IIIEE Theses 2007:07

On whether vegetation could contribute to major climate change mitigation efforts: Forestry for carbon credits or carbon credits for forestry?

A multi-criteria decision support model for forest carbon offsets

Stefano Barchiesi

Supervisor

Lars Hansson

Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden, September 2007

iiiee

Published in 2006 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiee@iiiee.lu.se.

ISSN 1401-9191

Acknowledgements

First of all, I would like to thank all those people who concretely contributed to the realization of this thesis and whose personal inputs are somehow reflected in the contents: Lars, my supervisor, for so effectively steering my research design with always *ad-hoc* references and guidance *per se*, as at the beginning as at the end, i.e. in the time of greatest need; Danilo, my father, without whose informatics advise my 33-million-row analysis would have never been born nor come to completion in time (in that respect, I have to implicitly thank I.B.M. Bologna as well for lending significant hardware memory and processing capacity to my data elaboration); all my informants, as reported in bibliography, for the time they found in their own busy schedules of these modern days to either have a talk with me or kindly reply to my electronic enquiries; all the IIIEE staff for first offering me the opportunity to attend this Programme and then for the 'air of knowledge' which I was let breathing in the House up to this point.

As separately as in an equally grateful way, I also intend to acknowledge the financial support provided by the Lions Club International District 101-S (Lund) for the completion of this Master s thesis (and my livelihood back to Lund).

In the second place, I would like to thank all those people who nonetheless helped realise this thesis in many indirect ways. Therefore, first prize for cosiness goes to my two-woman family in Bologna and in the person of my mother, Rosamaria, especially. Then, my affection is split amongst all my closest relatives who gave me room and board while I was carrying my laptop from Rimini through Catanzaro to my father's touring site.

A collective token of gratitude is for all my friends who, on the Italian shore, I spent some time with during the summer (if we happened to meet it probably means we will keep doing it for long…), and, on the Swedish shore, I was ferried with until this end (I do not need to tell names since friendship bonds are not mysterious to those concerned…). Concerning thesis-making though, Monica deserves a special mention for both making my visit to IUCN possible and hosting me so kindly as you can do with an old dear friend; as well as Teresita because of the first steps we took together on the same research stairway.

Finally, I would like to thank all those important people who did not contribute to the realization of this thesis but nonetheless to my own peace of mind which I have been enjoying for the last years preceding this life step. In particular, I would like to thank Veronica because I did not the first time I could while she still deserves it (I hope that the bigger occasion, the bigger the chances you will forgive me that lack of mine); in never-ending addition, I would like to thank Valentino for so much inspiration in too little time (no matter you could witness my previous graduation and I cannot witness yours…our souls are tied).

Last but not least I would like to thank Mr. Bruno Liegi Bastonliegi for the continuous cue he represents in terms of daily merriment and goodwill.

Stefano Barchiesi

Lund, September 2007

Abstract

The transition towards a less carbon-intensive society has been initiated. Still, the international climate policy arena is seeking a significant mitigation strategy. Land-Use, Land-Use Change, and Forestry (LULUCF) activities have been acknowledged to represent both a valid carbon dioxide reduction option through biological removal and a considerable source of greenhouse gas emissions at the same time, especially through deforestation. However, forest carbon credits are not being extensively purchased by government tendering and multinational banks. Moreover, the compliance market is generally failing to support sustainable development carbon projects while voluntary offsets appear in that sense more successful, yet less stringent. Therefore, this thesis questions the adequacy of the project-based approach to biological removal and points out other non-technical uncertainties prior to the scientific understanding of carbon sequestration. As a consequence of the inherent complexity of the socio-ecological system, it is argued that the currently low contribution of land-use offsets to climate change mitigation has been determined by the biased definition of win-win goals in the first place, rather than by wrongful implementation. The plausible conditions for the market development of forest carbon offsets have been extracted by means of formative scenario analysis, i.e. the qualitative description of how present potentials could be deployed into alternative futures. Whereas project quality and market price compete on different dimensions, several bonds among system variables seem to limit the degree of intervention over aspects such as standardisation and demand activity. As a result, forest carbon credits do not appear bound for much more than today's state of the art. Natural carbon sources alike, general recommendations to policy making translate into decoupling sinks from market-based mitigation strategies. Besides scenario construction modelling, the paper contributes with preliminary insights into the relationship between probability and desirability of different scenarios according to stakeholders' decision criteria.

Key words: climate change policy, LULUCF, carbon sinks, voluntary offsets, Formative Scenario Analysis, stakeholder multi-criteria model, decision-making support.

Executive Summary

Land Use, Land-Use Change and Forestry (LULUCF) are a range of human-induced activities which imply loss and return of carbon from plants and soils to the atmosphere. This sector is held by proponents to offer opportunities to either slow carbon dioxide emissions by sources, e.g. by reducing the rates of deforestation in the tropics, or encourage removals by sinks, e.g. by planting trees or improving the management of forests and agricultural soils. Today's challenge of limiting the increase in the global average temperature is without doubt colossal. Therefore, the widest possible array of mitigation actions that might play a significant role in tackling climate change could be needed. Despite the fact that LULUCF activities have now been acknowledged to be both a valid carbon dioxide reduction option through biological removal and a considerable source of greenhouse gases emissions at the same time, projects are not generally being included into the extensive procurement programmes of national governments and multiparty investment funds. In fact, political reservations and scientific concerns have, for instance, led to the current exclusion of LULUCF credits from the EU Emission Trading Scheme (ETS), thus resulting in a general decrease of the global demand for this particular kind of carbon asset. In addition, the compliance carbon market is generally failing to support sustainable development carbon projects while voluntary offsets appear in that sense more successful, yet less stringent. In particular, the dual purpose of the Kyoto Protocol's Clean Development Mechanism (CDM) to assist with the achievement of sustainability in developing countries and with compliance in developed countries appears to be met depending on subjective criteria and political priorities.

Research justification

This thesis questions the adequacy of the project-based approach to LULUCF activities and points out more fundamental issues than the debate between the scientific arguments and media demagogy around the credibility of carbon sequestration. The challenge is in fact for climate policy to choose the best strategy in the face of the large non-technical uncertainties about the future of land-use carbon offsets. For instance, tendencies to beyond-compliance attitudes have been growing, such as the expansion of non-Kyoto trading schemes or the avoidance of spurious credits through the additional certification of sustainable CDM projects on a voluntary basis. As a consequence of the inherent complexity of the socio-ecological system, it is argued that the low contribution of land-use offsets to climate change mitigation has been determined by the biased definition of win-win goals in the first place, rather than by their wrongful implementation. The appropriateness of the current policy efforts on LULUCF is essentially discussed from the diverging perspectives as sketched below. At this level of analysis, the discrimination among scenarios is basically made in terms of expectations (1st and 2nd column) and differentiation of developments in the carbon markets (3rd and 4th column).

Carbon sequestration yield	**Sustainable development benefits**	**Commoditization of forest carbon assets in compliance markets**	**Commoditization of forest carbon assets in voluntary markets**	**Contribution to climate change mitigation**
High	Low	High	Low	Minor
				Carbon credits for forestry
Low	High	Low	Low	Minor
				Forestry for carbon credits
High	High	High	High	Major
				Carbon credits and sustainable forestry
Low	Low	Low	Low	None
				Neither carbon credits nor sustainable forestry

The latter criterion is however subordinated to the general agreement upon the two targets as the commoditization of voluntary markets implies the simultaneous occurrence of both high carbon sequestration yields and sustainable development benefits. Major contributions of natural sinks are expected to take place not only because of significant, additional carbon removals, but also in presence of the long-term component of sustainable development. In fact, hastily attained carbon yields tend not to assure permanence nor avoid leakage over time.

Analytical framework

Although the rationale to discuss the role of vegetation with respect to climate change mitigation is the same as the table above, a certain level of fragmentation is required to appreciate detail without losing sight of the bigger picture. In order to unravel the complexity, scenario modelling has thus been applied to the case of land-use offsets. As a tool for adaptive management, it was considered suitable to support the decision-making process over the transition of this particular socio-ecological system. Moreover, this study was expected to generate additional knowledge concerning the dynamics of LULUCF trade-offs. In essence, this is a prerequisite for the effective planning of targets or identification of transformation factors such as drivers or leverages. In fact, the exclusion of all impossible future alternatives as such is a necessary step to shed light on the desirability of consequences from carbon sequestration practices.

In particular, the plausible conditions for the market development of forest carbon offsets have been extracted by means of Formative Scenario Analysis. This method of scenario construction was chosen because the qualitative, non-numerical description of how the present system will evolve into future alternatives is based on a less intuitive and more transparently defined procedure. In practice, the case has been decomposed into a thorough set of 25 impact variables which describe the characteristic properties of project-based carbon transactions stemming from LULUCF activities. This particular number proved reliable and sufficient to discern amongst a realistic, still simplified variety of situations. For instance, the life cycle of carbon credits from project development to issuance has been compared to more traditional product systems as so not to disregard the value chain interactions between various actors not directly involved in project pipelines. Each scenario being one complete sequence of the attributes thus identified, all possible combinations have been filtered according to the logical consistency between concordant and discordant pairs of extreme impact levels. The levels were in turn established considering the maximum and minimum utility that each impact factor has for society as a whole.

Since future occurrences may be plausible but never assured, the descriptive approach taken by the mere scenario construction has been moreover complemented by some evaluative considerations around the assessment of the scenarios attained. In fact, the whole piece of research is an embedded case study centred on the qualitative side of knowledge integration. According to this principle, the formal method of scenario description has been arranged in such a manner to be merged with a multi-criteria evaluation technique inclusive of stakeholders' importance weights and relative utility. Therefore, the impact variables have been grouped under a limited number of criteria which is suitable for the elicitation of preferences by market actors. The hierarchical structure of 25 variables has been thus integrated with 7 decisional criteria in preparation for further research focused on stakeholder multi-criteria analysis. In order to solve complex problems, the rational weaknesses of intuitive, unaided human choices between competing options should be in fact supplemented by institutional guidance of individuals and organisations. In summary, this thesis constitutes a prescriptive piece of research because it has sought to develop a practical model to bring the normative ideals of cost-effective and allocative-efficient policies closer to generally descriptive methods like multi-criteria analysis.

Contributions

This paper chiefly provides decision-makers with a solid model to assess what alternative futures are plausible, before judging what are desirable. This is especially important to avoid inefficient policies which force the system capacity or trigger negative feedback loops. The thesis finds that efforts should be spent instead to first address those aspects which can bring about the most effective change. The results of the scenario construction show that several bonds among system variables seem to limit the degree of intervention over a few policy areas. In fact, aspects such as standardisation appear fairly progressed already and the demand for forest carbon credits tends to settle as it relates only reactively to project supply. Moreover, the selection of relevant scenarios for policy making has portrayed an average situation where the market price of the standard forest carbon unit are foreseen as reasonably high without excluding much better ratings. Secondly, the moderate accessibility to the market from the supply side will reflect project costs being subject to wide variability. On the other hand, forestry projects display established levels of quality while project innovation as product differentiation is moderately restrained. Regardless of the increasing complementarity between compliance and voluntary schemes, project quality and market price seem bound to compete on different dimensions.

In addition, this paper contributes with preliminary insights into the relationship between probability and desirability of different scenarios according to stakeholders' decision criteria. The latter information has been compiled to explore the applicability of the methods employed to the specific context of international policy. As previously explained, this is meant to stimulate further preference-based assessments which could be functional to conflicting agents' mediation.

General conclusions

The most stable conditions for the market development of forest carbon offsets pinpoint a range of situations which are quite similar to the current arrangements in place for LULUCF issues. On the one hand, slightly higher levels of commoditization for forest carbon credits are expectable within the compliance market segments. On the other hand, premium-price niches will fit voluntary offsets where the appeal for either/both environmental or/and social ancillary benefits is made more visible e.g. by branding. With reference to the four alternatives outlined above, it seems that the potential of this particular type of market asset does not reasonably allow for simultaneous attainments in both carbon sequestration and sustainable development. Therefore, it is argued that both objectives are not fully compatible and, even if pursued in a synergic fashion, can hardly lead to significant contributions with respect to climate change mitigation efforts. Natural carbon sources alike, general recommendations to model commissioners in support of policy advisors translate into considering the decoupling of sinks from market-based mitigation strategies. Although fundamental issues (e.g. deforestation and domestic accounting of emissions from land-use change) should not be disregarded by the multilateral treaties already into effect, perhaps more attention should be turned to the development of methodologies and enforceable provisions for non-permanent, yet carbon-neutral options such as bioenergy systems.

Table of Contents

List of Figures

List of Tables

1. Introduction

Institutional complexity concerns the number and nature of interactions within a system. Individual complexity is the way individuals experience and deal with complexity in the effort to get their work done. (Heywood, Spungin, & Turnbull, 2007) In cognitive analogy with that concept, the complexity of carbon-offset projects involving 'land use, land-use change and forestry' is predictably seen as a problem or, more formally put, as a risk which is still difficultly minimized at the present. As a risk entailing seemingly few opportunities, it is moreover understandable why this avenue is so scarcely pursued. Just like in management theory though, if the degree of individual complexity (i.e. the way organizational structures are top-down designed and processes and systems coordinated in the attempt of building each and every one's capability for the sake of efficiency) is not reduced, some real opportunities of the system might be missed and the harnessing of complexity itself to create value disregarded.

As a consequence of the undesirable uncertainties, the scope for such projects is presently limited by the provisions of the Kyoto Protocol. "However, the relation between land-use changes and carbon emissions represents an important area as far as the World Bank is concerned, because of the potential to involve and benefit developing countries whose economies and populations are primarily rural. … [Yet,] the existence of a global market for stored (sequestered) carbon does not necessarily translate to improved income or other benefits for the rural poor. A positive development outcome depends on how the market is structured and how it operates, at international, national and local levels. Key factors include investors' reactions to economic and political risks, rules governing ownership of the assets and institutional systems for distributing benefits and mitigating any negative impacts." (Kiss, Castro, & Newcombe, 2003, pp. 96-97) The amount of stakeholders involved as well as coordinating networks required by carbon-offset markets seems to be an additional clue to confirm how proximal we are to the sheerest definition of complexity.

Despite of the demonstrated complexity of this field, opportunities must have been seen since the past ten years have been particularly rich in research and institutional experimentation related to forest carbon. Most of those early efforts, however, had paid little attention to social issues and this is why later research has kept a special focus on the collateral delivery of sustainable development in community-based projects. In this way, the ultimate sustainability of projects can be integratedly checked as livelihood enhancement, on the one hand, leads to additional environmental benefits and, on the other hand, is a result of poverty alleviation. (J. Smith & Scherr, 2002) In that respect, a multidisciplinary approach in line with environmental sciences and the theory of knowledge integration as inherent elements of the embedded case-study methods were adopted to suit the purpose. In fact, the both qualitative and quantitative essence of this study was intended to exceed the holistic coverage of the problem by simultaneously contextualizing its manifold objects of analysis. (Scholz & Tietje, 2002) Nevertheless, a combination of statistical, ecological, and socio-economic research had already been deemed helpful since Kauppi & Sedjo (2001) proposed it "to better understand the situation of the land, the forces of land-use change and the dynamic of forest carbon pools in relation to human activities and natural disturbance". Furthermore, the increasing respectfulness of the chosen method also in the areas of policy and planning convinced the author to avail of it for the validity of the case. In other words, this thesis attempts to synthesize the previous knowledge attained in the LULUCF sector by extending the scope of existing literature around and between all the fragments disseminated.

This 'cement-like' action was carried out both horizontally, i.e. discipline-wise, and vertically, i.e. in terms of completeness and consistency of the scope.

1.1 Problem Definition

Since the Kyoto Protocol became fully operative with the Marrakech Accords of November 2001, carbon markets and carbon finance have been rapidly growing in activity, size and complexity. The awesome challenge of limiting the increase in the global average temperature to +2 °C is nonetheless colossal. In fact, more than one sign suggest that the pace of climate change is accelerating instead. Hence, the widest possible array of mitigation activities should be needed. In particular, increasing terrestrial carbon stocks or avoiding their release into the atmosphere, i.e. what is more precisely defined as Land Use, Land-Use Change and Forestry (LULUCF), might play a significant role in tackling climate change. These activities are now acknowledged as valid options for complying with the targets set by Annex I countries for reducing emissions of greenhouse gases (GHG). In fact, they can be both implemented domestically and regard project activities undertaken in other countries through carbon trading mechanisms. On the other hand, deforestation is responsible for about a quarter of the world's current carbon dioxide emissions and for about one-third of the historical emissions leading to present atmospheric concentrations. Therefore, it does seem worthwhile to attempt to invert such a trend.

Notwithstanding such a natural bounty, agro-forestry, or rather all LULUCF activities as carbon sinks, have been one of the most debated and controversial sectors for the last eight years of international negotiation. Despite the fact that the capacity of forest ecosystems to absorb carbon dioxide has been essentially acknowledged with the definition of Article 3.3 and 3.4 of the Protocol during the Marrakech Accords, some reservations about accounting systems for eligible activities still exist. For instance, different methodologies must be adopted in order to cope with the large disproportion between credits accruable from the various land uses and forest management practices pursuant to those provisions. Similarly, whereas no caps have been imposed to the use of credits stemming from afforestation, reforestation, revegetation, cropland management and grazing land management, the credits accounted for forest management cannot exceed the 3% of the country's emission in the baseline year. In addition, only 15% of those credits can be included in national carbon balance-sheets due to pre-1990 interventions and indirect effects, e.g. the enriched carbon dioxide atmosphere. On the contrary, only afforestation and reforestation (A/R) projects can be used in the Clean Development Mechanism (CDM) by governments from Annex I countries as credit-generating activities to meet their Kyoto Protocol commitments. However, at the end of the day, credits from such projects will be able to accrue only up to 1% of each Party's 1990 emissions during the second commitment period 2008-2012.

Therefore, with the exception of few major multilateral carbon funds, the so-called LULUCF projects are not, in general, being included into the massive public CDM and JI (Joint Implementation) purchase programs of national governments and multinational banks. Contrarily, the expectedly substantial demand for forestry Certified Emission Reductions (CERs) due to a noticeable shortage in the market seems to include potential buyers amongst the private sector, Annex I countries, and their financial partnerships. The main reason for such slow development and limited potential of the forestry sector in the CDM can be attributed to governments being less prone to purchase prospectively temporary credits as agreed at the United Nations Framework Convention on Climate Change (UNFCCC)'s Ninth Conference of the Parties (CoP) in December 2003. In fact, the replacement obligations following the purchase of time-bound credits seem too scarce an incentive to compensate for the flexibility that the private sector requires concerning investment cycles. In the meantime, the market share of LULUCF has progressively declined from around 20% in the pre-Kyoto trades at the end of the 1990s, to less than 4% in 2005 irrespective of the large supply potentials. In addition to the impossibility for European firms under the EU Emission Trading Scheme (ETS) to participate to this specific market, buyers under other regimes also refrain from acquiring LULUCF credits to keep their options open to being able to sell into the EU ETS. In fact, as the EU ETS is the largest component of compliance markets, followed by the CDM, it has created a large demand for carbon credits also from CDM and JI projects, thus accounting for more than half of that demand. Consequently, the current non-eligibility of LULUCF credits in the European scheme has definitely resulted in a decrease in the global demand for LULUCF CDM and JI credits. (World Bank, 2006)

The reasons that the European Commission pleaded in 2003 to justify the exclusion of forest carbon credits from the ETS, range from complicated technical issues to the simpler, though foreboding, call to prevent a market failure, i.e. not reaching an optimal solution to the more pressingly economic problem of climate change. In fact, the thriving of LULUCF credits is deemed leading unavoidably against any technological transfer to developing countries, with the additional risk of flooding the market of cheaper credits. Indeed, scientific concerns still linger on issues like the temporality of biologically storing carbon plus the inherent risk of displacing human pressure on forests, and new accounting methodology for emission removals by sinks have been continuously submitted for approval. Nonetheless, the latter considerations seem more consistently significant in light of the EU overarching policy to address long-term emission abatement improvements from energy and industrial sources. At the same time, the appeal to avoid a market distortion in the event that the legal problem of attributing entity-level emission for temporary credits does not find a solution, have definitely created a reluctant climate towards forestry crediting in the EU. (Bosquet, Streck, Janson-Smith, Haskett, & Noble, 2006)

On the other hand, some recent surveys have suggested that a certain amount of European firms express willingness to purchase LULUCF credits if only the EU ETS allowed them, thus showing submerged demand to some extent (EcoSecurities, 2006). However, more than a procedural barrier seems to restrain the inclusion of forestry CERs among buyers' options for compliance. Timing constraints in the political process to reach a well-consolidated amendment of the European scheme are holding out irrespective of any dispersal of other perplexity. In fact, the environmental concerns that led to the limitations as of the Linking Directive seem to have been gradually overcome while a large array of differently available benefits could be brought forth by LULUCF projects beyond global climate change mitigation, e.g. restoration and protection of soil, water resources and biodiversity habitat. The possibility of such an inclusion in the EU ETS would most likely augment the demand for LULUCF credits in the future, thus leading to a price increase. While prices of CERs and Emission Reduction Units (ERUs) are likely to come close to those of EU allowances though, temporary credits will be priced at a discount because of expiration. Neither replacement nor liability for these credits is then believed to become an issue as different solutions are being foreseen in that respect. Most importantly, using temporary LULUCF credits would help some operators gain time until their investments are economically justified. For all these reasons *inter alia*, appeals exist for the current market situation to desirably evolve towards a development of forestry credits supply according to the forecast demand. (Bosquet, Streck, Janson-Smith, Haskett, & Noble, 2006)

Nevertheless, other factors such as the increasing demand from voluntary and non-Kyoto markets might either accelerate the process or facilitate it anyhow. In addition to the integration with watershed and biodiversity protection services of forests, synergies may be found with regional development, biomass energy, and averted deforestation. First of all, a complementary opportunity will be thus opened to valorize prospective carbon-sequestrating assets in the least developed countries, i.e. where the dependence on the primary sector is still by far dominant and the participation to carbon markets negligible. Secondly, the linkages between afforestation/reforestation of degraded land, timber production and forest ecosystems conservation could allow for securing the growing bioenergy needs of the future without negating climate benefits of switching from fossil fuels to biomass resources. Appropriate levels of afforestation would thus contribute to reducing deforestation by preventing the timber and fuelwood sectors from availing themselves of existing forest stocks.

The above being the reasons which the believers in the LULUCF sector opportunities advocate, the debate burns likewise on the fuel cast by those who contrarily support the uselessness of harnessing biocarbon for climate change mitigation purposes. The strongest argument to back up the latter standpoint has to be sought in that the effectiveness of the economic instruments put in place to address the GHG emission problem is allegedly endangered by detour from fossil fuel switching. Notwithstanding the current state of the art which still testifies a rather high level of uncertainty, the evolvement of LULUCF practices according to both international climate policy and multiple sustainable development benefits is particularly poised. The ultimate doubt stems from the possibility that forests, and more generally vegetation, can be important for carbon sequestration just as much as carbon credits are important for forest ecosystems conservation. Currently, ancillary cobenefits are sought after in carbon sequestration to make the latter better off and nonetheless meet the sustainability requirements of the CDM. Still, the footprint-neutrality driver of voluntary offsets is not supposed to sponsor less sustainable projects either. In reality, conservation and development assistance agencies are claiming from their side that CERs and VERs serve as major payment to catalyze the joint implementation of other ecosystem services (and priceless amenities).

1.1.1 Problem Statement

The challenge is therefore for climate policy to choose the best strategy in face of the large non-technical uncertainties about the future of land-use carbon offset which have been brought forward by beyond-compliance tendencies, e.g. the expansion of non-Kyoto trading schemes or the avoidance of spurious credits through the additional certification of sustainable CDM projects on a voluntary basis. Regardless of the analogy with the 'egg-or-hen-came-first' dilemma, supporting LULUCF believers' or forest conservationists' perspectives may result in diametrically opposite hypotheses of scenarios.

a) Under the first rationale, LULUCF carbon removals are the end to accomplish by means of keeping a functional and fungible alternative to other more or equally expensive emission-reduction project categories. High sustainable development carbon projects are currently being bypassed by Kyoto-compliant regimes, not least because the CDM is prohibiting land rehabilitation and avoided deforestation. As a result, the looming scenario in that direction would reasonably tend to the complete commoditization of forest carbon assets so that they become perfectly equivalent to any other source of credits which can be availed of for the same reduction purposes.

b) Under the second rationale, LULUCF carbon credits are the means by which the end of sustainable forest management is pursued. In fact, the voluntary offset markets appear more able to support high sustainable development carbon projects despite of the doubtful additionality rigour and conventional donor financing being the main challenges. In that direction, the future would most likely outline a state of things where forest offsets will exist mainly out of regulated markets, namely as premium-prized niche products testifying a new fashion in funding sustainable landscape projects.

Yet, whether and at what conditions of market development this dichotomy of perspectives will either split towards the coexistence of several commoditized forest credits but few premium-prized niche offsets or meet halfway is to be researched hereinafter. In fact, two more scenarios can be preliminarily sketched in an all-or-nothing logic by combining different degree of development for each of the previous points, i.e.

c) Synergies are found between the two approaches as so that the carbon yield and sustainable development benefits are simultaneously optimized in the most suitable market platform that can support such coexistence;

d) Carbon yield maximization and high sustainable development projects are not compatible in any market setting as the former is inherent to compliance segments and the latter fits more voluntary schemes.

This study is thus intended to address as many of the case uncertainties as possible in the attempt of identifying the impact variables affecting forest carbon offsets, of understanding how the carbon-offset system can be represented as alternative scenarios, and of speculating on the desirability of different market developments in sight of conflicting stakeholders' concerns. In order to perform the scenario construction, the point of departure is framed by the analysis of the system properties and dynamics which compose the underlying elements of inquiry: carbon sequestration yield, sustainable development attainment, commoditization of forest carbon assets in compliance markets and in voluntary markets respectively.

1.1.2 Research Justification

In the current age of economic decline, social instability, and environmental depletion, calls for transitions towards sustainable development are becoming more and more frequent. Regarding various socio-economic activities of our modern society, combating climate change is no exception, rather, an overarching imperative. Certainly climate mitigation and climate adaptation strategies represent a large-scale, long-term development for the global system of GHG emitters. Passing through the different phases of scientific understanding, policy design and structured development of market-based instruments, forestry and land-use activities in general are experiencing the same process of change. In particular, the transition is evolving from an initial situation whereby the uncertainties have been so dominating to inhibit any significant harnessing of biocarbon sequestration, to a new, relatively stable state in which the role played by vegetation is largely unknown.

Possibly, the incapability of delivering indications in that respect has been worsened by the range of available policies, from regulatory schemes to voluntary initiatives through intervention on end consumers' power. Moreover, the interference with other topical issues such as land-use competition and bioenergy systems forces the limitedness of human discernment to apply to complex problem solving disciplines. Whether vegetation could contribute to major climate change mitigation efforts at the terminal point of its ongoing transition will be fairly dependent on which of the previously illustrated pictures is going to take place more closely, i.e. which of the four following standpoints will be prevailing in the debate.

a) First, the perspective of those willing to purchase LULUCF emission reductions in spite of their temporary character and the scarcity of approved methodologies. In their view, the uttermost utilization of **forestry for carbon credits** should be endorsed beyond the current restriction to afforestation and reforestation activities in the CDM and carbon buyers let access the vastly underexploited or misemployed resources in developing countries' primary sector. So far, the biocarbon route has been almost solely undertaken within the multitude of voluntary offsets.

b) Secondly, the perspective of those who support the usefulness of harnessing carbon finance for sustainable forestry management and livelihoods purposes, like conservation agencies whose primary mission is to tackle deforestation amongst others. Their view refers to the wary introduction of **carbon credits for forestry** as a market-based instrument in the toolbox of conservation, i.e. allowing payments for carbon sequestration work as additional means by which the ultimate end of forest landscape restoration can be pursued.

c) Then, the perspective of those experts and practitioners who advocate LULUCF sector's opportunities e.g. flexibility of investments and synergy with other environmental services and social benefits, and envision a further amendment of the EU Linking Directive in favor of forest credits eligibility. In a way not dissimilar from the CDM stated purpose of assisting both the achievement of reduction commitments and sustainable development, **carbon credits and forestry** altogether have the potential to make developing countries' contribute significantly to the ultimate objective of the Climate Change Convention according to the principle of common but differentiated responsibility.

d) Finally, the perspective of those who claim the uselessness of harnessing biocarbon for climate change mitigation purposes as if the game was not worth the candle. Their view adds on to the belief that no safe combination of forestry with carbon credits could be as soundly and as conveniently pursued before sustainability doubts are solved. The same ostracism seems to be taken by some forest-focused NGOs who condemn carbon-financed tree planting as being analogous to the indulgences that the Church used to grant in remission of people's sins. More prudently rather than avowedly opposing, the EU position is nonetheless reflected in the exclusion of forestry credits from the first period of the ETS. Such a decision was primarily made upon the judgment to be at risk of market failure, i.e. not reaching an optimal solution to the more pressingly economic problems of energy intensity and fuel switch. Accordingly, either a continuation of the current system would be plausibly agreed upon in post-2012 international climate agreements irrespective of the controversial attainments for the present experiment, or rather abolishment.

1.2 Research Framework

The roles which the different components played in contextualising the design of this Masters' thesis are hereinafter reported. According to Maxwell's theory on qualitative research (1996), the design took into concern the interlinks and connections between purposes, context, research questions, method, and validity.

1.2.1 Purpose and Context

The interest in studying the topic of forest carbon was driven by the personal ambition of merging previous with present education, but the decision was taken along with the expectation to find a different way of framing a recognizably complex problem. After a system of assumptions and past theory was formulated during a previous assignment serving as exploratory research, several thought experiments were triangulated with existing literature and own perspectives in order to innovate the angle under which the phenomenon under study could be logically probed.

1.2.1.1 Prior Theory

As recently pointed out by Sell, Koellner, Weber, Pedroni, & Scholz (2006; 2007), "…studies on decision criteria of market actors in the forestry sector are relatively scarce, particularly those with international scope" and "… only few … [are] using participative multi-criteria methods that explicitly refer to ecosystem services from forestry". If such deficiency in literature may hold reasonable because of the local implications of tropical forestry on the indigenous rural population, the global value of carbon sequestration as environmental service does not any longer justify keeping that scale for this kind of project. Moreover, the degree of actors' involvement in those cases is likely to range from a supply located in developing countries to customers and attached services providers operating especially from Europe. As a result, while interests and stakes are extremely likely to differ from side to side and across, each and every force represents a partial perturbation on market development though negligible it may seem. Previously, Landell-Mills & Porras (2002) had realized that minimal attention is paid to environmental service bundling in the literature. That very comment hinted at conducting the preliminary analysis reported in the third background of this thesis, for the opportunity offered by this kind of synergy may be overlooked in the trade-offs between carbon sequestration, local social development, economic well-being and access to environmental resources.

In addition, another major issue emerges from the literature review regarding the diversity of methods applied in the determination of the contingent sets of decision criteria. Quite similar steps to the techniques adopted within this research can, for instance, be applied in the field of forest planning where multi-criteria based studies performed using e.g. analytical hierarchy and multi-attribute tools demonstrated how stakeholders preferences and values can be credibly and viably incorporated into decision making where a conflictual, multidimensional, incommensurable and incomparable set of objectives co-exist (Ananda & Herath, 2003a, 2003b) The analytical diversity notwithstanding, it seems to be broadly agreed that purely economic evaluations like cost-benefit analysis are not capable of capturing the sustainability performance of certain technologies or socio-economic systems under comparative assessment. (ILK, 2004; Munier, 2006; UK DTLR, 2000) A single-criterion approach such as economics may fall short especially where significant environmental and social impacts cannot be assigned. This latter problem notwithstanding, the three dimensions would not be reducible anyhow to one single unit e.g. a monetary or non-monetary mono-criterion. (Haldi, Frei, Beurskens, & Zhuikova, 2002) Multi-criteria analysis (MCA) is instead more appropriate when decision makers are prone to include the full range of criteria other than monetary. This is particularly valuable where complex environmental problems have to be treated all at once and several alternative options for as many co-existing objectives are present. Furthermore, it is noteworthy to mention that non-monetary objectives often influence policy decisions. The many different types of criteria become thus the gauge through which weighing the different components of the intended system performance occurs.

Given that "[MCA] … is a decision-support process that aids decision-makers by providing a framework to gather and display the required data in a clear and transparent manner" (Jeffreys, 2004), the main features are more or less similar irrespective of the method adopted, namely a finite number of alternative options (which will be delivered by formative scenario analysis), a set of criteria by which the alternatives are judged, and a method for ranking the options on a criterion basis. Concerning alternative ranking in particular, Jeffreys (2004) provided an overview of 8 different "…compensatory and non-compensatory multi-criteria analysis techniques to evaluate and compare various options…" in small-scale forestry. Whilst criteria performances are mutually compensated in the former techniques, non-compensatory methods are better suited to alert decision-makers to the presence of poorly performing criteria. In fact, the great concern for some criteria from the community cannot be overlooked in favour of the high performance of other criteria which would otherwise result in poor decisions. For the latter strength, Jeffreys advocates the combination of non-compensatory with compensatory methods in order to also harness the necessary rigour in measuring the overall performance of the system. Multi-Attribute Utility Theory (MAUT) was the method chosen because it converts all the attributes, i.e. the single performances with respect to criteria, of each alternative option into a single dimensionless utility function. As the utility is the option's attractiveness to the criteria evaluators, it should allow for capturing the decisiveness of some attributes over others. Moreover, the area development negotiators whom this paper is addressed to are deemed responsible to review single stakeholders' concerns through participative workshops to follow. Simply put, this research is analogue to classic forestry options evaluations in that it employs the MAUT to assign stakeholder's importance weights to alternative scenarios. The overall MCA fabric is slightly different though in that it is triggered by attributes belonging to future states rather than from the actual attribute-wise performances of the current system.

It is thus necessary to point out that this study attempts to assess whether vegetation could contribute to major climate change mitigation efforts rather than whether it should. Firstly, regardless of all operationalised definitions of sustainability, there is still room for conceptual division between the stronger and the weaker meaning of it. To what extent compensating damage and discounting future events should suffice to leave next generations either man-made resources or equivalent natural capital is subject to interpretation. In addition to the numerous and diverging definitions the broad concept of sustainable development has received, complex systems like the one under study cannot be easily characterized by a few parameters, even though the assessment objectives are precisely defined. (Haldi, Frei, Beurskens, & Zhuikova, 2002) As a result, the idea of what constitutes development itself in the dual mandate of CDM projects is contested. (K. Brown, Adger, Emily Boyd, Corbera-Elizalde, & Shackley, 2004) In particular, neither sharp-cut nor widespread agreement has been reached upon all the issues surrounding LULUCF activities for carbon mitigation and to what scale they would be sustainable to adopt is still under discussion. Therefore, the idea of determining whether forest carbon projects are sheerly sustainable through this study was soon discarded and no research question was in that sense posed. On the contrary, the suitability of forest carbon projects for curbing climate change along with the contingent implications could be investigated in terms of potential and timeframe, and the implications of stakeholders' preferences tentatively explored too. At any rate, analogies with more traditional sustainability assessments could and were however traced. Since MCA as well entails the identification of attributes and indicators corresponding to analogously desirable objectives for multi-dimensional decision-support practitioners, a step further is thus taken in integrating quantitative analysis with a wide range of qualitative impact categories. As a result, the set of criteria and impact variables as later on elaborated was hierarchically built resting on indicators which traditionally belong and were synthetically borrowed from sustainability assessment frameworks.

