sustainable development of the country. *Qualitative analysis*: a qualitative approach is selected. The qualitative data are from the PDDs and the software program Nvivo 7 is used for the organisation, storage, the retrieval, and analysis of these data. *Results and discussions*: the results from the PDDs examination are discussed. Afterwards, three kinds of indicators have been chosen: *Economic:* national debt reduction, foreign expenditures reduction, cost-effectiveness of projects financing; and contribution to the diversification of energy sources and technology transfer. *Environmental:* air quality improvement, water and soil improvement, GHG emission reduction, and efficient utilisation of resources. *Social:* gender equity and poverty reduction. The examined technologies within

the projects in Kenya contain cement, reforestation, hydro, biomass and geothermal projects. However, the biomass projects seem to be more beneficial for Kenya, followed by hydro projects and geothermal projects. The greatest benefits are from growth sustainability criterion (100%), welfare criterion (86%) and energy (50%). The results show that there is no benefit from the learning and land sustainability criteria for Kenya.

Always in Kenya, in another case study, data are collected from public documents, from the United Nations Environment Programme (UNEP-Risoe), the United Nations Framework Convention on Climate Change (UNFCCC), the Kenya's National Environmental Management Authority (NEMA) networks. A database of 34 CDM projects of which 14 are registered (use for the analysis) is obtained from the UNFCCC website (Nyambura & Nhamo, 2014a).

The authors have used the MATA-CDM tool as Sutter and Parreno (2007). The MATA-CDM methodology is used in this study for quantitative analysis of CDM projects and their participation to sustainable development in Kenya. With this technique, all the considered indicators are measured against the reference scenario delineated in the PDDs. The utility values are estimated with A, B and C letters in this study. Employment (jobs opportunities) is adopted as a proxy for economic criteria. And this indicator is not estimated quantitatively since the PDDs do not designate the number of direct either indirect jobs opportunities. So, if a project mentions direct and indirect jobs creation during construction and implementation steps, it is rated A (1 value), if it indicates only indirect jobs, it is rated B (0.5 value) and if the project PDD does not mention jobs opportunities, it is rated C (0 value). Air quality is used as the proxy of environmental criteria and it is rated A, B or C according to whether the project allows direct and indirect pollutants reduction, does not have effects on local air quality or enumerate negative effects impacts to air quality. The proxy for social equity is the distribution of Certified Emissions Reductions (CERs) and a project is rated A, B or C according to whether a large part of the emitted CERs is caught by the poor, a portion of CERs is earned by the poor or none CER is mentioned to be acquired by the poor. Concerning the technology transfer, a project is rated A or B as to whether the proposed technology is sustainable, new and linked with training of local people. The results show 93% of the CDM projects which are rated 'A' and 7% are rated 'B' in jobs opportunities during the construction and implementation phases. Globally, all the CDM projects claim to offer employment opportunities. The CERs returns distribution analysis is done based on the information in the PDDs as most of the project in Kenya are in their construction phase. None of the projects is rated 'A' after analysis, 34% obtained 'B' and 57% got a 'C'. All the projects rated with 'B'

are multilateral (national and foreign participants). Concerning technology transfer, 64% of projects are rated ‘A’ for local training while 35% are rated ‘B’. The majority of the projects are rated ‘B’ or ‘C’ for their effects on air quality (36%). The ‘A’ rated projects (because of their direct and indirect positive impact on air quality) accounted for 29% (Nyambura & Nhamo, 2014a) . The overall ideal score for a CDM project to contribute to all the used sustainable indicators is equal to 1 and none of the project gets it. The highest scoring project register a score of 0.8. The sustainable development meaning and how to appraise it was one of the research questions of Göke (2012). Another one was: does the CDM project fulfil the sustainable development criteria and its sub-questions are: what are the others possible challenge to the studied project and what are the opportunities? How this project will contribute to sustainable development? How to measure the impact? The methodology he used is a developed instrument in order to answer the research questions. The analysis is done in three steps: causes of external effects (political, legal) on internal effects (transfer of knowledge) and vice versa, cause and effect usage (economic, social, and environmental), which refers to the dual goal of CDM. The contribution to development and the economic feasibility of the project are analysed through the SWOT methodology. For the economy side, the microeconomic performance is measured by the Internal Rate of Return (IRR), which is equal to 14% over ten-year period. This means that the project investment is economically attractive. The wages of the project’s employees are subject to the project’s corporate social responsibility and will be 30% to 50 % bigger than the national average. In addition, external agriculturists have an opportunity to participate to the project by selling raw material to the project. The number of people below the poverty line taking advantage from the project activities is very small. 15 vacancies are generated of which ten are creating only a basic income. These 15 jobs employed only 0.3% of the local population and 0.4% when the temporary workers are taking into account. The impact on poverty mitigation, combining employment and auxiliary activities of the project activities is negligible. 5 of the 15 vacancies engender a medium to high wage, implying that the positions require special knowledge and more than physical labour. Most of the transferred knowledge is technological quality and it is only for the project staff. These employees gain high bargaining power over the company, as they obtain essential knowledge. This high learning, they have received may lead them to leave the company for another business. The electricity generated by the project and its connection to the power grid supported the domestic development in all factors characterized in an analysis of sustainable development. The contribution of the project to electricity generation of the country is evident but its function in emission reduction is

debatable (Göke, 2012). The goal of Pechak et al., (2011) was to propose a framework for projects comparison which the aim of discussing a specific aspect: the effectiveness of initiatives aimed at fostering regional sustainable development gains. Data from the PDDs and other studies are used for the analysis. A total of 39 CDCF and Gold standard projects are compared with ordinary projects which have identical features. Results proved that both Gold standard and CDCF projects outperform the non-labelled projects, the advantage being slightly more marked for the Gold standard ones. Concerning the individual indicators, a better contribution of social sustainable development criteria of labelled projects is noted. The environmental criteria gave mixed results. Evenly, the CDCF activities score under the average in terms of economic indicators. This event is not surprizing since the CDCF endeavour to promote activities which seem to be rejected by the market. Globally, labelled projects do not, remarkably, outperform non-labelled projects. These last years, the global wind energy (installed capacity) is growing with an annual rate of about 30%, causing by the high rates of global energy demand, the concern for environmental issues, the remarkable improvements of technology. The higher wind CDM projects hosting countries are China and India. An important number of projects was also under implementation in Latin America. During the realisation of this study, it had only four implemented projects in Africa (Egypt and Morocco). This study is concentrated only on wind projects from China and India. The used data are from the projects' PDDs. The authors stated that the PDDs from China and India's projects contain more rich information than the ones from other countries. In the process of CDM analysis, the Internal Rate of return (IRR) of the project is compared to the local benchmarks (which vary from country to country). The China's IRR benchmark is 8% and the one adopted by India is equal to 16%. It is important to note that the data from PDDs have limitations: the PDDs developers used different approaches and methodologies, non-uniformity of data from several PDDs, etc., creating difficulties in the comparison of projects (Pechak et al., 2011). It is confirmed in this research that major factor for the development of CDM projects in China and India is legal and political framework. In Chinese's PDDs, the 8% financial benchmark is between the mean value without CERs (6.3%) and the mean value incorporating revenue from CERs (9.1%). In fact, the IRR instability is low. Usually, based on the PDDs' information, the impact of CERs income on the IRR of a wind power project is rather small, and in many cases, almost insignificant to attain the benchmark. In addition, in an irrational and ambiguous manner, different assumptions for the CERs price are constituted and these assumptions are so crucial on whether the IRR will achieve and extend over the benchmark or not. Beside the IRR benchmark and the CER estimated price, we know that the

certain profitability of a wind energy project and the contribution of CDM projects in wind energy depend on country-specific-characteristics, specifically, the current electricity price, and the baseline emissions which determines the number of produced CERs. These characteristics may then diverge from region to region in the same country. This analysis is only based on the contribution of CER earnings in the investment cost because of the fact that the PDDs do not indicate financial details but only the eventual CERs. So, the annual produced CERs and the investment cost are used. A benefit/cost ratio, (B/C) is constituted for each project by dividing the Net Present Value (NPV) of the revenue from the CERs with the investment cost. This ratio does not contain the additional costs and the revenue from the electricity sale due to information default. Despite the investment cost characterizes the main cost element for wind energy projects, there are also somewhat low other costs (but practically significant) such as maintenance and operational costs, transaction and registration costs, staff's training, taxing. 21 years is adopted in the NPV computations projects mentioning a renewable crediting period and 10 years for the rest. Results show that for low CERs price (5US$), the incomes from CDM represent a small part of the total investment cost which is down from 30% for all projects. There is better performance for projects from India. The situation is improved with 15US$, the revenues from CERs may be almost half of the initial investments for most of the projects. At a CERs price of 25US$, the revenues can compensate the bigger share of the annual projects investments even without considering the electricity selling. Almost 40% of projects from India and 30% from China have a ratio value of more than 0.5. The distribution of this ratio is almost homogeneous with the cumulative distribution close to be linear. This expresses the differentiation among projects with regard to their B/C ratio increases while the CERs price increases also. Finally, a high diversity is observed with regard to the economic effectiveness of CDM projects. High CERs prices (25 US$ for instance) should be applied for positive returns on investment. CDM cannot assure a high attraction of wind energy projects under low CER price, except in very appreciative conditions of high electricity tariffs and high wind speeds. And the most critical factor, in these conditions, for investment in wind energy projects is the framework of the country in the direction of such investments, than the financial help from CERs earnings (Pechak et al., 2011). Mok and al. (2013) have analysed the impact of CDM projects on construction and building environment. The authors start the analysis with a contextual analysis of CDM and new ideas and suggestions were found based on the opinion of the CDM experts through surveys. Surveys and follow-up interviews with experts through email, open-ended and closed questions. In addition, for more relevant and accurate data, surveys were sent to **critical**

parties involved in CDM projects, consisting of the government entities such as the Designated Operational Entities (DOE), the Designated National Authority (DNA) of each country and other CDM professionals. On the survey design, the CDM professionals were asked to rate the demand for CDM measures, constraints and propositions for diverse measures of the CDM measures approach connected to the Construction and Built Environment (C&BE) industry, using a five-level Likert scale. As results, the larger part of the CDM professionals (95%) were absolutely agree about the high potential of the utilisation of the CDM energy efficiency approach and 83% of them praised the fossil fuel switch approach in the C&BE industry. The CDM professionals suggested also a well-developed database of baseline data. Focusing on the construction and building environment industry, the authors suggested an amelioration of policy measures such as the sharing of baseline information, a widespread baseline data setup, awareness and training which will provide extensive co-benefits to the nation in the long term (Mok, Han, & Choi, 2013). With panel data, Huang and Barker (2009) evaluate, empirically, 34 CDM projects host countries, if they fulfil their sustainable development goal, over 1990-2007. Especially, it is evaluated whether CDM projects lead to CO_2 abatement. While controlling specific effects of the different countries, the authors examine the short-run and long-run dynamics of CDM project evolution through an Environmental Kuznets Curve framework. This research used the pooled mean group method to identify a shared long-run effect for CDM projects, while admitting for short-run dynamics to vary across countries (important heterogeneity is allowed across countries). The explanatory variable is the logarithm of CO_2 emissions per capita (from fuel combustion, energy sector, households and manufacturing industries), symbolized by CO_2. A dummy variable for the CDM, denoted CDM represents the independent variable. This dummy variable is equal to 1 if a country has a CDM project in the pipeline in a year and in all the next years, and 0 if not.

The log GDP per capita and its squared are included in the Environmental Kuznets Curve ‘s variables (carbon emissions and economic development). The OLS method (taking into account the country effects, time effects, GDP per capita in log and GDP per capita per log squared) is used for the estimation (Huang & Barker, 2009). It is then observed that CO_2 emissions, distinctly, move upwards in selected countries before they have CDM projects in the pipeline. However, an econometric analysis gave stronger evidence. It is supposed that CDM projects and CO_2 emissions are linked by an unrestricted autoregressive distributed lag (ARDL) systems and the within group (WG), mean group (MG) and pooled mean group

(PMG) approaches are applied and compared. The PMG estimations show, at 1% significance level, that CDM projects abate CO_2 emissions from either energy sector or manufacturing industries and 10% level from agriculture and households. The significant impact of income on CO_2 emissions is also proved.

The MG indicates a positive effect of CDM on CO_2 emissions when a time trend is admitted and a negative effect if there is no time trend. It is also confirmed by the PMG that CO_2 abatements are linked with CDM projects and the Environmental Kuznets Curve can be observed (Huang & Barker, 2009). In short, it is found that CDM projects could lead to CO_2 emissions reductions in the long-run and could also help developing countries achieving their sustainable development aim. For income impact on CO_2 emissions, the WG and PMG results acknowledge an EKC hypothesis while the MG results do not acknowledge it. In 2003, cases studies were conducted by Sutter in South Africa (electricity generation projects) and India (a biomass power project). The survey participants are: government, academia, NGO and business. Teachers at the elementary school completed the survey by filling questionnaires. As results, the preference aggregation (direct weighting method) is done through the arithmetical average of all the participants. Direct employment generation (11.3%) was the highest priority given the participants, the improved service availability and capacity development (social criteria) follows it. With a priority of 9.7%, the local water quality criterion is the fourth preference. Fossil energy resources and microeconomic efficiency, with a weight of 5.7%, are at the bottom. 65% of the participants estimate the aim of local sustainable development to be more important than the objective of climate change mitigation while 15% indicate the contrary.

Three electricity generation projects are assessed. When comparing the first project (energy efficiency) results with the baseline, there is no negative impact of the sustainability criteria. Social and environmental indicators show similarity with the reference scenario. Three of the four economic criteria (microeconomic efficiency, regional economy and technology transfer) reveal the highest utility of 1. The employment generation criteria show a slight increase of job creation (1.3 additional man-months /1000 CERs), which is almost equal to the baseline (utility 0). For the project 2 (methane capturing), a global good assessment is obtained but negative impacts are fund in two criteria: it would not be financially viable even with expected CERs revenues of 4 Euro/ CER. The low price of electricity in South Africa is one reason of that and compared to the baseline, the air pollutants emissions will increase (2.9 Kg NO_2 respectively 11kg CO per ton of CO_2 abatements. For a revenue of 4 Euros CER, the

project is financially viable with an IRR of 30%. So, the strongest benefits of the project seem to be economical. It is also found that the project contributes to decrease the land pressure since it substitutes coal-based electricity for the use of landfill gas for electricity production. The weighted utilities are summed up to get the global utility of the project. All projects have total utility scoring between 0.28 and 0.36 (the applied utility is measured on a scale from -1 to 1).

In India, the survey participants are: government's representatives (senior officers, nodal agencies for renewable energy projects), ministries which are involved in the CDM process (ministries of environment and forests), ministries of electricity, business participants selected between projects developers and consultants. Consequently, the preferences of sustainability of the participants were aggregated in order to make weightings for assessment criteria (arithmetic mean). Most average weightings are between 7% and 9%. Only the criteria of fossil energy resources and employment generation are score above 10% (11.8% for fossil energy resources). The microeconomic efficiency criterion is rated as less important (6.9%). 54% of all the participants think that the local sustainable development objective is more crucial than mitigation's objective. For 39%, the two are equally important and 7% judge the local sustainable development to be less important (Sutter, 2003).