1.2.1.2 Literature Review

Addressing the issue of whether the carbon economy leaves room for sustainable development, the work conducted at the Tyndall Centre for Climate Change Research on stakeholder multi-criteria approach (K. Brown, Adger, Emily Boyd, Corbera-Elizalde, & Shackley, 2004; K. Brown & Corbera, 2003) is to be cited with a special mention for its relevance for both scope and methodology of prior studies. The older piece of research is particularly interesting in that it discusses whether elements of equity such as access to markets and forests, and legitimacy in decision-making by those institutions bringing together government, private sector and civil society, are met in the new carbon markets. In doing that, it basically succeeds in crossbreeding multi-criteria analysis with stakeholder analysis. Therefore, not only the range of stakeholders, their roles, interests and perspectives, but also different aspects covering carbon issues, ecological and social aspects were explored. The dual nature of the latter investigation is strictly related to the scope and objectives of the present study as well. Moreover, the implications of forest carbon projects for different aspects of equity and development are to some extent important also for individuals representing the general public and stakeholders without direct market significance, e.g. non-industrial forest-owners. Unlike Sell et al. (2006; 2007), these interest groups were both included in the present study during the development of the criteria system. In fact, they were deemed relevant for they respectively take part to offset demand, e.g. expressing their preferences for community-based projects, and compete for land use when legitimate tenants of rights. This choice was chiefly taken because the system variables to analyse were intended to be as comprehensive as possible in terms of interdependencies.

The second piece of research by Brown et al. (2004) has basically adopted a similar case study approach to that previous cited, namely by utilising a multi-disciplinary, primarily qualitative methodology to address the same issues. A set of key criteria was preliminarily identified in the field to be then applied to other projects. In close similarity to the present work, a stakeholder analysis of local, national and international actors in forestry was hereinafter made preceding the development of a multi-criteria analysis model of stakeholder priorities for sustainable carbon sequestration criteria. Once again, this study is different in that, firstly, the scope of the stakeholder analysis exceeded the boundary of governmental officials, investors, NGOs and local producers, and, secondly, the criteria were synthetically developed through a peer review of the previous literature herein referred to. In addition, this review included all existing standards for forest carbon project development as well as they were deemed useful for the identification of a sufficient set of criteria. The fact is that several studies already adopted MCA for purposes other than sustainability assessments, e.g. certification of SFM practices. (Sell, Koellner, Weber, Pedroni, & Scholz, 2006) Whilst indicators and standards are fairly developed on the supply-side because they address project design barriers, demand-side attributes are not as much formalised. Nevertheless, surveys conducted on both the potential demand for CDM Forestry CERs (EcoSecurities, 2006) and offsets retailers' perceptions of the future voluntary market (Harris, 2006) were extremely useful in providing an insight into the market characteristics from the buyers' perspective.

1.2.1.3 Objectives

The present research was thoroughly designed after the three following objectives which are consecutively embedded in the structure of the paper:

1. To identify the impact variables affecting forest carbon offsets and analyze the system properties;

2. To understand how carbon-offset systems can be represented as alternative scenarios;

3. To speculate on the desirability of different market developments in sight of conflicting stakeholders' concerns.

1.2.2 Research Questions

Based on the objectives and the paper structure, there are three major research questions which address the contents of analysis, discussion, and conclusion respectively. Underneath the main architecture, a number of back-up sub-questions also seemed relevant to compile the overall answer to each of the three research pillars. In fact, the intermediate sub-questions were supposed to guide the research in the first stages as the general range of the three queries appeared rather broad for the thesis. As a consequence, the scope addressed by the research questions has been narrowed down and the relevant focus adjusted during the early stages, especially after the first interviews were conducted. In that respect, it is worth mentioning that the initial idea of making the same kind of analysis for compliance versus voluntary schemes was for instance abandoned following expert consultation (Dornau, 2007; Sell, 2007).

1. *What are the characteristic attributes of forest carbon offsets?*
   1.1. Who are the main actors, networks and institutions taking part in the functional patterns of the system?
   1.2. What are the properties describing offsets and how do they influence carbon-financed forestry projects, e.g. in which direction?
   1.3. What are the impact variables that determine the dynamics of demand and supply and how can they be sharply defined?
   1.4. How can interlinks and mutual importance amongst impact variables be represented?

2. *What market development is the most stable for current forest carbon offsets?*
   2.1. How can scenario-analytic and multi-criteria decision-support methods be integrated to provide a reliable model for further negotiation in the LULUCF sector?
   2.2. How do decisional criteria relate to the likelihood of different market developments?

3. *What market development looks the most desirable in relation to conflicting agents' viewpoints? What are the policy recommendations in that respect?*
   3.1. Where and how can the key areas of intervention be identified?

1.2.3 Methodology

The whole piece of research is designed after the methods presented by Scholz and Tietje (2002). It thus represents an embedded case study centred on the qualitative side of knowledge integration. Although single case-based, this type of study compensates for the strengths of multiple cases as the embedded design returns a larger level of understading than in holistic approaches. In other words, the identification of sub-units of analyis within the phenomenon at issue allows for a more detailed level of inquiry. Qualitative and quantitiative information have not been fully integrated in that, though supportive of numerical quantification of variables, this type of scenario modelling is a structured procedure for generating descriptions of the future alternative system under a qualitative view. (Wiek, Binder, & Scholz, 2006, p.745)

1.2.3.1 Analytical Framework

Climate policy in general and land-use offsets in particular seem to be undergoing a transition process which is hopefully bound for sustainable development. Yet, the ill-defined, society-relevant and real-world nature of such an environmental problem requires an underlying framework to assess effective policies. (Wiek, Binder & Scholz, 2006)

<u>Transition phases and milestones</u>

Since 1995 when the so-called Berlin Mandate first picked up the concept of 'removals by sink', the history of LULUCF activities in climate negotiation had gone through a rather slow pre-transitional phase due to the lack of scientific knowledge and competence building. During that phase, only micro-dynamic changes had occurred to the initial state of the debate whereby vegetation kept having no formal contribution to climate change but in terms of source of GHG emissions. (Jung, 2004) Then, the coining of the Marrakech Accords' definitions along with the first reporting from those 20 land-use-related projects in the CDM Activities Implemented Jointly pilot phase acted as a take-off point for the acceleration phase of this transition. As a result, the World Bank's Bio Carbon Fund has to date signed emission reduction purchase agreements for at least 15 very different projects carried on over all five continents in spite of the sole LULUCF registration signed by the CDM Executive Board. In the meantime, a number of standards and protocols have been released to certify the sustainability performance of voluntary forest offsets in the attempt to bridle the 'wild' but promising non-compliance market. Still, the rate of change in the use of biological carbon sequestration is far from being the highest if compared to the volumes of other emission reduction options and much could depend on upcoming decisions such as to include mechanisms for 'reducing emissions from deforestation and degradation'. More importantly than when the system will turn stable again though, no clue is available concerning the terminal dimension that the land-use carbon expedient can afford.

<u>Applicability of transition management</u>

In business as in policy, understanding uncertainty in complex systems and having methods to evaluate it is important for the application of decision support tools to strategic decision making. In order to back up the specific complexity of sustainability-oriented regulatory intervention in the greatest need of steering actions, some form of adaptive management is required. In that respect, the concept of transition management as an intentional influence over the development of organisational and societal systems has been developed in linkage to a variety of approaches e.g. integrated planning, complex problem solving, and decision making (Lessard, 1998, Ravetz, 2000, Rotmans, van Asselt & Vellinga, 2000; DeTombe, 2001, Mingers & Rosenhead, 2004; Scholz & Tieje, 2002; Bell & Morse, 2003; in Wiek, Binder, & Scholz, 2006). In particular, scenario construction has been recognized as a valid tool that can help unravel this kind of complexity thanks to its fairly broad spectrum of applications including e.g. companies, cities, regions, energy systems, countries, and even global systems (Keijzers, 2002; Ravetz, 2000; Binder et al., 2004; Rotmans et al. 2001; Jeffries, 2004; Kates & Parris, 2003, in Wiek, Binder, & Scholz, 2006).

<u>Functions of scenario construction</u>

As that part of future studies concerned with the definition of terminal states in transition processes, the construction of scenarios appears an appropriate tool for transition management. While the function of scenarios *per se* is to provide the basis for decision making, scenario construction needs to be initially calibrated before generating the intended set of scenarios to be assessed. Essential elements in this process are therefore goal formation, procedure, results, strategic agents and operating agents. (Wiek, Binder, & Scholz, 2006, pp. 745-748) On the one hand, goal formation relates to the definition of system boundaries and to the respective base of knowledge required to accordingly carve the scope and design the background (cf. sect. *1.2.3.1*). On the other hand, goal formation relates to the expected results of scenario construction as it is reflected in the definition of the research objectives (cf. sect. *1.2.1.3*). For what concerns the scenario construction procedure, the first research question is specifically meant to guide the iterative sequence of steps in that sense. For their part, the second and third guiding questions address instead the scenario construction results in preparation to their assessment in terms of consistency and desirability. (cf. sect. *1.2.2*) Although no strategic agent framed the process at its early stages, the normative role of scenario contextualisation is preserved as model commissioners in support of policy advisors are the target audience for this paper. It is moreover not trivial to specify that the operating agent for the scenario construction has been the author. As a layman, in fact, the formal approach to scenario modelling organised by means of Formative Scenario Analysis has proven more appropriate to provide structure and generate competence step by step.

<u>Transition management requirements</u>

The lack of expertise in the scenario construction notwithstanding, the multidisciplinary approach of the system representation is at least functional to open up to as many trans-disciplinary settings as possible at the stage of follow-up research. According to this perspective, processes of mutual learning amongst scientist and practitioners should be initiated and values integrated from society in order to investigate and promote sustainability in the most appropriate way which can reflect both the complexity and multidimensionality. (Scholz & Marks, 2001, in Steiner & Posch, 2006, p. 880) Besides transdisciplinarity, knowledge generation is especially relevant for the transition management of land-use climate policy at this stage of development. In order to build strategies surrounding the resort to biocarbon removals, the analysis of the current dynamics must be complemented by normative directions scoping the planning process. (Wiek, Binder, & Scholz, 2006, pp. 743-745)

In the latter respect, the features of both Formative Scenario Analysis (FSA) and Multi-Attribute Utility Theory (MAUT) have been integrated to combine case representation with case evaluation and seek for the best output from knowledge generation in the context of embedded case-study methods. The reasons for method integration can be found in the principle of backward planning as the rationale for binding *ex-ante* knowledge to 'learning by doing'. According to this principle which aims at attaining the best orientation for future development, the variants construction phase which the FSA fulfils should be followed by data-based evaluations such as MAUT. In addition, 'area development negotiations' like 'exploration parcours' should be run in parallel as so to add the agent-based evaluation component to the case as well. (Scholz & Tietje, 2002) As a result, an exploratory multi-criteria analysis has comparatively investigated the likelihood of different scenarios for forest carbon market evolvement as a function of stakeholders' expectations on differently preferred developments. However, only FSA is hereinafter described while the MAUT procedure is reported in *Appendix I* for the minor role the latter played with respect to the research contributions (cf. sect. *1.2.3.5*).

1.2.3.2 Formative Scenario Analysis

Results characterisation

Unlike most traditional approaches to forecasting, scenario analysis provides a qualitative, contextual description of how the present will evolve into the future, rather than adding numerical precision to that. The multiple futures are usually described through a set of alternatives, each of which represents a possible state of the considered system. Since future occurrence may be plausible but never assured, no probabilities are however assigned to scenarios as they may convey a sense of precision that does not belong to the simulation exercise. Nevertheless, the accuracy of the assumptions is more important than the method of construction itself. "The term Formative Scenario Analysis (FSA) was introduced by Scholz (1996) in order to distinguish impact variable based construction of future states of a system from intuitively and less transparently defined scenario constructions." (Spielmann et al., 2005, p. 326)

Applications to sustainable transition cases

The versatility of application to sustainable transitions for the FSA group of embedded case study methods is testified by very different topics dating from 1994 to 2006. Relevant instances are, for rural areas, the landscape development and future of the traditional industries in the Appenzell Auserrhoden Canton (Scholz et al., 2002, 2003); for urban systems, the leisure mobility and railway station dynamics study in the City of Basel (Scholz et al., 2004b, 2005); for organisations, eco-efficiency and cargo transportation in the case of the Swiss Railway Company SBB (Scholz et al., 2001); for policy processes, the decision process for a repository for low-level radioactive waste in Wellenberg (in progress). Besides 12 Switzerland-related applications due to the authorship location at the Swiss Federal Institute of Technology in Zurich, 7 case studies have nonetheless been conducted in Sweden (among which Scholz et al., 2004a), Austria and Germany as well, and 5 case-related high-ranking papers have been published by peer-review journals (Binder et al., 2004; Loukopoulos & Scholz, 2004; Scholz, Mieg & Oswald, 2000; Scholz & Wiek, 2005; Scholz & Stauffacher, 2007).

Relevance for the case

FSA is a tool that is fit to address disturbances variables, i.e. only those aspects of the system under consideration which are known and bring about fundamental change to the whole. The application of FSA to the particular problem at hand can be justified as follows. The carbon market mechanism or the behavioural pattern of carbon buyers in terms of demand reactivity are known to have an influence on the current LULUCF development. However, the knowledge about their interaction is insufficient to allow for the formulation of quantitative relationships. In the absence of quantitative relationships between variables, conventional sensitivity analysis based on both fixed model structure and known quantified relationships of a model is not applicable. Therefore, FSA may be considered as a type of structured sensitivity analysis for cases characterised by a fixed model structure in terms of variables, but unknown quantitative relationships between the model variables. (Spielmann et al., 2005)

For a more detailed description of the formal procedure, please see *Appendix I*.

1.2.3.3 Contributions

Knowledge integration

As previously explained, scenarios are basically different from predictions as they are judged according to possibility and consistency. When referring to normative scenarios and desirability of consequences, the scope goes beyond the mere scenario construction. However, descriptive and evaluative approaches can be combined by means of knowledge integration. Concerning transition management in particular, three different types of knowledge should be generated. (Wiek, Binder, & Scholz, 2006, pp. 743-744) Target knowledge relates to the normative definition of what are reasonable and appropriate terminal states for the future. Transformation knowledge investigates the leverage points which are necessary to reach the desired conditions. System knowledge is about the sound understanding of what seems to be possible and what seems not to be possible about the future. To some extent, this study has contributed to the generation of all three types of knowledge. However, the clearest contribution has been done to system knowledge in the scenario construction phase as some similarities and contradictions between system elements have emerged from the results even without proceeding to scenario assessment.

System knowledge

The main function for the scenario analysis has been to provide a more robust basis for multi-criteria scenario assessment than in literature (cf. section *1.2.1*). As discussed with reference to scenario assessments in general, FSA is unlike those descriptions of stepwise change attained by combining the qualitative information of a storyline with the quantitative complement of model calculations. In particular, it has been here applied focusing on the driving forces in the process of gaining an insight into the system hidden dynamics. The specific kind of system knowledge attained in this respect is a more detailed and comprehensive problem understanding along with information about both system dynamics and the potential and consistent developments of forest carbon offsets. The arrival point for this research is therefore to exclude all those policies and actions which are simply pointless because of scenario inconsistency.

Target knowledge

The ultimate purpose of this study has however been to provide a decision-support scenario-based model for market development which could be consistent to future inducements or blocking mechanisms by policy-makers. Regardless of how sustainable the most likely market development will be, stakeholders' preferences for one or another future state of the system should be revealing where and how to intervene for bending the system towards the most concerted definition of sustainability as soon as development goals will be accordingly set. Figure 1-1 below illustrates how this concept of target scenarios can be depicted with respect to one particular instance. In this case, the two conditions of commoditization of forest carbon assets in compliance markets and low commoditization of forest carbon assets in voluntary markets as hypothesised in section *1.1.1* have been there synthesized into a 'macro-variable'.

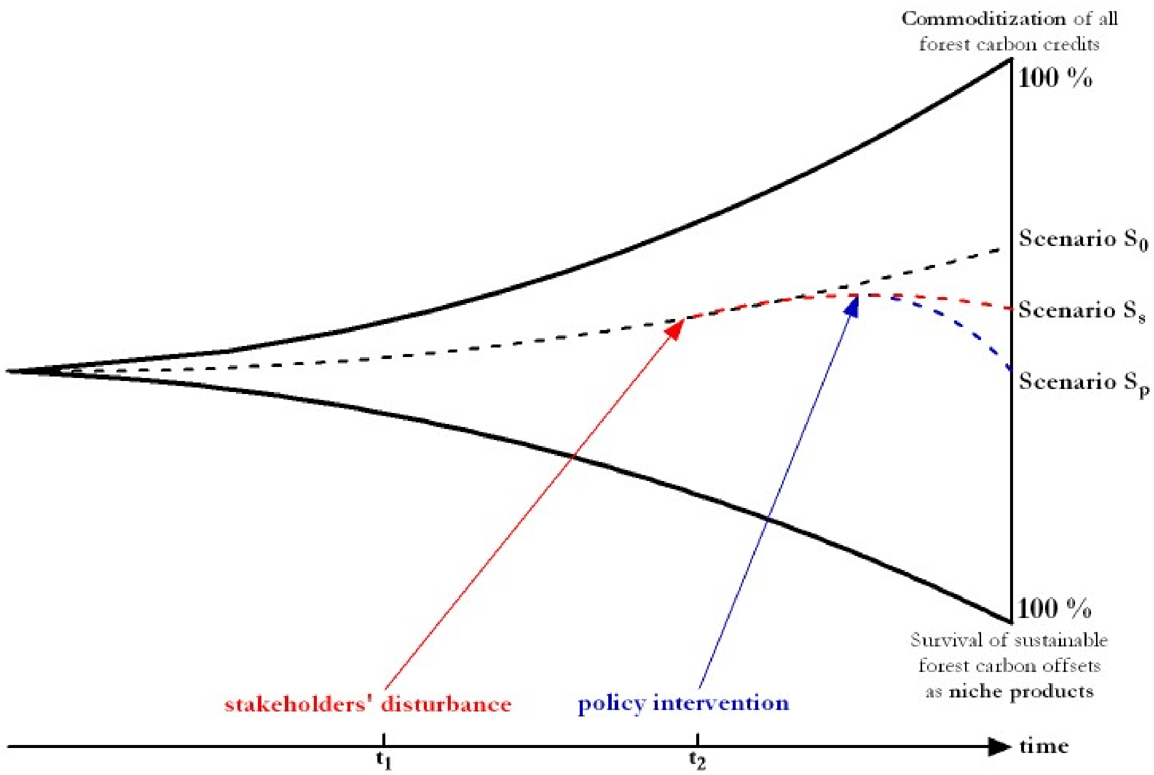


Figure 1-1 Scenario Trumpet Metaphor (S_0=surprise-free-scenario; S_s=stakeholders-disturbed scenario; S_p=policy-corrected scenario)

Source: (Scholz & Tietje, 2002)

According to the double function of this research, the starting point is now to build strategies on the scenarios constructed. After stakeholder consultation, different strategies might emerge e.g. to bet on the most probable scenario, to support the situation where a specific interest group has the highest utility, to aim at hedging risks with a satisfactory result for all scenarios, to keep a flexible approach until new evidence, or to explicitly influence one target because assessed the most sustainable.

<u>Transformation knowledge</u>

In order to realize the intended transition to a more effective use of LULUCF activities, drivers and barriers have been studied in terms of existing constraints and conflicts in the current state of things. Yet, at what conditions or course of action the effects of both drivers and barriers are synergic or counteracting seem to have been overlooked so far. While stakeholder analysis and MCA have already been combined by Brown et al. (2003; 2004) in the context of protected area management and forest planning, a different exercise has been here performed than constructing a set of sustainable development indicators for project assessment and monitoring which reflect the carbon, ecological and social dimensions of forestry carbon projects alone. Instead, a relatively simple model for MCA that is more comprehensive though, has been set up to embrace market actors' perceptions of the entire value chain between offset supply and demand, i.e. from project ideas to carbon credit issuance. As such, all the assumptions within this study are meant to be corroborated through further research in the field of case development and transition by prospective focus groups that might pick up the task of highlighting potential biases amongst experts and practitioners. The specific kind of transformation knowledge attained with respect to this research is thus an indication about the potential trade-offs among different evaluation criteria which may turn into either consensus or disagreement among different stakeholders.

1.2.3.4 Sources and References

Concerning sources and references, the information contained in the first and in the second background sections was mainly collected from literature. In order to get an understanding of the context, both the themes of carbon trading and forestry sector's current contribution to climate change mitigation were thoroughly investigated in the probing stage prior to analysis. As these two sections are chiefly theoretical background for the research, interviews were not targeted to gain additional information in that respect. On the contrary, 'softer factors' associated to environmental services, e.g. opinions and mindsets of key-position actors, were preferably collected through specific interviews and unpublished sources. Although some facts and figures surrounding the use of market-based conservation could be however retrieved from publicly available documentation, the third background was deemed to require additional input from other sources than secondary data. In fact, the border area between ecosystem services and carbon markets at large appeared to deserve more dedicated investigation for they are still relatively unexplored terrain for scholars. However, the main objective of this part of the research was directed to attaining specific information regarding the characteristic attributes and representativeness of some concrete experiences in carbon sequestration. Therefore, aspects regarding the underlying principles and concepts of economic instruments for conservation were deemed more inherent to the background sections and no piece of primary information was collected about those themes but partly through targeted interviews in the preliminary analysis.

1.2.3.5 Empirical Evidence

The choice of the empirical evidence, i.e. what information could be supplied from literature or had to be investigated empirically through questionnaires, interviews or computer-aided data sampling, was based on the different steps of the MAUT method due to its overarching role in relation to formative scenario analysis. Therefore, what the alternatives under consideration are was tentatively explored through expert consultation as mentioned above. As a result, the experiment of comparing Kyoto-compliant markets with voluntary offsets as alternative systems in a MAUT was discarded for "there is not just one compliance market or one voluntary market…. [As such,] each respondent might have different compliance or voluntary markets in mind." (Dornau, 2007) Even though "… a comparison would probably change when the VCS is operational later in this year." (Sell, 2007)

From that stage of the research on, valid alternatives to be analyzed have been identified instead in the single scenarios coming out from variables' combinatorial calculation. Thus, which properties each alternative option exhibits with respect to its associated attributes were elaborated with the aid of a database processor and related programming assistance. The associated attributes of the alternative options were progressively defined through literature review and periodical consultation with a few experts (Jung, 2007; Pettenella, 2007). A tentative survey containing an exploratory questionnaire was moreover sent to 155 practitioners of the sector in different market positions (Designated Operational Entities, project proponents, consultants, FSC certification bodies, private investors, public-private investment fund trustees and participants, project designers, international forestry research organisations, NGOs, carbon brokers, policy advisors, standard developers and advisory board members, offset retailers and buyers) to both test the suitability of a prospective stakeholder consultation and obtain some feedback on the chosen set of criteria. The few replies collected were nonetheless sufficient to shed light on a new path for the research and thus shift the scope from the mandatory-voluntary dichotomy to a wholly encompassing development analysis.

1.2.4 Validity and Limitations

The validity of the conclusions for this piece of research is strictly related to the details of the procedure carried out throughout analysis and discussion, e.g. system representation and consistency appraisal. Despite the fact that a highly formal method was adopted for the sake of transparency and objectivity, scenarios have been evaluated as being at least intuitively consistent, i.e. from no quantitative point of view. However, the overall decision-support model remains valid as long as it is acknowledged that many of the assumptions are inherent to the methodology adopted to develop it. A few of them are for instance embedded into the subjective judgement which is necessary during the exercise of creating both the impact matrix and consistency matrix. In those cases, the outcome is highly dependent on the author's views, knowledge and methodological awareness of potential fallacies. (Scholz & Tietje, 2002)

Particular attention has been given to the definition of the criteria which result from variables grouping. In order to be as sufficient as possible and to define proper questions to prospective respondents to elicitation surveys, the criteria had to reflect the preferences of the stakeholders or the different points of view, as so to summarise and group together diverse characteristics used to evaluate two separate regimes, i.e. mandatory and voluntary. Therefore, the first lists of criteria produced have been verified by a third party against the characteristics of completeness, redundancy, operationality, and mutual independence of preferences and size. Completeness means whether all important criteria have been included whereas redundancy refers to the concept of double counting, i.e. if some criteria are unnecessary or entail the same effects of others. Then, criteria are operational when it is possible to judge each option against each criterion in order to allow for a process where each future state of them can be compared satisfactorily, meaning that the criteria developed can apply to any development of carbon markets. In addition, the condition that the assessment of each option's attribute should be most desirably objective with respect to some commonly shared and understood scale of measurement was satisfied by the very nature of the computer elaboration of scenarios.

In addition, the mutual independence of preferences is particularly important because the chosen criteria need to be logically independent from one another, i.e. that preferences associated with the consequences of the options are independent on each other from one criterion to the next. Whilst impact variables are often interlinked as displayed in *Appendix VII*, *Appendix VIII* and *Appendix IX*, the overarching decisional criteria have been grouped in such a way that no complete subordination was possible among them. For instance, project costs and market prices for forest-based offsets are clearly related though not uniquely dependent on each other (Bayon, Hawn, & Hamilton, 2007) as so that variations in one or another attribute result in the same consequences. Finally, the size of the criteria set was chosen according to references suggesting that eight criteria are considered a large enough number for an effective evaluation (EU, 2004; UK Department for Transport, Local Government and the Regions, 2000) For what concerns the definition of what utility function is associated with the scale measuring the attributes and of how significantly importance weights are apportioned, no formal investigation was conducted in that respect as stakeholder multi-criteria analysis is only exploratory and indicative in this research. Moreover, Sell (2007) pointed out that many methods can be tried to determine weights e.g. WTP studies, discriminate analysis, Logit models, choice experiments, direct weights and some others. However, the approach of pair-wise comparison was deemed not convincing because distributing points when comparing the compliance with the voluntary market creates decision conflicts where there are none due to systems' functioning independence.

Concerning the scenario construction in section *3.4*, neither the scale employed for determining impacts strengths nor judging consistency measures are infinite but based on merely two or four levels respectively. Therefore, only extreme (top or bottom conditions) states of impacts have been considered because the already high number of variables examined urged simplification, but no intermediary configuration. Another fundamental assumption lies in consistency being a binary relation between pairs of impact factor levels as so that interactions between more than two impact variables are neglected. (Scholz and Tietje, 2002; Goetze, 1993; Brauers and Weber, 1988; in Tietje, 2005) Although the so-called MIC-MAC analysis of the indirect impacts, which is a constituting step of the method employed, was not performed due to data-handling constraints, a more detailed insight into impact variables' relative importance is nonetheless deemed partly compensated. In fact, the process of attributing consistency measures was conducted from an overall system dynamics perspective. First, while assigning consistency scores to pair of impact variables, the effect of their variability has also been weighed against the consequences on their higher system attributes, i.e. decisional criteria. Secondly, since it was recognized that third variables may modify the consistency rating of two other variables during the assessment of the consistency matrix, more than one redefinition round of impact variables or their levels has been performed.

For a detailed description of how consistency ratings of scenarios have been coped with, please refer to the relevant section *3.4.2*.

1.3 Paper Outline

The structure of the paper reflects the way the research has been formally designed without being a linear process. The chapters going from *3: Analysis* to *5: Conclusions* unfold harmonically with three consecutive cycles of research questions and objectives as it can be especially inferred from *Figure 1-2*. For the research questions (in orange) are closely related to the objectives and raised by the context, the answers are found at the end of the respective chapters after specific theoretical tools have been applied to the phenomena at hand. Research questions alike, the objectives (in blue and yellow) are also induced by the context. However, the choice of relevant theory and specific knowledge has been gradually made and adjusted depending on the changing objectives and questions. As a consequence, the methods adopted (in grey and yellow) have progressively enabled the author to both answer each research question and deal with the plausible validity threats to the answers. The appropriateness of the analytical tools was in turn facilitated, for the research questions were beforehand framed after feasibility and reliability of the methods. Synthetically put, each chapter between *3: Analysis* and *5: Conclusions* is the description of a process which is supervised by one objective and operated by one specific method, the input of which are the findings of the previous chapter and the output of which are the answers to the corresponding research question. In particular, the triple *Background* helps form the goals for the scenario construction, while the *Analysis* is preparatory to the formal procedure of scenario construction. Lastly, the *Discussion* yields the results for strategic agents to use in the contextual process following scenario construction. The latter point refers to the decision-makers addressed by the *Conclusions* to this paper.

Apart from where objectives and research questions are placed in the paper outline (in green), other information that is synoptically conveyed in *Figure 1-2* regards:

- The analytical framework to come to the conclusions is represented by the square dotted-lined box surrounding the whole research structure. The yellow labels refer to at what stage standard-qualitative research methods have been used, while grey labels refer to the formal procedure inherent to the specific embedded case-study technique. On the left side of the square border, the formal procedure can be followed stepwise along the research structure whereby the two orders of numbering points represent the embedment of FSA into MAUT, i.e. from step IV on.

- The numbers in the 'Background chapter area' refer to the three-fold structure of that chapter whereby the third one is bringing together the information compiled by the previous two into some preliminary analysis.

- The horizontal arrows in the 'Analysis chapter area' represent the innovation-oriented approach functional to relate factors to actors in front of stakeholder analysis and described in *Appendix I*.

- The vertical arrows in the 'Analysis chapter area' reveal how the definition of impact variables has been carried out taking into concern the three bottom aspects of sustainability without being limited by such categorization at the end of the process.

- The horizontal arrows in the 'Discussion chapter area' show how criteria and variables have been eventually referred to scientific-technical, financial and social aspects instead.

- The winding single arrow in the 'Discussion chapter area' represents how, being sustainability the ultimate objective for any policy assessment, the initial perspectives outlined by the *Problem statement* (cf section *1.1.1*) are now to be turned into actual preferences by stakeholder multi-criteria analysis to follow up.

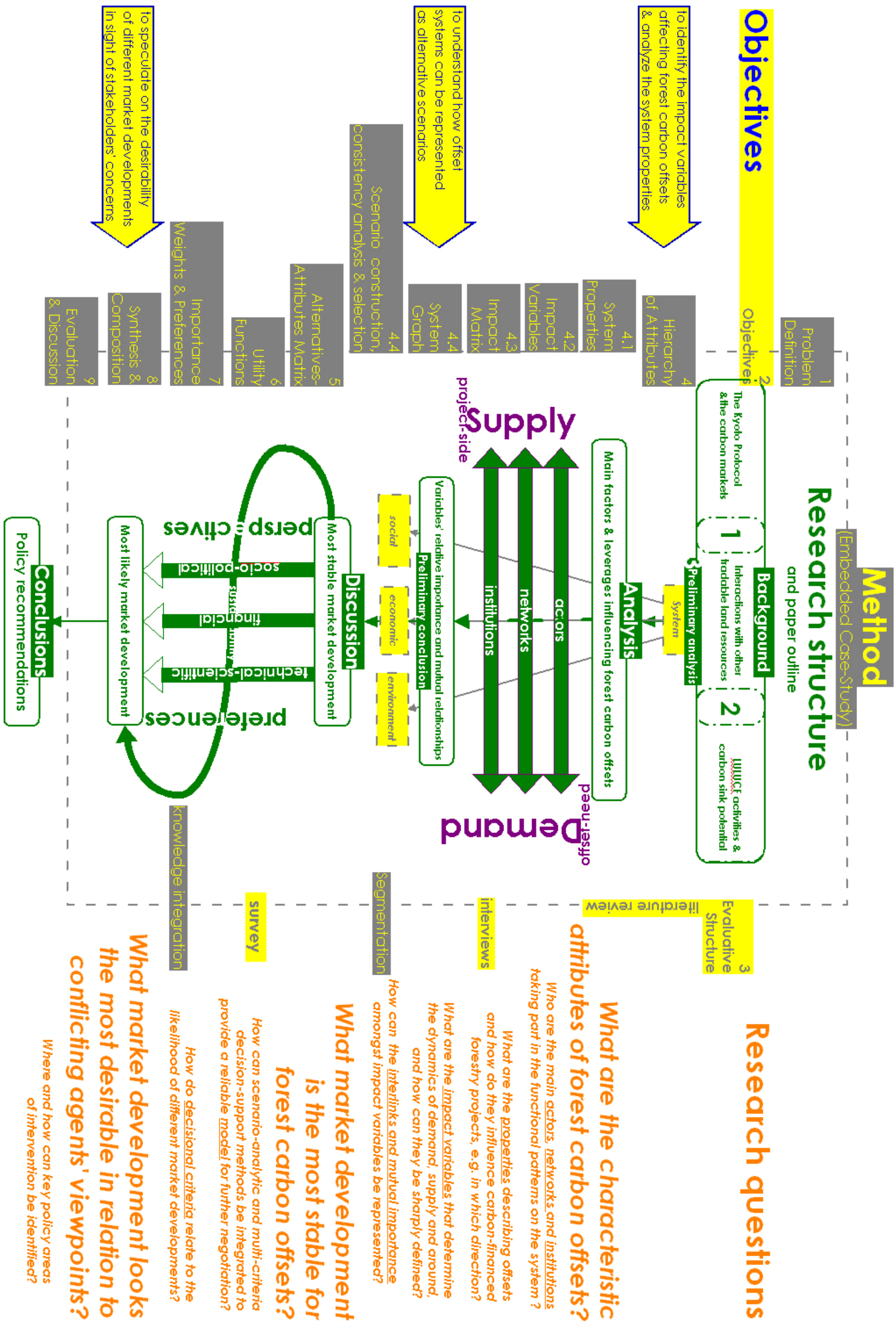


Figure 1-2 Research structure and paper outline

Source: (Barchiesi, 2007)

2. Background

The first part of this background is meant to deliver a general overview on the Kyoto Protocol and on the consequent array of carbon markets stemming from the trading mechanisms provided for by this well-known international agreement. As a consequence of the international climate policy scene being presented as the ultimate driver which led to the creation of these new forms of trade, the current state and trends of the carbon markets are entrusted with the task to give the feeling of how the carbon finance has risen to its present development. Then, the focus is shifted on project-based transactions as the production chain where forest carbon offsets are specifically traded in compliance markets. In addition, a 'panning' over country- and scheme-wise distribution helps understanding where from and where to carbon credits have historically been exchanged before shifting to the situation concerning CDM and voluntary programmes respective shares of the markets.

Scaling down from carbon markets as a whole, the second part will act as a sort of bridge between the inherent properties of the economic system around carbon offsets as such and the theory of ecosystem services to which carbon sequestration belongs. Hence, it focuses on LULUCF activities and on their own specificities from both the agro-forestry and carbon storage perspective. After presenting the global climate mitigation potentials for different types of carbon pools and land uses, the concept of carbon sequestration is transposed into the context of the Kyoto Protocol. The main provisions which followed the most decisive meeting for the LULUCF sector regulation are there reported in order to highlight the newly created opportunity to include credited sinks domestically along with the country-wise economics which thus result, among others. In that respect, the differences between potential and real development of the LULUCF CDM market will be related to current market volumes and the main national strategies. For key issues concerning LULUCF e.g. permanence, additionality and baselines, leakage, and socio-economic and environmental impacts, etc. have always been on the forefront in making climate-policy negotiators cautious and reluctant ever since, they have instead been treated further in course of the analysis. Besides portraying the scale to which this type of emission reductions (and thus the different cost allocation across countries) will be sought after, the viability of the different sink options described previously will be also presented. Ideally, this paragraph serves as the main base for the following analysis, at the end of which the first objective of identifying the system properties of forest carbon offsets finds fulfillment.

Despite carbon sequestration and storage is deemed one of the main kinds of environmental service that can get payments for on a significantly commercial scale, some forest carbon projects do not seem to be providing the most synergic and balanced bundle of benefits in the attempt of maximizing their carbon yield, especially mono-cultural fast-growing plantations. Nevertheless, converting the resources of tropical forests from public goods to tradable services has been indicated a promising approach to sustaining endangered ecosystems' functions and nature usefulness. (Sell, Koellner, Weber, Pedroni, & Scholz, 2007) In that respect, the conditions under which it is fair to advocate PES theory from a conservation agency's viewpoint are here investigated along with the level of agreement upon the development benefits that market-based policy instruments for climate mitigation claim to deliver. The ultimate aim was to confirm or prove wrong whether the management of natural resources by carbon project implementers is aligned to the targets which dedicatedly appointed organisations have for ecosystem parameters. In other words, a cross-check was performed on whether the methodologies adopted and priorities defined are acknowledged and shared, at least qualitatively or to some extent. Moreover, opinions were also collected concerning whether it is not illusory or ambitious that even the most advanced and carefully designed forest carbon project can reach the satisfactory level of collateral benefits claimed in project idea notes.

2.1 The Carbon Markets at a Glance

Before providing any background information, an early warning is required by the very definition of "carbon market" itself. Indeed there is no single carbon market defined by a single commodity, by a single contract type or by a single set of buyers and sellers. Rather, several fragmented carbon markets encompassing both allowance- and project-based assets co-exist with different degrees of interconnection. What is called instead carbon market is thus a loose collection of diverse transactions through which quantities of greenhouse gas (GHG) emission reductions are exchanged. For this reason, some analysts have usefully compared the carbon markets as being more analogous with currency markets rather than the more traditional, undifferentiated, standardized global commodity markets. Loose because it is still difficult to date to compare prices or quantities traded over the whole market. As long as there is no world-wide central clearinghouse for carbon transactions, the information will thus keep being limited as such, especially on prices. (Capoor & Lecocq, 2002, p. 9) The carbon markets are complex and fast-moving entities which continue to be influenced by both the development of policy and regulation that led to their creation and the market fundamentals. Such markets are developed to different degrees in different parts of the world as national and regional policies evolve on their own. Nonetheless, carbon finance is the term used for carbon credits that help finance GHG reduction projects and are traded like ordinary financial assets on dedicated stock exchanges.

Furthermore, the word "carbon" as before offset, credit or finance, generally refers to the other five GHG as well besides carbon dioxide: methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). In fact, all six gases are put in the same basket for accounting reasons in the context of a Kyoto-compliant mechanism. The different global warming potential (GWP) of each of them is then synthetically translated into carbon dioxide equivalent (CO_2e) through the following formula: $CO_2e = \Sigma_i \; GWP_i \bullet E_i$ i.e. CO_2eq are the normalised sum of the three main substances responsible for the climate change (Ei are CO_2 (in kt/y), CH_4 and N_2O (in t/y) emissions; and GWP_i. coefficients are respectively 1, 0.021 and 0.31 for CO_2, CH_4 and N_2O). (IPCC, 2001b, pp. 385-386) As a result of the above explanation, 'greenhouse gases' and 'carbon' are often used interchangeably in the terminology as done hereinafter in this paper. Moreover, the definition of forest carbon offsets will be as whatever techno-socio-economic conditions surround the effect of negating or neutralising a ton of CO_2e emitted in one place by avoiding the release of a ton of CO_2e elsewhere or absorbing / sequestering a ton of CO2e that would have otherwise remained in the atmosphere. This definition will apply to both regulated markets where only Kyoto-compliant projects that are registered with relevant authorities will be able to generate approved carbon credits, and non-compliance projects that are not seeking official registration since their demand is not created by mandatory reductions. Therefore, the latter offsets will not be able to be used for meeting Kyoto or EU targets, though the credits generated by these projects may be certified as well under third-party verification as legitimately alike carbon currency (Taiyab, 2006)

2.1.1 The International Climate Policy Scene

In order to curb global warming as stated in Article 2 of the United Nation Framework Convention on Climate Change in pursuit of its ultimate objective, CO_2 emission shall be dramatically reduced as it is widely known. The punishment for humanity being otherwise to cope with increased likelihood of extreme weather events, vector-borne diseases, changes in hydrological patterns, melting of polar caps leading to a rise in sea levels. With that aim in mind, 149 countries agreed on adopting a strategy to reduce Green House Gases (GHG) emissions when they signed the Kyoto Protocol in 1997. The Kyoto Protocol was enacted on 16th February 2005, as it should also be known, and has so far been ratified by 156 Parties. According to this agreement, 39 countries have committed to limit and/or reduce their own GHG emissions. The commitment regards the period 2008-2012 in particular, when objectives have to be reached at latest. The Protocol assigns to industrialised countries a certain amount of GHG allowances in the fashion of emission caps. These caps are defined as a percentage of each country's emissions in 1990. The European Union has fixed its own target to reduce GHG emissions down to 8% of 1990 levels during the period 2008-2012. Italy, for instance, has received a reduction target of -6.5%, whereas Sweden is committed not to let its emissions increase beyond +4%.

The countries involved have been divided in three annexes (Annex I, Annex II and non-Annex I) depending on their emission reduction duties. Annex II countries are OECD countries included in Annex I along with economy-in-transition countries. According to the principle of common but differentiated responsibility, the Protocol has defined reduction objectives which have become compelling after ratification but that keep different across Parties. In particular, being Annex I countries the most industrialised, expectations on them developed as so that they should commit more thoroughly in abating GHG, undertake the first steps towards their reduction objectives, and report on the first results achieved in that direction. Consistently with that principle, non-Annex I countries were attributed no reduction obligations, though room for contribution is anyhow left by the purpose of the below mentioned Clean Development Mechanism.

It is noteworthy that, whereas the UNFCCC is a soft law, the Kyoto Protocol defines legally-binding reduction targets along with a precise verification timeframe corresponding to the three commitment periods. A third element supplementary to domestic actions are the so-called flexible mechanisms which allow for Annex I countries to fulfil part of their own reduction goals by implementing emission abatement projects where it is economically more profitable. The underlying rationale is that emission reductions can take place everywhere irrespective of their geographic occurrence in face of a globally equal warming impact and a worldwide climate crisis. The overarching purpose to that is to facilitate the accomplishment of these targets while minimising the consequences of climate policy on the development of committed countries. In fact, the battle field between economic growth in a globalised world trade and the environmental urgency of retrofitting the existing energy and production systems has led to encompassing solutions where the marginal costs for emission reduction or sequestration are the lowest. To reduce some countries' emissions by more than one third by 2012, not so many means indeed would have been possible other than shutting down production, taxing all energy consumption or mandating energy efficiency at any cost. The three flexibility modalities devised by the Kyoto Protocol in light of that "equivalence principle" are then the Joint Implementation (JI), the Clean Development Mechanism (CDM), and the Emission Trading (ET).

Besides the cap-and-trade approach defined by this third flexibility option to operate within industrialised countries, the CDM and the JI allow for credit trading also with countries that do not have overall emission caps. In that sense these mechanisms are different from the ET mainly because they are project-based while the latter mechanism entails allowance-based transactions. By defining carbon transactions as purchase contracts whereby one party pays another party in exchange for a given quantity of GHG emission reductions in the form of permits (either allowances or credits) that the buyer can use to meet its compliance objectives, two main categories can be eventually grouped:

1. Allowance-based transactions, in which the buyer purchases emission allowances created and allocated (or auctioned) by regulators under cap-and-trade regimes, such as Assigned Amount Units (AAUs) under the Kyoto Protocol, or European Allowance Units (EAUs) under the EU ETS. The cap-and-trade approach to emissions trading allows for an aggregate cap on emissions to be distributed in the form of allowance permits. Such allowance markets have high environmental credibility because they establish a flexible structure to achieve the desired level of environmental performance established by the level of caps set.

2. Project-based transactions, in which the buyer purchases emission credits from a project which can credibly and verifiably demonstrate it reduces GHG emissions compared with what would have happened otherwise, i.e. the baseline. According to the baseline-and-credit approach to emission trading, firms earn emission reduction credits for as many emissions as they manage to keep below their own historic baseline. The most notable examples of such activities are under the CDM and the JI Framework under the Kyoto Protocol, generating Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) respectively. Even though these project-based mechanisms have strong environmental credibility because they are created using approved methodologies and benefit from being independently certified before they are issued, there are other types of pre-certified project-based transactions such as Verified Emission Reduction occurring under voluntary offset programmes. Besides these reduction credit trading types though, also emission rate averaging in which credits and debits are certified automatically according to a set average emission rate exist. (Capoor & Ambrosi, 2007a; Ellerman, Joskow, & Harrison, 2003)

Therefore, according to the ET mechanism provided for by Article 17 of the Kyoto Protocol, each and every Annex I party has the right to purchase allowances on sale on the emission market by some other Annex I country which has been able to reduce its own emissions more than the provided target. However, not only emission allowances available at national level as AAUs can be purchased and sold at market prices, but also ERUs and CERs attained respectively from JI and CDM projects. In this way, OECD countries and their regulated companies can also meet part of their obligations from sustainable projects overseas while an opportunity is created for resources to flow to support clean development e.g. in Africa or where it is more needed as so that it can be seen from now on as "…a multi-year hard currency revenue stream as payment for verified performance of global atmospheric services". (Capoor & Ambrosi, 2007b)

In the very same framework, a European Union Emission Trading Scheme has been consequently created for emission allowances trade at the communitarian level. Such a tool pursues GHG emission reduction according to the same rationale of economic efficiency and abatement costs restrains. Given a -8% compliance by 2012, the European Union has thus decided to adopt its own system beforehand, defining emission caps country-wise as well as respectively domestic allocations for the facilities belonging to the sectors involved.

As the main instrument within the European strategy for curbing emissions, the ETS should facilitate the companies' task by enabling them to appeal to the EUAs market in the event of marginal abetment cost exceeding allowance prices. *Figure 2-1* hereinafter pictures the timeframe of the EU ETS insertion into the abovementioned key dates of the FCCC history.

The Directive 2003/87/EC first established a mandatory permit regime that from 1st January 2005, is covering around 5 000 industrial facilities and accounting for about 40% of EU emissions of carbon dioxide. Its scope includes energy activities (power plants beyond 20-MW capacity), mineral oil refineries and coke ovens, production and processing of ferrous metals, cement clinker, glass and ceramic products manufacturing, and other activities such as the pulp and paper industry. Before the emission trading became officially operational on 1st March 2005 though, each and every Member State should have established both its own emission caps for the 2005-2007 Phase I and a national registry serving as means of allowance transaction accounting and emission reduction assurance. The initial allocation of allowances was performed 95% by grandfathering and 5% by auctioning for the 2005-2007 Phase I, whereas these figures are meant to turn to 90% and 10% respectively in the post-2007 Phase II. Some flexibility elements were introduced within the very same EU ETS as well. For instance, Member States could ask the temporary exclusion of certain specific installations for the first phase through an opting-out mechanism, whereas it will be possible to opt other activities or gases in the Directive scope from 2008 (e.g. mobility management, waste disposal, small and medium enterprise, national allocation plans). Moreover, Member States will be allowed to pool plants under the same GHG emission management. The sanction system for those operators who would not give back as many allowances as their emissions, presently foresees 40 € per tonne CO_2eq. This fine is expected to grow up to 100 € for the second phase. Paying the fine does not prevent the operator from the obligation to procuring enough allowances to offset his/her surplus emissions. (Parliament and Council Directive 2003/87/EC OJ L 265 25.10.2003)

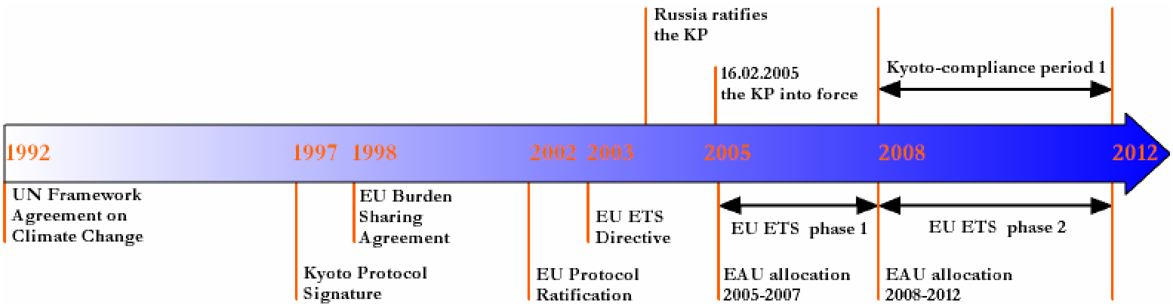


Figure 2-1 Kyoto Protocol and EU ETS chronology

Source: (Magni, 2005)

2.1.2 The Rise of the Carbon Finance

As a result of the growing pressure to address climate change by both means of regulatory demands and voluntary objectives of governments and industries to decrease GHG emissions, multimillion-dollar markets for carbon are now created. The overall value of the global aggregated carbon markets was over US$30 billion in 2006, thus fulfilling the apparently excessive predictions of some analysts from the first quarter's volumes and values. Clearly, a key driver for such a development has been the Kyoto Protocol and the 38 industrialised countries' agreement to cut their emissions between 2008 and 2012 down to levels to on average 5.2% below 1990 amounts. Carbon derivatives are now traded like an ordinary financial commodity as so that to date such trade goes well beyond the physical exchange of emission allowance certificates for compliance. Other early evidences of market matureness have been thoroughly fulfilled in that allowance trading has overtaken project-based transaction since the UK spot market soared and the secondary market has definitely emerged since it is no longer an experiment for companies to liquidate small quantities of reductions from their portfolio. (Capoor & Ambrosi, 2006a, 2007a; Capoor & Lecocq, 2002)

To date, a large number of international financial institutions and funds engage in secondary transactions of carbon portfolios with other banks primarily in Europe or companies facing compliance obligations in both Europe and Japan. No wonders then that the abovementioned figures reflecting all financial transactions for allowances have been driven in particular by the prices for Phase I EAUs since the market was by far dominated by this kind of sale and re-sale in their first two years. The EU ETS has been growing up to nearly 82% in value (US$ 24.4 billion) across all market segments since the 75% of transactions in 2005 (US$ 8.2 billion). This corresponded to an increase from 322 to 1 101 million tons of CO_2eq. (Capoor & Ambrosi, 2006b, 2007a) Such an expansion is depicted in *Figure 2-2* below along with the role of project-based credits in the market trading.

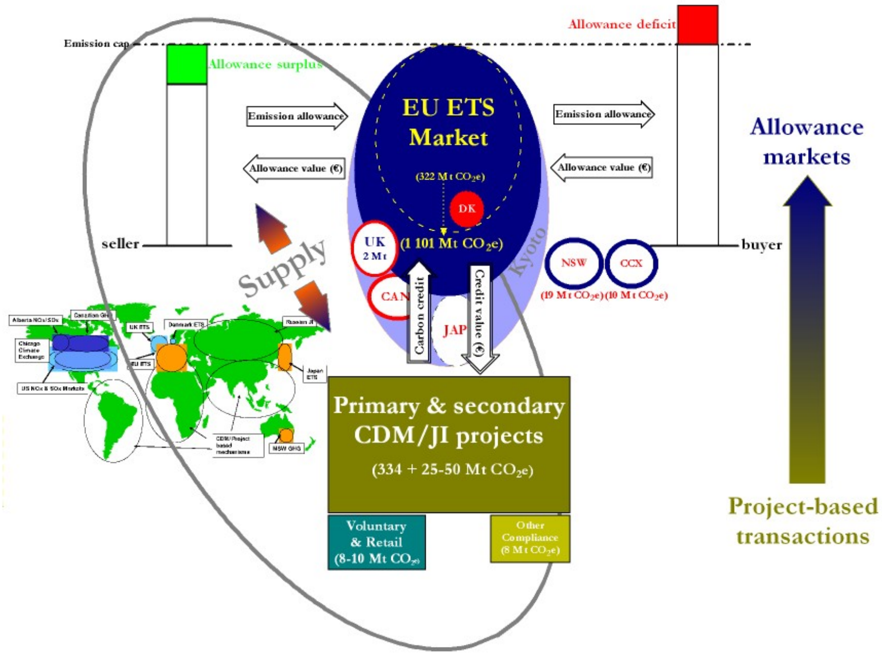


Figure 2-2 Structure of the market in 2006 and relationship between project-generated credits and allowances

Source: (Capoor & Ambrosi, 2006a; Magni, 2005)

Carbon cap-and-trade regimes currently in place allow for the most part for the import of credits from project-based transactions that can be used for compliance, above and beyond the initial supply of allowances. For example, ERUs and CERs issued and delivered to an account in a registry can be used to meet obligations under the Kyoto Protocol. Similarly, the EU 'Linking Directive' allows mandated facilities to use credits from the CDM (yet with some limitations) during Phase I.[1]. *Figure 2-2* provides an insight into the market segmentation as illustrated under the following heading and complemented by the figures in *Table 2-1*.

Table 2-1 Carbon markets in volumes and values 2005-2006

	2005		2006	
	Volumes ($Mt\ CO_2e$)	**Values (MUS$)**	**Volumes ($Mt\ CO_2e$)**	**Values (MUS$)**
		Allowances		
EU ETS	321	7 908	1 101	24 357
New South Wales	6	59	20	225
CCX	1	3	10	38
UK ETS	0	1	n.a.	n.a.
Sub Total	**328**	**7 971**	**1 131**	**24 620**
		Project-based transactions		
Primary CDM	341	2 417	450	4 813
Secondary CDM	10	221	25	444
JI	11	68	16	141
Other Compliance	20	187	17	79
Sub Total	**382**	**2 894**	**508**	**5 477**
Total	**710**	**10 864**	**1 639**	**30 098**

Source: (Capoor & Ambrosi, 2007a)

2.1.3 Project-Based Transactions

The EU market has been thriving in the past two years not only in the trade of allowances but also for the import of project-based reductions in light of the high demand from European and Japanese companies. After so strong signal therefore, price expectations on project-based trading were raised as well in 2005, leading to 374 million tCO_2e mainly of CERs transacted at a value of US$2.7 billion and with an average price climbing over US$7.23. These numbers reflected a respectively threefold and fivefold increase above the previous year's value and volumes from project-based transactions. Already promising in the first quarter of 2006 alone with 79 million tonnes transacted, last year the carbon market for project-based activities grew sharply in value to an estimated US$5.5 billion, primarily

[1] The so called "Linking Directive" is Directive 2004/101/EC which in 2004 amended Directive 2003/87/EC establishing the European-wide emissions reduction and trading scheme (the EU ETS). Pursuant to the amendment, the use of CERs and ERUs for compliance in the EU ETS became allowed with the exception of those credits generated by LULUCF activities which are not linked to the EU ETS.

through the CDM and the JI. In the first three months of 2006 in fact, prices for project-based emission reductions had already soared with an average reported price of US$11.45 per t CO_2e. (Capoor & Ambrosi, 2006b, 2007a)

The reasons for harnessing the "Joint Implementation" of projects by industrialized countries, including those with economies in transition, are provided by the Article 6 of the Kyoto Protocol itself. It allows an entity in one such country to finance or purchase ERUs from a project in another industrialized country and thus the trading between two developed countries. Eligible projects include, for example, emissions reductions in energy, industry and transport sector activities, as well as carbon sequestration through land-use change, agriculture and forestry activities. Through the implementation of JI projects, the investing country will therefore attain the transfer of as many ERUs from the host country as those resulting from either reducing emissions at the source or enhancing sinks of GHG in any sector of the economy. ERU prerequisite is to be additional to any other reduction that would otherwise occur regardless of the project. Then, acquired credits can be either stored or immediately sold on the carbon market. Although all submitted and approved projects since 2000 are considered JI projects, respective ERUs can only be issued stemming from reductions occurring later than 2008. (Kiss, Castro, & Newcombe, 2003)

Similarly, Article 12 defines the "Clean Development Mechanism" under which an entity in an industrialized country may purchase CERs from a project in a developing country, or "removal units" (RMUs) if the project concerns carbon sequestration (long-term removal from the atmosphere) through afforestation and reforestation activities. The dual purpose of this mechanism is to contribute to the reduction of global carbon emission and simultaneously assist developing countries achieve sustainable development through the transfer of cleaner technologies or sustainable forestry and agro-forestry practices and financial resources for specific projects. In fact, the clean development is to be boosted by Annex I countries through technological innovation which allows for high energy efficiency and low GHG emissions inside targetless non-Annex I countries. The investing country will practically receive as many Certified Emission Reductions CERs as equal to the difference between the reference scenario without the project and the actual attainment. Therefore, emission reductions resulting form such project activities shall be real, measurable, long-term beneficial in relation to climate change mitigation and additional to any removal that would occur without the project. Awarded CERs can then be sold on the emission trading market or stored to fulfil the assigned national targets. All CDM projects have been submitted and approved since 2000; nevertheless, CERs produced from that date can only be banked to reach the national targets for 2008-2012.

In addition to the Kyoto Protocol which is the largest potential market though, and to the EU ETS as its main "tributary", there are or have been a few other national or regional emissions trading schemes established to help Kyoto signatories meet their targets. Some of these have expired since they were intended by individual EU countries to serve as proactive measures hedging against prospective regulatory measures. As known nowadays, the EU-wide emission trading system has eventually harmonized the various national schemes. With such a purpose to first prepare and then adapt the industry under jurisdiction, Denmark was thus the first country to launch a GHG-trading scheme in 2002. In the same year, the first allowances were auctioned in the UK for the start of its own national market that though ended in December 2006. (Capoor & Lecocq, 2002) During this time, the voluntarily participating organisations have supposedly gained valuable experience in developing emissions reduction strategies in addition to better understanding the mechanics of trading. Aiming at the same learning plus shaping future regulated schemes, even giant private emitters e.g. BP-Amoco and Royal Dutch/Shell had started and concluded their own internal trading schemes designed to help them meet self-imposed company-wide targets in advance. Either voluntary or mandatory for the various business units, mimicking the foreseen Kyoto-introduced markets proved that bringing down GHG emissions requires long-term preparation and regulation certainty besides information sharing. (Nicholls, 2007)

Outside Europe, Canada and especially Japan have been the more awaited actors amongst the countries that ratified Kyoto, lagging behind with just some attempt to institute emission trading systems at the national level. This until the latter which has always been an active market player especially in the purchase of CDM credits launched the nation's new Voluntary Emissions Trading Scheme in 2005, to be compatible with the Protocol and with the recurring aim of accumulating knowledge and experience in this field. 34 companies and corporate groups who responded to an open invitation were hence selected as participants on the base of their cost-effectiveness and consequently subsidized in exchange of reduction commitments. Some concerns about this programme still remain as no major emitting industry is taking part to it. (Sudo, 2006) As far as Canada is concerned, it is remarkable that the North American country is engaged in the only other effort of regional level like the EU ETS. In fact, a New England Governors and Eastern Canadian Premiers (NEG/ECP) initiative is still tentatively under development as the Eastern Canadian Provinces and New Brunswick, together with the District of Columbia and Pennsylvania, are observers in the currently operational Regional Greenhouse Gas Initiative of the North-East and Mid-Atlantic States of the U.S.. This embryonic process was actually inspired by the creation of such multi-state cap-and-trade programme to which Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont are participating. (Climate Action Network, 2007; Regional Greenhouse Gas Initiative, 2007)

By contrast to the abovementioned ETS-analogous programmes, the USA and Australia which neither signed the treaty are also hosting a series of sub-nationally regulated programmes which can primarily or secondarily access project-based windows. The Oregon Standard (the oldest carbon dioxide emission regulation in the U.S.) of the Oregon Power Plant Offset Programme on one hand and the New South Wales (NSW) Greenhouse Gas Abatement Scheme on the other testify that. The Australian state-level programme, for instance, allows the purchase of Australian forestry sequestration certificates as one possible option to meet regulated emissions reductions for the electricity sector, while Oregon's new energy facilities are required to offset their emissions via projects which are either directly proposed or implemented by The Climate Trust, an ad hoc non-profit organization. Therefore, thirty out of fifty states in the US are still purchasing carbon credits in anticipation of future regulation and thirteen states have passed legislation mandating emission reductions to date. Moreover, a nation-wide trading programme stemming from the merge of East and West coast regimes is even more looming in the U.S. after California and New York State's Governors came together for a link-up discussion. Following California enactment of the Global Warming Solutions Act of 2006, the RGGI is increasingly looking at the already well-developed California Climate Action Registry (CCAR) for GHG emissions as a means of unification, possibly in connection to the Chicago Climate Exchange (CCX) (Bayon, Hawn, & Hamilton, 2007)

Initially developed both as trading system compatible with emerging rules under Kyoto and federal regulation advising tool, CCX has in fact announced a willingness to expand its activity to other schemes and other regions, in particular for the development of financial instruments relevant to the RGGI. All these initiatives testify that a small but significant non-

Kyoto market for organizations seeking to meet local and national emissions reduction requirements, voluntary initiatives and smaller retail sub-markets for high quality tons regarding socially responsible companies and individuals wanting to become 'climate neutral'. In fact, transaction volumes have been led up across all market segments, including U.S. and Australian programmes. The EU ETS prices notwithstanding, both the CCX and the NSW scheme saw record volumes and values traded in 2006 with a respectively thirteen-fold and fourfold increase. Indeed is there also a strongly growing retail carbon segment that sells emission reductions (ERs) to individuals and corporations seeking to offset their own carbon emission footprints which was estimated being worth US$100 million in 2006. In between, the likewise voluntary but legally-binding compliance objectives of the companies participating to the Chicago Climate Exchange (CCX) are noticeable where more than 11 Mt CO_2 from offsets have been issued on the CCX so far and the vast majority of which originate in North America (U.S. 34%, Canada 18%). (Capoor & Ambrosi, 2006a, 2007a, 2007b) It is finally noteworthy that Australia witnessed the abortion of the Sydney Futures Exchange (to be linked to a subsidiary in New Zealand as well) which had carefully planned all the key features of a platform before reversing its plan in 2000. (Landell-Mills & Porras, 2002)

In summary, EU ETS Phase I proved that a carbon price signal in Europe can succeed in stimulating emissions abatement and innovation both within Europe and especially in developing countries. In fact, the stimulation of the supply by European and Japanese demand of credits has led to a meaningful participation of developing countries to bringing real emission reductions as well. This reflects the main compliance buyers across the world being:

1. European private buyers interested in the EU ETS;
2. Japanese companies belonging or anticipating an enlargement of the recently launched domestic emissions trading scheme;
3. Government buyers interested in Kyoto compliance (mainly EU and Japan again);
4. U.S. multinationals operating in Japan and Europe or getting started for the Regional Greenhouse Gas Initiative (RGGI) in the North-eastern U.S. States;
5. Power companies regulated by the New South Wales (NSW) market in Australia;
6. North American companies with voluntary but legally binding compliance objectives in the Chicago Climate Exchange (CCX);
7. The growing retail carbon segment that sells emission reductions (ERs) to individuals and companies seeking to offset their own carbon emission footprints.

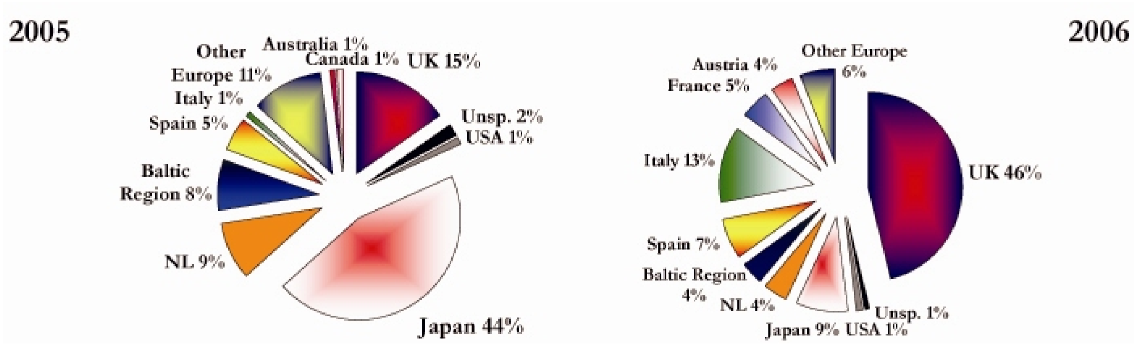


Figure 2-3 Buyers' market shares in volumes

Source: (Capoor & Ambrosi, 2007b)

While the EU and Japanese private sector were dominating the buy-side of the market with nearly 90% all transacted project emission reductions as much in 2005 as in 2006, the former year's figures corresponded to US$4.6 billion in CERs and ERUs. 100 Mt CO_2e of these credits were committed to purchase by the Government of Japan and over 365 Mt CO_2e by the EU Governments. Within the latter, the U.K. led the market for a second consecutive year with nearly 50% of project-based volumes. Whereas the City of London is actually home to a number of global financial institutions, Italy and Spain follow the UK with respectively 10% and 7% due to their more and more compelling national strategies with respect to Kyoto commitments. On the contrary, Japan dropped its shares dramatically from the first year to the next (*Figure 2-3*).

However, European buyers dominated the primary CDM & JI market soaring from 50% in 2005 to 86% market share as Japanese purchases of the primary market dwindled sharply in 2006. Private sector buyers, especially banks and carbon funds, continued to buy large volumes of CDM assets, while public sector buyers continued to dominate JI purchases. Before Europe and Japan became such active buyers though, Canada, USA, and to a lesser degree Australia, used to be the leaders in volumes purchased through projects in the 1996-2002 period, testifying the impact of certain allowance trading regulation enforcement. Likewise, projects used to be mostly LULUCF activities before relevant limitations were set and the span of lowest-cost technologies explored in project-based transactions widened evenly. (Capoor & Ambrosi, 2006a, 2007a; Capoor & Lecocq, 2002)

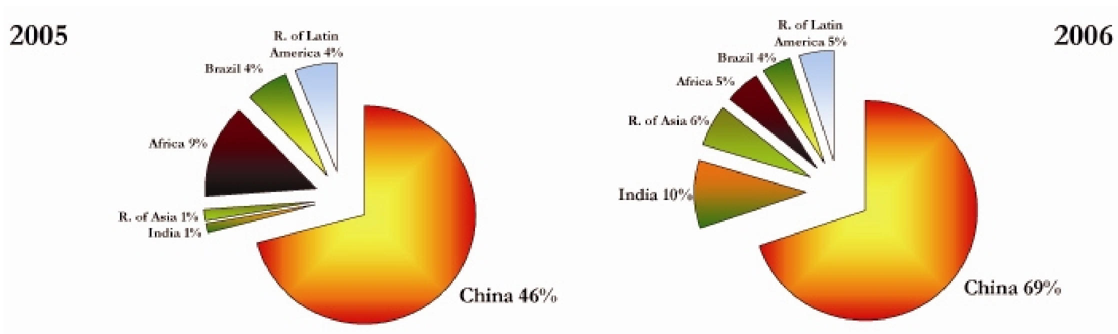


Figure 2-4 CDM sellers' market shares in volumes

Source: (Capoor & Ambrosi, 2007b)

From the supply-side depicted in Figure 2-4, China deserved the award of the biggest seller for two consecutive years, followed by Brazil at first and then by India which used to own more shares in 2004. By that time, the EU-15, the economies-in-transition countries, the USA, Canada, Australia and New Zealand accounted for less than 8% instead. Since 2002, a cumulative 920 Mt CO_2e (equivalent to 20% of EU-15 emissions in 2004) have been transacted through primary CDM transactions for a value of about US$8 billion. This market share of CDM credits from developing countries was about 49.2% of overall volumes transacted globally in 2005. If compared to *Figure 2-2*, the CDM market share of the overall carbon market volume was approximately 29% in 2006. By contrast, JI remained a very small contributor at about 2.6% (4.7% in 2005) of project-based volumes (just 0.5% of the entire carbon market) because of the relatively low prices reflecting the perception of regulatory and institutional risks. (Capoor & Ambrosi, 2006a, 2007a)

The primary CDM 2006 volumes were equivalent to 2005, even though entailing smaller projects and higher average price. HFC project are in fact starting to recede while N2O, flaring and wind are expected to significantly expand this year. On the contrary, secondary CDM volumes expanded significantly in the second half of 2006 with only forward trades as a financial reaction to the developments in the EU ETS, e.g. swaps between EUA 2008 and secondary CERs, and to long-term expectations. A market shift and differentiation from compliance-driven transactions of offsets to a more financial intermediate market of asset classes may then start to be observed. Finally, JI are definitely awaited to do more in 2007 as regulatory and procedural uncertainty is expected to fade away in the year and the big competition is already pushing prices up. Prospects over the future balance of carbon offset demand and supply and CERs/ERUs prices agree in stating that an overall shortfall of 3 750 Mt CO_2e for Western Europe, Canada, Japan and New Zealand is likely to occur in the second commitment period 2008-2012. On the other hand, there is consensus that primarily the EU ETS Phase II will be setting a coinciding price for EUAs in favour of its participants for Canada and Japan do not seem to compete for the these assets. Unless the 812 Mt CO_2e CERs which have already been contracted will be undelivered, there is still a projected potential of 1 500 Mt CO_2e plus 7 100 Mt CO_2e AAUs prospectively coming from the Russian Federation, the Ukraine, the EU 10 new members and other economy-in-transition countries "to fill the gap in the West". (Capoor & Ambrosi, 2007b)

2.1.3.1 The CDM Market Development

As previously described, any CDM project basically involves two actors, namely one project sponsor or developer from an investing Annex I country and one beneficiary in a non-Annex I host country. Concerning emission reduction or removal, it can be carried out according to three main modalities: emission reduction through technological enhancement of existing facilities, avoided emissions through renewable energy system implementation, and GHG sequestration thanks to Land-Use, Land-Use Change and Forestry (LULUCF) activities. Given these two sets of variants, the market equilibriums have produced the distribution illustrated in *Figure 2-3* and *Figure 2-4*, i.e. where and by whom certain types of projects can be more cost-effectively sponsored.