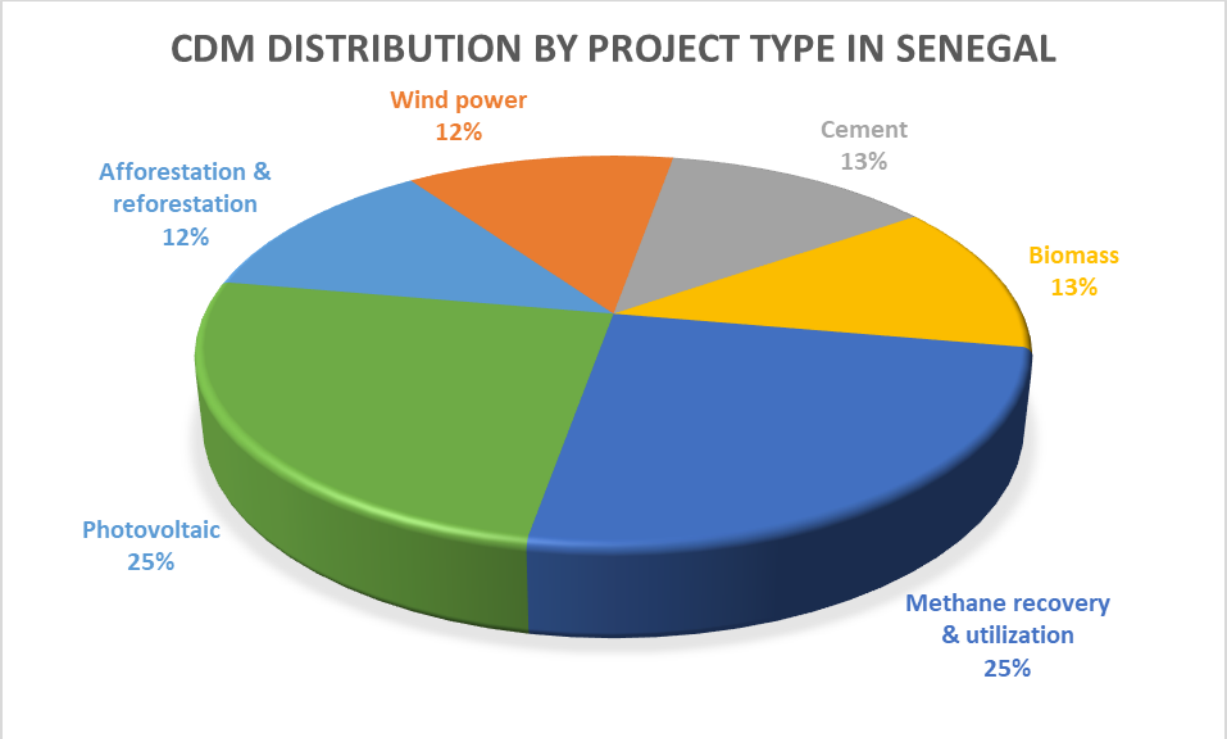
National value, the influence of strong partners, incentive for foreign investments among others could strongly be the factors which influence the acceptance or the refusal of projects. The risk that different host countries rival to attract CDM projects by alleviating the minimum criteria is certain and can lead to what it called the 'race to the bottom' (Nussbaumer, 2009). So, it is up to the host country to clarify a policy that will balance the short term benefits of foreign investment and the long term gains of sustainable development (Nussbaumer, 2009). In addition, Sutter (2003) has also identified three groups of actors which can play an important role in CDM projects sustainability. By the project's design, the project developers can assure a premium quality. In order to avoid reputation risks, the CERs buyers could pay a premium and for the usage of CERs, governments of Annex I countries should set additional sustainable development obligations. Research institutions and NGOs can also, indirectly, play a relevant role as rewarding institutions or try to ensure that projects meet high sustainable development criteria. Another suggestion is done by Kolshus, Vevatne et al. (2001) by underlining the importance of tools to appraise the nature of trade-off and to determine critical indicators. It is also said that international standards should be applied for sustainable development rather than to leave to the host countries to carry out. For Huang and Barker (2009), developing countries' governments have to improve the quality of institutions

and develop favourable policies to stimulate projects' productivity, principally at their early stage of development. Governments can also base on their international exchanges of experience and network to reinforce their capacity and accumulate beneficial information on other countries' CDM plans.

However, another crucial indicator of sustainable development is employment creation, which is a real concern in African countries. Employment impact is a fundamental indicator of Sustainable Development. There is a unanimity about the fact that job creation is more intensive with renewable energy technology than fossil fuels (Simas & Pacca, 2014).
In 2015, the renewable energy sector employs directly and indirectly 8.1 million people. Solar photovoltaic system was the largest jobs generator with a total of 2,772 followed by liquid biofuels with 1,678 jobs, the wind energy technology with 1,081 jobs, etc. China was the bigger solar PV employer with 1.7 million employments in 2015 owed to its acknowledged lead in installations and manufacturing (IRENA, 2016). Africa has an important undeveloped potential for the expansion of renewable energy and has testified several interesting developments, influencing jobs creation. Egypt and Morocco have a manufacturing base while developing also wind farms. About the employment opportunities in off-grid solar PV, the MKOPA Company as created more than 700 fulltime jobs along with 1,500 sales representatives in Kenya, Uganda and the united republic of Tanzania. In Sub-Saharan Africa, the Foundation Rural Energy Service Company has created 342 full-time jobs in countries like Mali, South Africa, Burkina Faso, Uganda and Guinea Bissau (IRENA, 2016). Simas & Pacca (2014) have tried to address issues from previous studies on jobs creation by Renewable Energy Technology (RET) by developing an index for employment assessment based on production instead of installed capacity. The authors have computed both direct employment in production (or manufacture), construction, operation and management; and indirect jobs in the upstream supply chains of physical substances and inputs to manufacture of wind turbines and making of wind farms. The number of jobs generated in Brazil due to wind power development from 2010 to 2017 is evaluated. Dealing with wind power CDM projects which are already installed up till 2013, the created jobs are estimated to be of 170 thousand persons-year equivalent (Simas & Pacca, 2014). The applied method, in comparison with familiar approach to estimate the created employment through renewable energy technology, is focus on production capacity in place of installed capacity. So, the computation of created employment is done in three steps: the life cycle perspective, data collection from reviews and interviews and construction of employment indexes (Simas & Pacca, 2014). The

results of this study suggested that the construction stage of projects has the higher potential to create jobs. This outcome is distinct to previous analyses which concluded that manufacturing stages are the most labour intensive. This difference is may be arisen because of the fact that previous studies did not exclude production for exports from their index and they were particularly conducted in equipment exporter countries (Simas & Pacca, 2014). Can the present GHG mitigation policies in the power generation sector bear more jobs to China? (Cai, Wang, Chen, & Wang, 2011). To analyse direct and indirect jobs, both analytical and input-output models are used in order to answer the above research question. The authors set their methodology by beginning to identify the key mitigation policies in China's power generation sector, which are: the replacement of inefficient small generating units with large ones and the development of renewable and new energy. This identification is followed by the definition of employment impacts and the establishment of a reference scenario (it is set as only building up large coal-fired generating units). For the specific cases of mitigation policies, the reference scenario of each policy is: no substitution of small coal-fired generating units, only building up the bigger coal-fired ones, and no growth of renewable and new energy, only building up large coal-fired producing units). To compute the policies' direct jobs impacts, the authors consider that for each scenario, the total of direct jobs changes from 2006 to 2010 and are equal to the total of direct jobs changes produced by each generating unit under the scenario (Nyambura & Nhamo, 2014b). Results shown that, from 2006 to 2009, the mitigation plans in China's power generation as lead to 44 thousand net employments losses but a total of 472 thousand employments is gained. So, Government has to encourage biomass, wind and solar PV technologies in order to guarantee to co-existence of green jobs and economy in China. In 2010, for solar PV generation, each one percent enhancement, there could be 0.68% enhancement in total jobs in China (Cai et al., 2011). An input-output method is also used by Wang and al. (2013) to quantitatively evaluate the employment impact of CDM project in the power sector of China. Based on the power grids where the project is implemented and the projects types, direct and indirect employments generation is computed. Jobs losses are also evaluated. Results shown that CDM projects implementation has caused 99.000 net employments losses but it also created 3.08 million of indirect jobs, where an increase of 2.98 million employment through CDM. Hydro power projects caused the most jobs losses (about 0.89 million loss of employment). This study confirms also that solar energy has the most potential in jobs generation. The highest indirect jobs generation by one GWh is obtained in solar projects (approximately 104 jobs / GWh) (C. Wang, Zhang, Cai, & Xie, 2013).

Figure 5: CDM distribution by project type in Senegal



Source: author, using IGES database

C. Data and method

C.1. Sampling and data collection

2 CDM Project under consideration:

- ✓ **Grid-connected Solar PV project in Bokhol (2016-2023)** for a reduction of 22,641 tonnes of CO2 and a net electricity production of 237, 073 MWh.
- ✓ **Reforestation project/Oceanium project (2008-2037)**: the regarded areas of the project are Sine Saloum regions (Thiés, and Fatick).

The data are collected using questionnaire and checklist. While the questionnaire is used for the selected households, checklist is used for the key informants. The checklist is a guide that would contain a list of guiding questions or headlines to assist interaction with the key informants. The questionnaire on the other hand involves a list of questions, both close and open-ended, that is administered to the households. The advantage of using questionnaire is that enough information can be generated for. These two instruments have been used in most empirical studies for data collection. Among others, the questionnaire includes likert-scale type questions.

Primary data are collected from households and key informants: For households' selection, a two-step sample random sampling is used. Firstly, 7 villages are selected from the two projects under consideration. In the second step, simple random sampling is used to

households from each of the selected village. A total of 102 households are selected in addition to 15 key informants, giving a total sample of 117.

For the solar energy in Bokhol, 4 villages are selected: **Dialawaly, Geume Yalla, Mery and Ngamou Thiélé**. The number of questionnaires by each of these four villages is selected as follows: the weight of population of each village over the total population of Dagana region where the project is implemented.

For the Oceanium forestry project, 3 villages are under consideration: Thiés (Jaol) and Fatick **(Niodior 1 and Niodior 3**). In this case, the number of questionnaires by region is calculated based on the reforestation surface of each region.

These household data are collected from representatives of villages (village chiefs or their representatives) as well as the households within the close are on influence of the two projects.

The key informants are selected using purposive sampling. The use of purposive sampling is based on the fact that the researcher believes that enough information can be obtained from informants. Data from key informants are gathering from government officials, the Senegalese Designated National Authority (DNA), business participants, projects developers and consultants.

The justification of our sample size is that the type of assessment we are intending to conduct is a 'Needs assessment', different from a process evaluation and an impact evaluation. A needs assessment is an effective mechanism to identify problems and clarify appropriates solutions. It allows to identify the gap between what is and what should be. In addition, the questionnaire contains principally qualitative questions. It is said that there are no specific rules when determining a correct sample size in qualitative research. Some researchers suggest 30 to 50 participants while others suggest only 20 to 30 (Morse, 1994; Creswell, 1998).

Projects under consideration:

Grid-connected Solar PV project in Bokhol (2016-2023) for a reduction of 22,641 tonnes of CO2 and a net electricity production of 237, 073 MWh. This project involves the construction and operation of a solar photovoltaic plant of 20.03 MWp in Bokhol department of Dagana, region of Saint Louis, Senegal. The solar power plant covers an area of 50 hectares and is equipped with 77,040 modules of 260 Wp each. It is connected to the national grid. 4 villages are randomly selected in Bokhol.

Reforestation project (2008-2037): The Sine Saloum constitutes the regarded areas of this project (Thiés and Fatick regions). 1 village is randomly selected in the region of Thiés and 2 villages in Fatick regions.

C.2. Method

Because of the holistic sense of sustainable development concept (ecological, economic and social dimension), the sustainability assessment would take into account the spatial and temporal system boundaries. To measure a project's contribution to sustainability, four requirements are needed: adjustable in regards to preference, relative measurements, valid results and a comprehensive approach.

Several methods exist for sustainable development assessment. For exemple Fichtner, Graehl et al. (2002), Anagnostopoulos, Flamos et al. (2004) have developed approaches especially oriented towards CDM projects in energy sector. Checklists and multi-criteria measurements or a mix of the two were common reference approaches by several authors. Others have used cost-effective analysis, cost-benefit analysis, ranking methodologies, guidelines and negotiated targets. Factor AG, the Prototype Carbon Fund (PCF), the sector specific ranking by WRI and Teri India are multi-criteria approaches which are used in some studies (Sutter, 2003). The SouthSouthNorth (SSN) matrix tool is an example of checklists and multi-criteria combination. The SSN matrix is based on a scoring system, where qualitative appraises are affected to each criterion based on chosen quantifiable indicators. Somewhat simple to use, this tool is limited to **subjectively assigned scores**. In addition to the conditions of positive benefits applying the sustainability assessment tool selected from the SSN matrix, an accurate public participation and an environmental impact analysis must be performed (Karen, Olsen, Risø, 2005). The Gold Standard approach proposes a tool for project developers which allow to ensure the delivery of credible projects with real benefits to the host country. This approach claims to represent the best-practice benchmark for CDM. The Community Development Carbon Fund (CDCF) endeavour to boost broad sustainable development benefits as seeking to reduce the uneven projects distribution. The CDCF furnishes to project developers' premium prices for projects bearing demonstrable community benefits. Sutter (2003) have tried to improve the existing SD tools by proposing the MATA-CDM, a multi-criteria approach.

The multi-criteria approach inspired Pechak et al., analysis in 2011 since the sustainable development is naturally multi-dimensional. MATA-CDM is also applied by the Designated National Authority (DNA) of Uruguay to assess CDM projects and decide on if they contribute to Sustainable Development and give their approval or not (Patrick Nussbaumer, 2009). The Multi-Attributive Assessment of CDM (MATA-CDM), proposes a set of criteria and a utility function is designated for each criterion and the principle is: the maximum utility

serves as the benchmark best-practice. It is important to notice that **trade-off exists between the different criteria** (bad performances are compensated by good performances).

Theoretically, the Multi-Attributive Utility Theory (MAUT) frames the MATA-CDM. Based on the utility theory, the Multi-Attributive Utility Theory (MAUT) approach can combine qualitative and quantitative data (De Montis et al 2000b cited by Sutter, 2003). Attaining a conjoint measure of each action's utility of a set of alternatives is the purpose of the MAUT. For that, the overall utility or (attractiveness) of each alternative is disintegrated into several attributes (criteria which allow to evaluate each decision alternative). **Then, the criteria's trade-offs are measured as importance weights or other scaling factors**. And lastly, to aggregate the single-criteria evaluations, formal models are employed and the ratings are composed in a one-dimensional utility measure.

In partnership, MATA-CDM has been developed by the Swiss Federal Institute of Technology (SFIT) in 2002. During an e-conference organized, the sustainability criteria were developed in teamwork with the International Emission Trading Association (IETA) and the World Business Council for Sustainable Development (WBCSD). This methodology was firstly applied in Pretoria (South Africa) and Uruguay by Sutter in 2003. He also applied it in 2007 with Carlos Parreno to analyse if the current registered CDM projects deliver sustainable development as claimed. Fundamentally there are two challenges in the application of MAUT to CDM projects. Firstly, the possibility to integrate qualitative and quantitative information in order to evaluate a project without harmonizing the proposal to other concrete projects. Secondly, the difficulty of aggregating the results of several criteria to a global utility of the CDM project. MATA-CDM deals with these challenges as follow:

All the evaluation results are changed into a single utility value (u) comprised between -1 and +1 and absolute utility functions are used for that. By using an additive model, MATA-CDM aggregates the results of the different criteria. This additive model estimates an overall utility (U) of the project between -1 and +1. The project has a net positive effect on sustainable development (compare to the baseline) when aggregated value is positive and otherwise when the value is negative.

The analyser can also formalize some restrictive criteria within which a special threshold has to be achieved (for instance only a positive utility). Projects which do not achieve restrictive criteria thresholds will fail the sustainability assessment. From the above description, the application of MATA-CDM can be summarised into five steps as follows:

1. Sustainability criteria identification

There is not an absolute set of criteria. They are to be identify by the project evaluator base on the country's particularity. In our analysis, the MATA-CDM approaches and the SSN matrix too are combined, with the reality of the country to define the most relevant criteria for our analysis.

2. Indicators definition:

2. a. Indicators specifications

Each criterion is computed by clearly defined and evaluable indicator.

2. b. Indicators' utility functions

$$U(P) = \sum_{i=1}^{n} W_i \, U_i[C_i(P)]$$

U : Global utility

P : CDM project

W_i: Criteria i weighting

U_i: Single utility of criteria i

C_i: Sustainability Criteria i

3. The criteria weighting

4. CDM project evaluation

5. Results aggregation and interpretation

The sustainability criteria are classified in social, economic and environmental sub-goals.

During the survey, it is asked to each respondent to classify each criterion as highly increase, increase, unchanged, decrease or highly decrease, with the implementation of the project compared to the scenario without the project. A utility of '1' is assigned to the response highly increase, '0.5' is assigned to the response increase, '0' to unchanged, '-0.5' to decrease and

'-1' to the response highly decrease.

Table 7: Retained SD indicators

Criteria	Category	Measurement/Indicator
	Local environment	
		Net reduction of GHG emissions

GHG reduction	Quantitative	measures in CO2 equivalent
Water quantity and quality	Semi-quantitative	Water quantity: number of people with access to water supply in comparison with the baseline. Water quality: concentration of main pollutants in any effluents created by the project activity and their contribution, if any, to local water quality.
Local air quality	Semi-quantitative	Air quality change in comparison with the baseline (qualitative judgments)
Health	Qualitative	Qualitative appreciation of Population's health compared to the baseline
Soil conditions	Qualitative	Erosion and soil pollution
Biodiversity (species and Habitat conservation)	Semi-quantitative	Destruction or alteration of natural habitat and species compared to the baseline. An improvement will be showed by previously disappeared species recolonizing the area. A negative change will be given to the disappearance of species or by foreign species introduction. A key impact to consider is the inputs gained by the local communities.
Fossil energy resources	Semi-quantitative	Reduction of fossil energy use (in MWh) compared to the baseline
	Social Sustainability	
Employment quality	Qualitative	highly or poorly qualified, temporary or permanent jobs compare with no project scenario
Livelihoods of the poor	Semi-quantitative	*Poverty alleviation:* change in income compare to the BAU. *Distributional equity*: Changes in income and improved opportunities particularly in excluded or marginal social groups. This indicator combines qualitative (improved opportunities) and quantitative evaluation (changes in estimated

		earned income) *Access to services*: health, education, access to facilities, etc. as social sustainability estimated by the access improvement in comparison with no project scenario. Access has to be directly related to the service and not a spin off. *Access to energy services*: the clean energy access should be improved in poor and rural areas through CDM projects. So, coverage of reliable and affordable clean energy services, security and energy supply are considered here. *Human and institutional capacity*: This indicator allows measuring the contribution of the project to bring the local communities to participate in economic and social development. It comprises three sub-indicators: <u>Empowerment</u>: Project contribution to empowerment, access of local people to and their participation in community institutions and decision-making processes. <u>Education / skills</u>: impact of the project on education (through more widespread education) and knowledge (skills) in the community <u>Gender equity</u>: improvement in empowerment, education/skills and livelihoods of women.
Economic and Technological Development		
Job creation	Quantitative	Monthly employment generation per GHG reduction as an economic sustainability, compared to the baseline
Land access	Quantitative	Land loss or land restoration

		compared to the baseline
Balance of payments	Quantitative	With a CDM project, net foreign currency savings may be noted through, for instance, a reduction of fossil fuel imports. Any change on the balance of payments of the hosted country has to be compared with the baseline.
Technology self-reliance (Replicability, hard currency, liability, skills development, technology transfer)	Semi-qualitative	When CDM projects induces a reduction of foreign expenditure through a greater contribution of domestically produced equipment, royalty payments and license fees, imported technical assistance should decrease in comparison with the baseline. Quantitative appreciation about technology improvement (new sills) compared to the baseline.
Microeconomic efficiency	Quantitative	Internal Rate of Return (IRR)
Regional economy	Semi-quantitative	Economic performance of the project zone

Adopted from Sutter (2003)

D. Results

Table 8: Data summary, demographic characteristics of the respondents/frequency

Variables	Bokhol Project	Oceanium Project
Gender		
Male	51	53
Female	49	47
Relationship status		
Single	9.8	9.8
Married	90.2	82.2
Divorced	0	4
Widower/widowed	0	4
Residential status		
Indigenous	100	96.1

Non-indigenous	0	3.9
Education level		
None	78.4	21.5
Primary school	1.9	19.6
Secondary school	0	15.7
Professional training	0	1.9
University	0	1.9
Koranic	15.7	33.3
National language literacy	3.9	5.8
Occupation		
Farmer	29.4	0
Breeder	11.7	0
Housewife	37.2	1.9
Trader	3.9	7.8
Fisherman	0	47
Navigator	0	9.8
Inactive	3.9	0
Others	13.7	33.3
Have you heard the carbon market?		
YES	0	1.96
NO	100	98.04

Source: Author

Criteria weighting

All the indicators are measured against a baseline (situation without the project).

Utility= (0; 1) absolute utility functions give (-1; 1)

a. Bokhol project

Table 9:Level of information of the respondents on the objectives of Bokhol Project

For you, what is/are the objective (s) of the solar project implementation?

	Number of respondents
Energy production	42
Carbon credit issuance	1
Sustainable development support	1
Others	2

Table 10: Brief assessment of Bokhol project

Criteria	Utility	Explanations
	Environment	
GHG reduction	1	It is estimated in the PDD that 22,641 tonnes/year of CO2 will be reduced by the projects from 2016 to 2023
Water quantity/quality	0.03	All the respondents admit that the project did not change the quality of the water. It is also mentioned that, in addition to wells, the project promoters' have installed drinking water sources for the population.
Local air quality	0	The calculated utility is equal to zero. The project does not have influence on the local air quality. The impacts on air quality can then been seen as those of the baseline scenario
Health	0	With the implementation of the project, no change is noted on the health side. The impacts are the same as those of the BAU. The population continues to uses their usual energy sources: woods, coal
Soil conditions	-0.01	Amongst the 4 considered criteria to analyse the soil quality (soil contamination, acidification, erosion and desertification), erosion and desertification were mainly mentioned by few respondents as occurred soil problem
Biodiversity (species and Habitat conservation)	-0.02	The project has implied some biodiversity loss
Reduction of Fossil energy use	1	In the BAU, the 20.03 Mega-watt peak (MWp) of electricity generated by the project would have been generated by fossil fuels. Senegal uses more than 35% of its foreign exchange earnings for imports. The solar project participates to self-sufficiency of Senegal in

		energy. On average, for each CER, 3.42 Mega-Watt hour (MWh) of fossil fuel use is avoided. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf The project will allow to produce 33,868 MWh of electricity per year during 7 year

Social Sustainability

Employment quality (labour standards achievement)	0	Most respondents state that the generated jobs of the project require unskilled labour. Recruits are usually guards, sweepers, etc.
Livelihoods of the poor	0.23	little social assistance (school and mosque under construction) and exclusion (loss of agricultural lands) are noted. Respondents have also underlined a kind a gender empowerment with the implementation of a shelling machine by the projects developers.
Land access	-0.60	78.4% of the respondents declare that there is a loss of agricultural land with the project implementation

Economic and Technological Development

Employment generation	0.35	According to the respondents, the project does not allow employment opportunities as it was mentioned in the PDD. Very little unqualified jobs are generated by the project.
Balance of payments	0.019[2]	The avoided import of fossil products has a positive effect on the balance of payments
Technology self-reliance (Replicability, hard currency, liability, skills development, technology transfer)	0	No technology transfer is noted
Regional economy	0.009	A very little change is noted for the regional economy

b. Oceanium project

[2] 2014 data from the Word Bank are used to compute this value. Energy consumption in Senegal in 2014 is firstly calculated by multiplying the energy consumption per capital with the population (0.2235 MWh*14.55 millions). Secondly the energy import by Senegal is calculated using the energy consumption and percentage of energy import in the same year. And finally, the yearly energy produced by the project is divided by the annual energy import to obtained the value of 0.019.

Table 11: Level of information of the respondents on the objectives of Oceanium project

For you, what is /are the objective(s) of the mangrove's reforestation?

	Number of respondents
Forest restoration	7
Biodiversity restoration	6
Land restoration	3
Carbon credit	1
Support for sustainable development	1
Sources of revenues	14
Others (fishing, honey picking, livelihoods)	36

Table 12: Brief assessment of Oceanium project (calculated values)

	Utility	Explanations
Environment		
GHG reduction	1	2,704.43 net annual anthropogenic GHG removals by sinks (tonnes of CO2) from 2008 to 2037 is estimated in the PDD
Water quantity/quality	0.001	The reforestation has little effects on water quality and quantity. Some respondents said that the mangroves 'plantations have reduced their fishing space.
Local air quality	0.647	The planting mangroves have an important effect on local air quality
Health	0.617	As the local air quality, the forestry project has an important effect on the population's health.
Soil conditions	0.059	The local soil quality is improved by the project
Biodiversity (species and Habitat conservation)	0.529	According to the respondents, the mangroves planting has allowed the conservation and the re-colonization of new species in the area. The appearance of new seafood is noted by the fishers.
Reduction of Fossil energy use	-0.052	The use of fossil energy (mainly wood) is increased with the project implementation. In fact, the dead wood from the mangroves are used as energy or sold by the population.
Social Sustainability		
Employment quality (labour standards achievement)	0	There is no qualification of the jobs created by the project
Livelihoods of the poor	0.5	In one hand, the project has positive effects on livelihoods criteria like poverty alleviation, access to services, new opportunities, women empowerment, social assistance, etc. In the other hand, some respondents assume that their revenues have decreased with the project implementation. They used to cut the mangroves

		for sale in Mauritania or the Gambia and it is now forbidden because of the project.
Land access	0.137	The project has a positive utility on land access since most of the planted areas were lost lands before the project implementation.
Economic and Technological Development		
Employment generation	0.88	the project generates employments. More dead woods are available for sale and the fishers (47.06%) of our sample) get more products for sale.
Balance of payments	0	The project has no effect on the balance of payments
Technology self-reliance (Replicability, hard currency, liability, skills development, technology transfer)	0.196	Little technology transfer is noted through new planting techniques, seafood processing and preserving
Regional economy	0.544	The forest reforestation allowed an improvement of the regional economy

Table 13: Ranking of the weighted criteria

Rank	Weighting (%)	Criteria
1	12.2	Livelihoods of the poor
2	11.6	GHG reduction
3	10.4	Reduction of fossil energy use
4	9.4	Employment generation
5	8.4	Biodiversity protection
6	8.4	Technology transfer
7	7.4	Health
8	7	Air quality
9	6.8	Employment quality
10	5.6	Soil quality
11	5.1	Water quality
12	4.1	Balance of payments
13	3.1	Land access

Source: Author

The purpose of the criteria weighting is to express the relative importance of each indicator or criteria. The participants of the ranking are a sample of a very restricted group. They are all, directly or indirectly involved in CDM matter. The different participants are from governmental sector (DEEC, FONSIS, ASER, COMNACC, and PAPEM), inter-governmental sector (CILSS) and member of CDM executive board (AEE/Africa Energy Environment). The participants are asked to rank the 13 criteria from 1 to 13 in order of

importance as CDM benefits for West African countries and particularly for Senegal based on their personal point of view. For each participant, we assigned 1 point for the last ranked criterion, 2 points for the next to last criterion and so one. All the points are aggregated for each criterion and a percentage is calculated for each criterion.

The highest score (12.2%) is assigned to the criteria livelihoods for the poor followed by the criteria GHG reduction with a score of 11.6%. the smallest scores are given to the criteria balance of payments (4.1%) and land access (3.1%).

All these participants have a negative appreciation of the actual situation of CDM in general and in Senegal in particular. The problems that are usually mentioned are, between others, the low demand for CERs involving a very low price of CERs, the high costs of CDM implementation, sometimes associated with quite small results to be expected, constraints of human capacities in CDM domain, the weak economy of West African countries which does not allow sub regional projects (large scale-projects).

The participants gave also their point of view on the participation of CDM projects on sustainable development (local environment, social and economic development). While some think simply that there is no impact on local environment and very little impact on social development and local economy, some others think that the contribution of CDM projects on local sustainable development depends on the type of projects. Forest projects can play an important role on the local environment. Small projects (mini-grids, improved stoves, solar central), projects for CO2 sequestration or avoidance have some kind of impact on sustainable development. Solar projects have more interesting impact on local economy and large solar central or hydroelectric projects are not very profitable for developing countries. Some others, like some international researchers on carbon market, said that the positive impact of CDM impact on sustainable development exists only in theory. In really there is no impact.

However, 57% of the respondents suppose that energy projects are more profitable for developing countries and only 28% of them think that forestry projects are better.

It is then recommended that African countries like Senegal have to analyse whether the CDM projects have effectively a positive impact on sustainable development before their implementation. The international actors have a great role to play in order to make the carbon market more active. Indeed, they have to increase their ambition and should increase their commitment of CO2 reduction. International entities also like UNFCCC are key to address the issue of making the mechanism less elitist by simplifying the processes. Local actors also

(government, private sector, DNA, DOEs) are major actors for CDM revival in developing countries. Language barrier is also a constraint.

Reinforcing capacity building of local CDM actors in developing is the greatest recommendation gave by the participants for African countries and Senegal to get more advantages in the carbon market.

AND west African countries should train, aware and inform their population (meanly the policy makers and the private sector) as it was the case in Senegal in 2005-2006 where several trainings were organised to inform the population about the carbon market.

Article 6 of the Paris agreement should also be appropriated by developing countries in order to understand the problems of transition between the Kyoto protocol and the Paris agreement and a better understanding of the new mechanisms.

African countries have also to keep registering projects and trying to work with the GCF. Then they should have the willingness to integrate Carbone-finance in their public finance strategies.

About the future of CDM, different points of view are given

- ✓ The future of CDM in African countries will depend on the evolution of their economy.
- ✓ CDM is going to morph into something simpler and there is a lot of value in this.
- ✓ We can be optimistic because of the new mechanisms which are introduced in the Paris Agreement. With the entry of 2 new big players in the formal carbon market (civil aviation and marine navigation (shipping)), the demand of CERs will surely increase. So, Senegal and other African countries need to be prepared and to be well organized in order to grasp more advantage in the market and avoid being left behind once again. Experimental activities can also help these African countries to get more opportunities in the market.
- ✓ The price of the CER has a great role to play in the future of CDM. The price should be higher for more attractiveness. It is why, for a while, the objective of developing countries, in different international conferences, is to have a fixed price of the CERs.
- ✓ The future of the CDM will be shaped by the rules of article 6 of the Paris agreement. This article will play an important role. In line with the Paris agreement, the commitment of all parties is trying to be raised.

Table 14: Evaluation of the projects

		Bokhol project		Oceanium project	
Criteria	**Weightings (%)**	**Utility**	**Weighted utility**	**Utility**	**Weighted utility**
GHG reduction	11.6	1	0.11	1	0.11
Water quality & quantity	5.1	0.03	0.0015	0.001	5.14 E-05
Air quality	7	0	0	0.647	0.045
Health	7.4	0	0	0.617	0.046
Soil quality	5.6	-0.01	-0.0005	0.059	0.0033
Biodiversity	8.4	-0.02	-0.0017	0.529	0.044
Reduction of fossil energy use	10.4	1	0.10	-0.052	-0.0054
Employment quality	6.8	0	0	0	0
Livelihoods	12.2	0.23	0.028	0.5	0.06
Land access	3.1	-0.6	-0.019	0.137	0.004
Employment generation	9.4	0.35	0.033	0.88	0.08
Balance of payments	4.1	0.019	0.00078	0	0
Technology Transfer	8.4	0	0	0.1	0.008
Aggregated utilities			**0.252**		**0.407**
Error (U)			**(+/-) 0.0077**		**(+/-) 0.01**

Source: Author

*0.995 is the weighted utility of the reference (Utility=1 for each criteria). So, 0.995 is the benchmark of our aggregated utilities

Incertitude computation

Since the participants who ranked the criteria represent a part of the whole targeted group, utilities and weightings include errors that can influence the results (the aggregated utilities).

To calculate the errors, the standard deviation of each weighted utility is computed. And the incertitude noted U_x is calculated as follows:

$$U_x^2 = \frac{\sigma^2}{N} = \frac{1}{N.(N-1)} \sum (x_i - \bar{x})^2$$

σ represent the standard deviation and u measures the uncertainty (errors) of our estimations.

D.1. Interpretation of the results

Our analysis of the contribution of CDM on sustainable development in Senegal show that the utility of both projects (solar and forestry) are positive. So, the projects have a net positive effect on sustainable development (compare to the baseline). Nevertheless, the forestry project (Oceanium) is more profitable with a utility of 0.407 than the solar one (Bokhol) which has a global utility of 0.252.

In addition to the capacity of oceanium and Bokhol projects to participate to the reduction of CO2 emissions, the greatest benefits with oceanium project are noted on employment generation, improvement of the livelihoods of the poor and the conservation of the biodiversity; and reduction of fossil fuel use, employment generation and livelihood improvement for Bokhol project. So, the solar and forestry CDM projects are both profitable for employment generation and livelihood enhancement.

The oceanium project has negative impact on one criterion (fossil fuel use) while Bokhol project acts negatively on three different criteria (soil quality, biodiversity conservation and land access). Indeed, the reduction of fossil fuel use criterion is associated with a negative utility for the forestry project since a huge quantity of woods are produced by the mangroves. These woods, which are not sustainable source of energy and are source of CO2 gases are used by the populations as source of energy. The reason why wood is not sustainable is that it has very poor energy density compared to oil and coal for instance. In spite of wood has traditionally been regarded as carbon neutral because the released CO2 could be offset through sequestration due to biomass regrowth, most of the recent researches attributed a global warming potential (GWP) generated by the biomass (biogenic CO2) (Holtsmark, 2015). The negative utility of Bohol on soil quality and biodiversity conservation is explained by the deforestation of the place where the project is implemented. Some vegetation was present in the area of implementation; their destruction has reduced the humidity of the surroundings soils (fields). People also pointed out that the area was as well an area where animals came to graze and where there were some birds. The negativity of the land access

utility is due to the loss of agricultural lands. In fact, 78.4% of the respondents from Bokhol stated a loss of their farms.

The utility associated with employment generation (quality of employment) is equal to zero for both projects, so the jobs created by these projects are no qualified jobs. Bokhol project has no utility on local air quality, the population's health and technology transfer. Oceanium has no utility for the balance of payments. In fact, unlike the Bokhol project, Oceanium did not prevent from import.

D.2. Comparison of the results with the PDDs estimations

The solar project of Bokhol

In the PDD, it is stated that the project will have positive impact on sustainable development through energy security and supply, health improvement, employment opportunities and technology transfer.

As it was mentioned, the project has allowed to improved energy self-sufficiency of Senegal by allowing a production of 237076 MWh of clean energy in a period of 7 years. The project contributes to the energy-mix diversification of Senegal through renewable energy.

For health conditions, the ex-ante analysis shown that health conditions will be improved with the avoided $PM_{2.5}$ NO_X and SO_2 which used to cause negative health effects like lung problems, bronchitis, asthma worsening, respiratory illness and premature death. Despite health being rated by professionals as one of the seven most important criteria this project must meet, people say that they have not noticed any change in their health conditions.

The project will create employment opportunities for technicians and local construction workers, stated the Project's PDD. According to the populations, job creation is the criterion that best meets their expectations with a utility of 0.35. In fact, they confirm that some of the villagers have been able to find a job with the project but the positions are often unqualified and not well paid.

The PDD mentioned that with solar PV technology, skills and advanced technology, the project will assist in capacities building in Senegal.

However, the local population does not feel the technology transfer brought by the project. This can be explained by the fact that the inhabitants of the village have unskilled jobs from the project. The other Senegalese who work in the project as technicians for instance must then be those who benefit from this technology transfer.