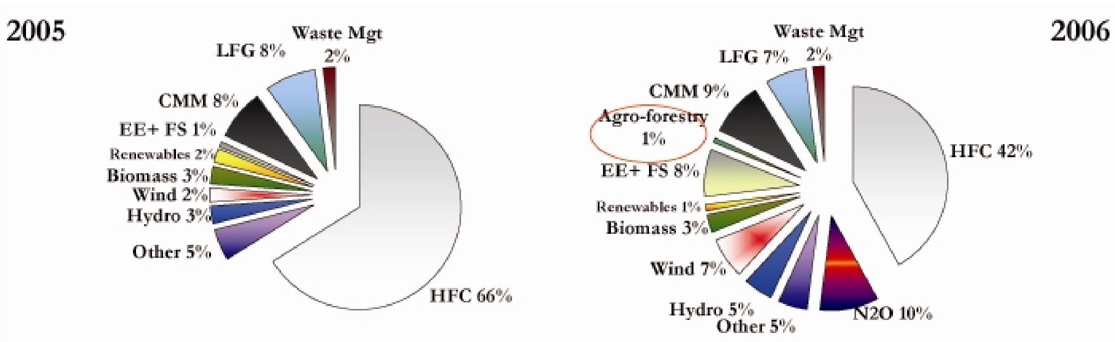


Figure 2-5 CDM market share of carbon asset classes and technologies in volumes[2]

Source: (Capoor & Ambrosi, 2007b)

Since LULUCF activities will be the focus of the next chapter, the share of agro-forestry among others is highlighted in details below. A quick look at 2006 market data through the above *Figure 2-5* shows that the lowest-cost options, i.e. the first asset classes to be systematically tapped globally, are still those involving the so-called industrial hydro-fluorocarbon gases reduction (HFC) followed by nitrous oxide (destruction projects N_2O). These two project classes alone accounted for approximately half of the market volumes, while renewable energy and energy efficiency transactions together accounted for nearly 21% of the CDM market. (Capoor & Ambrosi, 2007b) Carbon assets from LULUCF remain at 1% of volumes transacted so far with the sole 'Facilitating Reforestation for Guangxi Watershed Management in Pearl River Basin' project in China contributing with an expected 26 k CO_2e per year but no CER issued as to date. (Fenhann, 2007) "Voluntary markets may consider less complex and costly ways to manage permanence risk than the current approach of temporary credits under the CDM. Large classes of LULUCF assets including possibly soil sequestration, fire management and avoided deforestation, among others, remain attractive opportunities to promote sustainable development in Africa and in other natural resource-based economies, but are still systematically excluded from the CDM and other regulatory markets." (Capoor & Ambrosi, 2007a, p. 29)

When looking at the pipeline of CDM Project Design Documents (PDD), the number of credits issued per project[3] have ranged from few units to the 8 651 562 CERs of a raw-material-substitution project in the Brazilian cement-processing industry. The number of CDM projects being validated as to July 2007 results in roughly 63 million CERs, while the projection for the end of 2012 forecast over 3 billion CERs assuming 87.5% of issuance success and 50-million-CERs increase per year. As factual sources of CERs out of the 2285 submitted applications, 761 projects are officially registered and 71 more are in a requesting-registration status[4]. (Fenhann, 2007) For what concerns transactions fundamentals, CDM projects are mainly part of the primary market (>95%) and are characterized by high diversity and little standardisation due to upfront purchase of emission reductions that still have to be generated. As far as credit delivery is not secured directly through forwarding to buyers, price is thus linked to project risks which in turn depend on factors, e.g. the underlying project itself, the counterparty, the host country, etc. However, a sort of secondary market is anyhow

---

[2] EE + FS = Energy Efficiency + Fuel Substitution; CMM = Coal Mine Methane; LFG = Landfill Gas Capture.

[3] The number of projects with CERs issued is 213. (Fenhann, 2007)

[4] 1417 projects are still at validation while 20 were rejected already and 5 withdrew. (Fenhann, 2007)

present in the CDM chiefly as a means of partly reducing these project risks. In fact, project developers can pool among themselves in order to ensure a certain flow of credits at various times. In the end, CERs price will be more exclusively linked to EUA prices and the whole project-based system more standardised. Furthermore, if carbon credits are to be pooled right in front of the exchange platform by asset traders, prices will be even more locked in and the system highly standardised for carbon commodities as such. The significant risks of CERs notwithstanding, carbon credits show some advantages once they have reached the EU registries. In fact, CERs can be used for compliance in the first allocation period, can be banked and can be sold to entities outside of the EU ETS. These advantages seem to increase their attractiveness with respect to other carbon commodities. (Streck, 2006)

Finally, some considerations can be done for what concerns prices as well. While approximately before 2005 the price of CERs was set by early buyers as a benchmark, it has now risen beyond € 5 per CER since then and the benchmark is set by sellers against EU allowances. Besides the development of energy markets which chiefly determine in turn the trend of EAU prices, other factors such as geopolitics and new categories economics will be relevant. Firstly, the so-called 'sleeping beauties' such as China, Russia and the Ukraine, but also Coal Mine Methane and N2O reduction as project categories, will influence the supply of ERUs and CERs and the whole market equilibrium as a whole. (Streck, 2006) However, the fact that the market increasingly favours both low-cost, high-volume projects, such as HFC destruction or landfill, and economies in transition's surpluses to domestic energy projects is seen under great criticism for CDM capacity in adequately delivering more than few local livelihoods. (Taiyab, 2006) Moreover, the supply would be probably increasing anyhow along with development and trust in the market as that matures. Plus, other emerging techniques than forestry, e.g. carbon capture and storage, may create significant competition to ordinary emission reductions. Then, overarching policies such as the long-discussed inclusion of the transport sector or the new allocation plan for the EU ETS Phase II will be decisive in the design of post-2012 decisions upon which much uncertainties are poised.

2.1.3.2 Voluntary Offset Programmes Development

The first carbon offset project ever organised was in 1989, when AES Corp.'s plans to build a 183 megawatt coal-fired power station in the US were approved partly due to an agro-forestry pioneering offset. It involved planting 50 million trees in the impoverished Western Highlands of Guatemala. (K. Smith, 2007) Since that event long pre-dating brokerage, a voluntary market for carbon offsets has emerged parallel with the CDM market. Unlike legislation or commitments to global treaty, the drivers for voluntary markets are more philanthropic or marketing reasons. In fact, buyers consist of companies, governments, organisations, organisers of international events, and individuals, taking responsibility for their emissions by voluntarily purchasing offsets to reduce their 'carbon footprint'. The resulting emissions reductions from voluntary offsets, which hence do not necessarily have to follow the CDM procedure, are often bought in slices by businesses or non-profit organisations that invest in a portfolio of offset projects based on different models. Eventually, these retailers sell customers a range of products in relatively small quantities which may be certified to a wide array of standards (Bayon, Hawn, & Hamilton, 2007)

The great deal of criticism and concern that have plagued voluntary offset schemes ever since had already beset that initial project initiated by AES Corp. in the far-away 1989. Apart from offset targets which were far from being reached ten years on from the start of the project, the non-native trees that were planted initially proved inappropriate for the local ecosystem thus causing land degradation. Moreover, the local community had habitual subsistence activities, such as gathering fuel wood, criminalised. (K. Smith, 2007) For there is no legally mandated demand triggering voluntary offsets, these markets suffer from fragmentation and information deficiencies as so that poor uniformity, transparency and registration are the major arguments to disapproval. Not to mention the volatility that is inherent to the lack of a regulatory driver. (Bayon, Hawn, & Hamilton, 2007) On the other hand, project developers are freer of the stringent guidelines, lengthy bureaucratic paper-work, and high transaction costs to invest in small-scale community based projects which are often not economically viable under the CDM. Furthermore, the majority of projects are concentrated in large markets, such as India and Brazil, and have virtually bypassed the least developed countries. (Taiyab, 2006) Despite the shortcomings of the voluntary markets, the co-benefits of these projects which may be factually innovative and flexible, in terms of e.g. local economic development or biodiversity, are often a key selling point. As a result, companies may find themselves in the awkward position to warily choose between real risks of non-delivery and NGOs' assaults when purchasing carbon credits which have not met the highest possible standards in terms of sustainable development benefits. (Bayon, Hawn, & Hamilton, 2007)

2.2 Land Use, Land Use-Change and Forestry (LULUCF)

Land use change, agriculture and forestry activities have been gradually recognized by the Kyoto Protocol as valid source and sink activities that parties could use to meet greenhouse gas reduction commitments. As opposite to source, 'sink' is defined by UNFCCC Article 1.8 as "any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere". In light of this property, the development of policy had evolved to cover as like emissions as removals of GHG resulting from direct human-induced changes over land. Eventually, the acknowledgement that land-use change and forestry (LUCF) activities could be both sources and sinks of carbon led to their inclusion in the KP. In fact, the term LUCF was firstly used in the Treaty's Article 3.3 which allows for net accounting of such emissions by sources and removals by sinks, though limiting the latter to afforestation, reforestation and deforestation. LUCF was then replaced by the term Land Use, Land Use Change and Forestry (LULUCF) in 1998, which was therefore adopted to address also improvements in current land use and crop management as enabling practices for reducing carbon release from land degradation. The acronym is now widely used to refer to this sector. (FAO, 2000)

2.2.1 Carbon Storage and Carbon Sequestration

As from *Figure 2-6*, the natural carbon cycle entails 4 main carbon stores, namely the reservoirs in the geological deposits, in the atmosphere, in the oceans, and in the terrestrial biosphere. The most important fluxes are instead due to the gross primary production, i.e. absorption of carbon from the atmosphere through photosynthesis, and to respiration, i.e. release of carbon to the atmosphere either by the land surface or because of the physical air-sea exchange. This yearly balance under natural conditions is around 210 Giga tonnes of carbon (Gt C), of which approximately 120 are attributable to the bijective flux between atmosphere and land. (Malhi, Meir, & Brown, 2003, pp. 16-17) Such amount is roughly split in half (60) between plants and soil. In addition, the oceans and land vegetation are currently taking an extra 4.9 Gt C yr^{-1}.

The global carbon cycle is thus recognised as one of the major biogeochemical cycles because of its role in regulating the concentration of the most important GHG in the atmosphere, i.e. carbon dioxide. As shortly introduced at the beginning of this section, forests play an important role in the global carbon cycle because they store large quantities of carbon in all their lignin, cellulose and oily tissues. By exchanging carbon with the atmosphere through photosynthesis and respiration though, they can also become sources of atmospheric carbon as soon as they are disturbed by human or natural causes. The use of poor harvesting practices, clearing and burning for conversion to non-forest use, or even wildfires, can all dramatically affect the carbon storage capacity of woods. On the contrary, land abandonment and regrowth after disturbance lead to the activation of a net transfer of CO_2 from the atmosphere to the land, i.e. carbon sinks. Therefore, humanity does have the potential to alter the role of forests in the carbon cycle, especially through changes in land use and management, by both scaling the magnitude of stocks and inverting the direction of fluxes. (Malhi, Meir, & Brown, 2003) In addition to the opportunities provided by less carbon-intensive activities, LULUCF also acts to impact on methane from or to the atmosphere and thus helps further either aggravating or mitigating the effects of climate change. (Schlamadinger et al., 2007)

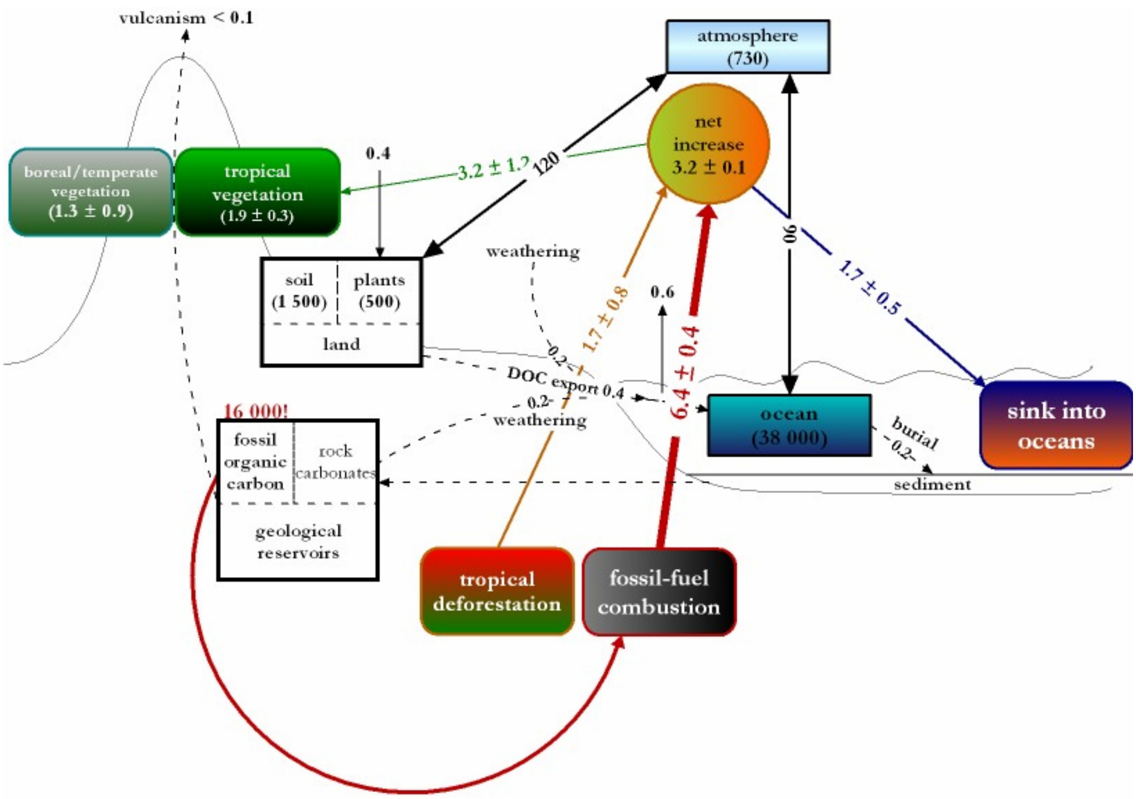


Figure 2-6 Natural and human-induced carbon cycles (the units for fluxes are Gt C/yr, the units for stores are Gt C)

Source: (Malhi, Meir, & Brown, 2003, p. 17)

2.2.1.1 Global Carbon Pools and Land Uses

The natural cycle notwithstanding, the impacts of the industrial carbon disruption in the so-called Anthropocene, i.e. the age of mankind on Earth, have determined a considerably different situation, especially with fossil fuels combustion and land-use change. Besides fossil-fuel combustion which is notoriously responsible for relatively recent major changes in our atmosphere, the other main source of carbon release to the air by human disruption has been the conversion of forests into e.g. croplands and pasture. In fact, the major types of land-use change that affect carbon storage are the ones represented in *Figure 2-7a)*:

1. The permanent clearance of forest for pastures and arable crops;
2. Shifting cultivation that may vary in extent and intensity as populations increase or decline;
3. Logging with subsequent forest regeneration or replanting;
4. Abandonment of agriculture and replacement by regrowth or planting of secondary forest, i.e. deforestation, afforestation and reforestation.
(Malhi, Meir, & Brown, 2003)

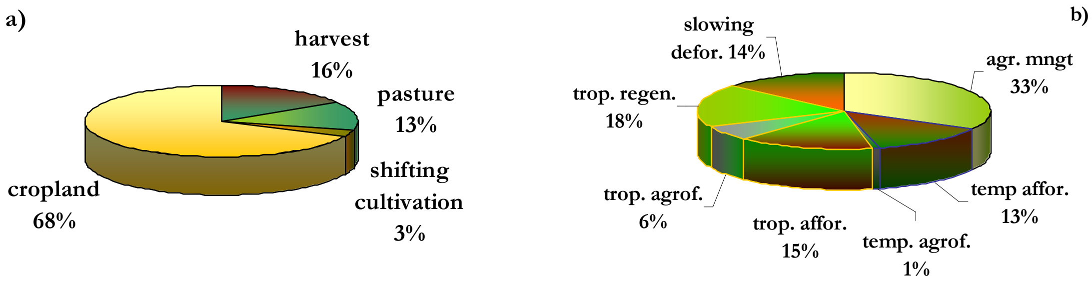


Figure 2-7 a) Estimated total net carbon emissions from land-use change, 1850-1990; b) Climate mitigation potential of various land-management activities

Source: (Houghton, 1999; The Royal Society, 2001, in Malhi, Meir, & Brown, 2003, pp. 25, 35)

Excluding the increased use of biofuels to replace fossil-fuel combustion, biosphere management options could include, as shown in *Figure 2-7b)*:

1. The prevention of deforestation (slowing defor.);

2. The reduction of carbon loss from forests by changing harvesting regimes, converting from conventional to reduced-impact logging, and controlling other disturbances such as fire and pest outbreaks in both temperate and tropical regions (temp. agrof. and trop. agrof.);

3. Reforestation/afforestation of abandoned or degraded land in both temperate and tropical regions (temp. affor., trop. affor. and trop. regen.);

4. Sequestration in agricultural soils through change in tilling practices (agr. mngt) (Malhi, Meir, & Brown, 2003)

In particular, 138 million hectares (Mha) from slowed tropical deforestation might be available for carbon conservation globally while it is suggested that 217 Mha could come from regeneration of tropical forests and 345 Mha from plantations and agroforestry. The IPCC Second Assessment Report estimated that about 60 to 87 Gt of carbon could be conserved or sequestered in this 700 Mha of forestland by the year 2050, of which 45 to 72 Gt in the tropics and another 23 to 44 Gt could be sequestered in agricultural soils. (IPCC, 2001a, p. 303) In summary, terrestrial ecosystems in tropical regions seem to offer significantly large opportunities for climate mitigation at modest social costs. Yet, broader policies in forestry, agriculture, and other economic sectors cannot be overlooked for options may vary by social and economic conditions in the region. While slowing or halting deforestation might be the absolute priority in some areas, improved natural forest management practices and afforestation and reforestation of degraded forests are more attractive opportunities in other places where deforestation rates have declined to marginal levels. Cumulative mitigation potential of forests in India and China accounts for respectively 8.7 Gt and 9.7 Gt, the latter amount being just as much as what is estimated for Latin America. (Sathaye & Ravindranath, 1998; Ravindranath & Somashekar, 1995, in Kauppi & Sedjo, 2001, p. 320) Moreover, some of the regions in the tropics are expected to lead to changeovers of viable biomes as well due to the effects of the ongoing climate change, e.g. extensive droughts and higher temps.

Irrespective of the vast potential which still remains in tropical forest, it is worth noticing that the global biomass carbon stored into there (26%) is actually outnumbered by boreal forests (20%) and temperate forests (7%) altogether. (Dixon et al., 1994; Prentice et al., 2001, in Malhi, Meir, & Brown, 2003, p. 19) Therefore, non-tropical countries as well have opportunities from a quite broad range of forest-related activities which can preserve or enhance the existing carbon pools. Without mentioning the use of biomass to offset fossil fuel, examples of strategies include various silvicultural and forest management practices addressing the protection against both human-induced and natural disturbances in the first place. For those are the major driving forces in determining the transition of forest stands, landscapes, and regions from carbon sink to source and back, measures in that respect are suggested mainly for wildfires and insect control, but also tackling of abrupt disease and pest outbreaks, herbivore overgrazing, forest flooding or destructive wind-throws. In addition to leaving primary forests untouched with the exclusion of the abovementioned interventions, conservation can also be reached through taking exploitable forests out of production. On the other hand, carbon sequestration potential for non-tropical forests is also either the restoration of degraded lands or the management of wood products in terms of e.g. elongation of lifetime, control of stand density and growth speed, harnessing of useful species and genotypes, selection of appropriate harvest methods such as reduced-impact logging and thinning, and changes to rotation length and fertilization patterns. Of course, managing logging residues, recycling wood products and increasing the efficiency with which forest products are manufactured and used should not be neglected in a comprehensive life-cycle perspective. (Lunnan et al., 1991; Hoen and Solberg, 1994; Karjalainen, 1996; Row, 1996; Binkley et al., 1997; Price et al. 1998; Birdsey et al., 2000; Fearnside, 1999; Anonymous, 1999; Nabuurs et al., 2000, in Kauppi & Sedjo, 2001, p. 316)

All the above depends on that, for instance, the amount of carbon carried into boreal forests soil down to a depth of 1 m (471 G tonnes) almost equals the total pool of tropical stand vegetation (428 G tonnes). (IPCC, 2000b, p. 4) In reality, for temperate forests have always been cleared for agriculture and pasture as a result of being quite densely populated areas, particularly in comparison to the boreal zone, other carbon sequestration opportunities relate instead to alternatives in managing the existing lands already destined to agriculture. In fact, to increase carbon stocks in agricultural lands two ways are generally available: changing the management within a given land use (e.g., cropland, rice land, grazing land, or agroforests) or changing from one land use to another (e.g., cropland to grassland or cropland to forest) In fact, more carbon can be generally stored in soils, the management of grazing lands improved, and grasses or trees re-planted on cultivated lands. (Kauppi & Sedjo, 2001)

2.2.1.2 Climate Change Mitigation Potentials

The potential to mitigate carbon emissions by LUCF activities means at first preventing these emissions from occurring through the conservation at least of the existing carbon stocks on land. This can be accomplished chiefly by avoiding deforestation, but also by changing harvesting regimes and converting from conventional to reduced-impact logging. Secondly, LUCF activities are essential in providing carbon sequestration opportunities. This applies also to expanding the storage of carbon in forest ecosystems by increasing the area and/or the carbon density of forests. The protection of secondary and other degraded forests in order to allow them to regenerate, the restoration of native forests through assisted and natural regeneration, the establishment of plantations on non-forested lands, can all be instrumental to the very same aim as far as forests are concerned. For what regards agricultural lands, the carbon content of soil and woody matter can also be enlarged by several techniques: adopting zero- or minimum-tillage practices on arable land, improving rangeland management, using green manures and cover crops, amending soil with straw and manures, increasing the tree cover on agricultural or pasture lands with agroforestry, etc. Finally, the substitution of energy intensive and cement-based products e.g. biofuels and construction materials with sustainably grown wood is another means of attaining carbon mitigation through LUCF activities (Myers & Goreau, 1991; Brown et al., 1996; Kauppi & Sedjo, 2001, in S. Brown, Swingland, Hanbury-Tenison, Prance, & Price, 2003, p. 44; Pretty, 1995; Drinkwater et al., 1998; Lal et al., 1998; Smith et al., 1998; Tilman, 1998; Smith, 1999: Petersen et al., 2000: Robertson et al., 2000; Sanchez & Jama, 2000; USDA, 2000; Pretty & Ball, 2001; Robert et al., 2001; WCCA, 2001; in Niles, Brown, Pretty, Ball, & Fay, 2003, p. 71)

Among the mitigation opportunities that forests have to offer, wetland areas are often neglected for large reserves of organic carbon are there contained in both northern (302 Mha, 397 GtC) and tropical (50 Mha, 144 GtC) peat-forming forest-associated biomes (Zoltai & Martikainen, 1996 in Kauppi & Sedjo, 2001, p. 324) More than augmenting accumulation thanks to improved management in boreal forested peatlands where net ecosystem GHG changes are far from being clear, preservation of threatened vast reservoirs seems to be a significant mitigation measure. Human use of peatlands including mining for fuel and drainage mostly for agriculture and forestry purposes as a result of land reclamation has been practiced throughout history. However, at this moment peatlands are being destroyed faster than ever, mostly in South-east Asia. Particularly there where forested tropical peatlands store at least 42 Gt of soil carbon[5], large-scale drainage of former rainforest has occurred to enable logging of the peat swamp forests and to transport logs in the drainage canals. The formerly stored carbon is thus increasingly released to the atmosphere due to drainage and fires associated with plantation development and logging. After deforestation though, deep drainage continues or gets even more intense to establish oil palm and pulp wood plantations with dry-loving tree species. The most important GHG emission tradeoffs of water-logged soils regard the lower oxidation of carbon compounds due to the fewer air content against the release of methane which has a much higher GWP factor. Nevertheless, the issue is even more controversial as one important crop in drained peatlands is palm oil, which is increasingly used as biofuel in Europe while no recognition seems to come from the UNFCCC (Hooijer, Silvius, Wösten, & Page, 2006; Wetlands International, 2006)

Such system approach addressing interdependencies among wood products and sectors do not yet incorporate the use of wood as a fuel to displace fossil fuels when in the developing world most fuelwood and charcoal is devoted to satisfying energy needs for cooking and brick or pottery making. Therefore, an important opportunity for mitigation would be in conserving wood fuel and charcoal through improved efficiencies of stoves and charcoal kilns. However, the cross-cutting interrelations among various timber-investment decisions and climate-mitigation activities seem to have been recognized within the joint-product nature of industrial wood and carbon sequestration. Despite the large uncertainty in the estimates, the current global stock of carbon in forest products is proportionally non-negligible though rather small.[6] Options to increase the physical sequestration of carbon in wood products include increasing consumption and production of wood products,

[5] Peatlands make up 12% of the SE Asian land area but account for 25% of current deforestation for 12 million hectares of peatlands out of 27 (45%) are currently deforested and mostly drained.(Hooijer, Silvius, Wösten, & Page, 2006)

[6] The current global stock of carbon in forest products is somewhere around 4-20 GtC (IPPC, 1996; Sampson et al., 1993; Brown et al., 1996b; in Kauppi & Sedjo, 2001, p. 323)

improving the quality of wood products, improving processing efficiency; enhancing recycling and re-use of wood and wood products, etc. (Kauppi & Sedjo, 2001) The latter option is especially important in that the difference between the production of new products and decay of the carbon stock in existing products should be as large as possible. Based on the relative importance of each of the above carbon mitigation potentials, the UNFCCC has progressively established a precise framework for LULUCF activities as the following paragraph presents. Nevertheless, voluntary schemes do not follow the same rules and, therefore, are generally more flexible and innovative.

2.2.2 The Legal Framework after Bonn and Marrakech

The UNFCCC deals with five economic sectors that are sources of anthropogenic GHG in the atmosphere, these sectors being energy, industrial processes, agriculture, LULUCF and waste. For how the sectors are defined though, GHG removals from the atmosphere occur only in LULUCF because of biomass growth. This results in specific accounting characteristics which make the LULUCF sector distinct from the rest. (Schlamadinger et al., 2007) The articles to refer to in the Kyoto Protocol with regards to carbon sinks are 3.3, 3.4, 6 and 12. In particular, under Article 3.3, the Parties to the UNFCCC decided that GHG removals and emissions through 'afforestation and reforestation' shall be accounted for in meeting Annex I industrialised countries' emission targets. Conversely, emissions from 'deforestation' activities will be subtracted from the amount of emissions that an Annex I Party may emit over its commitment period. For those LULUCF activities under the Article 3, both paragraphs 3 and 4, the following definitions apply which were resolved and agreed upon as part of the famous Marrakech Accords of October/November 2001:

1. 'Afforestation' is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources;

2. 'Reforestation' is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989;

3. 'Deforestation' is the direct human-induced conversion of forested land to non-forested land. (UN, 2001)

Afforestation and reforestation (A/R) are hence eligible if they took place after 1990 and because of a clearly voluntary human action. In case of a positive difference between A/R and deforestation, RMUs thus generated will be eligible to use for each and every country's emission reduction targets. Theoretically, there is no limit to issuance and use of such credits for that purpose. A/R is also eligible for the CDM during 2008-2012, although a 1% cap has been nonetheless maintained. Literally as written in 8th paragraph of Section VII of the Bonn agreement, "… for the first commitment period, the total of additions to and subtractions from the assigned amount of a party resulting from eligible LULUCF activities under Article 12 shall not exceed 1% of base-year emissions of that party, times five." (UN, 2001) As a result, the upper theoretical level of the LULUCF-CDM market would be limited, for the period 2000–2012, to 605 Mt CO_2e, when excluding the USA. If the USA were to reverse their decision and accept the Bonn agreement, the theoretical upper limit would be increased by 302 Mt CO_2e, thus reaching 907 Mt CO_2e. Without including the USA, the highest individual market would belong to the Russian Federation that alone represents 25.2% of the total. (Bernoux, Eschenbrenner, Cerri, Melillo, & Feller, 2002) However, various country-specific conditions determine a quite different scenario as it will be explained at the end of section *2.2.2.2*.

2.2.2.1 LULUCF Activities in the Annex I Countries

Unlike A/R, Article 3.4 provides for no accounting of additional activities is included in the CDM. In fact, the 'Bonn Agreement' did not allow any JI or CDM project which involves carbon sequestration through improved agricultural practices nor by protecting or maintaining existing forests or other natural vegetation during the first commitment period (i.e. 2008-2012). Pursuant to the same Article 3.4 of the Kyoto Protocol though, the Parties are allowed to elect additional human-induced activities related to LULUCF, namely forest management, cropland management, grazing land management and revegetation, to be included in domestic accounting for the first commitment period.

- 'Revegetation' is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here;

- 'Forest management' is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner;

- 'Cropland management' is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production;

- 'Grazing land management' is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.
  (UN, 2001)

Last but not certainly least, a common definition was equally established for the term "forest" of course. Notwithstanding the consistency and comparability among Parties thus assured, some flexibility is however allowed to take account of national circumstances. Any Party may choose, for example, to select a minimum tree height of between 2 to 5 metres for its definition of one forest. Once the values are chosen, however, they remain fixed according to the "once Kyoto land, always Kyoto land" rule. At any rate, all the activities as above defined follow the same post-1990 and clearly human-induced criteria as A/R and are named 'additional' because it is up to each and every country whether and which to account. It is noteworthy that, a cap has been put on credits stemming from forest management whereas no restrictions were set for the other three activities. Such a limitation on forest management reflects the concerns that the use of LULUCF activities should not undermine the environmental integrity of the Kyoto Protocol. Therefore, naturally-occurring removals, including removals as a consequence of indirect anthropogenic effects (e.g. the natural increase in atmospheric CO_2 and nitrogen depositions, not to mention human intervention prior to 1990) should be excluded from the system as like as any re-release of GHG (e.g. through forest fires) must be promptly accounted for. These natural and indirect effects were thus compensated by ruling a sort of 85% discount as so that only 15% of forest management credits are eligible for national inventories. In addition to this cap, forest management credits can at no rate exceed 3% of the national emissions in the baseline year, i.e. 1990. For what concerns the CDM in particular, two issues were long and accurately negotiated. In order to take into account the high risks of projects failing to deliver their expected carbon removals, temporary (tCERS) and long-term (lCERs) credits have been introduced. These credits need to be replaced depending on their expiry. In addition, simplified requirements e.g. baseline determination methodologies, monitoring programmes and verification, were devised for small-scale projects below 8 000 t CO_2e/yr as so to curb transaction costs. (Lumicisi, 2006)

2.2.2.2 LULUCF Activities in Developing Countries

Rules and modalities for A/R in the CDM were not agreed upon until COP 9 in Milan, December 2003. A/R baseline and monitoring methodologies need to go through an arduous and strict reviewing process. It took until late 2005 to approve the first methodology for the Guangxi project in China. To date, there are seven approved methodologies for large-scale CDM forestry projects. (Fenhann, 2007) Nevertheless, the first decisions made on LULUCF by the UNFCCC date back to 1989 and COP 4 when some drafts on definitions related to activities under Article 3.3 and modalities, rules and guidelines about how and which additional human-induced activities might be included under Article 3.4 were recommended. By that time, also the IPCC Special Report on LULUCF had been completed to support any decision on the matter. After country-specific data collection and several inter-session workshops though, failed negotiations forced to forward the issue to further consideration at the second part of the 6th meeting of COP to the UNFCCC which was held in Bonn during July 2001. The Bonn agreement covers three principal areas: funding to help developing countries, carbon sinks to be credited towards emissions targets, and operating rules for market-based flexibility mechanisms established under the Protocol. (Bernoux, Eschenbrenner, Cerri, Melillo, & Feller, 2002) In those circumstances, the most important issues regarding LULUCF e.g. definitions for all activities under Article 3.3 and 3.4, and rules by which activities under Article 3.4 will operate for the first commitment period were thus finalized in the draft decision text which was few months after adopted as part of the Marrakech Accords as Decision 11/CP.7 (*Figure 2-8*). Besides the general set of principles to govern LULUCF activities and the abovementioned definitions which were decided during the CoP 7 at Marrakech, the rules for LULUCF activities include a four-tier capping system limiting their use to meet emission targets:

1. "If a Party's afforestation, reforestation and deforestation activities result in more emissions than removals, then the Party may offset these emissions through forest management activities, up to a total level of 9 megatons of carbon per year for the five-year commitment period.

2. The extent to which forest management activities can be accounted for to help meet emission targets beyond 9 megatons of carbon per year is subject to an individual cap for each Party, specified in an appendix to the decision on LULUCF. This cap includes joint implementation projects involving forest management.

3. Emissions and removals from cropland management, grazing land management and revegetation can be accounted for to help meet emission targets on a net basis (e.g. changes in carbon stocks during 1990, times five, will be subtracted from the changes in carbon stocks during the first commitment period, in the lands where these activities will take place).

4. Only afforestation and reforestation projects are eligible under the clean development mechanism. Greenhouse gas removals from such projects may only be used to help meet emission targets up to 1% of a Party's base year emissions for each year of the commitment period."
(UNFCC, 2007)

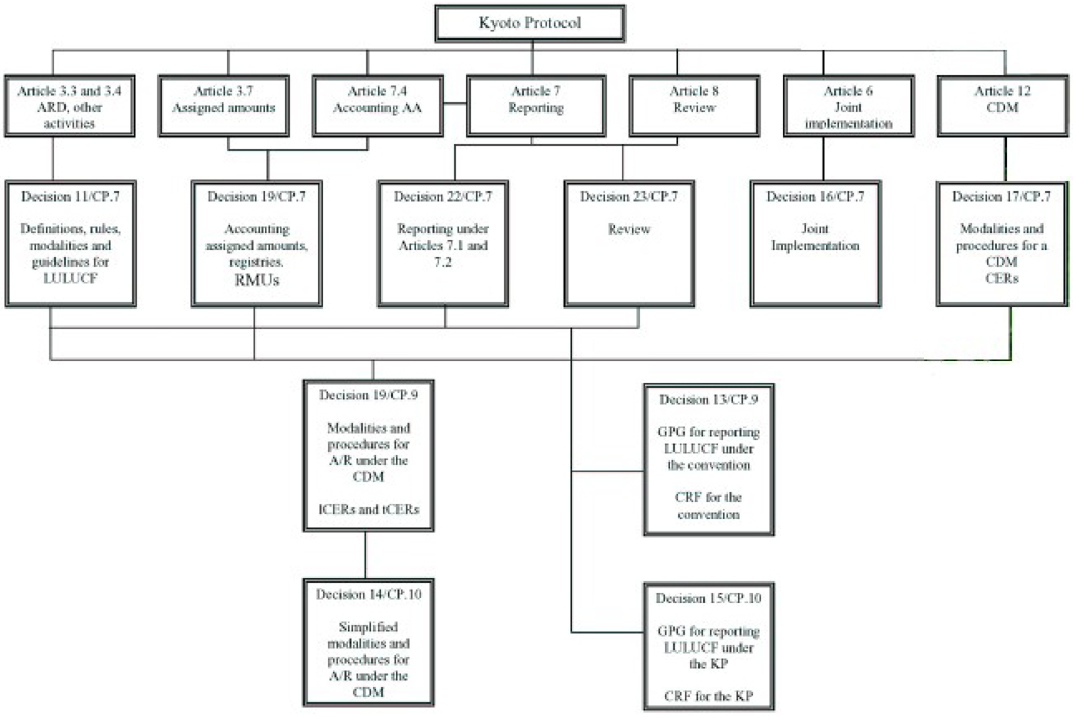


Figure 2-8 The UNFCCC legal framework

Source: (Forner, 2005)

As a result of the 'Bonn Agreement', industrialized countries are allowed to sponsor only a limited amount of A/R projects in developing countries which is equal to 5% of their respective 1990 emissions. Whereas the economy-wide and sectoral effects of implementing the Kyoto Protocol have been estimated in numerous studies, carbon sinks had been excluded from those calculations before the rules for their crediting were established in Bonn CoP 6 Part II. Yet, economic simulations started to take carbon sinks into account after the Marrakech Accords restricted the carbon credits that can be generated annually from CDM A/R projects by each and every industrialised country during the first commitment period of the Kyoto Protocol (i.e. 2008-2012). First of all, if no country can exceed 1% of its base year emissions as of 1990, then the total global market potential for A/R project credits is limited to a maximum of approximately 33 MtC per year, or 165 MtC over the five-year commitment period. Yet, CDM is a market-driven process and the actual extent of it depends mainly on the pure trade mechanism, on the costs for the project pipeline and on long-term emission scenarios. The 1% market limitation notwithstanding, various studies have anyway produced some estimations of the yearly potential of carbon sinks in the attempt to outline scenarios for industrialised countries' participation in the CDM. However, "… some countries have formulated policies refraining from the use of the CDM at all …" (Neeff & Henders, 2007)

Some authors (Bernoux, Eschenbrenner, Cerri, Melillo, & Feller, 2002), however, have also produced some more realistic estimations to contradict the likelihood of the figures reported at the end of section *2.2.2*. According to those figures, the potential size of the real LULUCF CDM market would be about 110 Mt CO_2e for 2000-2012 (in opposition to a maximum upper level of 907 Mt CO_2e). In reality, not all Annex I parties have the same interest in funding LULUCF projects under the CDM for various reasons depending on whether they belong to the so-called economies in transition (EITs), to the European Union (EU), or to the remaining parties. First of all, EITs have fallen well below their required level of emissions as of 1990, as so that from potential they have been transformed into actually large net sellers on the market, Russia ahead. Then, distinctions have to be made within Europe between those countries which are meeting their emission target paths and whose which are far away. The latter will be the almost certain to use complementary mechanisms such as the CDM. Austria, Denmark, The Netherlands and the United Kingdom belong to the first wave of countries which unambiguously declared their intention of adhering to the Kyoto mechanism and proved to be actively engaged in related operations from the very start. More recently, Italy and Spain have shown that they will be likely to use their 5% quota of 1990 emissions, due to heavy delays in their reduction targets and possibly to a more accurate revision of national strategies as well. While for a long time the World Bank's funds were the only ones who specifically announced their intention to buy LULUCF credits, public and private sectors in these countries got increasingly interested and seem prepared to start buying the next forestry credits on the market (Ecosecurities in Neeff & Henders, 2007, pp. 16, 19-20) The significant remaining parties are Australia, Canada, Japan, New Zealand, Norway and Switzerland. However, Kyoto-suited forests occupy nearly a third of New Zealand plantation forests, Australia's native forests and woodlands cover about 20% of its total land area, and Canada as well intends to achieve the majority of its GHG reductions through actions taken domestically, though unequivocally. Therefore, only Japan is in the situation of having the second largest gap in reduction target to face. From the latter maximum individual markets of Austria, Denmark, The Netherlands, Canada and Japan, the claim that most probable size of the LULUCF-CDM market would be around 110 Mt CO_2e for the period 2000–2012. In addition, the same authors pointed out that the maximum global market value of about US$ 876 million estimated as such would be quite a small amount if compared to the US$ 53.1 billion given to non-Annex I countries as official development assistance (ODA) from OECD in the year 2000. Either precautionary or not, these arguments are more consistently based on the potential size of the real LULUCF market as of each and every country's actual GHG-reduction strategy (cf. section *2.2.3.1*.)