Figure 6: Comparison of the projects

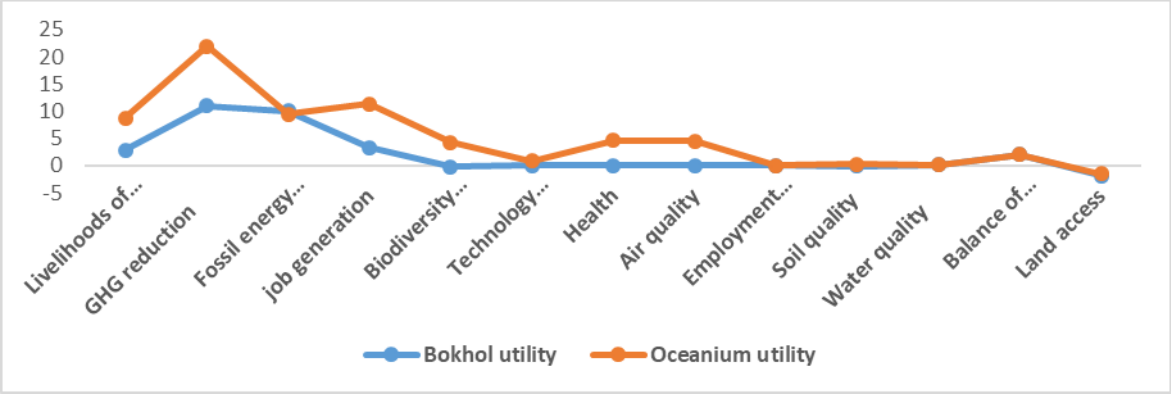
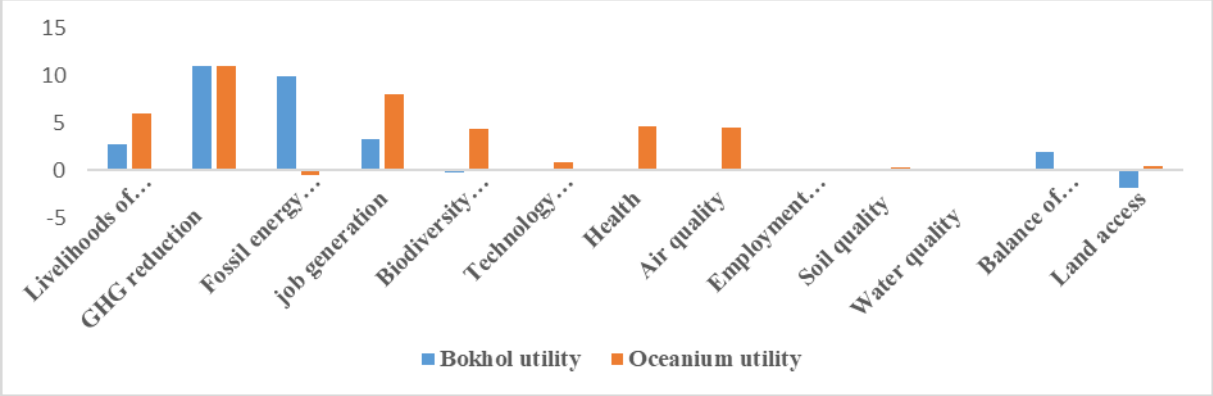
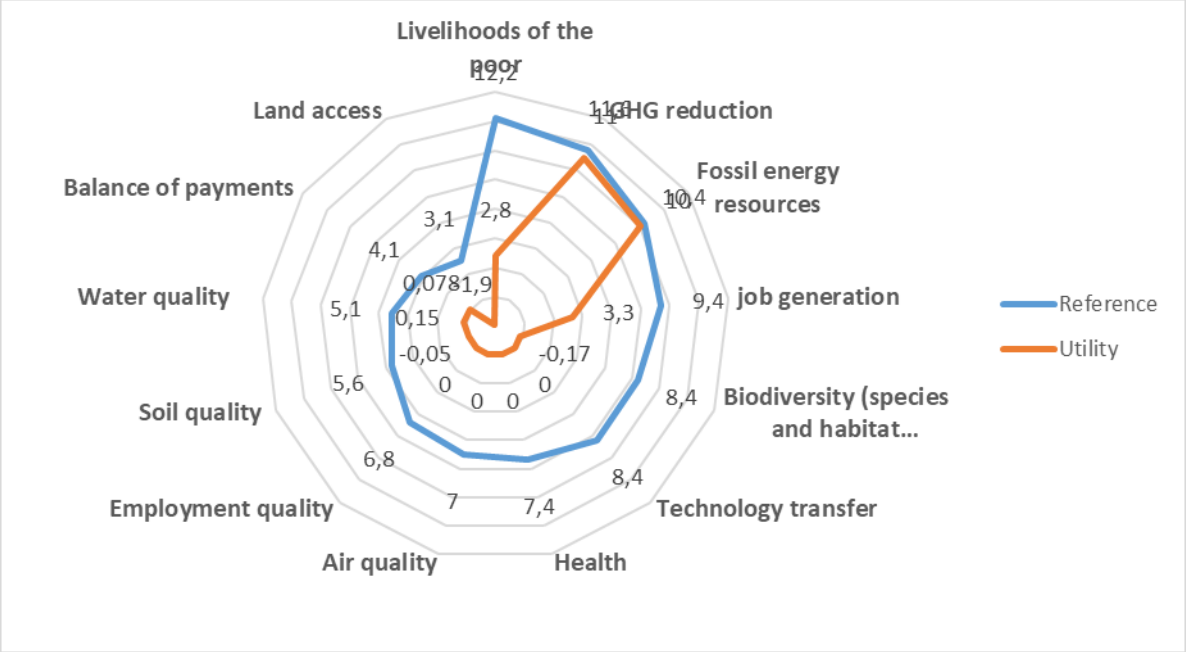


Figure 7: Projects utilities comparison



In these 2 previous graphs, we can see, as it is found with the utility's calculation, that the Oceanium CDM project (forestry project) has more positive impacts on the sustainable development in Senegal than the CDM project in Bokhol (solar energy project).

Figure 8: Bokhol project utility

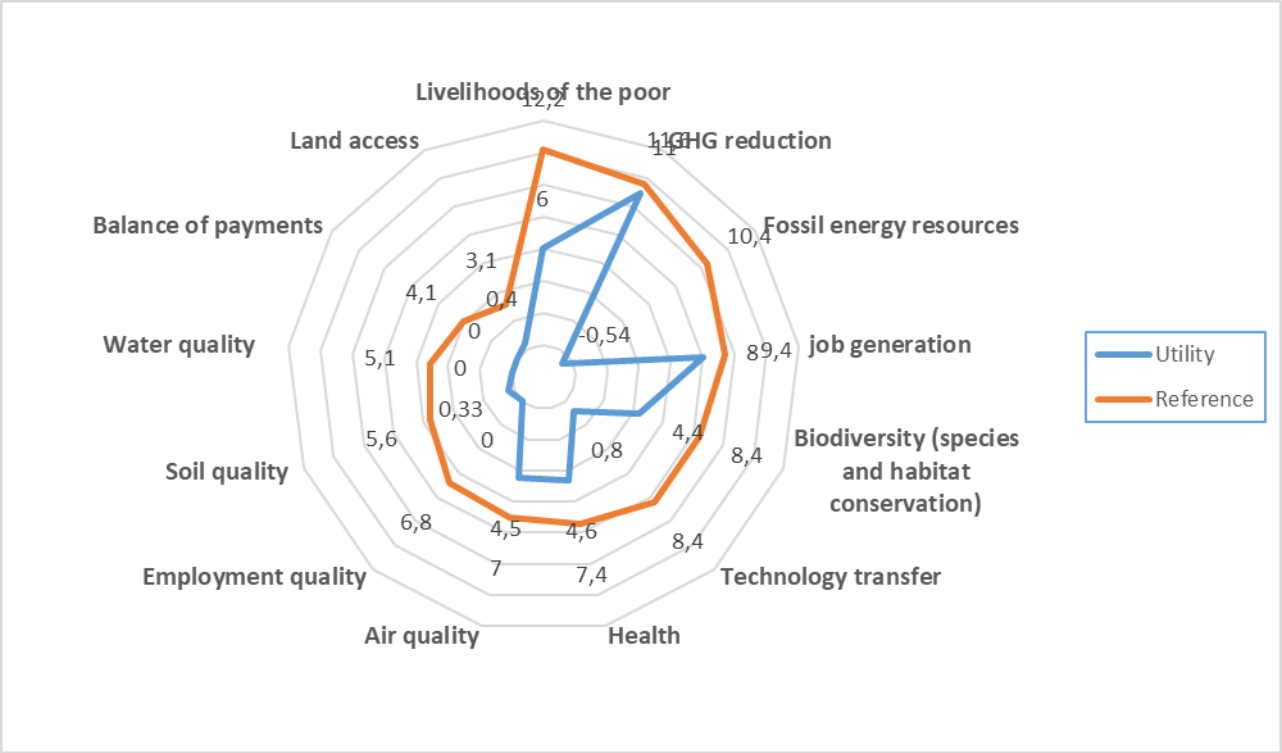


The weighted reference (utility of 1) and the weighted estimated utility are used to draw the radar graphs.

'Livelihoods of the poor' is ranked by the professional respondents as the most important criterion that a CDM project has to satisfy. The maximum value of this indicator at the reference level is equal to 12.2% while the value given by the solar project is only equal to 2.8%. It is only with the criteria 'Reduction of fossil energy use' and GHG reduction that the utility and reference values merge (respectively 10 and 11 against 10.4 and 11.6). Solar energy CDM projects seem to be efficient in GHG reduction and a decline of fossil energy utilization. According to the ranking, the 'land Access' criterion constitutes the less crucial

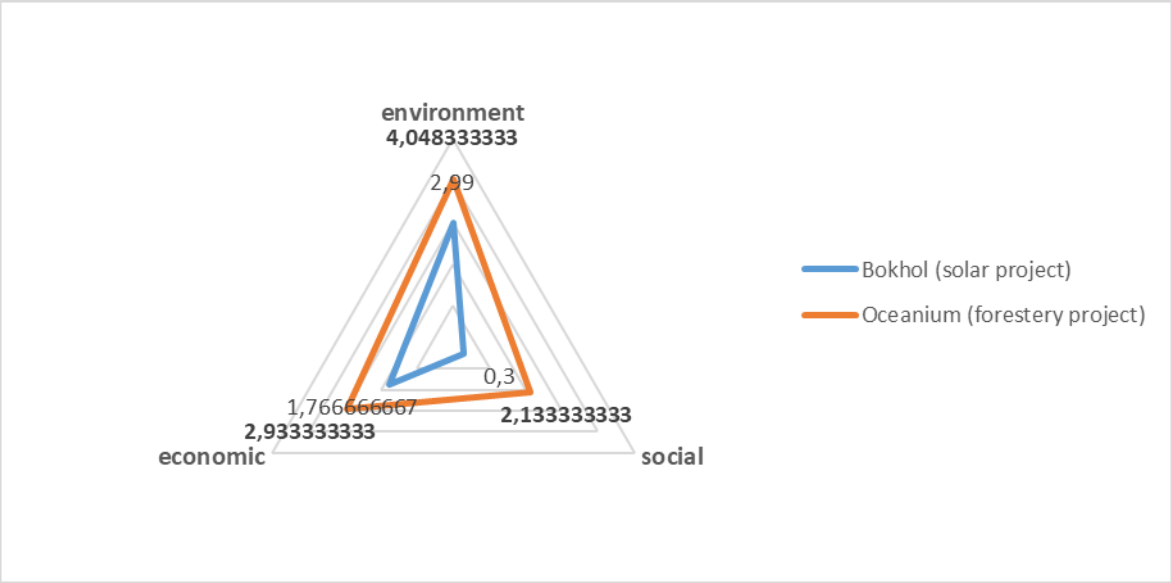
criterion. It is given a weight of 3.1% and the solar project has a negative effect on lad access with a utility of -1.9%.

Figure 9: Oceanium project utility



With the mangrove's reforestation project (oceanium project), only the criterion GHG reduction has reached a similar level of utility at the set reference level (11 against 11.6). 'Job generation' is the criteria which get the highest utility value after GHG reduction criteria. The jobs created by the project (utility of 8) is near to the reference value (9.4). The project has almost the same impact on health and air quality (utilities of 4.6 and 4.5). Reduction of fossil energy use is the unique criteria which has a negative utility. Unlike the solar project, the reforestation project involves an increase in the use of fossil fuels.

Figure 10: Contribution of the projects to local Sustainable Development



For each indicator, the mean of the utilities is considered to draw this figure. Here we can see more clearly the results obtained previously. The reforestation project (oceanium) is more profitable that the solar one (Bokhol) at the environmental level, economic and social. However, these 2 CDM projects have more impact on the environmental indicator, followed the economic one and the impact is less important at the social level.

Conclusion

The Clean Development Mechanism was established by the Kyoto Protocol as a flexible mechanism to help annex 1 countries to meet their emissions reduction commitments while contributing to sustainable development in the CDM host countries. The Clean development mechanism is the only mean to engage developing countries in the carbon market. Due to the lack of studies evaluating the CDM benefits in West Africa, this empirical study assesses the contribution of CDM to sustainable development in Senegal and in West Africa in general, unlike studies that only give theoretical or potential contributions.

Globally, our results showed a positive and slight effect of a solar energy CDM project and a forestry CDM project on sustainable development in Senegal. However, outcomes from the forestry project are greater than those of the solar project. Both projects are favourable for GHG reduction, employment generation and livelihood improvement. The forestry project (oceanium project) has a negative effect on fossil fuel use while the solar project (Bokhol project) has a negative effect on soil quality, biodiversity conservation and land access. Employments generated by the projects are unskilled jobs according to the respondents living near the implementation sites.

The greatest benefit of these projects is noted at the environmental level, followed by the economic level and finally the social level. Yet, at each level, the effect of the reforestation project is greater than the solar project effect.

It then comes out of our analysis that Senegal, like other west African countries must give preference to forestry CDM projects that seem to have more effect on sustainable development. With the large potential of African regions to participate to the carbon market, they should be well prepared by strengthening its local capacity and engaging both public and private sector in CDM projects development and implementation to grasp more benefit from the CDM and to be in the transitional slide from CDM to SDM (Article 6 of the Paris Agreement). Indeed, the Paris agreement tend to better promote carbon market, allowing countries to meet their Intended Nationally Determined Contributions (INDCs). The carbon market participation rules, measurement and enforcement of offset projects will be simplified by the new mechanism, making it more receptive for African countries participation (Bernard, Wang 'ombe, & Kitindi, 2017). However, Governments of WAEMU countries should advantageous policies and improve their institutional quality for more productivity of CDM in West Africa. This can be done through national and international networking and exchange of experience. Countries like Mali, Niger and Burkina Faso can acquire beneficial information

on the CDM programs of Senegal and Cote d'ivoire which have a little more experience on CDM experience.

III. How carbon market interferes with the priorities of WAEMU's countries government? An analysis of the National Determined Contribution (NDCs)

Introduction

In the preparation of the COP21 in December 2015 in Paris, most countries submitted intended nationally determined contributions (INDCs). Once a country ratifies the Paris Agreement, the INDC becomes the country 's NDC – unless the Party determines otherwise. Although Parties can still update their INDCs in light of the adopted Agreement during the ratification process, most INDCs will likely remain unchanged. Article 6 of the Paris agreement plan a use of international market mechanisms to satisfy the Nationally Determined Contributions (NDCs) implementation. (Greiner & Hunzai, 2017). The INDCs constitute presently the best understanding of the climate actions plan to pursue after 2020. Among other things, these INDCs address a set of issues like avoiding climate change, adapting or coping with it (Rogelj et al., 2016). In their different INDCs, WAEMU countries express their desire to continue using CERs delivered by CDM projects and PoAs (Programmes of activities) to accomplish the pre-2020 mitigation goals through national programmes. An option to reach these aims for all countries is to obtain international support from donors (conditional option). However, the carbon market mechanisms will allow WAEMU countries to meet 46.82% of the targeted CO2 emissions reduction. Other emissions reduction actions should be taken by WAEMU countries to offset the remaining of their global emissions reduction targets as pointed out in their INDCs. All these actions are expected to be reached with the new mechanism of the Paris Agreement which should fully integrate the CDM pipeline. In fact, the Sustainable Mitigation Mechanism (SMM) constitutes the new mechanism in the Paris agreement. It is also designated in the Paris Agreement that this new mechanism should be established on 'Experience gained with and lessons learned from existing mechanisms and approaches under the Convention and its related legal instruments. In other words, The Kyoto mechanisms like the CDM are to serve as the foundation for the new SMM. The architecture of the SMM should also be built from the governance framework of the CDM (Olsen, Arens, & Mersmann, 2018).

A. What is a Nationally Determined Contribution (NDC)?

Intended Nationally Determined Contributions (INDCs) establish the post-2020 intentional national climate goals likewise as mitigation and adaptation, that countries committed to and which will become a binding Nationally Determined Contributions (NDC) when a country ratifies the Paris Agreement (World Bank, 2016). INDCs represent both the means of implementing countries' ambitions and the outcome to be achieved, which makes understanding sometimes difficult. Overall, contributions take three forms:

-Economy-wide emission reduction targets: quantified, in the more or less long term, expressed as a function of a base year, a scenario or GDP. This type of contribution would mainly concern developed countries.

-Policies and actions covering the whole economy, with an overall result: by for example, an intensity target that defines emission targets per unit of GDP or per capita. This type of contribution would mainly concern emerging countries.

-Actions or policies by sectors and sectors, with an estimate of limitations or emission reductions compared to a reference scenario: this would mainly concern developing countries (Botoni & all., 2015).

Each country which has formally joint the Paris Agreement by submitting an instrument of ratification, acceptance and agreement got its INDC converted to a Nationally Determined Contributions (NDC), unless this country decides otherwise. NDCs characterize countries' efforts to achieve the long-term temperature goal of the Paris Agreement or limiting warming below 2°C with efforts to stay below 1.5°C. Parties to the Paris agreement can communicate or update their NDCs by 2020 and continue to do so every five years. While countries ratify the Paris Agreement, some have decided to revise their INDCs and share the modifications as part of their first NDCs. Yet, 15 (including Mali and Benin) of the 185 (out of 197) countries that have communicated their NDC offered a program which differ from their INDC, they are not waiting until 2020 to make changes to their national climate engagements (Ge M. and Kelly L., 2018).

B. How carbon market is addressed in WAEMU countries' Intended Nationally Determined Contributions (INDC)?

Across the board, WAEMU countries like most African countries, have not furnished much detail on their intentions to use market mechanisms in achieving the purpose of their INDCs.

In fact, except Mali and Senegal, by ratifying the Paris agreement, all the WAEMU countries acknowledged that their INDC will become their NDC with more ameliorations. In their NDCs, WAEMU countries relate to a reduction in projected emissions compared to the business as usual (BAU) and are not economy wide. Another characteristic is the fact that they all have a conditional option which will be carried out in condition to get an international support. Each of the considered country have addressed the market mechanisms uses (CDM) in their NDC as follows:

Senegal: «*The Senegalese government do not have the intention to purchase emissions reduction units from any existing or future market mechanism. Nevertheless, Senegal will be a host country for any international climate mechanism which meet its sustainable development goals. In addition, Senegal supports the continuation of the Clean Development Mechanism (CDM) established under the Kyoto Protocol and its continuation in a form to be defined in the new agreement." Elements of the INDC that are conditional, with international assistance, could include projects that are registered under non-market mechanisms established under the convention*. » (République du Senegal, 2015)

Burkina Faso: « *supports the use of market mechanisms such as the Clean Development Mechanism (CDM) as an effective monitoring, reporting and verification (MRV) tool for mitigation activities and an instrument for results-oriented financing. Thus, Burkina Faso supports the use of certified emission reduction units (CER's) delivered by CDM project, programmes and activities to reach the pre-2020 mitigation goals. Hence, payments for carbon such as to make this economically viable in the specific context of the less advanced countries, the developing countries and the small developing island states is a priority. To do this, the establishment of new accounting rules within the framework of the UNFCCC is necessary to guarantee the environmental integrity of market mechanisms and avoid double counting. These accounting rules will also be introduced for the EIF in order to achieve the required financial transparency*» (Republic of Burkina Faso, 2015).

Mali: « *Intends to use the market mechanism (CDM) through improved stoves, Energy valorization, Reforestation, biofuel production and Afforestation. Mali has a portfolio of more than 40 projects for the Clean Development Mechanism (CDM) which reduces potential emissions by 15 million Teq C02 per year*» (République du Mali, 2016)

Niger: «S*upports the mechanisms of the international CO2 market, such as the Clean Development Mechanisms (CDM), but revised to facilitate the access of National*

Development Programmes (NDP) to this financing. For this purpose, it hopes to see a high price for CO2 (US $50 /t) that will permit it to reach the global objective of 2°C. » To obtain the necessary financing, one option would be to request international aid from the donors (the conditional option). Another option would be to attract financing from the private sector to implement the SF-SLM. For this purpose, the communities have the possibility of selling mitigation services on the carbon market. The possible problems with this option are the difficulty of accessing this market and the low level of current prices for carbon credits. Whether the financing is acquired conditionally or unconditionally, follow up actions will be essential to assure efficient use of the funding that is granted. (Republique of Niger, 2015)

Cote d'ivoire: « *Supports the inclusion of international carbon markets such as the Clean Development Mechanism (CDM) in a post-2020 climate agreement and proposes that such an instrument, coupled with an appropriate accounting regime (MRV), can be used to help finance some investments in low carbon and climate resilient infrastructure. Côte d'Ivoire considers that some of the low-carbon development options contained in these INDCs, or additional actions, could be financed in whole or in part by the international transfer of carbon assets taking into account the integrity considerations of the environment and transparency. »Cote d'ivoire will use the market mechanism as source of financing* (République de la Cote d'ivoire, 2016)

Togo: « *In accordance with the declaration of the African Ministers in Marrakesh in April 2015, the country wants to encourage investments in mitigation projects on its own soil, thanks in particular to the Clean Development Mechanism (CDM) and the REDD+ Programme.* » Togo plans to meet most of its INDC's commitment through national programmes (Republic of Togo, 2015)

Guinea-Bissau: «*Project of stored carbon quantification and the carbon sink capacity of forest vegetation in Guinea-Bissau - CARBOVEG-GB (2007-2009) - Monitoring and Reporting, funded by the Portuguese Environment Agency - APA), with the overall objective of contributing to assist the forestry sector of Guinea-Bissau in the emerging carbon market*» (Republic of Guinea-Bissau, 2015)

Benin: «*National resources (public funds and private investments) for the financing of the INDC will be complemented by external financial support (bilateral and multilateral*) (Republic of Benin, 2015». This statement in the NDC of Benin suggests that the country intents to use market mechanisms through external financing.

The analysis of the CDM's explanation in the different NDCs showed that in the market mechanisms, CDM projects constitute an important source of financing in WAEMU countries for the implementation of their INDCs (République du Bénin, 2015).

In Senegal, under the unconditional option (INDC) emissions reductions from their intended path are 3%, 4% and 5% respectively in 2020, 2025 and 2030. With the conditional option (INDC +), reductions expected emissions are of the order of 7%, 15% and 21% over the same years

Figure 11: WAEMU countries profile in the INDCs

Parameters	**WAEMU countries**							
	Benin	**Burkina Faso**	**Cote d'ivoire**	**Guinée-Bissau**	**Mali**	**Niger**	**Senegal**	**Togo**
Commitment period	2021-2030	2015-2030	2016-2030	2020-2030	2015-2030	2015-2030	2016-2035	2020-2030
Prior sectors	**Energy, AFULO**	**Energy, AFOLU, transportation**	**AFULO, energy, waste**	**Forestry, energy**	**Energy, AFULO**	**AFULO, energy,**	**Energy, industry, AFULO, wastes**	**Energy, AFOLU, buildings and cities (human settlements)**
Emissions 2010 (Gg)	9405	38560	21220	876	41970	50700	13800	20445
Émissions 2010 per capita (tonne metric)	0.882	2.13	0.936	0.565	2.89	2.86	1.02	2.87
BAU emissions at 2030 (Gg)	22 500	118 323	34 253		94 074	96 468	36000	34 533
BAU emissions at 2030 (TM) per capita	2.11	6.53	1.51		6.48	5.45	2.66	4.85
GHG Reduction With the implementation of INDC	-16.17%	-18.20%				-38.10%	-26%	-31.14%
	Unconditional : 3.63%	**Unconditionnal :** 6.6%	28.25%	N. A	31.60%	**Unconconditional :** 3.5%	**Unconditional:** 5%	**Unconditional:** 11.14%
	Conditional : 12.55%.	**Conditional :** 11.6%				**Conditional :** 34.6%	**Conditional :**21%	**Conditional:** 20%
Financial needs for mitigation		US $ 1,840,953,571			US $ 34.68 billion	US $7.060 billion	US $ 6.8 Billion	1.1
Financial needs for adaptation				USD 42 million		US $1.607 billion	US $ 14,558 million	1.54
Total Financial Need	US $ 11637.02 millions	US $ 2,363,129,566	US $ 19.788 billions	US $ 700 billions	US $ 34.68 billions	US $8.667 billions	US $ 21.5 billions	US$3.54 billions
Financial Need per year	**US $ 1.293 billion**	**US $ 0.157billion**	**US $ 1.413 billion**	**US $ 70 billion**	**US $ 2.312 billion**	**US $ 0.578 billion**	**US $ 1.131 billion**	**US $ 0.354 billion**
Population of the country	**10,653,654**	**18,110,000**	**22,670,000**	**1,548,159**	**14,500,000**	**17,700,000**	**13,508,715**	**7,121,673**

Sources: adopted from the INDCs and (UEMOA, 2017) and author calculation

Energy and AFULO are the 2 prior sectors used by all WAEMU countries to meet their GHG reduction commitment. In Benin, the envisaged measures are likely to contribute to reducing cumulative GHG emissions (excluding LULUCF) by approximately 49.49 Mt CO2 relative to the BAU scenario (16.17% over the period 2021-2030).

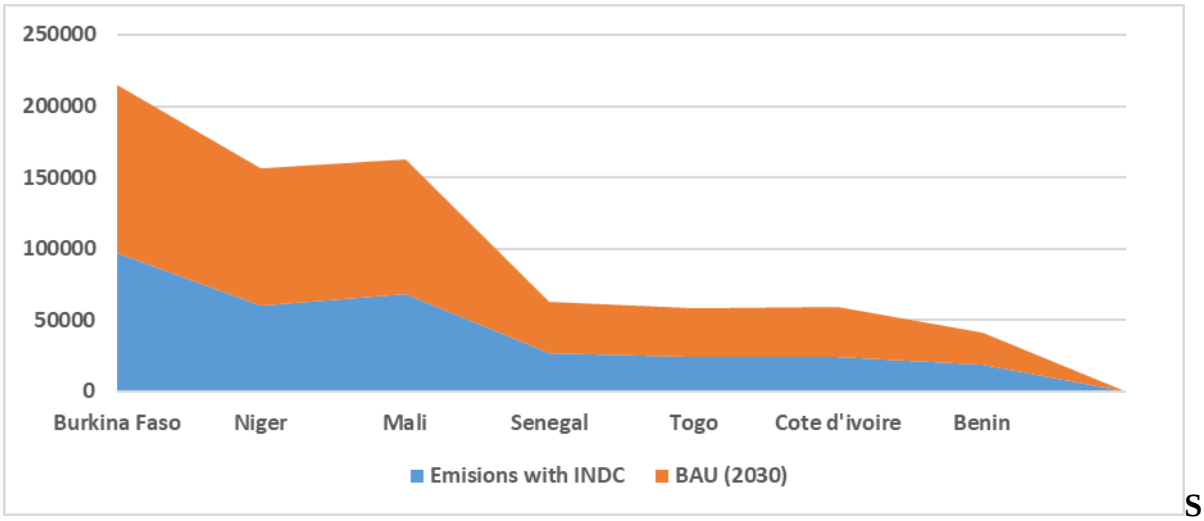
Figure 12:Other carbon market uses in the INDCs

	Benin	Burkina Faso	Cote d'ivoire	Guinea-Bissau	Mali	Niger	Senegal	Togo
Used as MRV	No	yes	yes	yes	No	No	No	No
Financing INDCs and other actions	No	yes	yes	No	No	yes	No	No
Conditional INDC	No	No	No	yes	No	No	No	No
Conditional and unconditional INDC	yes	yes	yes	No	yes	yes	yes	yes

Source: Author

The function of MRV (measurable, reportable and verifiable) is to enhance transparency through the tracking of national GHG emission levels, the pursue of climate finance flows and the impact of mitigation actions. MRV simplifies information sharing and lessons learnt, allow to assess if set targets have been accomplished (Wartmann S. & al., 2013). Only three countries (Burkina Faso, Cote d'ivoire and Guinea-Bissau) planned to use CDM as an MRV tool. Only Guinea Bissau does not have both conditional and unconditional actions for in the INDC, meaning that this country needs external support in order to fulfil its actions mentioned in the INDC. In fact, unconditional actions are implemented without any explicit external support while conditional targets require external support and are more ambitious. It should be noted that Guinea-Bissau has the greatest financial need per year for the NDC's realization and the smallest GDP per capital among the WAEMU countries.

Figure 13: Emissions (Gg) in WAEMU in 2030



Source: Author's compilation

This figure compares the GHG emissions between the Business as usual scenario and the INDCs' scenario in 2030 (end of the INDCs' targets for WAEMU countries, except Senegal). Without INDCs, the total emissions would go beyond 200000 Gg for a country like Burkina Faso. Actions for GHG emissions reduction taken by Burkina Faso in their INDC will allow to reduce the emissions by half (100000Gg). The same phenomenon is observed with the other countries which emit in any case lest that Burkina Faso. A total of 39650018.5 Gg of GHG will be avoided in 2030 thanks to the INDCs.

However, in the article 6 of the Paris Agreement, the market mechanisms are redefined through three different cooperation mechanism: Cooperatives approaches, mechanisms for mitigation and sustainable development and a framework for non-markets-based approaches. The market mechanisms of the Kyoto protocol are reformulated in the article 6 paragraph 4 and 7 (6.4 and 6.7) of the Paris agreement. The CDM will be transitioned to new mechanisms after 2020.

Table 15: Approaches of the Article 6 in the Paris Agreement

Cooperation mechanisms	Article 6 of the Paris Agreement
Cooperative approaches	**6.2** *"Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement"* **6.3** *"The use of internationally transferred mitigation outcomes to achieve nationally determined contributions under this Agreement shall be voluntary and authorized by participating Parties".*
Mechanisms for mitigation and sustainable development	**6.4** "A *mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development is hereby established under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Agreement (CMA) for use by Parties on a voluntary basis. It shall be supervised by a body designated by the Conference of the Parties serving as the meeting of the Parties to this Agreement (CMA), and shall aim:* *(a) To promote the mitigation of greenhouse gas emissions while fostering sustainable development;* *(b) To incentivize and facilitate participation in the mitigation of greenhouse gas emissions by public and private entities authorized by a Party;* *(c) To contribute to the reduction of emission levels in the host Party, which will benefit from mitigation activities resulting in emission reductions that can also be used by another Party to fulfil its nationally determined contribution; and* *(d) To deliver an overall mitigation in global emissions"* **6.7** *"The Conference of the Parties serving as the meeting of the Parties to this Agreement shall adopt rules, modalities and procedures for the mechanism referred to in paragraph 4 of this Article at its first session"*
Framework for non-markets-based approaches	**6.8** *"Parties recognize the importance of integrated, holistic and balanced non-market approaches being available to Parties to assist in the implementation of their nationally determined contributions, in the context of sustainable development and poverty eradication, in a coordinated and effective manner, including through, inter alia, mitigation, adaptation, finance, technology transfer and capacity building, as appropriate"*

Adopted from (UNFCCC, 2015)

It is understood from the article 6.4 that the new mechanism is a crediting mechanism under the guidance and the control of the Conference of the parties serving as the session of the parties to the Paris agreement (CMA). This new mechanism has the same dispositions than the CDM: a dual objective of supporting sustainable development and mitigation action, involves public and private entities, supervised by the UNFCCC, requires mitigation activities (actions) to be real, measurable, additional, and verified by the designated operational entities.

On 31 December 2020, the second commitment period (CP2) of the Kyoto protocol will end leaving uncertain the fate of the CDM. The main focus of countries still now the Paris Agreement where they announce their (Intended) Nationally Determined Contribution (INDC) in which they plan their ambitions of adaptation and mitigation. Some developments may then impact on the operational status of the CDM after 2020 even if it has no expiration date and could be operational indefinitely. In ongoing negotiations, some parties state that it will not be efficient to let CDM be indefinitely active in parallel with the article 6.4

mechanism of the Paris agreement since the two mechanisms have almost the same objectives.

Paris agreement and NDC

Article 6 has some elements that give possibilities to achieve NDC. Article 6.2 indicates the use of Internationally Transfer Mitigation Outcome (ITMOs) in NDCs. This indication may suggest that article 6.2 apply only to the situations where NDCs are achieved through international transfers. This interpretation is one among others.