2.2.3 Carbon Sinks Economics

2.2.3.1 Cost Reduction Allocation

The result of a study by Pohjola, Kerkelä, & Mäkipää (2003) indicated that the gains from carbon sinks are not distributed evenly among countries, although they partly reduce the difference in economic burden of achieving the Kyoto target. Regardless of the limitations of not including international emission trading and costs of carbon sequestration, the main argument of that paper is still valid and shared. In fact, the Marrakech decision about sinks is of relatively minor importance for the world economy and emission reduction dynamics when compared to the US withdrawal from the Kyoto Protocol. This might not be the case for the economies of individual countries which have either considerable forested areas or whose prospective sinks are smaller compared to the required emission reduction. In fact, for Sweden, New Zealand and Japan the positive impact from sinks exceed the negative impact from the US withdrawal. On the other hand, for the EU and Australia, the slightly positive impact from sinks on compliance costs cannot compensate the negative consequences of the US quit. As inclusion of sinks decreases the need for domestic emission reduction, the positive impacts are due to the smaller efficiency loss from reallocation of resources. The same cost-equalisation principle applies to the differences between sectors as fossil fuel producers or fossil-fuel intensive manufacturers do benefit from inclusion of sinks while other sectors do not. On the other hand, for most of the countries the negative welfare effects following from the US withdrawal are a result of the losses in terms of trade (*Figure 2-9*).

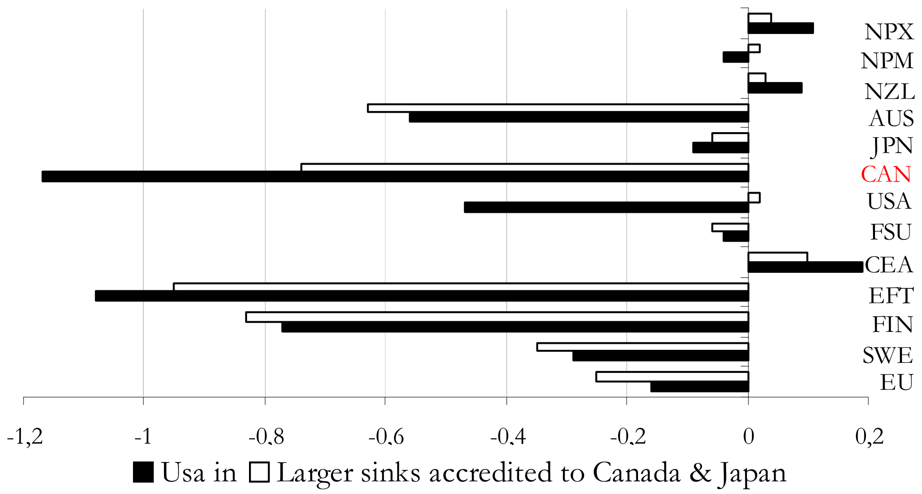


Figure 2-9 Change in welfare in 2010 (%) from achieving the assigned emission targets with the current crediting of forest carbon sinks (i.e. larger sinks to Canada & Japan) and a US-in scenario

(NPX stands for net pulp, paper & publishing exporters while NPM stands for net pulp, paper & publishing importers)

Source: (Pohjola, Kerkelä, & Mäkipää, 2003, p. 459)

It is therefore especially interesting how in Canada both sinks agreement and the US withdrawal could reduce costs, though the former being larger impact. In fact, while export trade of fossil-fuel intensive goods decreases as a result of US industry's maintained competitiveness, exports of machinery and other equipment become more competitive due to US prices of capital and labour being not adjusted downwards. (Pohjola, Kerkelä, & Mäkipää, 2003)

Specific projections regard the total amount of tradable credits from afforestation and reforestation projects under the CDM, if industrialised countries fully exploit their credits. With these figures ranging from 18.3 to 33.3 Mt C, 20 Mt C should be assumed with an average sequestration rate of 6 t C per year-hectare over a ten-year rotation period. This would roughly result in 330 000 hectares of new forest establishment annually, which is in line with the average carbon uptake rate of industrial plantations in tropical regions. In fact, the supply of carbon may depend on the amount of both the actually available land and the carbon that can be sequestered by that particular land use. Therefore, figures can also sink down to 0.25 t C at the minimum potential of rehabilitated or restored degraded forestlands. Moreover, for the average plantation establishment rate ranges below the abovementioned tradable credits projections, alternatives like agro-forestry or forest landscape restoration should be the resulting focus for project developers (Elzen & Moor, 2001a, 2001b; Eyckmans, 2001; Jotzo & Michaelowa, 2002; Kemfert, 2001; Orlando et al., 2002)

All the above projections were based on the economic impacts and relative stability of the climate policy strategies of that time. As previously mentioned, especially den Elzen and de Moor (2001b) pointed out that the United States' decision not to participate in the Kyoto Protocol would have by far been reducing the demand for project credits, particularly from the CDM. As a confirmation, it seems that the market has been actually affected more by the absence of the U.S than by the 'sink agreement' to limit the size of the CDM forestry portfolio. With a more precautionary outcome though, Jotzo and Michaelowa (2002) assumed that industrialised countries with economies in transition (EIT) would not have participated in the CDM market anyhow as long as it was profitable for them to trade their own emission allowances with other industrialised countries. Because of the fairly large number of such allowances and low prices at which they are expected to trade, Kemfert (2001) came to apportioning according to an absolute domination of the latter and attributed a value of zero for carbon credits from CDM projects.

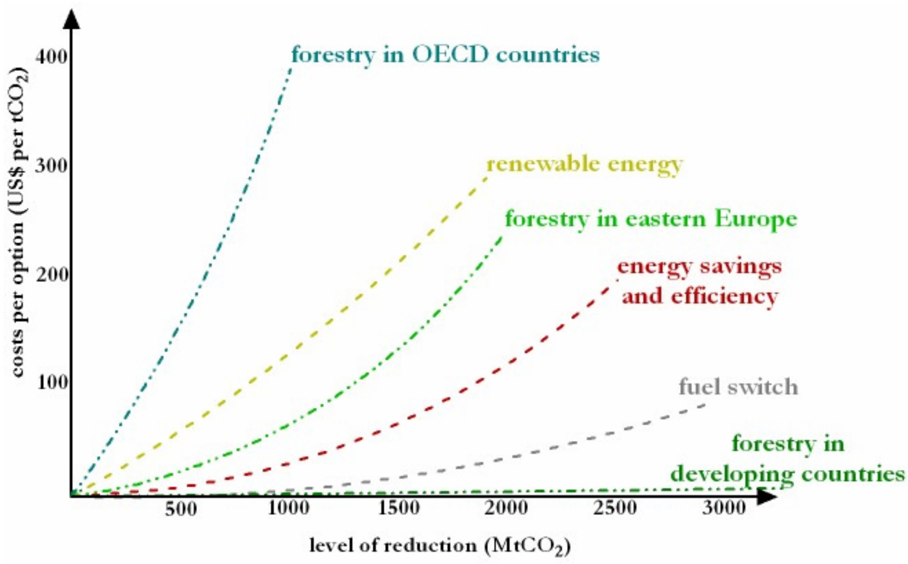


Figure 2-10 Indicative curves emission reduction costs or carbon sequestration by level of total reduction

Source: (Kauppi & Sedjo, 2001 in S. Brown, Swingland, Hanbury-Tenison, Prance, & Price, 2003, p. 45)

However, if EIT restricted their sales in order to maximise profits and credits were banked for the second commitment period in light of the U.S. ratification, the predicted market prices per unit of carbon would fall most likely within the range of about 15-20 US$ including the opportunity cost of land, infrastructure, monitoring and data collection, maintenance and all other project costs. Reality is that these prices dropped considerably as result of the U.S. withdrawal from Kyoto, precisely from 11-286 down to 3-57 US$ per t C. In addition, although sink projects have to compete with a variety of low-cost CDM projects, their prices keep being low (1 to10 US$ t C) if compared to domestic abatement measures in the energy and transport sector (10 to 200 US$ t C) (*Figure 2-10* Indicative curves emission reduction costs or carbon sequestration by level of total reduction). Hence many economical models predicting that sink CDM potential will be further explored, where not fully, can still be deemed valid. In addition, such a gap in costs seems to allow for enough margins of investments in competitive, environmental sound and socially equitable sink projects. (Orlando et al., 2002; Grubb et al. 2001; Point Carbon 2001; den Elzen & de Moor 2002 in J. Smith & Scherr, 2002, p. 17)

2.2.3.2 Viability of Carbon Sink Options

The discussion above comes from the demand side which, as far as CDM is concerned, is artificially induced. With respect to the supply-side, opportunity costs of turning a piece of land to carbon sequestration have to be examined instead, especially in view of modern human migrations to the forest margins and consequent policy determinations. Both Gokowski (1999) and Vosti et al. (1999) in Smith (2002) described the optimal tradeoffs between carbon capture and economic and social benefits and came to similar conclusions. Extensive cocoa plantations, fallow agroforestry and traditional pasture lie below the profitability threshold as so that e.g. there is no return to labour in terms of wages. On the other hand, intensive cocoa plantations mixed with fruit trees or managed forests of oil palm, coffee and rubber trees produce a better yield ratio, although often with limited carbon contribution. As a result, the effective competition of sustainable forest management with conventional timber harvesting should be assessed now that carbon markets have emerged and are a not new establishment.

Once it is agreed upon that conventional logging is "... more short-term in focus, less concerned with forest generation, and often lacking in government control ..." it is worth mentioning the literature debate presented by D. Pearce, Putz and Vanclay (2003) as follows. On the one hand, it is argued that a forest management system aiming for sustained timber yields serves best conservation because outright protection exceeds sustainable forest management (SFM)'s potential. On the other hand, others argue that the high costs of protection, the pressures to use forest for profits, and human population growth constrain Sustainable Timber Management (STM) to be so successful. As SFM aims for sustained yields of multiple products and services from the forest, sometimes these are the only chance of maintaining ecosystems and biodiversity in many places. In addition, the recognition of non-timber values alters the focus of the perspective and, as far as carbon is concerned, the issue becomes how these different regimes affect both carbon storage and additional sequestration by stimulating tree growth. Therefore, if the thesis that sustainable forestry is neither profitable nor necessarily preferable to conventional logging is discarded, only two options, namely STM and SFM seem worth consideration. However, factors such as timber prices and growth rates, wood-extraction efficiency, low confidence due to political change and insecurity, etc. are all strong drivers to the financial competitiveness of conventional logging in the tropical regions. Nevertheless, if the options to all forest use were widened, land use allowed for sequencing and other values than timber recognised, the national interest could serve to contrast private loggers priorities. (D. Pearce, Putz, & Vanclay, 2003)

When arguing about the optimal forest land use in the humid tropics, another issue is relevant for discussion. Tropical forest conversion contributes as much as 25% of the net annual CO_2 emissions and up to 10% of the N_2O emissions to the atmosphere. For this reason, calls for structured solutions to such a vast problem have strongly echoed in the recent time. Moreover, the net effect on GWP also depends on the net fluxes of GHG from land-use systems following deforestation. However, efforts to mitigate these effects must take into account not only the GHG fluxes of alternative land-use systems but also the social and economic consequences that may influence their widespread adoption. This is because the process of deforestation is generally profitable in the short run, so that land-users would need some sort of compensation and institutional support from the government in terms of land tenure and access to markets to be able to adopt some tree-based system. Global alternatives to slash-and-burn, though, require accurate investigation as so that the GWP of the considered range of land-use alternatives is actually lower in comparison to annual cropping and pasture In addition, the profitability of tree-based systems in the humid tropics has to be assessed in terms of returns to land and labour as well. For the widespread adoption of these systems can be limited by start-up costs, credit limitations, and number of years to positive cash flow, in addition to the higher labour requirements, projects offsetting GHG emissions through carbon sinks in land use in the tropics might be a means of overcoming these limitations as long as the economy of the marginal value of carbon, the social discount rate, the production cycle of the agroforestry system, and the rate of carbon sequestration over time are verified beforehand. (Palm et al., 2004)

Tomich et al. (2002) in Palm et al. (2004, p. 159) estimated that the payment needed to offset incentives for forest clearing in Indonesia, where this problem is particularly pressing, would be $0.10 per tonne of carbon for community-based forest management, under $4 for large-scale oil palm plantations, and as high as $10 for rubber agroforests. This suggests that a world price of $25 per tonne of carbon could shift incentives from forest conversion to conservation, if these payments only reach the people making the decisions and agreements are enforceable. Nevertheless, this is not a conservative figure any longer as from what reported in the previous section about the global price of carbon stocks. Besides how adequate actual transaction costs should be in providing an incentive to induce a change in land use for smallholder communities involved in the carbon trade, it is still not clear how such institutions for transferring carbon credits would work. Included in these costs would be baseline and monitoring measurements in addition to those costs normally associated with project development and implementation.

Therefore, a key to making LULUCF activities both effective and sustainable is to balance carbon sequestration with other environmental, economic, and social goals of land use. While many biological mitigation strategies may be neutral or even favourable all in all and thus become accepted as "no regrets" or "win-win" solutions, in many other cases this may be less straightforward or compromises needed. Sullivan, Aggett, Amacher & Burger (2006) studied the financial viability of financial viability of forestry on reclaimed mine sites returned to hayland or pasture generally resulting in abandoned non-productive land. The authors concluded that, although carbon payments carry the ability to relieve the burden of conversion costs of grassland to forest, other "soft factors" beyond sheer profitability may foster or prevent land-use decisions from actually occurring e.g. open contribution to the local economy or landowners' own initiative. Besides reforestation incentives, carbon payments have also been researched for testing the biophysical and economic implications of introducing agroforestry as a means of maintaining or increasing both land productivity and profitability in the medium to long term. Growing trees with continuous cropping system has been observed to enhance crop yields and improve soil quality while simultaneously producing subsistence and adding to the number of already marketable outputs such as firewood, fodder, fruit and timber. However, fact is that if growing trees alone is often an unattractive alternative due to high establishment costs and delayed revenues, the interactions with crops may also prove competitive rather than complementary. (Callaway, 1995; Sanchez, 1995; Young, 1997, in Wise & Cacho, 2005, p. 1140) Calculations about this subtle equilibrium contained in the same study showed that economic benefits could accrue from carbon trading as so to become a viable option to exceed the expenses of switching land use.

Nevertheless, the range of assumptions regarding carbon and crop prices and discount rates, as well as the transaction costs of participating to the actual market, undermine the validity of many economic analyses carried out so far. Furthermore, additionally negative impacts may have also been overlooked e.g. the use of fertilizer or the need to compensate for the loss of soil carbon over time. As Kiss, Castro & Newcombe (2003) summarised though, the apology of carbon sequestration rests on that it "represents a non-extractive non-consumptive sustainable use of living natural resources which can be incorporated within a multiple-use 'integrated ecosystem management' approach." If forested land should be used to maximize its social value, that would imply a rate of return embracing unusually captured investments such as carbon offsets and taking into account the widest and most equal distribution of gains and losses. Beyond traditional financial competitiveness of forestry investments, a three-order stakeholder perspective would hence include local loggers, while not neglecting illicit forest users or enforced migrants, national interests and the worldwide community. (D. Pearce, Putz, & Vanclay, 2003) It is under this rationale that the theory of payments for ecosystem services (PES) is presented in the following paragraph.

2.3 Bundling Forest Environmental Services to Livelihoods

Although the strategic pursuit and systematic avail of potential synergies between forestry industry and other ecosystem services is still in the prime of life in terms of policy enforcement, a definite interest has already been showed by the 'three Rio Conventions' along with several conservation organizations. (Bioclimate Research & Development, 2004; Gommes, 2007) Not to mention that the sustainable development component of the CDM is still a supposedly mandatory requirement of projects. In this very last section, the background will help gaining an insight into the conceptual framework of market failure for ecosystem services externalities, i.e. when the spectrum of benefits that could be attained by taking into concern certain external consequences is by far lower than the costs altogether. Nonetheless, the vast majority of aspects linking land-use change and forestry not only with climate but also with desertification, water availability, biodiversity loss, and human population not least are still largely disregarded. Hence, the potential for carbon sequestration to be bundled with the other three typical kinds of environmental service of forests (i.e. biodiversity protection, watershed protection, and landscape beauty) and to which it relates in terms of associated opportunities. Generally speaking, "… ecosystem services are seen as a chance to foster sustainable forest management (SFM)." (Sell, Koellner, Weber, Pedroni, & Scholz, 2006) Moreover, the livelihood approach is likewise presented to outline how social aspects within community-based forest project can be enhanced in a parallel manner with carbon yields. In particular, livelihood issues are shown their relevance e.g. for CDM forest carbon projects that are able to deliver social benefits.

According to the 'Ecosystem Approach' as endorsed by Decision V/6 of the COP 5 to the Convention on Biological Diversity (2000, p. 103-107) and the World Conservation Union, a comprehensive and holistic strategy should be adopted for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Among other things, ecosystem approaches recognize that human needs as social and economic systems are an integral part of ecosystems which constantly interacts with other physical and biological components and should be thus put at the centre of biodiversity management. Pursuant to this definition, a rapid adoption of market-based approaches in forestry sectors around the world has been witnessed. In addition to the private sector's growing interest in participating to the potential for market creation, also governments have been increasingly attracted to market-based instruments as a new set of tools for guiding private investments and overcoming market failure. Still, several forest goods and services which could benefit both local and global communities are not being traded in markets for they have no observable price. Hence, they cannot be harnessed to generate financial returns which would be instead commensurate with their true economic value. In many instances, environmental services could be jointly produced as so that investments in one service would result in the simultaneous production of other services. Being rather frequent, at least in terms of prerequisites, the issue is particularly relevant for CDM arrangements which regulate carbon sequestration while requiring sustainable development benefits.

Mirroring Landell-Mills & Porras (2002) and Wunder's (2005) framework, the four environmental services examined in this thesis are biodiversity protection (e.g. conservation donors paying local people for setting aside or naturally restoring areas to create a biological corridor); carbon sequestration and storage (e.g. a Northern electricity company paying farmers in the tropics for planting and maintaining additional trees); watershed protection (e.g. downstream water users paying upstream farmers for adopting land uses that limit deforestation, soil erosion, flooding risks, etc.); and landscape beauty (e.g. a tourism operator paying a local community not to hunt in a forest being used for tourists' wildlife viewing). It is noteworthy that the first two tend to be the most commonly combined within the foursome. However, given the complex dynamics of natural systems and site-specific attributes of projects, assuming that environmental services are perfectly complementary and linkages always positive is faulty. Focusing investments on one single service, though attractive it can be, may lead to seriously negative consequences for others, e.g. when wagering on scenic views for tourism purposes proves to be unfavourable for the biodiversity richness of ecosystems. Hence, bundling of environmental services can chiefly take place in two fashions, namely merged bundles and shopping baskets. The former "… when environmental services are sold together and cannot be subdivided for sales to separate purchasers"; the latter "… where purchasers can acquire specific services on their own or as part of a package and land stewards can sell different services to different buyers." (Landell-Mills & Porras, 2002, pp. 184-185)

For what concerns the current market dynamics under analysis in this research, favourable advantages for either route can be evenly split between the two categories. In fact, the key point of merged bundles is transaction costs savings, which in turn relates to commoditisation tendencies. On the contrary, shopping baskets allow sellers to better capture the total earning potential due to separate clients' willingness to pay for individual services. Without loosing in efficiency of allocation and market breadth, this approach tends to maximise returns because it is better suited for creating market niches which deliver additional market shares or extra revenues from premium prices e.g. for biodiversity services piggybacked on carbon sequestration (cf. *3.1.1.3* and *3.2.1.2*). The emergence of shopping baskets is a clear signal of how intermediaries and suppliers can steer the demand through marketing experience and innovative products even in markets that were started by regulation for mere compliance like carbon sequestration. (Landell-Mills & Porras, 2002)

Before continuing the present discussion though, it must be made clear that no formal, homogeneous definition of payments for environmental services (PES) seems to exist in the literature. However, Wunder (2005, p. 3) suggests PES ought to be first "… voluntary transaction where … a well-defined ES (or a land-use likely to secure that service) is being 'bought' by a (minimum one) ES buyer … from a (minimum one) ES provider … if and only if the ES provider secures ES provision (conditionality)." Concerning voluntariness, it can be agreed that even under compliance motives like in the CDM, project-based options are an act of election. Concerning definitions, some watershed experts (M. Smith, Groot, & Bergkamp, 2006) report that a very broad view is often quite explicitly preferable, especially in terms of measurability, and PES could thus range from private contractual agreements to governmental green taxes through subsidies for landholders or premium prices for organic food. As long as the payment mechanism creates reward for conservation and good management it does not matter whether it comes from a private source, a public fund or a premium price Moreover, no consensus is shown with the CDM on what measurability the service provided should require for "it should be paid for a particular kind of management rather than for a specific output of water" (or carbon). At the end of day, a desirable form of management is a way much easier to measure and adjust through adaptive management principles like participation and social learning. Given the influences nature has on the conditionality of purchase-delivery with regards to scientific uncertainty and those LULUCF shortcomings such as permanence and leakage, the marked contractuality of many carbon forest projects looks quite self-tangling in many ways. (M. Smith, 2007)

After a specific PES scheme e.g. carbon credits has been defined, then comes the issue of how it differs from other conservation approaches. In particular, PES is simply deemed one tool that it should be applied where it fits within the full conservation toolbox of command and control, SFM and production, Integrated Conservation and Development, social markets, environmental taxes and subsidies, certification standards, land acquisition, etc. Despite it is in the human nature to put all hope in seemingly promising solutions, the next temptation to rely blindly on PES should be balanced by the awareness that, for large their niche is, there will be no 'passepartout' and all-or-none uses of tools are not deplorable either. Besides carbon sequestration which already has a huge number of people talking about it, the magnitude of successful PES schemes complying with the abovementioned criteria and definitions is potentially big for water, though not globally but in particular regions or basins where circumstances are such to make the scheme be built and government oversee stakeholders. Uses of water and conditions of the upper catchments, for instance, might be very different from place to place. In summary, plenty of quite diverse examples exist around the world if the abovementioned broader view of PES is taken instead of accounting for contractual agreements (M. Smith, Groot, & Bergkamp, 2006, p. 46).

As it is likely that different forms of payment suits some land-use scenarios better than others, the extent to which an ES has been delivered may fall short. Moreover, the difficulties in evaluating so relate very much with the issue of baselines for LULUCF activities. In fact, baselines for PES can be accounted statically according to the historical approach like in the CDM or in a more dynamic way, i.e. where deforestation is increasing or has experienced some sort of turnaround. If flexibility is not so desirable from an economic efficiency point of view because of money deployment, the outcome is still the point. The appeal of the CDM is precisely to achieve some form of offset with sustainable development while its concretely defined baselines become the very impediment to achieving that. So paradoxically, what makes the scheme appealing is actually making it hard for those who could benefit the most while the people with 'financial muscle' can easily prove the baselines. It is thus better to set criteria for the conditions funds are being applied to rather than getting tied up with baseline measurement and monitoring Voluntary schemes in principle are good but little is known about how money is deployed in them. On the other hand, little money is anyway deployed in the CDM because the rules about how to do it are too strangulating and certainly not worth the outcome. A fair compromise would be to set criteria as tight as to let market players enter the market. In other words, carbon trading as a whole is not a failure just because of the difficulties with the CDM. Still, the CDM could be deemed a failure in terms of relative effectiveness. However, climate change regulation is not the sole policy area where allocative efficiency can be questioned. Shifting the attention to voluntary initiatives and how society is generally reacting to global warming, also there seem to be much more important problems to address than, for instance, offsetting individual flight emissions. It basically means that the 4% of the overall emissions is diverting the public from much bigger (and probably even easier) aspects such as road transportation or power industry. (M. Smith, 2007)

When comparing the different major LULUCF shortcomings to other ES than carbon sequestration, leakage appears less of a prominent issue for e.g. watershed management and also permanence is not concerned for the more immediate nature of payments for water services. Nevertheless, awareness and good governance are always the optimal solutions in both cases. Finally, when assessing whether LULUCF activities are different for other PES than carbon sequestration, two broad categories of land use seem to fit in particular for watershed protection: forested upper watersheds where hydro power reservoir managers pay for the maintenance of forest cover to prevent sediment runoff, agricultural landscapes where farmers are paid to shift their forms of management to the use of fewer fertilizers. However, much more sophisticated land use and landscape type than the above would be probably possible, especially if there was better understanding of how parts interact one with another and where an optimal land-use location for or within a landscape is (M. Smith, 2007)

From a community-oriented perspective, merged bundles of environmental services are meaningful as far as breaking down components for sale is more complicated than making sure that a number of land stewards are rewarded for the suite of services they provide. Furthermore, the shopping basket approach may be constrained by the multiplication of individual difficulties with tenure rights and political stability. Moreover, there is a big hurdle for the successful establishment of pre-packaged bundles of environmental services in line with the delivery of collateral benefits by forest carbon projects. This is the serious lack of information on trade-offs and synergies between services in specific locations and under different conditions. In that respect, research organisations with stakes on forests are working in the attempt to improve the overall understanding of those forest management routines which optimise the delivery of manifold benefits. Significant complications arise when adding on social aspects to the bundling.

In that respect, a particular project group under the supervision of the IUCN (World Conservation Union, previously known as the International Union for the Conservation of Nature and Natural Resources) was analysed because of its expected outcome, e.g. to provide a both complete and participatory list of criteria for sustainable forest carbon projects. Most of the following information stems from personal interviews conducted on site at IUCN headquarters. The case was deemed furthermore interesting because of the linkage with the BioCarbon Fund (BCF), i.e. the sole LULUCF-investing multilateral fund. In addition, the very composition of IUCN's executive board which is formed by governmental members makes the CDM the preferred framework for assuring credibility along with strictness e.g. concerning the issue of baseline definition.[7] Despite the potential for climate-change-mitigating projects to deliver social and environmental benefits has been acknowledged by conservation agencies amongst many others, the need for adjustments in the field of forestry is still perceived a topical issue. In fact, the role of payments for carbon sequestration as economic instrument has so far been limited to adding credibility to situations where some

---

[7] IUCN's partners include among others the World Wildlife Fund, the International Tropical Timber Organisation (ITTO), the Centre for International Forestry Research (CIFOR), the International Centre for Research in Agroforestry (ICRAF), CARE, the Secretariat of the UN Forum on Forests (UNFF), the UN Food and Agriculture Organization (FAO), the United Nations Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC) and the Secretariat of the Convention on Biological Diversity (CBD).

business was already involved. Therefore, sustainable attributes of carbon forestry keep being confined in a niche which further requires strengthening action.

For what concerns the development of criteria for sustainable forest carbon projects, it can be anticipated that robust sets of indicators have been tentatively produced so far in terms of environmental and social components. Nonetheless, the economics of project-based reductions have been deliberately left by IUCN for more appropriate entities to discuss. In fact, while IUCN is well aware of the need to develop tools and methods to assess the climate adaptation component of projects, a much more careful approach is however kept during negotiations for climate mitigation. This is because no particular economic activity should be indirectly supported or endorsed while interfering with climate change and nature conservation policies before more thorough experience is reached. By contrast, the actions addressing climate adaptation are more marginal and less prone to create perverse incentives, so that a few changes are deemed sufficient to increase the knowledge about this issue and produce an effective leverage on the project level. (Häger, 2007)

However, it is worth noticing that quite a large variety of conservation tools and interdisciplinary approaches is nonetheless being deployed to continuously add on and advocate the most desirably conservation-delivering attributes of biocarbon sinks. This is testified by the use of the Forest Landscape Restoration framework as recurrent element of IUCN activity on carbon sequestrating assets. (Pfund & Stadtmüller., 2005) Sometimes, this approach is followed even regardless of the rather small project scale (100-3 000 hectares) which may turn limiting its applicability. Yet, since FLR shifts the emphasis away from maximising tree cover on individual sites to optimising the supply of forestry benefits such as clean water, timber production and nature conservation within the broader landscape, it is understood why this approach has been extended to draw guidelines for a sound inclusion of collateral aspects into carbon project development. Such integration amongst different instruments to cope with LULUCF shortcomings (cf. section *3.1.3.1*) is also testified by the use of transversal structures like the Forest Law Enforcement, Governance and Trade (FLEGT) taskforce and the Voluntary Partnership Agreement (VPA) framework. In particular, the FLEGT focuses on the legal aspects surrounding governments' negotiations, institutional empowerment and law enforcement. Such a function was developed to address those issues including carbon projects which typically occur in those countries where great need for conservation does not match the quality of international relations namely the overall governance of the forest state and land tenure. This is particularly relevant for the six-fold Global Environmental Facility (GEF) project proposal where the assessment of issues like distribution fairness has been addressed after small landowners' and community rights were already set and in place. (Häger, 2007) The Voluntary Partnership Agreements deal instead with forest certification and products' guarantee of origin.

As a proof of reciprocal interest with the World Bank, IUCN recently submitted a project proposal after the Forest Programme was commissioned technical assistance on six ongoing forest carbon projects for a 3-year partnership with the managing institution of the BFC. The project is to take place in as many different African countries (Mali, Niger, Kenya, Uganda, Ethiopia and Madagascar), at sites where the BCF provides carbon finance (cf. section *3.2.1.2*). According to Riche & Häger (2 007):

> "This GEF MSP [Medium-Size Project] will seek to demonstrate if an integrated approach to carbon sequestration can create multiple, measurable benefits that should be part of sustainable land management (SLM) up-scaling approaches. This will be done through the establishment of locally appropriate environmental and social baselines and indicators that can

> be monitored and measured in a cost effective way by local community participants and project proponents. Particularly within Africa, few such models exist, yet the need for them could not be greater. It will provide a synergistic complement to the carbon finance projects by building the capacity of project implementers and stakeholders to maximize and monitor the projects' environmental and social co-benefits."