Table 16: Observations on market mechanisms under Kyoto Protocol and Paris Agreement

Elements	Kyoto protocol (CDM)	Paris Agreement (Article 6.4)
Objective	Achieve sustainable development in Non-annex I countries; Emissions reduction in Annex I countries in a cost-effective way; Fulfil the Kyoto protocol targets	Achieve NDC targets; Contribute to GHGs mitigation and adaptation; Support sustainable development ;
Applicable countries	Projects are hosted by Non-Annex I countries Annex I countries acquire CERs	All countries are concerned
Governing bodies	CDM EB and CMP Parties (project approval) Stakeholders (consultants)	UNFCCC bodies and CMA authority and guidance Party authorization
International rules	Rules adopted by the CDM EB Modalities and procedures for different project types Annual CMP (serving as the meeting of the Parties to this Protocol) guidance to the CDM EB	Rules adopted by the governing body Rules, modalities and procedures
Participation of private and public sector	Yes	Yes
Crediting period of activities	(2013 - 2020)	Not yet defined

Environmental integrity and transparency provisions	Long-term benefits, real, measurable; Additionality; Impact assessments; Third party verification The CMP must develop techniques and procedures with the aim of ensuring transparency, efficiency and accountability through independent auditing and verification of project intervention	Long term benefits, real and measurable; Additionality; Third party verification But not particularly defined in the article. Emissions reductions resulting from the mechanism shall not be used to demonstrate achievement of the host country's NDC if used by another country to achieve its NDC
Applicable activities (Scope)	Projects and programmes Approval by the Executive Board of a validated project (and PoAs) as a CDM project activity	Specific scope of activities Parties raise more extensive approaches and inclusion of REDD+ in the negotiations, not further defined
Authorization	Communicating endorsement of voluntary participation from the DNA of each party	Membership by public and private bodies authorized by a party
MRV	Emissions reductions resulting from each project have to be certified on the basis of: measurable, real, and long-term benefits related to the mitigation of climate change; and emissions reductions that are additional to any that would occur in the absence of the certified project activity (art 12.5 of the KP)	Advocate that the CMA adopt rules, procedures and modalities for article 6.4 on the basis of: measurable, real, and long-term benefits related to climate change mitigation; emissions reductions that are additional to any that would otherwise occur; verification and certification of emissions reductions resulting from mitigation activities by DOEs
Issuance	The EB has to establish and maintain a CDM registry to ensure the accurate accounting of the issuance, holding, transfer and acquisition of CERs by parties which are not in Annex I countries	Despite a registry is not clearly mentioned, it would be an important institution if art 6.4 is establishing a crediting mechanism
Finance provision	The CDM must assist in arranging funding of certified project activities as necessary	Not mentioned in article 6

Prompt start	CERs obtained during the period from 2000 up to the beginning of the first commitment period of the KP can be used to assist in achieving compliance in the first commitment period	Not mentioned in article 6
Ambition	The aim of the CDM is to assist Parties not included in Annex I in achieving SD and to assist parties in Annex I countries in achieving compliance with their quantified emission limitation and reduce commitments under the KP, the application of CDM shall be supplemental to domestic action	Allow for higher ambition in adaptation and mitigation actions and promote SD and environmental integrity (art 6.1) and deliver an overall mitigation in global emissions (art 6.4)

Adopted from (Lambert Schneider and Derik Broekhof, 2016) and (Greiner & Hunzai, 2017)

C. Arguments to maintain the CDM

Until the end of the first commitment period (2008-2012) of the Kyoto protocol, more than 8,000 climate and sustainable projects are registered in 111 developing countries, over 1.6 billion certified emission reductions are issued and over USD 300 billion are invested through the CDM. (Stephan and Michaelowa, 2017; Schneider, Day, La Hoz Theuer, & Warnecke, 2017). During the DOE forum in Bonn (2017) about essential for a smooth transition to new mechanism, it was recalled that **significant expertise** (capacity) and **infrastructure** (DOE, DNA, RTI, RCC, etc.) have been built with the CDM implementation, and the use of this capacity and infrastructure in the future mechanisms would be time and cost efficient approach. In addition, new opportunities for CERs demand are likely to emerge from sectors like civil aviation and shipping. It would be worthwhile to maintain experience and tools CDM professional as the DOEs have gained in the CDM over the past years (UNFCCC, 2018). Cancelling easily all CDM investments, regardless of their merits, would completely destroy private sector trust and make it very difficult to attract new private sector investments in the coming decades. (Michaelowa and Hock, 2017). In order to achieve a smooth transition between the Kyoto and Paris agreement, it would be captivating to use CDM as the roots of the Paris mechanism and to translate the CDM portfolio into the Paris mechanism. A provision on early action for the Paris mechanism could play a crucial role in making it competitive against the CAs and generate trust between market participants and governments (Axel Michaelowa and Stephan Hoch, 2016).

The context under which CDM operates is changed by the adoption of the Paris agreement. Article 6 of the P mitigation outcomes across borders and to account those outcomes towards their NDCs. Article 6.4 set up a new crediting mechanism under the guidance and the authority of the Conference of the Parties serving as the meeting of the Parties to the Paris agreement (CMA). The statements of the Paris agreement article 6.4 greatly resemble to those of the CDM even if the scope of article 6.4 may be broader (Lambert Schneider and Stephanie La Hoz Theuer, 2017). The Kyoto protocol will not have a third commitment period. Parties could choose to end the Kyoto period once the second commitment have been closed (2020). This would involve that CERs will not be issued for emissions reductions after 2020. Many parties and stakeholders proposed plans to transition the CDM to the Paris Agreement in the ongoing negotiations on the article 6. CDM could be included under the Paris agreement through many processes. The Paris agreement mechanisms could adopt the governance and rules arrangements from the CDM. It is also possible to transition CDM projects to the Paris agreement and allow them to generate emissions reductions units to use after 2020. Finally, CERs issued up to 2020 could be used to achieve international mitigation targets after 2020, involving NDCs under the Paris agreement and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) adopted in recent times by the International Civil Aviation Organization (ICAO).**The total CERs supply potential from registered and non-registered projects in the pipeline is about 5.7 billion CERs, from 2013 to 2020**. **However, the CERs demand, for the same period is estimated to be 600 million CERs. Consequently, almost 5.0 billion CERs could be left over for use after 2020.** This estimated remaining CERs is significantly larger than the potential demand from CORSIA which is calculated to be about 2**.7 billion from 2020 to 2035**. Presently, the potential demand from countries that have the intention to use CERs in achieving their NDC is unknown (Lambert Schneider and Stephanie La Hoz Theuer, 2017**;** Greiner, S., Howard, A., Chagas, T., and Hunzai,T.). Compliance costs could be reduced by using CERs, CERs could also support stranded projects and ensure sufficient supply for CORSIA implementation.

New sources of CERs demand

New CERs demand could arise from different sources. These expansions could create more demand and CERs price signal for some kind of CDM projects (Schneider et al., 2017).

- Since 2016, the international Civil Aviation Organization has the intention to establish a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). The scheme has the objective to reach neutral emissions growth from 2020 levels. The resolution institute that, under certain conditions, emissions units generated from mechanisms established from the UNFCCC and Paris framework are eligible for use in CORSIA. One query about this is about the projects types from which mechanism will be eligible and which vintage of emission reductions will be recognized.

- Certain countries intend to recognize CERs as a way of compliance in national mitigation policies. For instance: South Africa has plans to recognize CERS from meeting carbon tax obligations, as well as Mexico. In the EU, CERs may be approved as a compliance mechanism under the Fuel Quality Directive. In South Korea, domestic CERs are recognized in the emissions trading scheme.

- More than 190 countries have submitted their NDCs in order to adopt the Paris agreement. The proposed mitigation targets or actions after 2020 are specified in these NDCs. In UNFCCC's negotiations, some parties have proposed that CERs should be recognized for NDCs achievement, but no agreement has been attained on this matter so far.

- Development cooperative offices consider purchasing CERs as a way to effectively disburse results-based climate finance, covering for closing the pre-2020 mitigation gap. For instance, the Pilot Auction Facility for Methane and Climate Change Mitigation of the World Bank

- Some initiatives intend to increase demand for voluntary offsetting GHG emissions, including the UN online platform for voluntary cancellation of CERs

However, two crucial questions are raised:

  - Taking into account the CDM uncertainty, from the registered CDM projects, how many CERs have to be issued for emissions reductions up to 2020?
  - Even without CERs returns, how much of these probable CERs supply would come from projects that would continue GHG abatement?

Through the first question, we can understand how the CERs supply is connected with any new demand and with the second question, we can apprehend how new demand produce

further emission reductions or whether these emission reductions would exist without new demand.

D. A process for transition

The transition of CDM activities from Kyoto protocol to the Paris agreement depends on the progress made with the Paris agreement targets. In EU, many policy makers think that CDM should be entirely eliminated. At the same time, others policy makers like in Africa and Brazil state that article 6 of the Paris Agreement should fully integrate the CDM pipeline. (Michaelowa and Hock, 2017). Two kind of market mechanisms are defined in the article 6 of the Paris agreement: the first one is to "contribute to the mitigation of greenhouse gas emissions and support sustainable development (article 6.4) and to 'decentralize cooperatives approaches (article 6.2 and 6.3). The term **Sustainable Development Mechanism** was seemed to be accepted for the mechanism under article 6.4.

The transition will:

- Help assure an organized transition between the Kyoto protocol and the Paris agreement
- Preserve the confidence of the investor in UNFCCC mechanisms and policy makers
- Allow article 6 mechanisms to rapidly serve new compliance demand (NDCs, increased NDCs ambition, CORSIA, ICAO)
- Enhance incentives to prevent the loss of existing mitigation efforts and trigger investment in new efforts
- Quickly scale up the mitigation achieve through the article 6 mechanisms, by leveraging the pipeline of CDM activities and its potential for replication
- Not lose intensity in the growing implementation of domestic carbon pricing measures making use of using UNFCCC-governed international crediting (Greiner & Hunzai, 2017)

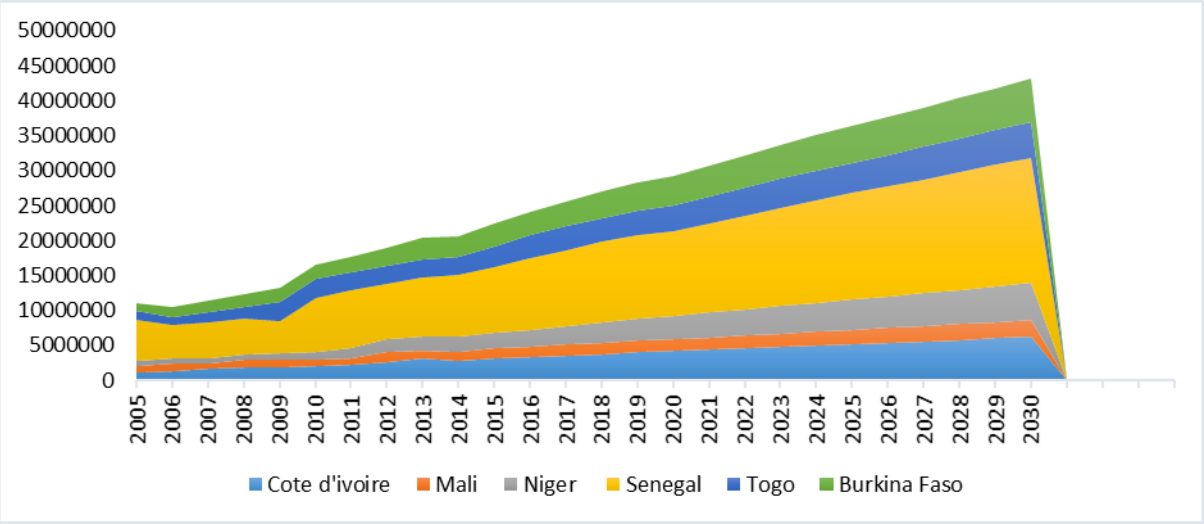
This transition allows the activities to continue mitigation emissions and issues credit under the Paris agreement. Credits which are generated after the date of their migration can be used by parties towards the achievement of their NDCs. The participants of CDM will still have the possibility to apply for the registration of their activities under another crediting mechanism. This transfer could be implemented as a procedure to conduct activities to the new crediting system, with or without changes, or as a kind of simplified registration process. It would be expected that the activities have to align with the requirements of the new crediting

mechanism. Despite the CDM EB would not need to approve the migration, it should be informed that the activity has ended under the CDM to assure that it is no longer issues CERs under the CDM. And an approval would (Greiner & Hunzai, 2017).

Transitioning CDM rules and institutions

Already on the negotiation's agenda: CMA to adopt the rules of the articles 6.4 mechanism based on: "***experience gained with and lessons learned from existing mechanisms and approaches adopted under the convention and its related legal instruments***". However, the rulebook of the CDM can provide a strong starting point for the article 6.4 rules. Next to transitioning the CDM rules, individual institutions initiated by the CDM could potentially play a crucial role in article 6.4. A rapid start, the fact that many issues have already been solved by parties, familiarities of participants (stakeholders and governments) with the institutions and their integration into the UN system and with countries' domestic institutions may be some advantages. For the transition of EB and its panels, one option is that the CMA created a new body to supervise the Art 6.4 mechanism that reflects the modalities of the present EB but makes improvement where these are approved. Concerning the DNAs, parties can appoint existing DNAs to work under the Art 6.4 mechanism.

Table 17: CO2 emissions projections (BAU) in WAEMU countries



Source: The author

Process of the CO2 projections: Linear regression technique is used on excel,

- We first calculated the Correlation coefficient for each country with the available figure: CO2 emissions from 2005 to 2014
- The table below shows the found correlation coefficients

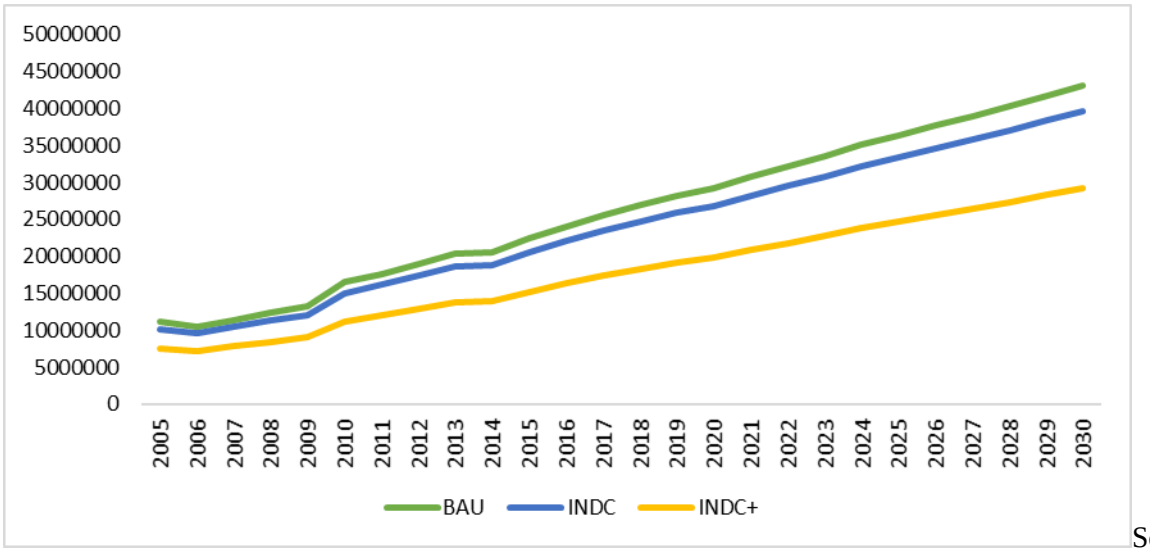
Table 18: Coefficients correlation

Countries	Correlation coefficients
Cote d'ivoire	0.97
Mali	0.56
Niger	0.95
Senegal	0.84
Togo	0.85
Burkina Faso	0.97

Source: Author

For Mali, the CO2 of 2007 is considered as the one of 2005 since emissions of 2005 are not available. And the projections are done until 2032 to have the same number of years as the others countries. CO2 emissions of Benin and Guinea Bissau are not available. They are then excluded from this analysis.

Table 19: Global CO2 emissions in WAEMU countries from 2005 to 2030



Source : Author

This figure considers 3 scenarios: Business as Usual (BAU) scenario, the Intended National Determined Contribution (INDC) and INDC+.

BAU scenario: can be defined as the scenario of future patterns of activity which assumes that there will be no significant change in people's attitudes and priorities, or no major changes in technology, economics or policies so that normal circumstances can be expected to continue (Oxford, dictionary of environment and conservation).

INDC scenario: Post 2020 climate actions that countries intended to take under the new international agreement (COP21 in December 2015) under unconditional options

INDC+ scenario: Actions taken under conditional options

The projections shown the following global emissions reduction in WAEMU countries:

Table 20: Global emissions reduction in WAEMU (in % and tons of CO2)

Period	INDC (%)	Ton of CO2	INDC+ (%)	Ton of CO2
2020	8.30	2424142.81	32.20	9419871.25
2025	8.25	2999701.02	32.24	11725176
2030	8.23	3556773.16	32.30	13953606.2
Total		**8980617**		**35098653.4**

Source: Author

On average, WAEMU countries will reduce 8.26 % of their emissions by 2030 with local governments' efforts and 32.24% if international aid (financial or any kind of support) is received. These reductions correspond to 44079270.4 tons of CO2.So, based on the various INDCs, our projections show that by 2030, the actions of the different WAEMU countries will prevent 44079270.4 tons of CO2.

E. The potential supply of CERs from projects in WAEMU countries

We found that the total CERs supply from CDM in WAEMU countries is estimated to 9591896.02 CERs by 2020 and **20 640 853.7** CERs by 2030 (using CERs forecasts data base from IGES-CDM (2017), meaning a mitigation of 20640853.7 tons of CO2. So, carbon market mechanisms will allow WEAMU countries to meet only 46.82% [(20640853.7/44079270) *100] of the emissions reduction targets. However,

The WAEMU countries will have to find other means of mitigation to avoid a total emission of 23 438 416.7 tons of CO2.

Here is what each country plan to do for more mitigation actions

Benin: The different mitigation measures concern three sectors: agriculture, energy and forestry. Promote improved farming techniques in crop production, promote soil fertility management techniques in the context of crop production, Promote hydro agricultural development; Develop electric power generation from natural gas and renewable energy sources, Extend household access to electric lighting to replace kerosene lighting; Increase the carbon sequestration capacity of the country's forest ecosystems through the implementation of sustainable natural forest management and reinforcement of reforestation / planting efforts

Senegal: In Senegal, The activities which generate GHG emission reductions will be realized in the following subsectors: 1) energy through electricity production, energy efficiency and transportation; 2) Agriculture forestry and others land uses (AFAT) through manure management, rice cultivation and agricultural soils, organic fertilizers forest land and plantations, 3) industry and 4) waste management by the treatment of solid waste, industrial, domestic and commercial wastewater.

Guinea-Bissau: The mitigation contribution in Guinea-Bissau embodied in the implementation of policies and planned actions. Guinea-Bissau's contribution to GHG emission reduction covers the energy and forestry sectors. Therefore, reforestation constitutes the main mitigation measure to be adopted by the country, which can be a national contribution. In the sector, an increase in electricity power capacity of 90 MW at least using heavy fuel and diesel is intended.

Burkina Faso: The identified sectors for mitigation actions in Burkina Faso are: waste and energy, including electricity production, transportation, residential and tertiary, as well as manufacturing industries, housing etc.

Togo: The country has already implemented activities to reduce GHG emissions mainly in sectors like energy (use of biomass, solar electricity and road transport), agriculture (introduction of fodder in livestock, promotion of varieties of rain-fed rice and better use of organic matter, practices that boost carbon's binding to farmland and agroforestry) and Land-use, Land-use change and forestry (LULUCF, reforestation through plantations and agroforestry promotion and protection, development of biofuels).

Cote d'ivoire: The mitigation actions in Cote d'ivoire are:

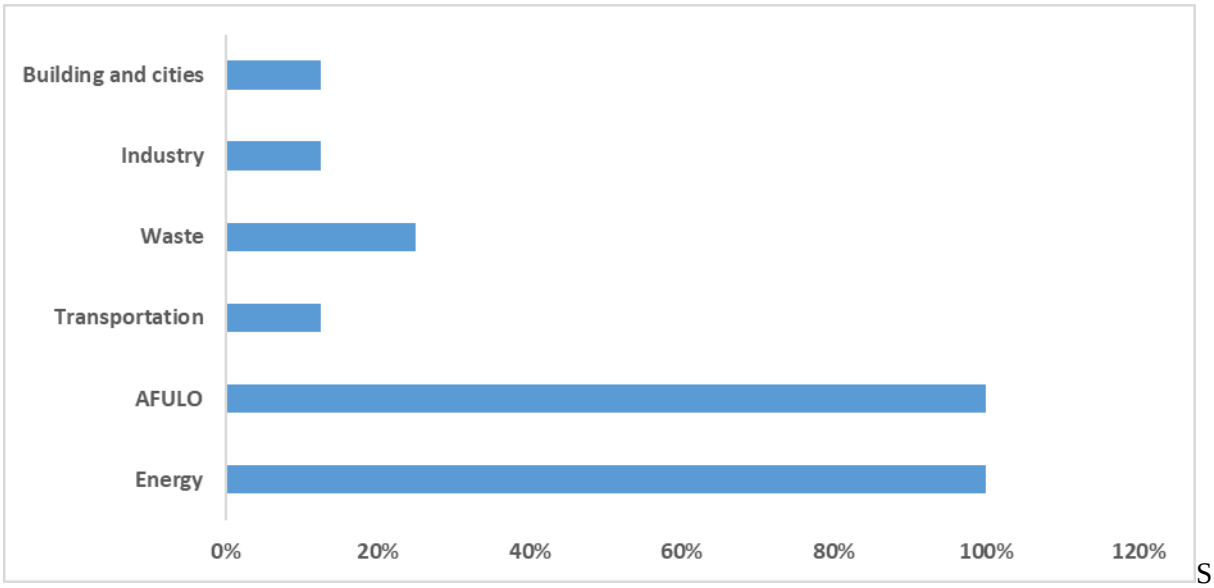
Composition of the electricity mix by 2030, intensification and mechanization of agriculture and animal production, reduction of GHG emissions due to deforestation and forest degradation and sustainable management and waste recycling (recovery).

Mali: Mali's mitigation actions are based on the following sectors: agriculture, energy and forests: acceleration of the inclusion of renewable energies in the energy mix, improvement of the performance of agricultural production processes, reduction of deforestation and intensive reforestation.

Niger: Mitigation measures in Niger are based on the energy and AFULO sectors. Mitigation actions in the energy sector will be taken through rural electrification wood energy save,

reduction of specific consumption in transportation, energy efficiency, exploitation of photovoltaic and thermal solar energy, wind energy, nuclear power plant and a gas power plant. Mitigation options in the AFULO sector concern the up scaling of good Sustainable Land Management (SLM) practices and improvement of agro-silvo pastoral productivity.

Table 21: Sectors covered by WAEMU's INDCs



Source author:

The percentage shown the number of countries in WAEMU which privilege these sectors in achieving their goals set in the INDCs. We found that energy sector and AFULO sector are both given preference by all countries in climate change fighting. Indeed, these countries are better equipped with opportunities that allow them to develop actions using, for example, clean energy sources such as the sun, wind, hydrology, etc. Despite the fact that forests and woodlands represent only 14% of the land area in West Africa (Faosa, 2003), forestry has also environmental assets allowing mitigation actions.

F. Gases covered by the WAEMU countries' INDCs

In addition to the carbon dioxide (CO_2), other traces of gases such as methane (CH_4) and nitrous oxide (N_2O) are naturally present in the atmosphere. At the beginning of the 21st century, it is estimated that carbon dioxide contributes 60% to the anthropogenic greenhouse effect (excluding deforestation), 20% to methane and 6% to nitrous oxide. Finally, chlorofluorocarbons (CFCs) and other industrial origin traces of gases account for 14%. The concentration of methane (CH_4) in the atmosphere has been multiplied by 2.5 and continues to increase. The sources of methane are both natural (livestock, rice-plantation, wetlands,

biomass fires) and industrial (natural gas and coal). As for nitrous oxide (N_2O) it is emitted by partly by industry (Seguin & Soussana, 2008).

The three main gases covered by the INDCs in WAEMU countries are:CO_2, N_2O and CH_4). Researches shown than the major contributor to the total emissions in Sub-Saharan Africa is carbon dioxide (CO_2) followed by methane (CH_4) and nitrous oxide (N_2O). Carbon dioxide is release when there are changes in land use as in slash-and-burn agriculture. Usually, methane emissions happen in breeding and crops of deep-water rice in also in African Landscape components such as termite mounds. In Sub-Saharan African, the main elements that cause nitrous oxide emissions are the type of vegetation, management of forest areas and changes in land usage. Agricultural lands and natural ecosystems are suggested to be an important source of emissions (Dong-Gill Kim et al.,2017). North and South Africa are responsible for almost the total emissions in Africa and the contribution of fossil fuel emissions of the country is low. The fossil fuel emissions represent 4 % of the total global CO2 emissions and South Africa has the highest per capita emission rate. Land use change and forestry (LUCF) represent 35% of total emissions in Africa (more than one third of the total emissions). Emissions from agriculture are also important: 26% of the total emissions (including CH_4 and N_2O). Removals from the atmosphere mainly due to forests are partially counterbalancing these different emissions. In West African countries as well as in East African countries, agriculture and land-use change and forester constitute the most emitting sectors (Valentini et al., 2014).

Conclusion

In April 2016, 161 countries out of 189 parties to the Convention (representing 96% to the parties) have communicated their INDCs. The communicated INDCs deal with about 99% of the emissions of all parties of the Convention. Parties built up adaptation component and information on mitigation contributions in their INDCs. Many of the INDCs have a national extent. They address major sources and sinks of national GHG emissions. Many of them include emission reduction targets which take diverse forms (Frizen, 2016). While countries ratify the Paris Agreement, some have decided to revise their INDCs and share the modifications as part of their first NDCs. Yet, 15 (including Mali and Benin) of the 169 countries that have communicated their NDC offered a program which differ from their INDC, they are not waiting until 2020 to make changes to their national climate engagements (Ge M. and Kelly L., 2018).

WAEMU countries intend to continue carbon market (the Clean Development Mechanism) and issue Certified Emission Reduction (CERs) in order to reach the pre-2020 mitigation goals. Obtaining international support from donors (conditional option) is an option to reach these aims for all countries. Our analyses show that, the carbon market mechanisms will allow WAEMU countries to reduce 46.82% of the amount of greenhouse gases they intend to reduce through the INDCs' programmes. Other emissions reduction actions should be taken by WAEMU countries to offset the remaining of their global emissions reduction targets as pointed out in their INDCs. All these actions are expected to be reached with the new mechanism of the Paris Agreement which has to fully integrate the CDM pipeline. In fact, the Sustainable Mitigation Mechanism (SMM) constitutes the new mechanism in the Paris agreement.

GENERAL CONCLUSION

The Kyoto Protocol (KP) has been adopted as a means to fight against climate change. The Kyoto Protocol has tree mechanisms or principles: *the Emissions trading* which concerns the trading of allowance rights to emit greenhouse gases (GHGs). The emission trading exists between industrialised country (or Annex I) governments, as they buy and sell the rights to pollute up to their own limits or assigned amounts. *The Clean Development Mechanism* (CDM) which is the largest offset mechanism allowing emission-reduction projects in developing countries to earn Certified Emission Reduction (CER) credits, each equivalent to one tonne of carbon-dioxides (CO_2). The issued CERs can be used by Annex-I countries to meet their Kyoto Protocol's targets. The *Joint Implementation (JI*) has the same activity as CDM, but it is only operational between Annex I countries. However, the CDM is the only mechanism that takes into account developing countries, allowing them to participate in the carbon market. Currently, certain supports and measures are available to facilitate the participation of Least developed countries which represent only 0.63% in the carbon market. Only 2.51% of all the CDM projects are implemented in African regions.

The CDM is a mechanism which allow to implement emission reduction projects in non-Annex I countries (developing countries and economies in transition) by developed countries or developing countries themselves. Each ton of CO2 avoided by the project corresponds to on carbon credit that developed countries can use to meet their national emission targets. Promoting sustainable development in developing countries while allowing developed countries to reduction emissions in a cheapest way are the double objective of the CDM. Studies conclude that CDM has an important impact on sustainable development in most of the countries while others state that the dual objective of the CDM does not hold for many projects, only developed countries take advantage from CDM. The conclusions drawn by these studies are usually theoretical contribution. In addition, studies estimating the contribution of CDM on sustainable development are almost inexistent in West Africa.

Into their Intended Nationally Determined Contribution (INDCs), WAEMU countries express their post 2020 climate actions and how the carbon market is important into achieving these goals. Presently, the best perceptive of climate actions are drawn into INDCs.

The aims of the studies are: 1) to analyse to factors influencing the participation of West African Economic and Monetary Union countries in the carbon market; 2) to estimate the contribution of CDM projects to sustainable development in WAEMU countries by a case study in Senegal and 3) to see how carbon market is taken into account by the national policies of the West African Governments.

Chapter one which analyses the first objective provides overviews on the factors which are estimated to be responsible for the WAEMU countries' presence in the carbon market. The regression shows that Population size, HCI (human capital), infrastructure quality as well as GDP per capita are the variables which pull forward the CDM projects implementation in WAEMU countries. So, countries which higher level of economic development, infrastructure quality, human capacity and population size are most likely to engage in CDM development. Developing countries should be support to develop the quality of infrastructure and the human capital can help them to gain new economic benefits through the Clean Development Mechanism. Necessary institutions should also be developed in West Africans regions to promote CDM.

The analysis of chapter 2 shows that the contribution of CDM on sustainable development in Senegal with a case study of a solar project and a forestry project is positive but slight. The projects have a net positive effect on sustainable development through social, environmental and social aspects (compare to the baseline). Nevertheless, compared with a benchmark of 0.995, the forestry project has a utility of 0.407 and the solar project has a utility of 0.252. We can see here that the forestry project (Oceanium project) is more profitable than the solar one (Bokhol project). Both projects are favourable for GHG reduction, employment generation and livelihood improvement. The forestry project (oceanium project) has a negative effect on fossil fuel use while the solar project (Bokhol project) has a negative effect on soil quality, biodiversity conservation and land access. Employments generated by the projects are unskilled jobs according to the respondents living near the implementation sites. The greatest benefit of these projects is noted at the environmental level, followed by the economic level and finally the social level. Yet, at each level, the effect of the reforestation project is greater than the solar project effect.

West African countries should give preference to forestry CDM projects which seem to have more effect on sustainable development. WAEMU countries should reinforce their capacity building, take advantageous policies and improve their institutional quality for more productivity of CDM in West Africa. This can be done through national and international networking and exchange of experience. Countries like Mali, Niger and Burkina Faso can acquire beneficial information on the CDM programs of Senegal and Cote d'ivoire which have a little more experience on CDM. West African countries should train, aware and inform their population (meanly the policy makers and the private sector) as it was the case in Senegal in 2005-2006 where several trainings were organised to inform the population about the carbon market. At the international level (where the greatest roles are played), the carbon market participation rules, measurement and enforcement of offset projects should be simplified by the new mechanism announced by the Paris agreement, making it more receptive for African countries participation.

WAEMU countries intend to stay into the carbon market (the Clean Development Mechanism) and issue Certified Emission Reduction (CERs) in order to reach the pre-2020 mitigation goals. Our analyses show that projects from the carbon market mechanisms will allow WAEMU countries to reduce 46.82% of the amount of greenhouse gases they intend to reduce through the INDCs' programmes. With an international support, all WAEMU countries are ready to undertake more emission reduction action to reach the pre-2020 mitigation goals.

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Annex

1. Hausman test: to choose between fixed effects model or random affects model

Ho: E (α_i / X_i) = 0 : There is no systematic difference in coefficient (no correlation between variables)

H1: E (α_i / X_i) ≠ 0 : There is a difference between the variables

	Coefficients			
	(b) fixed1	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
ltransp	-2.999487	-6.120107	3.12062	.
lgdp	2.660785	3.315827	-.6550416	1.658336
lbusiness	-2.847368	-2.685943	-.1614248	.
lco2	-.6584938	-1.213554	.5550602	.476555
lrenewener	2.028995	-4.552319	6.581315	.9232084
lfdi	-.2637001	-.6274252	.3637252	.063567
lqualinf	1.028532	5.011131	-3.982598	.5462501
lhci	11.13876	.837342	10.30142	5.621464

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 74.84
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

2. Between and within variation of the panel data set

Variable		Mean	Std. Dev.	Min	Max	Observations
Annual~s	overall	357646.2	633189.7	752.1288	2857521	N = 70
	between		622540.2	12461.17	1594339	n = 6
	within		256085.4	-293147	1620828	T-bar = 11.6667
Country	overall	.	.	.	.	N = 0
	between		.	.	.	n = 0
	within		.	.	.	T = .
Year	overall	2010.643	3.417923	2005	2016	N = 70
	between		.4082483	2010.5	2011.5	n = 6
	within		3.399702	2005.143	2016.143	T-bar = 11.6667
Transp~x	overall	49.99769	5.903967	39	59	N = 70
	between		5.975933	42.91667	56.75	n = 6
	within		2.255651	40.17477	56.29847	T-bar = 11.6667
GDPcap~P	overall	1496.782	445.0187	762.9627	2379.451	N = 70
	between		472.3986	832.0979	2191.534	n = 6
	within		86.94647	1305	1684.699	T-bar = 11.6667
Busine~r	overall	3.278571	.3772105	2.5	4	N = 70
	between		.3316799	3	3.833333	n = 6
	within		.2191056	2.778571	4.278571	T-bar = 11.6667
CO2per~p	overall	.2137405	.1745372	.0490419	.629137	N = 70
	between		.1811523	.0673956	.5221409	n = 6
	within		.0503088	.056812	.3207366	T-bar = 11.6667
Renewe~s	overall	74.55077	14.2107	35.85775	90.58276	N = 70
	between		14.76716	46.66176	85.64805	n = 6
	within		3.920119	63.74676	86.94733	T-bar = 11.6667
FDI	overall	3.560033	3.688177	.320222	19.37574	N = 70
	between		2.308119	1.340795	7.392028	n = 6
	within		2.995024	-2.727601	17.96603	T-bar = 11.6667
Qualit~e	overall	3.021186	.6382426	1.700402	4.028238	N = 70
	between		.513386	2.445349	3.758428	n = 6
	within		.4237233	1.719431	3.883434	T-bar = 11.6667
HCI	overall	1.389249	.2246525	1.116742	1.780253	N = 70
	between		.2404662	1.163839	1.764748	n = 6
	within		.0293107	1.321355	1.464453	T-bar = 11.6667
Popula~n	overall	1.40e+07	3904125	5683268	2.07e+07	N = 70
	between		3852100	6612289	1.69e+07	n = 6
	within		1558515	1.07e+07	1.78e+07	T-bar = 11.6667
pays	overall	3.542857	1.725224	1	6	N = 70
	between		1.870829	1	6	n = 6
	within		0	3.542857	3.542857	T-bar = 11.6667

3. Validation of the estimations

Test of residue normality

H0: the residue follows normal law

H1: the residue does not follow normal law

Skewness/Kurtosis tests for Normality

				joint	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
residu	70	0.1056	0.0228	7.07	0.0291

P-value is equal to 0.0291>0.1, the residu follows normality at 10% threshold

4. Random effect estimation for Asian developing countries

```
Random-effects GLS regression                   Number of obs      =        60
Group variable: year                            Number of groups   =        12

R-sq:  within  = 0.0000                         Obs per group: min =         5
       between = 0.0000                                        avg =       5.0
       overall = 0.6682                                        max =         5

                                                Wald chi2(9)       =    100.68
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000
```

lcer	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ltransp	.3745363	.7521079	0.50	0.618	-1.099568	1.848641
lgdp	-.5450238	.220298	-2.47	0.013	-.9768	-.1132477
lbusiness	5.347503	5.735623	0.93	0.351	-5.894113	16.58912
lco2	-.2286417	.3458702	-0.66	0.509	-.9065347	.4492514
lrenewener	-.4233199	.3325608	-1.27	0.203	-1.075127	.2284873
lfdi	.160625	.1382512	1.16	0.245	-.1103424	.4315923
lqualinf	2.281836	.7112745	3.21	0.001	.8877634	3.675908
lhci	-5.379247	1.678639	-3.20	0.001	-8.669319	-2.089174
lpop	-.3148278	.3152605	-1.00	0.318	-.9327271	.3030714
_cons	-5.726072	6.760824	-0.85	0.397	-18.97704	7.524901
sigma_u	0					
sigma_e	.79962438					
rho	0	(fraction of variance due to u_i)				

.