IUCN's role in that respect is thus to add up not only environmental aspects but also social ones, such as education, increased transparency and a fair share of carbon-generated money for the local community. Even though some of the project contracts have been signed already and a few implemented, IUCN was identified through existing relationship with the World Bank as a credible partner along with the International Tropical Timber Association and WWF to deliver such add-on contribution to the selected portion of BCF's project portfolio. It is nonetheless fair to mention that such forest carbon projects have a 30-year time-life on average, so that follow-up adjustments can still entail significantly strengthening effects. Fact is that the main tasks for which IUCN was granted US$ 1 million to assist the six BCF projects in Africa is to develop a baseline for both their social and environmental performance, to define a set of respectively functional indicators, and to allow for a simple monetary evaluation at the same time. Therefore, it is noteworthy that IUCN is involved in the stage to help creating new evaluation methods and tools required for efficiency measurement. Though complicating the demand on project implementation, the selling point can be founded on making these projects better off and thus provide the world community with a showcase about what else beneficial can be attained along with carbon sequestration. (Häger, 2007)

Hence, preliminary environmental and social indicators were preliminarily identified thanks to oriented discussions with project partners and local communities during initial assessments of these BCF project sites. A set of potential indicators like those ones presented in *Appendix II* could then be developed being based on the expected environmental and social outcomes and current issues and challenges of individual carbon projects. However, the final list of indicators for a MSP is recommended not to exceed 2-4 indicators per site. Therefore, a further consultative process involving again all project partners and stakeholders will be taking place while an analysis of existing and in-process environmental and social indicators will help determining the final list as well. Their literature review will comprise BCF Project Design Documents, Environmental and Social Impact Assessments, National Forest Plans, International Standards (like Climate, Community, and Biodiversity standards - cf. section *3.2.1.1*) and legal agreements that are part of the BCF project (e.g. community forest management agreements). (Häger & Riche, 2007)

Table 2-2 Comparison of the similar approaches presented in this section

	Ecosystem Approach	**Sustainable Livelihoods**	**FLR**
Origin	Conservation	Development	Conservation
Goal	Biodiversity conservation and sustainable development	Poverty alleviation	Biodiversity conservation in mosaic landscapes
Particular components	Process-oriented conservation	Livelihood assets	Forestry and process-orientation; relation between field expertise and policy-level
Level of intervention	On- and off-site impacts considered	Local	Scaling-up integrated, focus on site–landscape interactions

(Pfund & Stadtmüller., 2005)

3. Analysis: Impact Variables of Forest Carbon Offsets

In the present chapter, a set of system variables for forest carbon offsets is constructed in order to describe the current state of the case in a sufficient, valid manner and prepare for further modelling around its dynamics. Before proceeding to variables selection, the system properties of the present conditions have been strategically summarised through a brief plus-minus analysis. (Scholz & Tietje, 2002, p. 87) This exercise has been performed by both studying the structure and history of forestry-based carbon offset projects and considering some of the most widespread perspectives while triangulating personal glances over the future of voluntary markets in relation to compliance regimes. (Bayon, Hawn, & Hamilton, 2007; Broderick, 2007) Since what may be considered strength for voluntary programmes might be considered weakness beyond applicability for compliance schemes and *vice versa*, a reiterated process similar to SWOT analysis was meant to adequately identify both boundary and inward properties of the case and thus ensure sufficiency in the selection of variables.[8] Strengths, weaknesses, opportunities and threats were eventually synthesized into Table 3-1 to represent the case by means of the main vectors composing voluntary markets alone. In fact, the following attributes are deemed sufficient characteristics for the whole system because, regardless of intensity, the given sign and direction as below would result respectively reciprocal on the compliance side. The very same attributes were then refined in order to suit the conclusive MAUT analysis functional to scenario discussion. As a result, the descriptions hereinafter can be compared to the seven decisional criteria encompassing each group of variables within the three impact areas, with the only exceptions being market size and LULUCF drawbacks. The seven decisional criteria and three impact areas are reflected in the very structure of the present chapter and can be in fact referred to the headings *3.1.1*, *3.1.2*, *3.1.3*, *3.2.1*, *3.2.2*, *3.3.1*, *3.3.2* on the one hand, and *3.1*, *3.2*, *3.3* on the other hand. Market size and LULUCF drawbacks have been respectively incorporated as functions of market price and project costs for the sake of hierarchical consistency between system attributes. In addition, the synthesis is believed to be organised as robust and reliable as to let contingent redundancy between variables be partly supplement through vicarious mediation.[9] (Scholz & Tietje, 2002)

Table 3-1 Plus-minus analysis of voluntary offsets properties

Plus	**Minus**	**Ambivalence**
Product differentiation	LULUCF drawbacks[10]	Project quality
Competitive advantage	Lack of standardization	Complementarity of schemes
Market price	Market size	Project costs

Product differentiation means basically innovation and variety in the development of forest carbon projects. This can be attained through either geographically or sector-wise increased eligibility as well as through the potential combination of various LULUCF activities among

[8] SWOT analysis can be defined as a strategic planning tool that identifies both the internal attributes, e.g. strengths and weaknesses, and the external conditions, e.g. opportunities and threats, which are respectively helpful or harmful for a project, product or organisation (Kotler et al., 1999, p. 112)

[9] The term 'vicarious mediation' belongs to Brunswick's lens model and refers to the substitutability of pathways in achieving one same end, namely the new conception of the case.

[10] Drawbacks as those described in section *3.1.3.1 Support of Technical Competencies in Response to LULUCF Shortcomings*

themselves or with other mitigation opportunities, e.g. bioenergy efficiency. Variety relates to suppliers, i.e. deregulation and decoupling from the artificiality of demand as from UNFCCC provisions, but also to the existence of multinational monopolies in the sector at this stage. Product differentiation currently prevails amongst voluntary offsets because neither modality constraints nor bureaucracy seem barriers for compliance schemes alike. Competitive advantage refers to those benefits which are not driven by cost-effectiveness but attained through premiums for beyond-compliance strategies (i.e. emission reductions undertaken by non-mandated entities) and new patterns of responsible product consumption, corporate image greening, embedded climate-neutral products or reputation management. Therefore, they belong exclusively to voluntary initiatives due to their very nature. Finally, market price *tous cours* is also favourable to non-compliance markets because of the simply lower transaction costs and the relatively higher freedom of choice in dedicating budgets than under regulated targets. Yet, specific expectations on the supply chain, e.g. the degree of involvement in transactions, risk management through contractuality and the buyers' type or preferences for high-quality tons may limit price competitiveness in many instances.

In contrast, three general characteristics which are restraining voluntary carbon markets from developing further are the inherent drawbacks of LULUCF activities in general, the lack of a standardized carbon commodity and the still insignificant market size regardless of growth rate. On the one hand, factors such as saturation, non-permanence and the reduced degree of control by humans; on the other hand, transaction volumes and market players' size in comparison to Kyoto-compliant trading platforms, remain quite large hindrances to the system progress. Moreover, the little understanding and information sharing leading to consumers' confusion reflects into the lack of uniformity, consistency and transparency which are equally detrimental to the system confidence, certainty and fungibility.

A few attributes are ambivalent in face of so sharp-cut distinction. Project quality, for instance, may entail many different factors ranging from credibility to cost-effectiveness as so to be alternatively beneficial to both kinds of programme. Nevertheless, quality properties can be quite clearly distinguished from flexibility which goes alongside with innovation and thus product differentiation. Complementarity between regimes is strictly subordinated to some degree of coexistence between the two. In that respect, the function of voluntary initiatives can be of educational precursor or trading platform enabler. Ambivalently alike, project costs are partly independent from the market price of the carbon unit (be it CER or VER) in that, regardless of pure business profitability, many co-benefits can become a recognised value added to pay for on the market.

3.1 Supply-Side Impact Area (Project Development)

3.1.1 Project Quality

3.1.1.1 Stringency of Additionality (Regime Flexibility)

According to Paragraph 43 of Decision 17 of the Marrakech Accords, "a CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity." (UNFCCC, 2002) In particular, "an afforestation or reforestation project activity under the CDM is additional if the actual net greenhouse gas removals by sinks are increased above the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the registered CDM afforestation or reforestation project activity." (UNFCCC, 2004, p. 18) The mere interpretation of environmental additionality though, i.e. when a project reduces emissions as compared to the without-project scenario, has been rejected by the Executive Board to avoid events of free-riding. In that some projects would have been implemented anyways regardless of any investment additionality, project activity and baseline scenario are practically identical and no additional reductions are thus generated besides already existing removal rates. Therefore, a second interpretation of Decision 17 definition provides that a proposed project is eligible as long as there is no less GHG-friendly, and thus economically more attractive, alternative to initiate in its place. In fact, while baselines can only determine the GHG impact without specifying the reasons for the project's attractiveness, the additionality assessment brings about a new economics-wise definition of baseline. For instance, CDM-compatible methodologies have to show why barriers exist in light of project profitability or whether institutional and regulatory requirements which are common practice in the region are exceeded. (Jung, 2003) This translates into differentiating a project activity from its baseline scenario, especially through the use of performance standard baseline determinations.

Amongst other evaluations to prove the comprehensive additionality of projects i.e. the decisive reasons behind their implementation, there are some guiding tests like the one which the World Business Council for Sustainable Development and the World Resource Institute have jointly developed and recommend in their GHG Protocol Initiative. In addition to **business-as-usual** and the **legal, regulatory and institutional** check, other tests should be performed in order to deny that the proposed **technology** is likely to be employed for reasons other than reducing GHG emissions or that the project would have produced a low return of **investment** without revenues from GHG reductions. Furthermore, **timing** can also be a relevant limitation as some articulated projects starting before a certain phase of GHG reduction could hardly be motivated as such. (WBCSD & WRI, 2003, 2006) Flexibility is discussed in relation to the possibility that the explicit mentioning of beyond-regulatory requirement for LULUCF projects could in turn lead to a stricter regime than for energy CDM projects. Moreover, there have been cases like the carbon sequestration project in the Sierra Gorda of Mexico where unclear land tenure rights prevented project developers from initiating any application to the CDM procedure. (Bayon, Hawn, & Hamilton, 2007, pp. 71-74) By contrast, transparency and ownership shall be guaranteed to safeguard the system credibility. On a local level, the legal framework includes aspects such as the status of land tenure and the transfer of related rights, but on a global scale the issue about ordinary or subnormal compliance activity of legally-bound countries can turn into much bigger debate like the one brought by the concept of carbon colonialism. Claiming that as seemingly harmless as effective planting of trees in the 'Majority World' are by all means cheap investments to neutralise gases emitted in the privilege-holding North, several NGOs, such as the World Rainforest Movement, SinksWatch and The Corner House, keep exposing international financiers and forest resource holders acquiring thousand hectares to make profits out of the future sale of carbon credits besides timber. In addition to speculation and eviction due to local incapacity, such poor performances from Kyoto-committed countries with respect to energy consumption leads to condemning the culture of offsets as a mere business-as-usual option with a fair dose of 'green wash' in it or, otherwise sagaciously portrayed, as 'offset indulgences absolving climate sins'. (K. Smith, 2007)

3.1.1.2 Response to Negative Leakage (Off-Site Impacts)

Pursuant to Paragraph 24 of Decision 19 of the UNFCCC CoP-9, "An afforestation or reforestation project activity under the CDM shall be designed in such a manner as to minimize leakage." The reason is that "...the indirect impact that a target ... [LULUCF] activity in a certain place at a certain time has on carbon storage at another place or time". (IPCC, 2000b, p. 71) Simply put, leakage is any secondary off-site effect, including positive unintentional outcomes like the displacement of new emission-reducing activities instead of e.g. induced deforestation. First of all, the amount of leakage depends on the **inherent mechanism** that causes the phenomenon itself. In fact, the triggering project or policy can work shifting e.g. a plantation project forcing farmers to move and clear adjacent forests. Alternatively, the second major mechanism raising leakage is through the alteration of the market equilibriums between demand and supply, e.g. the cause-effect sequence determined by a large forest-conservation project: reduction of local timber supply, unmet demands, increase in prices and pressure on forests elsewhere. In addition, road traffic from newly attracted tourism or reforestation projects are classified as life-cycle emissions shifting, while an example of ecological leakage would be a plantation introducing some contagious pest to surrounding forests thus leading to blight and eventually net carbon releases. Nevertheless, the soundness of any forest carbon project depends on whether and how negative leakage is addressed. The response to negative leakage can be pursued either through **project-level specific solutions** or also through **policy-level standardized options**.

The first project-level option available for managing leakage is accurate site selection. Subsequently, responses should involve the prospective bearers of leakage either by creating incentives for local people, i.e. preparing multi-component projects with a range of socio-economic co-benefits, or by making no activity shifting a clause on contracts signed with the forest concessionaries. Finally, though to different degrees and thus costs, monitoring is the underlying response to negative leakage in that any problem must be known before attempting to solve it. Stemming from that, some standardized approaches exist as well. If the amount of leakage is calculated in the first place, it can be likewise deducted from the expected GHG benefits. More extremely, ruling out the eligibility of leakage-prone projects would be another drastic option. A more complicated solution is to expand the boundary of the project accounting, thus aggregating baselines as so to include data on indirect economic effects which are often incomplete for developing countries though. Some macro-level broader policy would be instead to either balance the project portfolio and thus the market-leakage effects of A/R and avoided deforestation or minimize the scale of leakage risks. This is typically achieved by placing a cap on the volume of forestry project for climate-change mitigation like the 1% ceiling put on CDM sinks. (Schwarze, Niles, & Olander, 2003) It is worth noting that many issues relating to leakage are specifically addressed by premium offset protocols such as the Climate Community and Biodiversity Standard, i.e. "The project proponents must quantify and mitigate likely negative offsite climate impacts; namely, decreased carbon stocks or increased emissions of non-CO_2 GHGs outside the project boundary, resulting from project activities …" Concerning biodiversity in particular, negative changes in biodiversity parameters could entail adverse effects of non-native species, on the area's environment, including impacts on native species and disease introduction or facilitation, detriment to species deemed threatened on nationally recognized lists that may be found within the project boundary, the use of invasive species or GMOs. (Climate, Community, and Biodiversity Alliance, 2005)

3.1.1.3 Delivery of Ancillary Co-Benefits for Sustainable Development

As described above (section *3.1.1.1*) for *Stringency of Additionality (Regime)*, forest carbon projects are supposed to produce net positive climate impacts such as a net increase in the annual rate of change in carbon stocks, the accumulating carbon uptake of stands or the estimated emissions avoided over the project lifetime. However, ancillary benefits are typically shared between other environmental and social aspects. From a cost-benefit analysis perspective, those can be either **immediately accruable positive impacts** as to biodiversity as to the local community or more **intrinsically beneficial in the future**. Examples of the latter could originate from the philanthropic opportunity to withhold carbon credits from the regulated trade in view of future scarcity or from projects designed to anticipate and adapt to probable impacts of climate change and climate variability. In that sense, these projects are deemed more likely to sustain the benefits generated over the long term. (CCBA, 2005)

The timing effect notwithstanding, several sets of indicators have necessarily been developed to measure the collateral positive impacts as devised for the changes in carbon stocks. Many of the underlying parameters adopted have been borrowed from recently raised concepts like sustainable landscape management or similar proven approaches able to integrate social, economic, and environmental planning over whole landscapes and human activities with the potential for achieving the desired balance between land use and protection. By seeking to strengthen the relationship between rural development, forestry and other natural resource management and conservation approaches, also the Forest Landscape Restoration framework has shifted the emphasis away from simply maximising tree cover on individual forest sites. (Maginnis & Jackson, 2005) In fact, when the aim is to optimise the supply of forest benefits such as clean water, timber production and nature conservation within the very broader landscape, even the re-establishment of the pristine forests of the past might not be prioritised for it should be applied at appropriate temporal and spatial scales necessary to achieve multiple management objectives. (Saint-Laurent, 2005) In order to ensure the long-term sustainability of ecosystems and their resources, a successful forest landscape restoration aims at involving each and every forest-related stakeholder, from local farmers to charcoal makers, from game hunters to logging companies. In line with this coordinated global effort to integrate nature conservation with the sustainable management of forests, intergovernmental agencies like IUCN have focused on a stronger social component in their programmes for forest and water resources enhancement. By scaling down their policy-assisting role to the field level, the livelihood component within forest projects can be thus advocated beyond any actual partnership in carbon trade (Häger & Riche, 2007) An equally effective monitoring tool for the enhancement of the social bottom line is provided by the well-known livelihood framework as reported more specifically in the following description (sect. *3.1.1.4*) of *Cost-Effectiveness of the Offset* .

3.1.1.4 Cost-Effectiveness of the Offset Option

Strongly related to the previous section (*3.1.1.3 Delivery of Ancillary Co-Benefits for Sustainable*), the cost-effectiveness of different project options (cf. section *3.1.2.3 Variety in Project*) depends on the various profitability curves as discussed in *Carbon Sinks* . Moreover, each and every income attainable according to multiple uses adds on to the overall cost-effectiveness of the same piece of land. Therefore, at least three increasingly comprehensive schemes of monetization have been considered in order to include all the inherent values of forests: the balance amongst the **commercial commodities from environmental services**, the optimization of all **forest management functions**, and the maximum **livelihood assets** capitalization. As explained in section *2.3: Bundling forest environmental services to livelihoods*, the four main categories of environmental services are basically identified in all possible objects of payment for ecosystem services, i.e. carbon sequestration, watershed protection, recreational value of landscape beauty, and biodiversity conservation. Differently, sustainable forest management can encompass also productive functions with a direct use or benefit for people such as timber and non-timber products for food and raw materials. The protective functions of forests which are notably related to soil and water properties like nutrient cycling, soil stabilisation and reduced risk of landslides are more referable to watershed-enriching ecosystem services, even though often with unexplored forms of cost internalisation. Alternatively to these functions and to the inherent forest vitality, non-use values like the socio-economic and cultural conditions associated to forests, e.g. the dimension of the forest sector in the national and regional economy, labour and employment aspects, or the value of recreational areas, are also accounted for in sustainable forest management. Such a classification of the different environmental uses has been especially formalised in the Pan-European Criteria and Indicators for Sustainable Forest Management (Finnish Ministry of Agriculture and Forestry, 2001; Third Ministerial Conference on the Protection of Forests in Europe, 1998) Thirdly, the difficulties in decomposing forest-based projects or activities into strict environmental, social and economic compartments have been surmounted by embracing the sustainable livelihood approach. In fact, while LULUCF projects can benefit local communities in a wide range of ways, they can also entail potential risks for both the community involved and the carbon investors. On the one hand, the rehabilitation of degraded areas would definitely increase the value of land and of forest assets while securing the productivity to some degree as well. On the other hand, equity and wealth distribution aspects may restrict access to some, deprive others from their income and impoverish the overall means of subsistence while the concept of sustainable development should lead to improvements (Scherr, Smith, & Robledo, 2000; World Commission on Environment and Development, 1987, in J. Smith & Scherr, 2002, p. 2)

In envisioning a carbon market that could deliver environmentally sound and socially beneficial outcomes, also Orlando et al. (2002) with the IUCN report "Carbon, Forests and People - Towards the integrated management of carbon sequestration, the environment and sustainable livelihoods" have hinted at the importance of the sustainable livelihood framework applied to forest communities. This paradigm pinpoints four more types of recognizably fungible assets in addition to the various aspects inferable from the environmental services or sustainable forest management approaches, i.e. the natural capital: human resources along with health and education, physical assets such as roads and hospitals, financial capitals like savings or credits, and the formal or kin-wise membership to social groups which can in turn facilitate the access to all previous ones. By playing with their reciprocal interdependencies, livelihood assets can and need to be expanded all at once on the path to promoting institutional development and building rural capacity. (Carney, 1987, in J. Smith & Scherr, 2002; UK Department for International Development, 2001) This approach holds especially true in a context of poverty alleviation. In fact, it is usually chosen because it promotes a multi-dimensional understanding of well-being which takes into account also aspects like vulnerability. Critically, the framework makes explicit the role played by the circumstances in determining the extent to which sustainability and welfare goals are achieved. (Landell-Mills & Porras, 2002) Although environmental services, forest management functions, and livelihood assets cannot be deemed complementary due to a certain degree of overlap, they are not equivalent either. Therefore, the non perfect match among these three accounting methods is believingly suggesting that the sustainability targets of projects should be scoped beyond the classical categorisation into environmental, social and economic aspects.

3.1.1.5 Credibility of the Offset Option

The credibility of any offsetting project proposal hinges in the first place on the **measurability and quantification** of the carbon sequestered. Moreover, the definition of the offset/carbon credit ownership should be clear and the respective **registration** put in place in order to prevent any event of multiple sales. (Bayon, Hawn, & Hamilton, 2007) Custodial registries can be centralised as so to expand the geographical boundary of recognizable trades and retirement platform created as seen in Chapter *2.1.3*. The other side of forest carbon project credibility regards the way the information is conveyed from project developers to credit buyers through retailers. In fact, it is especially important how providers **advertise the project quality** of the credits they sell. As in a sort of window-dressing, the first step for providers is their own understanding of the technical aspects of project quality. Secondly comes how project quality is prioritized amongst the entire product offering. In fact, even if offset sellers provide consumers with enough information to independently evaluate project quality, the information may not be stated clearly or fully made available since offset quality may not be the key strategy in some retailers' portfolio. That would reflect also into providers' transparency in operations and project selection. Apart from provider's history and project funding successfulness, examples of what level of insight the customers are to be given into operations include the monitoring of project performance. It is also important to track and record the retailing of offsets, in order to ensure that the same offset is not sold multiple times. Ultimately, the education potential to consumers regarding global warming is last but not certainly least negligible. For the influence on the public about climate policy can exceed the actual contribution to emission reduction, priority is attributable to those offset options which offer value added in that sense (TrexlerClimate & EnergyServices, 2006) It is finally noteworthy that the Gold Standard contains a thorough screening step of all '*project quality*' factors from the very pre-assessment phase of project development and for both CDM and voluntary offsets, i.e. pursuant to eligibility and additionality checks. (The Gold Standard, 2006a; 2006b) The screening involves an integrated 'sustainable development matrix', Environmental Impact Assessment requirements and some form of public consultation as well. Likewise, a sound selection of biodiversity indicators, the identification and evaluation of all impacts, the cost-effectiveness in baseline studies, the presentation of the information as so to promote a greater awareness and public involvement have been key elements for the World Bank as well since 2000 (The World Bank, 2000)

3.1.2 Project Innovation as Product Differentiation

3.1.2.1 Degree of Eligibility (Formal License to Operate Projects)

The first step required in the process of analysing a forestry-based carbon offset projects is its suitability in relation to a series of criteria against which the project developers intend to certify or verify it. In fact, it should be firstly evaluated if a project complies with the protocols and procedures addressed by the standard according to which it seeks credit issuance before embarking in its implementation. Borrowing the perspective on supply-influencing actors from Dalhammar, Kogg, & Mont (2003), the analogy of forest carbon projects as green products to launch climate neutrality or meet emission reduction requirements may be hazarded. Namely the formal license to operate projects, the degree of project eligibility is dependent on the strictness of the requirements included in the **initial documentation** for obtaining the **host country's approval**. This holds true both for the requirements of the Kyoto Protocol and for the rules and guidelines prepared by some verification companies, although the latter are so far laxer in comparison. Moreover, the **project type** itself can have an influence on eligibility, especially under the CDM procedures when **methodology approval** is needed. In that respect, the main reasons for methodology rejection have been studied, the first one being land eligibility pursuant to the '1990-forest' rule. In the second place, rejections have been determined by the wrong dimensioning of scope and applicability, by the lack of project-specific data, and by the incorrect definition or application of project boundaries. Furthermore, both baseline and additionality led to quite a few episodes of conceptual misunderstandings. As a consequence, no direct measurement of pre-project carbon stocks or prediction of stock changes was carried out for the designated area in those cases. Also the inappropriate treatment of leakage proved a usual cause for rejection. In addition, non-CO_2 gases were not even included in some assessments and the intentional exclusion of certain carbon pools failed in general to be motivated. Finally, errors and technical problems have been occurring in relation to quality assurance and transparency during monitoring. (Kägi & Schöne, 2005) As a result, the share of successfully submitted projects being fairly lower even than the quota allowed by the CDM suggests that the excess of bureaucracy is allegedly hindering innovation within LULUCF project proposals (cf. section *2.1.3.1*).

In addition, the **controversial, time-sensitive definitions of forests** and non-forests has led to substantial differences in eligibility across countries, especially in the industrialised Annex-I World where some 'Kyoto lands' have or have not already been locked accordingly. Finally, it is noteworthy that "the greater the restrictions on trading due to eligibility rules, the smaller the pool of carbon offsets available for sale and, thus, the level of potential supply-side competition." (Landell-Mills & Porras, 2002, p. 77)

3.1.2.2 Degree of Acceptability (Informal Licence to Operate Projects)

Acceptability is a measure of the agreement which the appointed authorities and agencies have upon a particular project type. In fact, the potential for a project placement into any national portfolio is indeed dependent on the consistency with the **host country's development objectives and economic priorities**. For instance, some conflict would emerge between the eligibility of projects to the CDM and budgeting financial aid like the Official Development Assistance as funding. Moreover, also the **host country's regulations** and priorities in matters of carbon offsets can some competition between Kyoto-Protocol-compliant mechanisms and other lighter schemes. Even the **investor country's or international standards** for this kind of operations play a role in determining the wider acceptability for a project. It can be actually considered a sort of informal license to operate projects as it affects eligibility in a more indirect and subtler manner. However, attention must be paid to those perfectly enacted national policies which promote distortional forest degradation. (Smith et al., 1999 in IPCC, 2000a, 5.2.5) According to such perspective, it should be assured that during project implementation also **international agreements and guidelines** are not run counter e.g. Agenda 21, the Convention on Trade in Endangered Species (CITES), the RAMSAR Convention for the protection of wetlands or the Geneva Convention on Human Rights among others (Costa, Stuart, Pinard, & Phillips, 2000) This holds true especially for the three Rio Conventions on Biodiversity, Climate Change and Desertification which have been remarked as having particular synergy potential.

In short, forest carbon projects should not maximize their efforts towards only one single Millennium Goal not to run counter the top principles of sustainability and create tensions for Parties between objectives of different conventions. Such situation can rise when, for instance, harvesting or degrading forest lands to receive revenues from both the timber products produced and the CERs generated from lands eligible for reforestation as project-based activities create a perverse incentive against the Biodiversity Convention. (Greenpeace, 1998; Chomitz, 2000; in IPCC, 2000a, 5.2.5) Hence, examples of activities being better off when addressed jointly with carbon sequestration, and with international supervision, are ecosystem restoration, prevention of land degradation, biodiversity conservation, watershed protection, promotion of sustainable rural livelihood, etc. (Bioclimate Research & Development, 2004) Therefore, acceptability links back to all the aspects of project quality such as '*Delivery of Ancillary Co-Benefits for Sustainable* ' (sect. *3.1.1.3*) and '*Cost-Effectiveness of the Offset* ' (section *3.1.1.4*). Furthermore, social acceptance at the local, national, and even global scale may also influence how effectively mitigation policies are implemented with respect to e.g. *Response to negative leakage* (cf. section *3.1.1.2*) when cumulative environmental, economic, and social impacts are assessed not only within individual projects but also from broader, national and international perspectives. (Kauppi & Sedjo, 2001) However, the possibility that participating in some CDM project would help host countries in meeting commitments under other conventions should be not overlooked. In fact, if an action justifiable under other obligations was included with the claim of the synergistic quality of the CDM project, it could be argued against its additionality from a legal perspective. Hence, careful determinations of MEAs commitments and project activities overlaps should be planned. (Manguiat, Verheyen, Mackensen, & Scholz, 2005, p. 65)

3.1.2.3 Variety in Project Portfolios

> "[Amongst all GHG-source economic sectors ... LULUCF ... uniquely presents no less than five avenues to reduce GHG emissions, namely: provision of renewable energy; substitution for more fossil carbon-intensive products; reduction of emissions of non-CO_2 gases (e.g., from agriculture); sequestration of carbon through enhancement of terrestrial C stocks; and conservation of existing C stocks (e.g., through reduced deforestation, devegetation, forest degradation, and land degradation." (Schlamadinger et al., 2007, p. 273)

Yet, when forestry projects are watched under a CDM perspective, they can hardly be deemed diversified for they comprise the sole **afforestation/reforestation** category. In comparison, voluntary portfolios may include other Article 3.4's project types ranging from **improved forest management** and **avoided deforestation**, even up to **sustainably produced biomass and improved fuel-wood management**, **improved soil conservation and agricultural practices**. Nevertheless, different forest carbon projects entail different benefits and risks to livelihood as previously outlined in the '*Cost-Effectiveness of the Offset* ' (section *3.1.1.4*). Large-scale industrial pulp and paper plantations, for instance, are understandably attractive to both the concerned private sector and the host countries' governments because of the potentially fast export revenues. Despite of a good rate of employment due to labour intensiveness and the consequent social services provided by foreign companies, tenure conflicts and non-timber forest products depletion have been well documented in many cases. (J. Smith & Scherr, 2002) Unless patches of varying land-use are adopted, this solution can hardly bring any environmental co-benefit beyond carbon sequestration. Brazil has been particularly involved in hosting industrial plantation projects, the more famous (or notorious) being the project proposed by Plantar S.A. and Ecosecurities, whose "Reforestation as Renewable Source of Wood Supplies for Industrial Use in Brazil" draft Project Design Document (PDD) led to CDM A/R-AM0005 methodology. This project should create emission reductions by avoiding a fuel switch from carbon-neutral charcoal to fossil fuel in pig iron production; it is also supposed to promote sustainable development under the CDM by reducing pressure on the native forest currently being decimated for charcoal used in the Brazilian pig iron industry, by helping conserve their unique biodiversity and preserve local community use of forest fruits and other non-timber products. In addition, the project should secure high-quality employment in rural areas with few other employment opportunities due to the negative feedback loop of small-scale pig iron mills closing down triggered by planted biomass shortage. As a result of those claims, the relatively young World Bank's Prototype Carbon Fund (PCF), which has a number of government and corporate investors who get a pro rata share of the credits from PCF projects, entered into an agreement to purchase 5 million tCO_2e emission reductions from this project through 2012.[11] SGS's certification for the forestry part and DNV's validation notwithstanding, forestry-project-scrutinizing NGO Sinkwatch along with the World Rainforest Movement (WRM), the Forests and the European Union Resource Network (FERN), and over 50 Brazilian NGOs, churches and trade unions have been urging PCF investors to refrain from buying carbon credits originating from that project because through a monoculture Eucalyptus tree plantation "industrialised countries will be allowed to meet their Kyoto reduction target using unsustainable plantations and climatically worthless credits." (Kill, 2003) In contrast to large-scale industrial plantations, agroforestry develops minimal risks while enhancing ecosystem services either by establishing community forest plantations or agroforests. (J. Smith & Scherr, 2002) The former applies to the PROFAFOR Project farm forestry in Ecuador which, in reality, is another instance of 'bad project' and a failed CDM application. When in 1999 the FACE (cf. section *3.2.1.3*) Forestación del Ecuador S.A. programme, known as PROFAFOR, established a 23 000 ha certified (monoculture pine and eucalyptus plus mixed with native species) tree plantations in an Ecuadorian Andes region of low forest cover, small-holders' farms were the community benefit addressees. Later on the project image was revealed as having improved at expenses of the peasants' land, labour and money. Despite SGS's assessment of sound forestry management, no rent had been paid, the generated employment was fictitious and the expected revenues proved largely insufficient. (WRM, 2006)

Also in the Fondo Bioclimatico Scolel-Té Project in Mexico, small-scale farmers from 30 communities of non-exclusively indigenous Mayan in central and northern Chiapas are sought to be involved in carbon sequestration by switching from agriculture to agroforestry. (K. Brown et al., 2004; J. Smith & Scherr, 2002) The project is managed by non-profit BioClimate Research and Development (BR&D) through the 'Plan Vivo' system. This participatory planning and project monitoring system was created by the Edinburgh Centre for Carbon Management (ECCM) for managing the supply of verifiable emission reductions from rural communities in a way that promotes sustainable livelihoods (cf. section *3.1.2.4*). Fact is that both PROFAFOR and Scolel-Té project apply two practices which are beneficial as long as the tree-species configuration is compatible with or sufficient land is available for other farm needs. This translates that, in order not to jeopardize the food crop production in light of the more volatile prices for perennial products, community forest plantations have to limit the woodlots to blocks or strips of trees whereas multi-species agroforests have to convert land to secondary forest fallows in such a fashion similar to ecological successions. However, the production of carbon revenues is contingent on local benefits. For what concerns curbing deforestation, forest regeneration and rehabilitation, strict forest protection, and multiple-use community management of natural forests are more appropriate project types. Necessary condition to involving instead of excluding communities from the project area is nonetheless to remove the threat of deforestation. Pursuant to current UNFCCC provisions, such projects clearly follow procedural routes other than the CDM as

[11] PCF's investors include BP- Amoco, Chubu Electric Power Co., Chugoku Electric Power Co., Deutsche Bank, Electrabel Fortum, Gaz de France, Government of Canada, Government of Finland, Government of Norway Government of the Netherlands, Government of Sweden, Japan Bank for International Cooperation, Kyushu Electric Power Co., Mitsubishi Corp., Mitsui, Norsk Hydro, RaboBank, RWE, Shikoku Electric Power Co., Statoil, Tohoku Electric Power Co., Tokyo Electric Power Co.

the Rio Bravo in Belize (cf. section *3.3.2.2*) and the Noel Kempff Project in Bolivia (cf. section *3.2.2.4*) have done. (J. Smith & Scherr, 2002) In short, "integrated projects or portfolios may offer potential synergies that address several technical issues. A sequestration component could provide sustainably managed forest products and reduce leakage from a conservation component, and a bioenergy component could provide jobs and low-cost power that is important to the sustainable development priorities of host countries, as well as enhanced profitability for investors." (Niles and Schwarze, 2000 in IPCC, 2000a, 5.2.5).

3.1.2.4 Engagement of Diverse Carbon Economy Actors within the Project Supply

A variety of carbon economy actors can be deemed beneficial to the overall design and implementation of community-based projects in several ways. In certain instances, institutions like intergovernmental agencies or research centres are engaged in the very beginning of project development. In that respect, capacity-building and advisory services for investors, community carbon service providers and intermediaries are important roles that can be strengthened in the process and are played by other entities than the leading private sector (cf. section *3.2.1.2: Market*) (Landell-Mills & Porras, 2002; J. Smith & Scherr, 2002) In line with the context for this study, the term 'market actor' is hereinafter referred to accordingly to Sell et al. (2006), i.e. any institution directly involved in supply, demand, or transaction management of voluntary offset/carbon credits from forestry projects. Consequently, the list includes a variety of private as well as governmental organisations involved in market activities ranging from defining market conditions to providing funds and loans. Amongst **non-profit organisations**, examples of governmental organisations with a stake on LULUCF carbon credit supply are ministries of forestry and environmental or economic sectors. NGOs include international NGOs or any NGO focusing on the forestry sector like the ones cited in section *3.1.2.3*. Differently from Sell at al. (2006) though, policy-making representatives and the scientific community were here considered in this study because, even without being directly involved in demand, supply or transactions of forestry-based carbon sequestration, they seem to seek for an influence (cf. section *3.3.2.2)* during the product creation phase, i.e. project development, and sometimes are even hired as consultants e.g. the Joanneum Research for the Guangxi project and the ECCM for the Scolel Té (cf. sections *3.2.2.4* and *3.1.2.3* respectively). In fact, climate-change-oriented NGOs, timber companies, privately specialized companies or more conventional public-sector actors are normally deemed more ordinary project developers (Bayon, Hawn, & Hamilton, 2007, p. 18) Despite of the current irrelevance as decision-maker and player in the carbon market, the general public, i.e. individual private consumers of offsets, has been included as well in light of the greater significance which it is believed to gain once the market develops. Although such a growing involvement makes it part of the scenario analysis especially for what concerns the demand-side impact variables, voluntary consumers' preferences would be strongly effective on the supply in a less artificial market.

With regards to **investors**, it is clear that banks and re-insurance companies are some financial institutions which may affect the '*Project* ' variables. Moreover, being a project stakeholder may exceed the boundary of mere sponsorship when the industry relates to companies and industrial associations which are not only carbon emitters (like the electric power sector) but which also have multiple interests in forest business e.g. timber trade. Finally, **intermediaries** of the carbon markets often speak out in project development, either if their offering is limited to local forestry consulting or if they are a multinational company selling an 'all-inclusive' assistance in offset/carbon credit creation. The same applies for certifiers which, if effectively engaged, typically work side by side to clients from the very start of projects in the provision of those 'additional services' highlighted by section *3.2.1.3* such as carbon credit verification or forestry certification. (Sell, Koellner, Weber, Pedroni, & Scholz, 2006) The reason why interests at stake in project development may attract more than one-function market player are not so different from some emission-reduction buyers' motivations. In fact, sellers might be interested in demonstrating leadership on the climate change issue, learning by doing, informing public policy, or shaping future trading rules (cf. section *3.2.2.3: Consumers' Preferences and Project Support*). For what concerns project sponsorship in particular, the improved creditworthiness of projects can be a serious driver for large credit-rated emission-constrained companies aiming at lowering their borrowing costs and thus gradually increasing overall returns in project investment. (Rosenzweig, Varilek, & Janssen, 2002)

3.1.3 Project Costs as Accessibility to the Market from the Supply Side

3.1.3.1 Support of Technical Competencies in Response to LULUCF Shortcomings

As Schlamadinger et al. (2007) pointed out, "there are three unique characteristics of the LULUCF sector that require consideration in the context of greenhouse gas mitigation, namely saturation …, non-permanence, and the degree of human control." However, the latter is strictly coupled with the influence which natural effects have during projects' life. Therefore, the issue of human control has been treated separately because of its relevance for the overall baseline and additionality of projects. At the end of day, tackling the shortcomings which make the LULUCF sector different from any other project-based emission reductions requires additional competencies. Hence, the effectiveness of the response depends on how these 'three unique characteristics' are addressed. In particular, **saturation** has been a decisive factor for the role that forestry plays in the CDM since the decisions on accounting modalities were taken. In fact, different crediting approaches can affect both the environmental impacts of forestry projects and their economic attractiveness.