5. Questionnaire and checklist

Questionnaire Bokhol project (solar energy project)

WASCAL GRP: Climate Change Economics, University Cheikh Anta Diop Dakar

I am doing my PhD on climate change economics and my researches focus on the carbon market, especially on the participation of West African Economics and Monetary Union (WAEMU) countries in the carbon market through the Clean Development Mechanism (CDM) projects. The aim is to assess the contribution of CDM projects to Sustainable Development in a WAEMU host country, Senegal.

Thank you for agreeing to answer these questions about the effects of CDM projects on your locality. Your participation is voluntary and your answers are anonymous and will be kept confidential. It will help to find answers to my research questions.

SECTION A : INFORMATIONS OF THE QUESTIONNAIRE	
	Questionnaire N° |__|__|__|__|__|__|__|
A.1 Region ……|__|__|	**A.4 Area** 1. Urban |__| 2. Rural
A.2 Department……..|__|__|	**A.5 Village**……
A.3 Community……	**A.6 Date** |__|__|__|__|**2_0_1_8**_|

SECTION B: DEMOGRAPHIC CHARATERISTICS					
B.1	**Name of the respondent**……				
B.2	**GENDER** Male……..1 Female……..2	|__|	**B.5**	**What is the level of your formal education?** 1. None 2. Primary 3. Secondary 4. Professional training 5. University 6. Koranic school 7. National languages literacy	|__|
B.3	**AGE**	|__|__|			
B.4	**What is your current relationship status?** 1. Single 2. Married 3. Divorced 4. Widowed/widower	|__|			
B.6	**Residential status:** 1. indigenous 2. non-indigenous	|__|	**B.7**	**If indigenous, for how long?** |__|__| (years)	
			B.8	**What is your primary occupation?** ……	

SECTION C : CLIMATE CHANGE APPRECIATION					
C.1	**Have you heard about climate change/climate variability?** 1. Yes 2. No **If C.1=No, go to C.5**	|__|	**C.6**	**If C.5=Yes, where do you hear about it?** 1.Television |__| 2. Internet |__| 3. Through the medium of the press |__| 4. Radio |__| 5. Friends/ Relatives 6. Others	
C.2	**If C.1=Yes, how do you feel its effects?** 1. Pollution |__| 2. Disease 4. Soil degradation |__| 3. Temperatures rise/ extreme weather |__| 5. Shifting rainfall / rainfall shortage 6. Flooding		**C.7**	**Which aspects of carbon market do you know?** 1. Carbon credit production |__| 2. Support for Sustainable development 3. CO2 abatement 4. Others |__| 5. I don't Know	
C.3	**Do you think something can be done to fight against climate change?** 1. Yes 2. No |__| 3. I don't Know		**C.8**	**Have you heard about Clean Development Mechanism (CDM) Projects?** 1. Yes |__| 2. No	
C.4	**Who do you thing to be more capable to tackle climate change?** 1. International organizations 2. National government |__| 3. Local government |__| 4. Social groups 5. Individuals |__| 6. Other (please precise)		**C.9**	**Do you know the objectives of the solar farm of Bokhol?** 1. Energy production 2. Carbon credit production 3. Support for Sustainable development 4. Others |__| 5. I don't know |__| |__|	
C.5	**Have you heard about the carbon market?** 1. Yes |__| 2. No **If C.5=No, go to C.8**				

SECTION D: EFFECTS OF CDM PROJECTS ON LOCAL ENVIRONMENT					
D.1	**How is the water quality and access compared to the baseline (before the project implementation)?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	⌊__⌋	**D.4**	**How do you perceived the soil quality indicator? (cf. codes)** **D.4.1** Concentration of soil pollutants / soil contamination **D.4.2** Soil acidification **D.4.3** Erosion **D.4.4** Desertification	⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋
D.2	**How do you judge the local (village) air quality compared to the baseline?** 1. Highly Clean 2. Clean 3. Unchanged 4. Unclean 5. Highly Unclean	⌊__⌋	**D.5**	**How do you perceived the status of biodiversity indicators? (cf. codes)** **D.5.1**.Habitat conservation **D.5.2** Species decline (birds, mammals, fishes, etc.) **D.5.3** Re-colonization of the area by species	⌊__⌋ ⌊__⌋ ⌊__⌋
D.3	**How do you perceive people's present health conditions as compared to the baseline (indirectly)?** 1. Highly Improved 2. Improved 3. Unchanged 4. Worsened 5. Highly Worsened	⌊__⌋	**D.6**	**How do you perceive the use of fossil fuel energy indicators? (cf. codes)** **D.6.1**.Coal **D.6.2**.Petroleum **D.6.3**.gases (butane)	⌊__⌋ ⌊__⌋ ⌊__⌋
Codes D.4 D.5 D.6 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease					

SECTION E: EFFECTS OF CDM PROJECTS ON LOCAL DEVELOMENT AND SOCIAL SUSTAINABILITY					
E.1	**Do you think that the implemented project has led to employments creation?** 1. Yes 2. No **If E.1=No, go to E.4**	|___|	**E.7**	**Do you think that the project has an effect on the following energy services compared to the BAU:** 1. Yes 2. No **E.7.1** Access to clean energy **E.7.2** Access to SENELEC energy **E.7.3** Reliability of energy **E.7.4** Affordability of energy **E.7.3** Other facilities	|___| |___| |___| |___|
E.2	**If E.1= Yes, What……** 1. Yes 2. No **E.2.1** Temporary jobs **E.2.2** Permanent jobs **E.2.3** Qualified jobs **E.2.4** Wages/salary **E.2.5** Standards achievements of the created jobs	 |___| |___| |___| |___| |___|	**E.8**	**Do you think that the project has effect on population's empowerment:** 1. Yes 2. No **E.9.1** Access in community institutions **E.9.2** Participation in community institutions **E.9.3** Participation in decisions-making processes **E.9.4** Responsibility level of the population **E.9.5** Self-help efforts	 |___| |___| |___| |___| |___|
E.3	**What is the effect of the implemented project on income in your locality?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	 |___|	**E.9**	**Do you think that the project has effect on gender equity?** 1. Yes 2. No **If E.10=No, go to the next section**	 |___|
E.4	**How do you judge poverty alleviation in the locality compared to BAU?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	 |___|	**E.10**	**If E.10=Yes, how do the appreciate the changes** **(cf. codes)** E.11.1 Empowerment (access to institutions, participation in institutions, contribution to decisions-making E.11.2 Education E.11.3 Skills/Training E.11.4 Livelihoods	 |___| |___| |___| |___|
E.5	**Do you think that the project has an effect on:** 1. Yes 2. No **E.5.1** Income improvement **E.5.1** Opportunities **E.5.1** Exclusion/ marginal social groups	 |___| |___| |___|		**Codes E.6 E.8 E.11** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	
E.6	**Do you think that the project has an effect on the access of the following basic social services?** 1. Yes 2. No **E.6.1** Healthcare services **E.6.2** Education **E.6.3** Food Security **E.6.4** Social assistance **E.6.5.** Others	 |___| |___| |___| |___| |___|			

SECTION F: EFFECT OF CDM PROJECTS ON ECONOMIC AND TECHNOLOGICAL DEVELOPMENT		
F.1	**E.1.Have you noticed any technological improvement with the implementation of the project?** 1. Yes 2. No **If F.1=No go to F.3**	|___|
F.2	**If F.1=Yes, how this improvement is manifested?** 1. Self-reliance 2. Technology transfer 3. Skills development 4. Domestically produced equipment 5. Others (to precise)	|___| |___| |___|
F.3	**How is land access compared to the BAU?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	|___|
F.4	**How do you appreciate the project's economic performance on the community?** 1. Highly Improved 2. Improved 3. Unchanged 4. Worsened 5. Highly Worsened	|___|

Questionnaire Oceanium project (forestry project)

WASCAL GRP: Climate Change Economics, University Cheikh Anta Diop Dakar

I am doing my PhD on climate change economics and my researches focus on the carbon market, especially on the participation of West African Economics and Monetary Union (WAEMU) countries in the carbon market through the Clean Development Mechanism (CDM) projects. The aim is to assess the contribution of CDM projects to Sustainable Development in a WAEMU host country, Senegal.

Thank you for agreeing to answer these questions about the effects of CDM projects on your locality. Your participation is voluntary and your answers are anonymous and will be kept confidential. It will help to find answers to my research questions.

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A.1 Region ……|__|__|	**A.4 Area** 1. Urban |__| 2. Rural
A.2 Department……..|__|__|	**A.5 Village**……
A.3 Community……	**A.6 Date** |__|__|__|__|2_0_1_8_|

SECTION B: DEMOGRAPHIC CHARATERISTICS					
B.1	**Name of the respondent**……				
B.2	**GENDER** Male……..1 Female……..2	|__|	**B.5**	**What is the level of your formal education?** 1. None 2. Primary 3. Secondary 4. Professional training 5. University 6. Koranic school 7. National languages literacy	|__|
B.3	**AGE**	|__|__|			
B.4	**What is your current relationship status?** 1. Single 2. Married 3. Divorced 4. Widowed/widower	|__|			
B.6	**Residential status:** 1. indigenous 2. non-indigenous	|__|	**B.7**	**If indigenous, for how long?** |__|__| (years)	
			B.8	**What is your primary occupation?** ……	

SECTION C : CLIMATE CHANGE APPRECIATION					
C.1	**Have you heard about climate change/climate variability?** 1. Yes 2. No **If C.1=No, go to C.5**	|__|	**C.6**	**If C.5=Yes, where do you hear about it?** 1.Television |__| 2. Internet |__| 3. Through the medium of the press |__| 4. Radio |__| 5. Friends/ Relatives 6. Others	
C.2	**If C.1=Yes, how do you feel its effects?** 1. Pollution |__| 2. Disease |__| 3. Temperatures rise/ extreme weather |__| 4. Soil degradation 5. Shifting rainfall / rainfall shortage 6. Flooding		**C.7**	**Which aspects of carbon market do you know?** 1. Carbon credit production |__| 2. Support for Sustainable development 3. CO2 abatement |__| 4. Others 5. I don't Know	
C.3	**Do you think something can be done to fight against climate change?** 1. Yes 2. No |__| 3. I don't Know		**C.8**	**Have you heard about Clean Development Mechanism (CDM) Projects?** 1. Yes |__| 2. No	
C.4	**Who do you thing to be more capable to tackle climate change?** 1. International organizations 2. National government |__| 3. Local government |__| 4. Social groups 5. Individuals |__| 6. Other (please precise)		**C.9**	**Do you know the objectives of the mangroves reforestation?** 1. Forest restoration 2. Biodiversity restoration 3. Land restoration 4. Carbon credit production 5. Support for Sustainable development |__| 6. Others |__| 7. I don't know |__|	
C.5	**Have you heard about the carbon market?** 1. Yes |__| 2. No **If C.5=No, go to C.8**				

SECTION D: EFFECTS OF CDM PROJECTS ON LOCAL ENVIRONMENT					
D.1	**How is the water quality and access compared to the baseline (before the project implementation)?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	⌊__⌋	**D.4**	**How do you perceived the soil quality indicator? (cf. codes)** **D.4.1** Concentration of soil pollutants / soil contamination **D.4.2** Soil acidification **D.4.3** Erosion **D.4.4** Desertification	⌊__⌋ ⌊__⌋ ⌊__⌋ ⌊__⌋
D.2	**How do you judge the local (village) air quality compared to the baseline?** 1. Highly Clean 2. Clean 3. Unchanged 4. Unclean 5. Highly Unclean	⌊__⌋	**D.5**	**How do you perceived the status of biodiversity indicators? (cf. codes)** **D.5.1**.Habitat conservation **D.5.2** Species decline (birds, mammals, fishes, etc.) **D.5.3** Re-colonization of the area by species	⌊__⌋ ⌊__⌋ ⌊__⌋
D.3	**How do you perceive people's present health conditions as compared to the baseline (indirectly)?** 1. Highly Improved 2. Improved 3. Unchanged 4. Worsened 5. Highly Worsened	⌊__⌋	**D.6**	**How do you perceive the use of fossil fuel energy indicators? (cf. codes)** **D.6.1**.Coal **D.6.2**.Petroleum **D.6.3**.Natural gases	⌊__⌋ ⌊__⌋ ⌊__⌋
Codes D.4 D.5 D.6 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease					

SECTION E: EFFECTS OF CDM PROJECTS ON LOCAL DEVELOMENT AND SOCIAL SUSTAINABILITY					
E.1	**Do you think that the implemented project has led to employments creation?** 1. Yes 2. No **If E.1=No, go to E.4**	|__|	**E.6**	**Do you think that the project has an effect on the access of the following basic social services?** 1. Yes 2. No **E.6.1** Healthcare services **E.6.2** Education **E.6.3** Food Security **E.6.4** Social assistance **E.6.5.** Others	|__| |__| |__| |__| |__| |__|
E.2	**If E.1= Yes, What……** 1. Yes 2. No **E.2.1** Temporary jobs **E.2.2** Permanent jobs **E.2.3** Qualified jobs **E.2.4** Wages/salary **E.2.5** Standards achievements of the created jobs	|__| |__| |__| |__| |__|	**E.7**	**Do you think that the project has effect on population's empowerment:** 1. Yes 2. No **E.9.1** Access in community institutions **E.9.2** Participation in community institutions **E.9.3** Participation in decisions-making processes **E.9.4** Responsibility level of the population **E.9.5** Self-help efforts	|__| |__| |__| |__| |__|
E.3	**What is the effect of the implemented project on income in your locality?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	|__|	**E.8**	**Do you think that the project has effect on gender equity?** 1. Yes 2. No **If E.10=No, go to the next section**	|__|
E.4	**How do you judge poverty alleviation in the locality compared to BAU?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	|__|	**E.9**	**If E.10=Yes, how do the appreciate the changes** **(cf. codes)** E.11.1 Empowerment (access to institutions, participation in institutions, contribution to decisions-making E.11.2 Education E.11.3 Skills/Training E.11.4 Livelihoods	|__| |__| |__| |__|
E.5	**Do you think that the project has an effect on:** 1. Yes 2. No **E.5.1** Income improvement **E.5.1** Opportunities **E.5.1** Exclusion/ marginal social groups	|__| |__| |__|		**Codes E.6 E.8 E.11** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	

SECTION F: EFFECT OF CDM PROJECTS ON ECONOMIC AND TECHNOLOGICAL DEVELOPMENT		
F.1	**E.1.Have you noticed any technological improvement with the implementation of the project?** 1. Yes 2. No **If F.1=No go to F.3**	|___|
F.2	**If F.1=Yes, how this improvement is manifested?** 1. Self-reliance 2. Technology transfer 3. Skills development 4. Domestically produced equipment 5. Others (to precise)	|___| |___| |___|
F.3	**How is land access compared to the BAU?** 1. Highly Increase 2. Increase 3. Unchanged 4. Decrease 5. Highly decrease	|___|
F.4	**How do you appreciate the project's economic performance on the community?** 1. Highly Improved 2. Improved 3. Unchanged 4. Worsened 5. Highly Worsened	|___|

Checklist addressed to institutions

Interview guide for Institutions

WASCAL GRP: Climate Change Economics, University Cheikh Anta Diop Dakar

I am doing my PhD on climate change economics and my researches focus on the carbon market, specially on the participation of West African Economics and Monetary Union (WAEMU) countries in the carbon market through the Clean Development Mechanism (CDM) projects. The aim is to assess the contribution of CDM projects to Sustainable Development in a WAEMU host country, Senegal.

Thank you for agreeing to answer these questions about the effects of CDM projects on your locality. Your participation is voluntary and your answers are anonymous and will be kept confidential. It will help to find answers to my research questions.

This interview is about CDM projects contribution on sustainable development (economic, social, and environmental) in Senegal

Respondent	**Date : _____/_____/_____**
Organisation/structure _____	

Q.1 How do you appreciate CDM mechanism in general and in Senegal in particular?

Q.2 How do you appreciate CDM projects on local environment?

Q.3 How do you appreciate CDM projects on local social development and sustainability?

Q.4 How do you judge CDM projects on local economy development?

Q.5 Which aspects of sustainable development do you judge more important? Especially for the country? Why?

Q.6 Based on your experience, which kind of CDM projects would be more profitable for the country? (Energy, forest, hydroelectric, etc.)

Q.7 In your opinion, who can improve the actual situation of CDM market at the local level? Local actors? International actors?

Q.8 which recommendations would you give for Senegal and African countries to get more advantages in the carbon market?

Q.9 What do you think about the future of CDM projects?