As far as **non-permanence** is concerned, it is remarkably important that the sequestration potential of biomass can be limited in favour of the provision of renewable energy or wood products which can be alternatively sought after. However, permanence has necessarily to be addressed if project duration and the validity of CDM credits such as temporary CERs and long-term CERs are the main concerns within project development (cf. section *3.3.1.3: Contractuality of*). While critical issues such as additionality, measurement, baseline and systems boundary including leakage, social and environmental impacts, and host country's institutional capacity are inherent to energy projects as well, the duration of carbon credits typically belongs to the LULUCF sector. (Chomitz, 2000; Sathaye et al., 1999; in IPCC, 2000a, 5.2.5) In that sense, the net positive climate impacts immediately attainable have to be balanced against the contingent fluctuations involving all the different carbon pools (*Figure 3-1*).

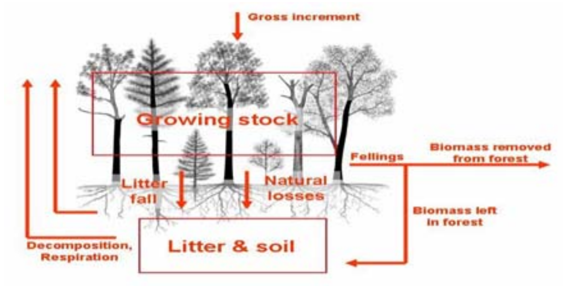


Figure 3-1 Biomass carbon stocks

Source: (Muukkonen, 2007)

In fact, while it is relatively easy to account for the aboveground living biomass, the belowground living biomass plus the dead organic matter stored in the soil is not as simple task. Although that carbon is not abruptly affected by felling, deadwood and litter stocks face microbial decomposition anyhow besides being much more difficult to estimate. Furthermore, the complexity of the contingent accounting for non-forest biomass modules like timber products adds on additional controversy. (Pettenella, 2007) Saturation refers to whether the potential for biological carbon storage might be limited by the volume of carbon that can be stored per unit of land. This is primarily depending on the lands available, on the type of land-use project, on the geographical location and respective vegetation type, and on the timeframe over which the project takes place. (Schlamadinger et al., 2007) The **degree of control by humans** is closely linked to the influence which natural effects have on forestry projects in determining the abovementioned phenomena of saturation and non-permanence. By impacting on the increase and decrease of carbon stocks, **natural effects** are the framework against which any additional human measures should be measured before and while operating. This is why baseline projections and the capability to thoroughly determine and demonstrate the without-project scenario are noteworthily important. Examples of natural occurrences which need to be adequately addressed for carbon management efforts are all those contingencies which may affect tree growth: droughts, storms, diseases, insect attacks, changes in temperature, rainfall, CO_2 concentration, atmospheric nitrogen deposition, etc. These factors are largely beyond the control of land managers, although their effects can be modified by management decisions such as planting density, thinning regime, pest and fire control, fertiliser addition or the choice of species. (Schlamadinger et al., 2007) When native species are not used in an exclusive way, the choice of non-native plants might be justified in light of their superiority for degraded-land rehabilitation or fuelwood production purposes in the specific local conditions. (CCBA, 2005) However, CDM rules for project baseline accounting are counterfactual in that forest carbon stocks are assumed to remain constant in light of a historical scenario On the contrary, existing deforestation is often an integral part of the conditions at the tropics which does not allow for the adoption of static baselines. Even in the event of turnaround in forest coverage, the reference baseline should be dynamically moving (*Figure 3-2*). (Wunder, 2005) Baselines would be even more meaningless if the effects of the ongoing climate change were given credit for the conditions which are changing rapidly away.

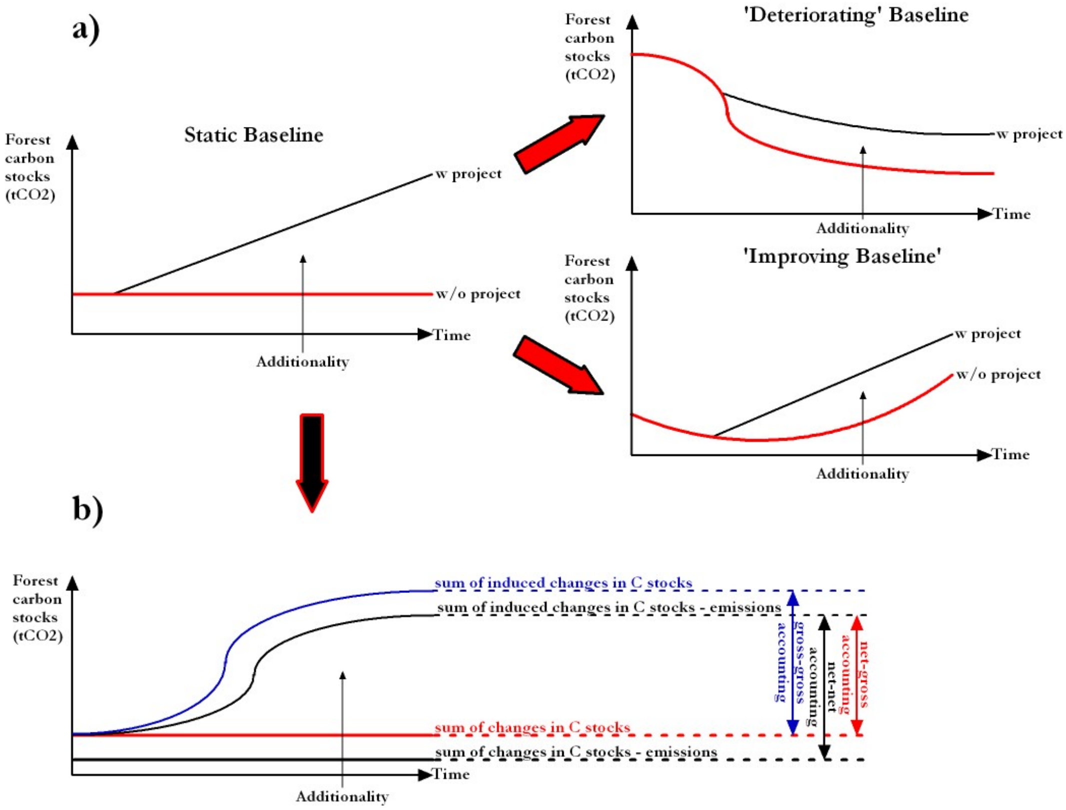


Figure 3-2 Calculating baseline scenarios using carbon stocks

Source: (Jung, 2003; Wunder, 2005, p. 9)

After following the IPCC Special Report on Carbon Capture and Storage and the 2006 Guidelines for National GHG Inventories, the current accounting rules under the UNFCCC decisional framework conceptually apply to both national registries and project-level *problematiques*. Pursuant to Decision 3/CMP.1, the modalities and procedures for a CDM as defined in Article 12 of the Kyoto Protocol provide for credit calculation as so that CERs resulting from a project activity during a specified time period shall be calculated by subtracting the actual anthropogenic emissions by sources from baseline emissions and adjusting for leakage. Neglecting leakage which has already been treated under the respective heading (section *3.1.1.2*), also natural emissions are a potentially large source of inequitable allocation of credits. In fact, the ideally unbiased baseline approach should cover all significant biospheric sources besides direct human-induced components of biospheric emissions or removals. Yet, neither gross-net accounting nor net-net accounting are deemed adequate to distinguish the anthropogenic component of carbon-stock changes from indirect and natural effects. Whereas the former compares with gross emissions baseline by assuming the absence of any natural phenomenon, the latter is biased in that it still does not rely on a dynamic baseline that should instead account for variation over time (*Figure 3-2b*). (Cowie, Kirschbaum, & Ward, 2007) New approaches have been suggested to solve such inaccuracies, e.g. by the GHG Protocol. *Figure 3-3* illustrates how the GHG reduction is calculated by first accounting separately and then finding the difference between project activity GHG removals (on the right side) and baseline GHG removals (on the left side in the same time period. The baseline emissions scenario is estimated by means of the performance standard procedure. This particular baseline procedure uses a benchmark GHG emission rate derived from all baseline candidates and can be thus used for any number of similar project activities in the same geographic area.

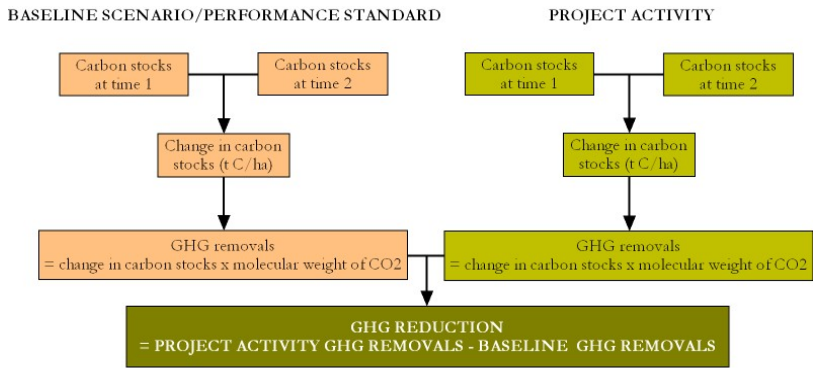


Figure 3-3 Calculating GHG removals using carbon stocks

Source: (WBCSD & WRI, 2006, p. 9)

3.1.3.2 Capacity in Sourcing Local Labour and/or Starting Up Local Entrepreneurship

Besides technical skills, other competencies in terms of human resources are required to tackle potential market development constraints from the supply-side. In fact, "… project developers are usually based in geographical regions that are far apart, come from different cultural backgrounds, speak different languages and belong to a different business environment:" (Neeff & Henders, 2007, p. 18) In the first place, the members of the local labour are typically unaware of their own or the client's **market opportunities**. Such business attitude might be caused by potential information asymmetries in the market and can be changed, e.g. through education. Further enhancement can derive from the increasing bargaining power which is gained as long as the local conditions are part of the knowledge management. Secondly, the **capacity to adequately organize the supply** should fill the contingent gap existing with demand where markets are underdeveloped. In fact, the supply does depend on the capacity to bring commodities to the market and abide by the terms of transactions. This capacity may be lacking in many developing countries. As previously discussed in terms of cultural acceptability of transactions, suppliers may hesitate where they lack an understanding of deals. (Landell-Mills, 2002; Landell-Mills & Porras, 2002) In this case, the cure should be sought according to marketing and negotiation skills which are required as soon as coordination becomes a more urgent need due to increasing partner involvement. All these factors are in turn contingent on other attributes such as education, bargaining power, and management, leadership, negotiation, conflict resolution and coordination skills. If all the above are minimal requirements, a few more **enabling conditions** for rural livelihood are however necessary such as. sufficient density of rural population, good market infrastructure, technical knowledge and local management, quality of the existing forest resource, security of land tenure, legal rights for indigenous people to sell carbon benefits, existence of local organisations, etc. (J. Smith & Scherr, 2002, p. 7)

3.1.3.3 Financial Resources and Liquidity (Investor Involvement)

The accessibility to the market from the supply side in terms of financial resources and liquidity to start a forestry project depends on various conditions which accompany investor involvement. Before that though, it must be clarified that carbon finance is often designed to provide a complementary cash-flow to projects whose investment decision is based on other sources or reasons. When it comes to carbon liabilities, however, projects that have the potential to provide carbon credits quickly though at a net cost (such as forest conservation) are more targeted by substantial near-term investors, while projects providing carbon credits relatively slowly, but at a net profit (such as managed plantations) will attract modest near-term investors. (Frumhoff et al., 1998; Smith et al., 1999; in IPCC, 2000a, 5.2.5) First of all, the outputs of any **investment appraisal** should enable investors to estimate all the costs alongside the expected stream of revenues as more precisely as possible before taking any budget decision. Direct costs often include land purchase or, alternatively, the rental costs of land, while other initial costs may be due to land clearing and site preparation, initial planting or other preparatory activity costs. Moreover, recurring costs which occur e.g. annually, usually comprise project maintenance and management including, for example, periodic thinning or other stand improvement and weed control in agricultural soil management. Nearly every project, then, needs to establish both a monitoring and evaluation systems which usually entail far from negligible expenses. On the contrary, opportunity costs of land (i.e. the marginal present value of the best alternative uses for a piece of land) are often not included in financial analyses of projects, not to mention infrastructure costs e.g. road development that tend to be overlooked. Paradoxically, forgetting to include monitoring data collection and interpretation costs, maintenance or other recurring costs that will be incurred in the future might constitute the worse negligence. (IPCC, 2000a, 5.2.3) Yet, the inclusion of other factors such as the return of investment given discount rates changing with the 'carbon inflator' along project lifetime would completes a sound assessment (Nagai, 2005) In fact, forestry projects entail long-delayed delivery returns depending on geo-ecological conditions and low rates of return when compared to other industry sectors. In addition, investment appraisals always undergo risk analysis, though 'beyond-business' decisions may be taken due to differently perceived uncertainties or irrespective of the purely financial viability of the project (cf. section *3.2.2.4*). (Neeff & Henders, 2007) In the forestry business, however, those willing to pay for carbon services may not suffice anyway to compensate for the whole risk aversion of providers since many limitations are firstly posed onto the forest resource holders.

A second key barrier which is relevant for both the *Contractuality of* (cf. section *3.3.1.3*) and investing in forest carbon projects is the **payment schedule**, especially where landowners do not have access to finance, seed capital, international exposure or technical capacity, credit rating or access to insurance, as perhaps capital-rich multi-national companies. (Neeff & Henders, 2007) Whether carbon credits are paid on delivery or beforehand (i.e. whether the seller receives payment for the carbon credits when the agreed amount is delivered or when signing a purchase agreement) may affect seriously the viable liquidity of small landholders' organisations which, in turn, very much relate to the social component of multi-benefit project. In many cases, "… the sale of emission reductions provides the [very] financial incentives needed to obtain and maintain landowner participation until the plantations reach sufficient maturity to provide the landowners with income from sustainable harvesting" like in the abovementioned carbon sequestration project in the Sierra Gorda of Mexico (cf. section *3.1.1.3*). (Bayon, Hawn, & Hamilton, 2007, p. 73) The need to raise upfront payments for implementation is generally due to securing lands or planting trees as so that a combination of the two financing systems with initial up-front payment can enable project development, while leaving most of credits to be paid only upon delivery. (Neeff & Henders, 2007) Following verification, emission reduction credits can then be issued yearly or e.g. every fifth year. Due to the reversibility of forest sinks, CDM projects have to verify every five years that the carbon is still stored and the decade-to-century growing period of trees is not suited for prompt accruing or the bulky consignments characterising other CDM deals. Economies of scale tend to favour larger operations which in this case compete with the cost-effectiveness of achieving emissions reductions in other sectors domestically within each country and internationally under continual technological innovation in the energy sector. (IPCC, 2000a, 5.2.5) In addition, the impact of upfront costs on project development depends on the stage at which **purchase agreements** e.g. like the Emission Reduction Purchase Agreement (ERPA) in the CDM occur, i.e. when the cash flow turns positive and the investment starts to pay off. Sometimes, investors are attracted and their participation in project cost coverage guaranteed by devising free-of-charge future options where no sum is paid in advance in exchange for pre-emption rights. (Bayon, Hawn, & Hamilton, 2007)

3.1.3.4 Material coverage of the project pipeline by the main contractor

From an innovative product perspective, the accessibility to the market from the supply side of forest-based projects chiefly depends on the **technical carbon reduction costs**. These activities basically consist of every material or intellectual resource added onto the value chain of the project cycle before either middlemen or end-consumers. That is because, even in the voluntary markets, the 'product' is ready to sell when project developers have financed the verification of their carbon emission reductions. (Bayon, Hawn, & Hamilton, 2007) All the relevant costs before that stage, e.g. project design, project validation and registration, monitoring, on-going audits, etc. can be somehow compared with the typical CDM project pipeline with the exemption of credit issuance fees, adaptation levies and taxes which apply to CDM only. As shown in *Figure 3-4*, the project cycle usually starts with the elaboration of a preliminary Project Idea Note (PIN) that summarizes a first concept and project structure. Although this stage is not mandatory is rather common that project developers send this document to Designated National Authorities (DNAs) in order to ease the issuance of a Letter of Endorsement (LoE) and thus obtain a no-objection to continue. The same document is also sent to prospective credit buyers in order to make expressive their intention to purchase CERs through a Letter of Intent (LoI). Then the project design phase can be consolidated in the PDD and Monitoring and Verification Plan as equally required. Besides estimating the GHG mitigation potential of the project, undertaking the feasibility analysis and developing a working plan, the PDD should identify the various process partners needed to lead project implementation to the end of the pipeline. Although beyond the threshold of project development, securing a reliable partner in the subsequent commercialization of credits is an essential part of the pipeline without which the whole carbon finance would be meaningless. Delays and additional costs may occur whether the project decides to submit a new methodology which needs to be approved by the Executive Board, i.e. the international authority supervising the registration and related procedures of CDM projects.[12] Therefore, the CDM provides for selected A/R small-scale project activity categories to follow simplified baseline and monitoring methodologies because of the too expensive design framework resulting otherwise.[13]

---

[12] To date, eight large scale A/R methodologies have been successfully approved.

[13] To date, the "simplified baseline and monitoring methodologies for small-scale afforestation and reforestation project activities under the clean development mechanism implemented on grasslands or croplands" is the only one approved.

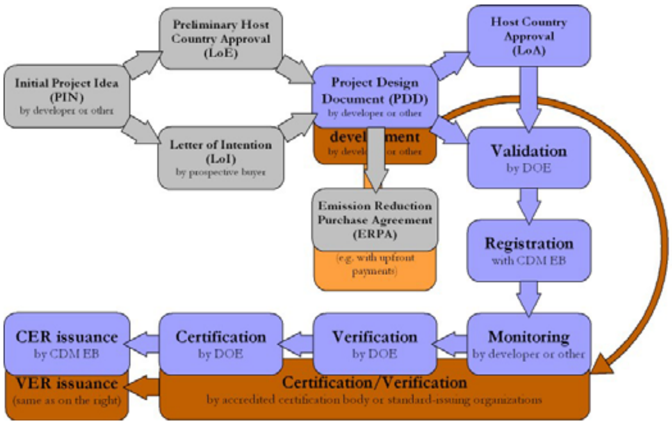


Figure 3-4 A typical forest carbon project pipeline

(In blue, officially required steps by CDM; in grey, common but not mandatory activities; in brown, voluntary offset pipeline for comparison; see the text for a detailed discussion)

Source: (Neeff & Henders, 2007)

Another legally binding contract at this stage is the ERPA, abovementioned with respect to section *3.1.3.2:* F*inancial resources and liquidity* (investors' involvement). Voluntary offsets are as likely to manage non-delivery risks with purchase agreements (cf. section *3.3.1.3*) as done in the CDM. Host country approval is a requirement which may take less human resource in case of non-CDM projects since internal procedures and government agencies are not likewise appointed for official responsibilities and Kyoto regulation does not have to be complied with. Nevertheless, host country legislation has most likely to be met anyway, the verification usually happening in parallel with project validation. Under the CDM such services are conducted by the as-of-to-date 29 Designated Operational Entities (DOE), while in voluntary schemes likewise accredited bodies or standard-issuing organisations verify the emission reduction (VERs) against particular set of certification protocols at the time of periodical monitoring. This very operation is generally subcontracted to external agencies specialized in forestry and carbon inventories. In addition, designated certification companies are often hired to certify the forest management in accordance to some forestry quality standard like the Forest Stewardship Council (FSC) or the best-practice criteria of e.g. the Climate, Community and Biodiversity Standard (CCBS) and the Gold Standard (cf. section *3.2.1.1*). After successful validation, a report is made publicly available and the project registered in order to avoid double counting of emission reductions. This usually applies to any credible offset which seeks third-.party verification (cf. section *3.1.1.5*). Finally, CDM projects are stricter than any other forest carbon project in that they are required to undergo independent verification, i.e. an audit of the occurred monitoring and project implementation, and then certification, i.e. the statement of successful verification, before any CER is issued. This serves as a sort of double guarantee of credit integrity for it basically undergoes official approval. (Neeff & Henders, 2007) Simply put, all these stages needs a certain technical expertise to go through which may not belong to the same contracting organisation's capacity or may be less expensive to outsource. For instance, project preparation is usually completed by a consultancy company which may be highly specialized and hold a quite large share of the market in that respect. Likewise, project validation is basically up to typically Europe-based multinational certification groups which compete by incorporating the most accreditations as possible and by offering 'all-inclusive' prices (e.g. fees and paperwork handling plus a pre-packaged number of visits). Therefore, all the factors affecting the **average realized magnitude of projects** are relevant in determining the material coverage of the whole project pipeline. In particular, the **successful commercialization** of a project tends to be a combination of cost-effectiveness and community, investor, and national government's priorities. Key elements in that respect are the *Delivery of Ancillary Co-Benefits for Sustainable* both socio-economic (e.g. employment, new sources of income for the local poor, no need for relocation or compensation) and environmental terms (use of native species, reclamation of degraded sites, no need for vegetation clearance), the *Credibility of the Offset* by means of various certifications, the *Degree of* to the requirements of the chosen programme, the *Support of Technical Competencies in Response to LULUCF Shortcomings* through specialist advise facilitating the chosen registration process, the F*inancial resources and liquidity* (investors' involvement) through secured investment, cash flow projections, insurance, and a strong partner or in-house department with access to carbon markets that can support the vending of credits. (Neeff & Henders, 2007)

3.2 Demand-Side Impact Area (Consumers' Mitigating Power)

3.2.1 Standardisation of the Carbon Commodity (Degree of Segmentation)

3.2.1.1 Diversity of Commercial Standards

To date, there are quite several categories of 'carbon neutral' standards which can be separated into accounting protocols, programmes implementing such protocols and certifying companies or products, and programmes certifying offset projects and carbon credits. (Bayon, Hawn, & Hamilton, 2007) The WRI/WBCSD GHG Protocol, for instance, is an accounting guide that does not certify offsets or organizations, but help them identify, calculate and report soundly corporate or projects' GHG emissions in analogy with the Global Reporting Initiative. These two set of standards were developed in 2003 by the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in a multi-stakeholder partnership. More recently, "LULUCF Guidance for GHG Project Accounting" was released the authorship of which is shared with professionals and practitioners from forestry governmental services and research institutes, certification bodies and environmental agencies. Fact is that Part 1 of ISO 14064, which is of specific interest to voluntary GHG registries and regulatory allowance-based schemes, was developed consistently with best practice established in the WRI/WBCSD GHG Protocol Corporate Accounting Standard. As far as ISO is concerned, some 175 experts from 45 countries and 19 liaison organisations contributing to Working Group 5 on Climate Change of ISO Technical Committee 207 (which is responsible for the ISO 14000 family of environmental management standards) participated in developing the three-part ISO 14064 as a result of several years of detailed study and engagement with the international community of governmental and business organizations with a stake in climate change. This set of unambiguous and verifiable requirements and specifications was presented in late 2005 in response to governments, business corporations and voluntary initiatives using a number of approaches and no generally accepted validation or verification protocols to account for organization- and project-level GHG emissions and removals. For what concerns project level, Part 2 provides proponents participating in voluntary programmes or regulatory credit-based schemes with guidance for the quantification, monitoring and reporting of GHG emission reductions and removal enhancements. While Part 1 and 2 may be of interest for either organisational GHG inventories or project scheme administrators and designers, Part

3 provides the specification for the validation and verification of greenhouse gas assertions and can be thus used by organizations or independent parties in the attempt to establish new international best practice for the GHG validation or verification process. As a consequence, ISO 14064 will be nevertheless complemented by ISO 14065 on accreditation of GHG verification or validation bodies. In order to neither be scheme sensitive nor lose market credibility and relevance, ISO 14064 development process embodied the principles of regime neutrality and technical rigour while ensuring extensive participation in standard development and promptness of release as so to restrain the quickly evolving diversity of standards.

Another standard which is aimed to be launched and hit the market in late 2007 is the final version of the Voluntary Carbon Standard (VCS) since the Climate Group (TCG), the International Emissions Trading Association (IETA) and the World Economic Forum Global Greenhouse Register (WEF) joined forces almost two years ago. In that respect, it is noteworthy that the VCS Steering Committee (SC) has also decided to use the ISO14064/65 series as a backbone of the standard. The SC, whose seventh and last working group was appointed to address LULUCF as outstanding issue, has been independently established to review the responses to partners' consultation and incorporate their comments. Apart from the founders, SC's members belong to internationally renowned consultancy, certification, and brokerage companies, trading programme administrators, asset management capitals, and early-mover corporations. "The VCS is designed to be a global benchmark standard for project-based voluntary emission reductions that provides a degree of standardization to the Voluntary Carbon Market and creates a credible voluntary emission reduction credit, the VCU, that can be trusted, traded and used by [Voluntary Carbon Market] participants.**"** The key message is that the concerns raised by the lack of oversight in the voluntary carbon market segment are addressed through wide stakeholder consensus, consumer confidence, market integrity, credibility and innovation. An independent non-profit organization owing and managing the standard will complete VCS functionality.

While the VCS aims at minimum quality requirements, for voluntary offsets, the Gold Standard on the other hand seeks to define a top-performance in both regulatory and non-regulatory markets. Originally born from the observation that only 34% of the CDM projects contribute for real to sustainable development which the WWF together with a variety of other NGOs, businesses and governmental organizations meant to supplement, the Gold Standard is now available also for voluntary offsets. Although the general requirements are the same for both the VER and CER streams (cf. *Figure 3.4*), some CDM specific procedures have been take out or simplified or adapted to the provisions of the voluntary market. The two main differences regard Official Development Assistance additionality and baseline methodology, which are significantly less strict for voluntary offset projects. Therefore, the uniqueness of this standard can be said to lie in the broader '*Degree of* ', especially for host country requirements, and in the three-fold sustainable development screen and public consultation as described in *3.1.1.3* which is however the same for any project.

Finally, the CCBA and its standard have a special connection with the Nature Conservancy projects referred to in section *3.2.2.4: Market Participation and Beyond-Compliance Attitude* in that it is a member of this partnership among research institutions, corporations and non-governmental organizations (NGOs). The Tropical Agricultural Research and Higher Education Center (Centro Agronómico Tropical de Investigación y Enseñanza – CATIE), the International Centre for Research in Agroforestry (ICRAF), and the Centre for International Forestry Research (CIFOR), three respected international forestry institutions, helped revise the standard as independent advisors. The three-fold criteria checklist of the

CCBS fosters the integration of best-practice and multiple-benefit approaches into project design and evolution with respect to climate change, local communities support and biodiversity conservation simultaneously. In addition, the general section helps mitigate risk for investors and increase funding opportunities for project developers. Finally, also TÜV SÜD, an established world-wide verifier in the carbon market, recently announced the release of its own standard for voluntary carbon credits, whose and other certificates tracking is planned to be entrusted to an *ad-hoc* founded organisation called Blue Registry.

In summary, all the standards analyzed are founded on the same principles of reality, measurability, permanence, additionality, independent verification, and avoidance of double accounting which are in turn reinforced by the partnerships highlighted through inclusiveness in the **participatory development process**. Therefore, they seem to be fairly contingent on the profile of the organizations that developed them in terms of representativeness of interests and sufficiency of requirements. In addition, the potential **competition amongst** such variety of **differentiated requirements** which is virtually applicable to many project types in many jurisdictions is not deemed significant since each and every standard either aims at setting a basic quality threshold or addresses different market segments with an eye on beneficial complementarities.

3.2.1.2 Market Infrastructure

According to Directive of the European Parliament and of the Council 2003/87/EC, any legal person can hold and transfer emission allowances within the EU ETS. Despite allowances are tailored to the specific attributes of carbon, they can be basically compared to any other negotiable commodity. Hence, carbon trading appears as equally exclusive of licensed intermediaries as in ordinary finance. Therefore, access to spot trading has not been simple for small and medium enterprise or purely industrial operators and EAU bourses' clearing members are basically big financial institutions, bulge investment banks, energy providers and hedge funds. For instance, "banks often represent industrial participants and small obligated installations, many of whom do not have direct experience of trading ... [while] some investment banks also speculate and act as primary brokers for hedge funds." (Capoor & Ambrosi, 2006b) Although admission and operation fees appear reasonable, emission traders are thus required to maintain a certain solidity of assets and significant guarantees. Hence the need to simplify transactions, reduce delivery/payment risks and help prices become more transparent at the same time led exchange platforms and auctions to eventually emerge over the past year, while in the past the carbon market used to be dominated by third-party intermediaries e.g. NGOs first and then carbon funds, emission brokers and consultants. "Most carbon exchanges … in [their] early stages of establishment … are often emerging alongside government regulatory systems like in the UK, Canada and Europe where promotion and endorsement has been more clearly oriented at minimising costs of implementing planned GHG emissions limits. For their part, carbon brokers initiated the process of setting up such platforms in the attempt to gain from early-mover and lobbying strategy once national requirements were put into effect. (Landell-Mills & Porras, 2002, p. 79)

Therefore, the development of a more robust market infrastructure took place and is likely to continue in accordance to the evolution of the carbon commodity. In other words, were carbon offsets going towards standardisation like an ordinary financial asset (**commoditization**), system components such as retirement platforms or custodial registries would prove necessary to ensure the transparent and reliable reporting of transactions and thus inspire confidence to investors (cf. section *3.1.1.5: Credibility of the Offset*). (Bayon, Hawn,

& Hamilton, 2007) Instances of carbon commodities could be the option for the purchase of future carbon sequestration at a price agreed today or the outright purchase or sale for 2008-2012 or before 2008 for use outside Kyoto, e.g. for meeting national commitments. For the fulfilment of their essential functions, verified certificates would be centrally channelled and lodged within a registry and, once registered, the carbon credits sold electronically. Payments for credits would be then made to the central clearing-house, which in turn would pass funds to suppliers. "… benefits for buyers [would include] … the opportunity to manage future liabilities by purchasing forward contracts, price discovery and easy access to the market." (Landell-Mills & Porras, 2002, p. 80) Given the large number of stakeholders involved and the global character of carbon credits, payments still tend to be channelled through intermediaries though. Including NGOs, trust funds, private brokers, community-based organisations and government entities, intermediary buyers willing to resell carbon credits can act as bridges between credits' users and primary providers.

Besides facilitating contracts between buyers and sellers and supervising enforcement, intermediaries bear a special value in that investment funds, for instance, can pool numerous beneficiaries in order to overcome the lack of technical expertise which restrain from engaging into business with forestry projects. With the opportunity to hold stakes in a number of carbon-offset deals while relying on the building and maintaining of knowledge, users' fees are thus collected and administered by the fund trustees. (Landell-Mills & Porras, 2002; Neeff & Henders, 2007) In short, a carbon fund is basically a public and transparent tender process, designed to build a project portfolio that is expected to deliver a certain volume of carbon credits. The first funds that were established and administered by The World Bank, as well as some country government funds (e.g., the Dutch CERUPT and ERUPT – cf. section *3.2.2.4*) have played an important role in developing carbon markets at their early stages and were able to accept the higher risks of a nascent market. The former funds are the Prototype Carbon Fund, launched in early 2000 with an initial capitalization of US$ 130 million and intended to include only some forestry projects like the heavily criticized 'Plantar', and two additional carbon funds i.e. the Community Development Carbon Fund (CDCF) and the BioCarbon Fund (BCF). The former focuses specifically on buying carbon offsets from projects working with rural communities, but the latter is the only specific forestry-based carbon fund with a window restricted to Kyoto-compliant credits and the second is for broader land based activities like avoided deforestation, silvopastoral, or sustainable agriculture among others (cf. section *3.1.2.3*). Although it took until May 2006 for BCF to announce the first CER transaction contracts due to the great uncertainties about LULUCF methodologies, it has to date signed ERPAs with 12+1 CDM projects (cf. section *3.3.2.2*) totalling approximately 4.4 million tCO_2e (exclusive of options) and 3 more projects had the Carbon Finance Document approved, only in the first tranche.[14] Conversely, other governmental and private carbon funds are solely concerned with shareholder value and none of the more than 60 currently includes forestry CDM. (Neeff & Henders, 2007) In more advanced countries, such structures have even become obsolete in some cases. As over-the-counter trading uses pre-packaged retail commodities directly between the two parties, clearing-house systems whereby some exchange agent is in charge of regulating trades and deliveries are no longer exclusive. Since the consumer can have a direct contact with the single share of carbon offset he/she purchases, this system is more compatible with the

[14] Participants to the already-closed first tranche of investments are, amongst public institutions, Government of Canada, Government of Italy, Government of Luxembourg, Government of Spain, and amongst companies, Agence Française de Développement, Eco-Carbone as representative of Lesley Investments Ltd., Idemitsu Kosan Co., Ltd., Japan Petroleum Exploration Co., Ltd., Sumitomo Chemicals, Sumitomo Joint Electric Power Co., Suntory, The Japan Iron and Steel Federation, The Okinawa Electric Power Co., Inc., Tokyo Electric Power Co., Inc.

direction opposite to commoditization, i.e. developing and preserving **premium product niches** for small voluntary markets where price is not the discriminating criterion but more *Variety in Project* and different *Expectations on the Supply* and *Consumers' Preferences and Project Support* . (Bayon, Hawn, & Hamilton, 2007)

3.2.1.3 Valuation of Additional Services to the Supply Chain of Payments for Carbon Removals

In an effort to become market leaders, an increasing pool of private, public and non-governmental organisations are setting up international brokerage services, investment funds, clearing-houses and even exchanges as mentioned above in section *3.2.1.2*. Insurance companies, consultants and certification suppliers have been prompt to offer potential buyers and sellers' services to support this international trade where a number of ventures are catering to customers interested in forest-based offsets. The emergence of exchanges offering trading and clearing functions for carbon offsets is the most visible sign of the growing sophistication of the market. By bringing buyers and sellers together in a central trading platform, exchanges offer a transparent system for price discovery. In addition, by supplying associated services, e.g. insurance, due diligence and strategic planning, exchanges minimise transaction costs associated with searching for trading partners, competing trades and risk management. (Landell-Mills & Porras, 2002) In the EU market, six exchange platforms are currently open, which represent about half of traded EUA volumes. Amongst the French exchange Powernext, Norway's Nordpool, the CCX-subsidiary's Amsterdam-based The German European Climate Exchange (ECX), the European Energy Exchange (EEX), the Energy Exchange Austria (EXAA) and the Dutch exchange Climex, the former three alone have captured almost 98% of the overall spot EAU volume traded in all exchanges up to the end of December 2006 (50 million) and increased by a factor of seven in comparison to the previous year.

In addition to the seven European trading platforms shown in *Figure 3-5*, Italy has also activated an exchange that has been operational since April 2007. (Frémont, 2005) Moreover, there are eleven national registries which are presently operational in Austria, Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Spain, Sweden and the UK. Moreover, there are six to eight classic inter-dealer brokers plus an increasing number of small brokers that have begun operating on the EU ETS. The most prominent big bulge investment banks, hedge funds and other financial institutions are very active on exchanges where they account for a large share of trading volumes. While some exchanges also trade other commodities, e.g. power (European Energy Exchange, Powernext, and NordPool for instance), several are preparing for CERs trade, e.g. by establishing relationships with the Asia Carbon Fund or the Brazilian Carbon Market (MBRE).

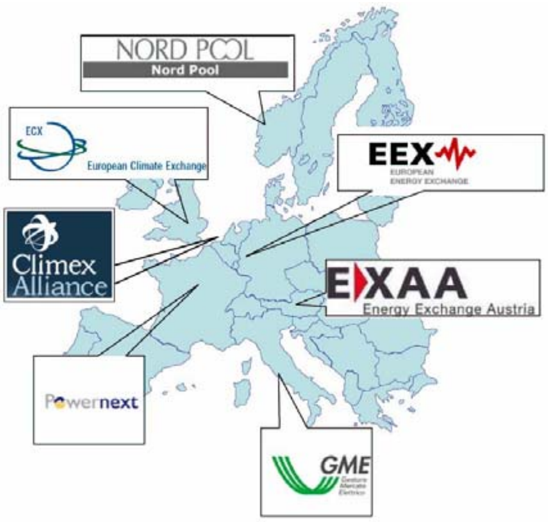


Figure 3-5 The EAU trading platforms

Source: (Magni, 2005)

On the other shore of the Atlantic Ocean, despite the process of creating carbon credits still not having been standardised, corporations and other entities in 7 Midwest States in the US have banded together under the CCX to begin trading carbon emission credits as mentioned in section *2.1.3*. Interestingly, the CCX set some standards for the listing of credits (including those from offset projects) on its exchange. (Bayon, Hawn, & Hamilton, 2007) Concerned that recent price developments in the EU ETS would flood the CCX with very cheap EUA-I assets for compliance, the CCX suspended its linkage with the EU ETS in December 2006. (Capoor & Ambrosi, 2007a) More recently, the CCX announced it was seeking to extend its reach to Asia and Oceania. Offsets from Indian, Chinese and New Zealand projects have also been listed on the exchange. Brazil is another developing country that has joined this voluntary programme using cap and trade because it also allows for offsets gained through the CDM.

According to section *3.1.2.2 Market infrastructure*, carbon markets can separately evolve in such a way that the willingness to pay for value added will be roughly directed either to **third-party protocols and certification** or to **ultimate producer inclusiveness**. When the buyer is mainly interested in complying with regulations, he/she is likely to be concerned with the fungibility of least-cost credits as so that the former services would prove a further easement of the access to the exchanges places. When the buyer is voluntarily engaged though, he/she is likely to be more selective about the carbon offset to purchase due to political, public relations or ethical reasons. In the latter case, he/she might be more interested in those services providing precise information during retail concerning the supply chain of the carbon removals down to the farmers in charge of the sequestering activity (Bayon, Hawn, & Hamilton, 2007) An excellent example of further additional service in that respect is the recently concluded EuropeAid-funded project for the design of sustainable CDM forestry projects ENCOFOR (ENvironment and COmmunity based framework for designing afFORestation, reforestation and revegetation projects in the CDM: methodology development and case studies). Coordinated by Face Foundation and Laboratory for Forest, Nature and Landscape Research at Leuven Catholic University with eight more partners, the project aims to come out with both fully documented (i.e. feasibility studies) projects ready for investment and a toolbox of manuals, models and databases built on cases. (Muys et al., 2007)

3.2.2 Demand Activity

3.2.2.1 Extent of the Artificial Demand[15]

The regulated market which artificially determines the physical extent of demand in terms of volumes and participants depends, in three dimensional levels, on any modification and amendments over **CDM project activity category caps** and ceilings as described in section *2.2.2.2*, on the **inclusion of LULUCF activities in the EU ETS** as discussed in the problem statement to this research, and on **enlargements to new industrial sectors** such as aviation and other **post-2012 issues** at the Kyoto Protocol level of decision. However, there is an underlying rationale for a legally-bound, long- or short-positioned (with excess or deficiency of emissions in comparison to allocated permits) installation to either participate in any project-based transaction or not, i.e. the range of actions that can be undertaken in different combinations as part of GHG corporate strategy (*Figure 3-6*).

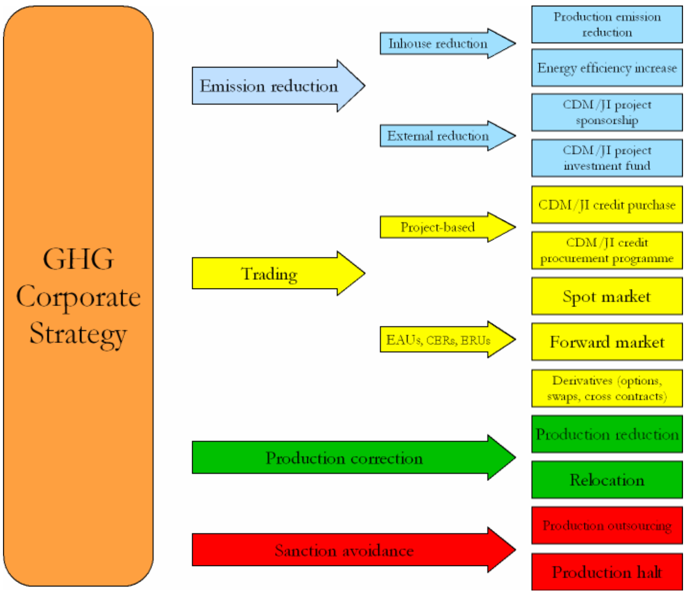


Figure 3-6 Tools for addressing emission capping

Source: (Magni, 2005)

With recourse to allowance trading, there are chiefly three routes to pursue either directly or through professional intermediaries (cf. section *3.2.1.2.*) In particular, allowances can be bought on the spot market, i.e. dealing in commodities for immediate delivery, on the forward market, i.e. over-the-counter contracts for future delivery, or through call options, i.e. the right to perform or not an agreed transaction in exchange for an additional fee. Furthermore, allowance remainder from past years can be used or borrowed from the future swapping in time with the present as so to resort to more complex derivatives and financial

[15] Here, artificial demand is not referring to false needs or low-value stocks spam, but rather, to the more genuine marketing dynamics and intrinsic demand of many voluntary initiatives in comparison to the political dynamics and the volatility of regulated markets where the consumer-facing nature of the exchange is less urgent. (Bayon, Hawn, & Hamilton, 2007)

instruments. Alternatively to AAUs, CERs can be acquired or attained for the emission reductions accomplished through direct sponsoring of projects or acquisition of carbon fund shares. (Magni, 2005) Similarly to the previous forms, payment for emission reductions can be made using cash, equity, debt, or in-kind contributions such as providing technologies to abate GHG emissions. Stemming from the alternatives above which imply different goals and abilities, different categories of market actors are consequently involved. For what concerns the theoretical potential for transaction volumes to exceed the current scale of compliance markets, it is worth mentioning that voluntary markets would have "… the ability … to target sectors which are beyond the reach of efficient regulation, such as with mobile or diffuse sources in the transportation or building sectors." (Bayon, Hawn, & Hamilton, 2007, p. 91) With respect to the enlargement of the EU ETS to civil aviation in particular, it is remarkable how the trade of emission offsets from this sector is particularly thriving in the voluntary retail market also through the offering of special premium ticket fares (cf. section *3.2.2.3*).

3.2.2.2 Expectations on the Supply Chain

The expectations on the supply chain of forest carbon offsets, from actual carbon producers up to ultimate credit buyers, regard aspects which seemingly relate to section *3.3.1.2: Market* such as the **number of steps** involved and **uniformity.** More precisely, the number of steps is relevant because the fewer stages exist between parties, the lower the risk for delays or insolvencies and the higher degree of involvement and control on project quality. Nevertheless, the project cycle before emission reductions brokerage as reported in section *3.1.3.4*, namely project development, project management like monitoring and accounting operations and project promotion with counterparties, is hardly avoidable, not to mention validation and verification. As a result, consumers' preferences over the supply chain tend to be proportional to the different levels of **risk management** and respective good practices of mitigation. Procedures for successful regime-specific registration address the risk of whether the project would be able to gain all necessary approvals while insurances buffer the risk concerning the entire infrastructure for the international transfer of carbon credits, e.g. valid buyer's country accounts or host country registries. For instance, counterparty default risk can be eliminated by exchange platforms offering clearing-house services which ensure that sellers are paid for their carbon credits and buyers receive those credits. Taking into consideration the future climate policy and follow-up agreements may alert carbon traders about the geopolitical risks, i.e. whether and how to expect further revenues. (Neeff & Henders, 2007)

Thirdly, **project quality and the degree of involvement in transactions** are more and more emerging as a visible and valuable part of certain types of carbon buyers' purchasing decisions (section *3.2.2.4*), or market actors' involvement in general (section *3.1.2.4*). Parallel to individuals' airplane emissions offsets, some carbon retailers offer the opportunity to sell "carbon-friendly products". Towards the same direction operates the Climate Neutral Network, an alliance of companies and organizations supported by respected corporate and environmental advisors, to develop Climate Cool™-braded products, services, and enterprises that have a net-zero impact on global warming. Likewise, UK-based Climate Care markets some warranties to attach to particular consumer goods e.g. cars, petrol or the abovementioned airline tickets, which are in turn through investments such as the famous Face Foundation's project on Mount Elgon in Uganda. (Landell-Mills, 2002) This project is renowned for the widely critical report "A funny place to store carbon" (Lang & Byakola, 2006) which brings back to the importance of evaluating soundly offset purchase, including the whole supply chain. Fact is that forest conservation NGOs such as the Nature

Conservancy and Conservation International have been continuously taking more or less extreme standpoints against the World Bank and those corporations financing carbon sinks. Furthermore, a few less moderate positions accuse WRI alongside the WBCSD and WWF of lobbying tirelessly for carbon trading because of the label and protocols they developed for the Kyoto Protocol's CDM projects. Some other NGOs e.g. the Climate Action Network claim that the role of governmental advisers on national emissions allocations can prove a new strategy in the attempt to reform or 'contain the damage' from inside (Lohmann, 2006)

3.2.2.3 Consumers' Preferences and Project Support Motivations

For the most part before the Bonn Agreement when uncertainties over the fungibility of different carbon offsets were still unsolved, companies involved in forest carbon projects did not seek least-cost carbon offsets, but instead aimed to gain experience, insure themselves against public criticism and hedge future carbon liabilities. (Landell-Mills & Porras, 2002). As a consequence, consumers' preferences can nowadays correspond also to specific characteristics of the projects they want to purchase from, with non-negligible effect on the final market price as well. For both CDM and voluntary projects, investments can be directed in such a way to allow for other goals than compliance with emission-reduction targets. Part of companies' strategy could be e.g. "… cementing regional influence, achieving corporate social responsibility, help public relations objectives, and fostering sustainable development." (Neeff & Henders, 2007, p. 30) In particular, consumers' preferences may range from **regional provenance** of credits/offsets to **sustainable development benefits** pursuit or **purchase modalities**. The regional origin of offset projects is deemed important when e.g. multi-national participants are interested in sourcing carbon credits close to their operations in developing countries. Alternatively, public-private funds and governmental agencies have proved to be particularly interested in projects from least-developed countries like in Africa (cf. section *3.3.2.2*). As far as the delivery of co-benefits towards sustainable development is concerned, that relates to '*Project* ' variables, especially section *3.1.1.3*. Likewise, purchase modalities are very much close to *Credibility of the Offset* as quality standards like in section *3.2.1.1* are perceived as the most suitable means to demonstrate a project's potential to deliver sustainability co-benefits.

Concerning the modalities to purchase, the voluntary retail-based market is worth special mention, in particular individuals, celebrities, international conferences and events' voluntary offsets. For instance, today is very easy to go online, calculate your emissions from flying, running the car or living the life, and pay the environmental due by simply purchasing some shares from various carbon offset portfolios. The CarbonNeutral Company, for instance, currently offers to offset the emission (0.2 tonnes of CO_2) from a one-way flight to Copenhagen from Bologna, Italy (1 236 km) with £ 2.15, £ 1.65, or £ 1.50 depending on whether the charge can support the development of new technologies, communities in developing countries, or UK forestry, respectively. Within the latter package, a forest site covering 13 hectares of formerly grazing land located in the heart of the Scottish Borders is being restored with birch and other native broadleaved trees and shrubs planting to additionally attract rare animal species.[16] (The CarbonNeutral Company, 2007) However, there is huge disagreement, and displayed calculations and price ranges testify that, upon flight emission accounting methods since many assumptions regard e.g. GHG warming potential or average seat occupancy. (F. Pearce, 2007) Nevertheless, a few airlines are already

[16] The British CarbonNeutral Company has received much publicity for having worked with e.g. Blackwell Publishing and several celebrities.

proposing their passengers to pay a premium for offsetting their flight emissions as so to mimic a forth-coming GHG-compliance fee in their prices. In this case, voluntary initiatives may eventually prove effective as a learning-by-doing experience for those sectors which are certain to be included in the regulated market within the near future. (cf. section *3.3.2.2*).

3.2.2.4 Market Participation and Beyond-Compliance Attitude

The carbon **buyers' mix** depends in the first place on how many sources of demand are actively participating to the markets, i.e. individuals; the private sector such as both large companies acting individually and commercial funds; public institutions holding shares of forestry-specific carbon funds, financial pools, government carbon procurement programmes; social-sector NGOs. (Bayon, Hawn, & Hamilton, 2007) These groups can alternatively be categorized as those who buy for use, namely primary buyers like governments and private companies; those who buy to sell to others, i.e. brokers; and secondary buyers, namely those who buy on behalf of others, i.e. carbon funds and traders. (Neeff & Henders, 2007) In particular, governments and policymakers are supposed to be the first ones willing to reduce GHG emissions in a cost-effective manner, gain business support and achieve broader sustainable development goals altogether. As a result, the Dutch, Canadian and Japanese governments have already proved they can be very large purchasers of carbon offsets. The Dutch government alone accounted for 30% of the total carbon market in 2002-2003 whereas Canada and Japan combined accounted for another 30%. The Netherlands in particular took early steps to begin acquiring carbon credits when an agency of the Ministry of Economic Affairs launched its Emission Reduction Unit Procurement Tender (ERUPT) programme for JI and Certified Emission Reduction Unit Procurement Tender (CERUPT) programme for CDM. About US$ 1.2 billion were then allocated to acquire carbon credits to meet the Netherlands' commitments under the Kyoto Protocol. Such programmes are worth mentioning because they were interested in investing, among others, in A/R projects in Central or Eastern Europe, not to mention FACE Foundation involvement in e.g. Ecuador (cf. section *3.1.2.3*). (Pronove, 2002) For what concerns US private buyers (which were only treated very briefly in section *2.1.3*), three energy companies (American Electric Power, PacifiCorp and BP Amoco) have teamed up to jointly implement the over-1.5 million hectares, US$ 11 million 'Noel Kempff Mercado Climate Action Project' in partnership with the Government of Bolivia, the Friends of Nature Foundation (FAN), and The Nature Conservancy. The Nature Conservancy also manages, through a partner organization in Belize, a private reserve carbon project where a number of energy producers provided $5.6 million in funding for the first 10 years of the 40-year project.[17]

Since the **existence of cheaper alternatives** amongst other emission reduction project categories (section *3.1.3.4*), **finance availability and closure** (section *3.1.3.3*) and emission reduction compliance obligations as **purchasing motive** (section *3.2.2*) have already been discussed previously; it is now worth considering other beyond-compliance business attitudes. Among several ways to voluntarily engage in carbon offsets, less carbon-intensive production patterns are embedded into strategies to include corporate-wide social responsibility and sustainability in the pursuit of footprint neutrality as a whole. "Buyers believe that providing financial support for emissions-reducing activities within this emerging policy framework demonstrates leadership on an issue of public concern…" and choose to

[17] Among these energy producers were Cinergy, Detroit Edison, Nexen, PacifiCorp, Suncor, Utilitree Carbon Company and Wisconsin Electric Power Company.

comply with voluntary corporate commitments irrespective of any '*Governments' Endorsement* of Voluntary . (Ellerman, Joskow, & Harrison, 2003) Closely related, the issue of carbon neutrality as competitive advantage and strategic positioning can also be raised by customers' requirements for near-zero or low emissions. Embedded carbon neutral products, e.g. tour operators' travels and airlines' zero-emission flights are a variant of the latter. (Landell-Mills & Porras, 2002) Moreover, public relation and reputation is not only important as part of risk management but also because it can lead in turn to a better access to capital by attracting investment and securing project finance. In contrast, taking part in controversial projects may prove very harmful for some organisations. Examples can be synoptically retrieved in the analysis of successful cases characterized broad consensus versus criticised cases that have faced fierce opposition, both within CDM and voluntary offset projects. In contrast with the shortcomings pointed out in section *3.1.2.3* for what concerns the 'Plantar' project in Brazil, the 'Guanxi' project in China, the only one A/R CDM registered, was developed with allegedly more accuracy in the design due to the participation of some forestry research institutes and the BCF investment appraisal. In fact, the BCF is now paying more attention to image than carbon maximisation by gradually focusing on CERs rather than voluntary offsets. (Lumicisi, 2007) In addition, carbon-neutrality-minded companies are able to recruit, retain and reward their staff more easily concerning in-house climate-friendly activities and behaviours. Learning-by-doing experiments have the dual potential of influencing future regulatory requirements and policy settings and preparing for upcoming regulatory requirements. (Bayon, Hawn, & Hamilton, 2007) Since few companies possess extensive experience with emissions trading or knowledge of the market price of internal emissions abatement options and permits, early GHG trading provides opportunities for several educational aspects including exploration of how to gain approval for emissions transactions through internal risk management procedures, how to contract for emissions reductions, and how to reflect the value of GHG assets and liabilities on company balance sheets. (Ellerman, Joskow, & Harrison, 2003) Finally, it is noteworthy that more sophisticated payment mechanisms (cf. section *3.1.3.3*) have stimulated the falling of '*Transaction* ' and greater competition which has been beneficial to '*Market Dynamics*' due to increased participation. (Landell-Mills & Porras, 2002)

3.3 Cross-Cutting Aspects (Transactions Management)

3.3.1 Market Price of the Standard Offset Unit

3.3.1.1 Market Dynamics

Like in any ordinary stock market, the price of carbon credits is sensitive to particular variables ranging from **investor confidence**, which can alternatively be characterized byto either bullish or bearish sentiments, to macroeconomics **market determinants**. Yet, the volatility of prices seems to be determined in the first place by **international climate policy** and the imposition of restricting caps (cf. section *3.2.2.1*). Following the release of verified emissions data, it became clear that the 2005-07 "learning phase" emissions cap had not been appropriately set at the relative level at which actual emissions were in that period. As a result, the Phase I price signal was based on incorrect assumptions of the carbon constraint, leading to high volatility in the EUA market (compare May 2006 in *Figure 3-7*). In contrast, project-based assets have now showed greater price stability since the focus shifted to Phase II with market expectations for caps being much more stringent. (Capoor & Ambrosi, 2007a) As the EU ETS regulates mainly the most energy-intensive industry sectors and power production, *Figure 3-7* illustrates also how a few parameters such as consumption and oil prices (which relates to GDP and economic growth) have been driving the variability of movements of carbon prices over time (the red circles indicate the most considerable variations in influential EU member countries).

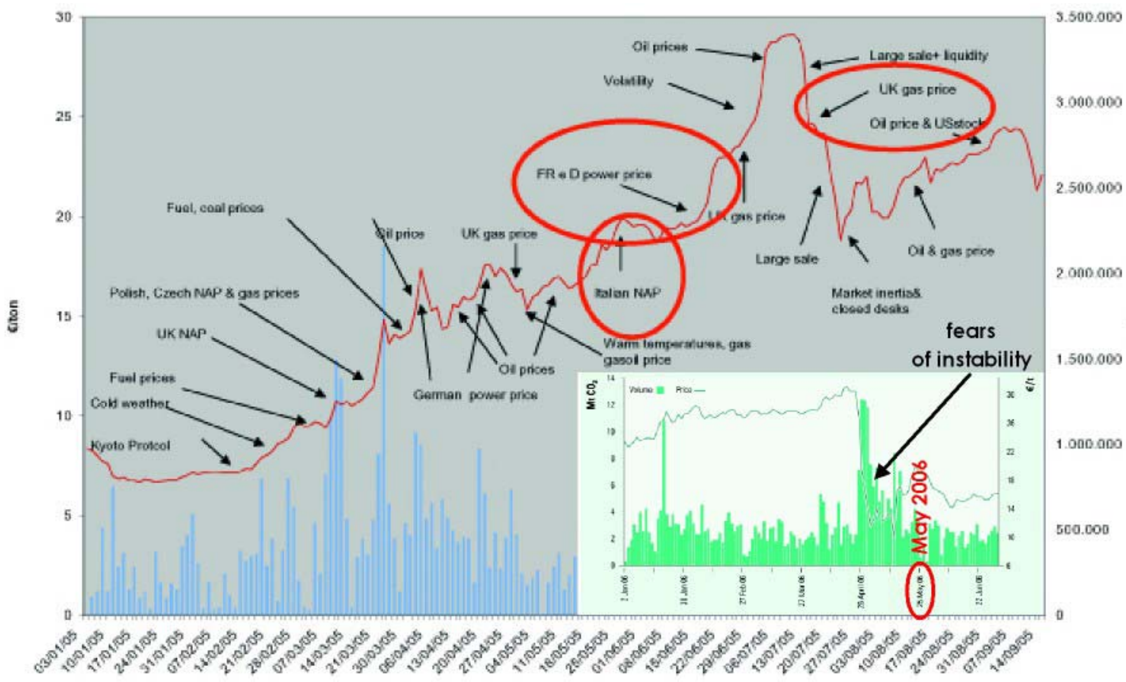


Figure 3-7 EU ETS carbon price trends: determinants and policy factors analysis

Source: (PointCarbon in Magni, 2005; and IETA, 2006, p. 31)

In addition, the increase of CDM/JI project supply would most likely affect both companies in surplus and emission-reducing entities, while the opportunity of banking would reduce both credits demand and consumption. Overall, market development would penalise countries with a surplus of allowances. Yet, the level of **market matureness** is contingent on a few more variables that can be gauged by current market size indicators such as the overall volumes of transaction for LULUCF credits/offsets, the projected market growth rate, sector profitability and returns, the average purchase scale (wholesale or retail), etc.

Concerning the level of competition in general, Landell-Mills & Porras (2002) specify that there are critical implications for the welfare impacts of PES markets as the higher the competition, the greater the benefits. However, competitiveness is difficult to establish in nascent markets and rules of thumb for assessing market competitiveness are less effective in nascent markets for a number of reasons. By their nature, young markets experience relatively high levels of price volatility and high concentration in supply and demand. In those phases markets are initially auction-wise with periodic calls and become eventually continual as liquidity increases. Policy-makers have thus a role in preventing anti-competitive behaviour in environmental service markets by paying close attention to the number of competitors and the intensity of competition, i.e. whether multi-national monopolies are prevailing or project suppliers are significantly varied. Competition has increased by itself, for instance, with the emergence of specialised intermediaries, pooling mechanisms and central trading platforms (cf. section *3.2.1.2*) since commodity tradability became more defined after Bonn (cf. section *2.2.2: The legal framework after Bonn and Marrakech*). The most notable development in the carbon offset market has thus been the shift from individual deals to trading systems that aim to provide a basis for regular and high volume trading. A number of trading systems are still emerging, ranging from more sophisticated exchanges to simpler over-the-counter and investment fund mechanisms that seek to promote a greater volume of payments at lower costs than the case-specific negotiations as before. For the time being, the carbon markets are therefore overall exhibiting few signs of immaturity, and the momentum of transactions keeps growing as more and more buyers pool to spread risks. In addition, "… the emergence of over-the-counter trades reflects a growing confidence [also] amongst suppliers who are beginning to set the terms of deals" (cf. section *3.3.1.3*). (Landell-Mills & Porras, 2002, p. 203) Further evidence of the market maturing is given by the emergence of secondary markets where companies experiment with liquidating small quantities of reductions from their portfolio. Other indications are from both commoditization tendencies (contract types are becoming more diverse as call options and forward contracts predominate within project-based transactions) and the growing retail market for high-quality tons testified by the the development of certain project standards. (Capoor & Lecocq, 2002; Neeff & Henders, 2007)

3.3.1.2 Transaction Costs of the Standard Offset Unit

As it can be inferred from the contents of this thesis so far, transaction costs are significantly associated with the setting up and implementation of any trade and are eventually reflected in the market price. Providing **information to potential carbon buyers** implies establishing additionality, measuring the incremental carbon benefits and auditing projects for certification. Obtaining **information about available project partners** means identifying and negotiating with prospective project participants, developing and marketing projects, organizing participants and performing some capacity building if necessary. Ensuring that **parties' obligations** will be fulfilled involves drawing up the contracts, enforcement through brokerage and other economical aspects related to the execution of transaction such as paying taxes and legal advice, covering margin requirements and entering into insurances. All these explicit costs components though are in turn contingent on the structure of the credits/offsets distribution network after middlemen, on the cost-effectiveness of intermediaries and on the seller's profit. Implicit costs, on the other hand, are due instead to the upstream research required for offset selection, to risk management, and to the market impact and opportunity costs of undertaking the operation or not. (Moles & Terry, 1997) From the buyer side, carbon procurement and investment funds are functional solutions to cope with organising multi-stakeholder transactions as any market aims to lower transaction costs associated with searching for trades. Administrative expenses for regulated companies and energy market operators with direct access to trading platforms cannot however be diminished beyond the different exchanges' transaction costs and fixed fees. In fact, not all sophistications such as retail-based trade, clearing-house mechanisms, investment funds and exchange-based platforms will necessarily result in some saving since advanced payment systems are costly to implement. Because of the complexity of CDM projects determines high transaction costs anyway, it could be optimal in that instance to use some intermediary because setting bilateral agreements may bring about contract problems and the imposition of a transaction price anyway. At least, traders and brokers operate according to some advantageous attributes, e.g. commonly accepted standard contracts; a number of reliable, solvent counterparties; deals over all global markets, market trends and legislative updates, customised services, and transacted value-based fees. On the supply-side, the development of the host country's service sector is especially relevant where costs are the greatest for poor community of developing countries.

3.3.1.3 Contractuality of Transactions (Buyer-Seller Relationship)

The stringency of forest carbon credit transactions, i.e. the complexity of the contract regulating the commercial relationship between buyer and seller, is basically determined by whether the **expiry of CERs** are addressed, whether all **delivery uncertainties** are considered, whether **risk hedging measures** are taken and whether **purchase clauses** are included. Temporary credits as provided for by the CDM are especially relevant for compliance regimes and replacement liabilities. “For an investor, the effect of buying expiring credits is equivalent to postponing compliance with reduction obligations to a future commitment period.” (Neeff & Henders, 2007, p. 22) Although using temporary LULUCF credits would help some operators gain time until their investments are economically justified, such a mechanism was chiefly devised to address the issue of non-permanence (cf. section *3.1.3.1*). The solution in place under the CDM is for project developers to choose between tCERs and lCERs on a credit-value and financial-need basis. The former are short-term credits which are valid for one commitment period of five years and are thus reissued proportionally to carbon stock fluctuations after each verification event. tCERs cannot be banked and, at expiry, have to be replaced by an AAU, a permanent CER, an ERU, a RMU or another tCER. Conversely, lCERs are valid until the end of the project’s crediting period because only the increment since last verification is credited. Unlike tCERs which can be sold regardless of potential losses of biomass, lCERs require to be substituted, thus causing liability, or retired before being sold when in case some silvicultural reversion of land is planned for the next period (*Figure 3-8*). (Bird, Dutschke, Pedroni, Schlamadinger, & Vallejo, 2007; Bosquet, Streck, Janson-Smith, Haskett, & Noble, 2006; Neeff & Henders, 2007)

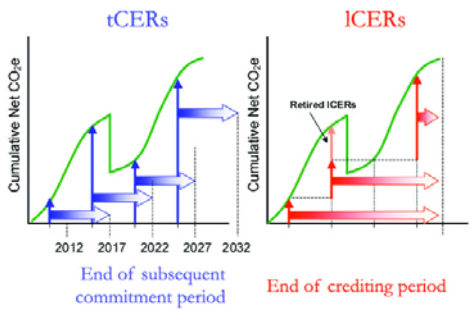


Figure 3-8 Fluctuating net sequestration with retirement

(Temporary CERs, in blue, expire at the end of each commitment period; long-term CERs, in red, last for the whole project lifetime but require retirement in case of biomass loss)

Source: (Bird, Dutschke, Pedroni, Schlamadinger, & Vallejo, 2007)

In a way, temporary credits are just the specific remedy to a special type of delivery uncertainty similar to other risks that carbon credits normally carry to the buyer when not purchased in real time or ‘over the counter’, i.e. through a bilateral contract in which two parties agree exactly on how the trade is to be settled in the future. Since the market matured shifting from a series of *ad hoc* deals to the establishment of trading systems that could provide a basis for numerous transactions, over-the-counter operations became another consequence of the spread of standardised carbon offsets (Landell-Mills & Porras, 2002). Still, some market participants purchase reductions both believing that current emission reductions are relatively inexpensive compared to likely future prices in a regulated emissions trading system and hoping that governments will allow to use them for compliance with future requirements. As a result, carbon reduction prices depend on the risk profile of projects, with those ones taking hedging measures augmenting their value added. As illustrated in *Figure 3-9*, the risk categories composing the price difference between over-the-counter EAUs and forward CERs are basically linked to the steps of the carbon credit supply chain, e.g. counterparty, performance, validation, monitoring, verification (cf. sect. *3.1.3.4*).

To hedge against some of these risks, the procedures for credit transactions can be designed beforehand as so to contain agreements pertaining to the protection of both the buyer and the seller. More generally, mitigation mechanisms and guarantees include insurances or the harnessing of broader portfolios and quality standards. Swiss Re, a reinsuring company which is self-committed to carbon neutrality through a combination of internal reductions and investment fund shares, is currently offering a combination of conventional fire insurance policies with institutional risk such as failure or delay in project approval. (Bayon, Hawn, & Hamilton, 2007; Neeff & Henders, 2007) In order not to rely on one single project, the risk of project failure can be spread by keeping various project and project types in a bigger portfolio (cf. section *3.1.2.3*).

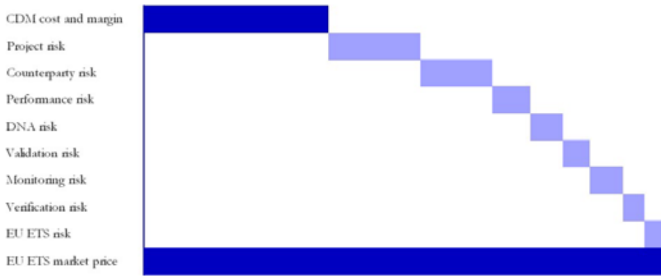


Figure 3-9 Risk categories composing the price difference between over-the-counter EAUs and forward CERs (not drawn to scale)

Source: (Neeff & Henders, 2007, p. 24)

Secondary-market buyers have less of a problem in that respect because secondary contracts work as guaranteed delivery compliance assets excluding bank risks and security of sale. As a result, many buyers hedge their risk by signing CER contracts after signing for secondary sales. Also adhering to quality standards reduces the risk of unsold credit in that following the best practices in the forest sector can lead to better prices as social and environmental co-benefits have a positive influence on the public image. From the contractual point of view again, there are some typical steps that projects go through towards emission-reduction purchase agreements. First, some sort of initial screening would allow potential buyers to collect data for an in-depth understanding of the project in order to make sure about its eligibility and additionality conditions. Then, the actual purchase agreement can be drawn up as a contract which is possibly built on other preliminary documents clarifying the parties' interests, obligations and timeframe of negotiations such as ERPA and LoI for CDM projects (cf. section *3.1.3.4*). Finally, specific conditions can be put down black on white concerning prior price settings as well as the volume and timeframe of delivery in the event that the project potential to generate emission reductions is unclear. In addition, formalised liabilities may regard both seller and buyer in that damages can be claimed because of default both in delivery and payment. The aspects related to the payment schedule have already been discussed in section *3.1.3.3*. In summary, buyers' contribution to delivery and performance risk management has been fundamental in bringing about operational agreements and upfront financing of projects. However, the creditworthiness of the seller still plays an important role in negotiations involving future delivery of emissions reductions (cf. sect.

3.3.2.1). Conversely, the contribution of sellers has been to raise attention over the need for an equal examination of buyers' creditworthiness before entry into contracts. (Capoor & Ambrosi, 2006a)

3.3.2 Complementarity Between Compliance and Voluntary Markets

3.3.2.1 Optional Market Depth and Liquidity

As seen in section *3.2.2.4*, the growth and diversification in market participation has produced significant innovation in the design of commodities and payment mechanisms. Expensive and complex project-based deals have given way to intermediary-based transactions, pooled investment funds, transactions that piggy-back on retail sales and even over-the-counter sales of standardised products. In it own way, each mechanism seeks to cut market risks (cf. section *3.3.1.3*) and overcome threshold effects to minimise '*Transaction* '. As risks and costs come down, market participation is likely to continue to rise in a sort of positive feedback loop. In such context, compliance and voluntary market are definitely converging in the sense that much of the framework that is in place in the former is being replicated in the latter. Some argue that voluntary markets are not alternative to regulation but only tentative because they will cease to exist once regulated markets will cover all the sources of emissions that are not globally addressed today. Yet, this scenario does seem very remote in time and unlikely in scope given all the cross-sector lobbying forces of industry and society. Most likely, voluntary and regulatory markets will co-exist interacting in such a way that the former can supplement the latter as long as education and engagement are needed while experience is little. In other words, the perceived contrast between voluntary and regulatory markets that Dornau (2007) and Sell (2007) agreed upon being deceiving, could be proven wrong by "…a broader spectrum ranging from compliance commoditized markets, through voluntary commoditized markets, all the way to voluntary gourmet markets". (Bayon, Hawn, & Hamilton, 2007, p. 104) Were voluntary markets able to provide depth and liquidity to compliance markets, the two could be deemed complementary as large amounts of carbon credits would be traded without significantly affecting their price. Transactions could thus occur more easily as the overall level of funds available for investing or trading would be increased.

Still, market liquidity is contingent on several financial factors in the **stock exchange dimension** such as where the security is traded, how many market-makers are participating, whether quoted prices are indicative or firm, how frequent and large transactions are, the degree of price continuity in the market, not to mention participants' subjective perceptions of the credit liquidity. In an **issue dimension**, the number of outstanding credits, the issue size in relation to the market norm and its tradable proportion, the difference between bids and offers are more relevant instead. (Moles & Terry, 1997) Concerning **credit worthiness** of issuers in particular (cf. section *3.3.1.3*), buyers are more willing to purchase from a financially sound seller because, in case reductions generated by its own projects are fewer than expected, or if they fail to meet certification requirements, it can have an easier time mobilizing the resources necessary to fulfil its contractual obligations. Strong seller's creditworthiness can even diminish the importance of the accuracy of the baseline or the adequacy of monitoring as long as acquiring substitute reductions of appropriate quality supposedly poses little difficulty to them. As a result, many buyers in the market have already chosen to transact only with companies of high investment grade rating, thus seriously complicating small producers' entry to the market. (Bayon, Hawn, & Hamilton, 2007) It is particularly noteworthy, though, that there is little need for strong creditworthiness as protection against non performance in case of transaction involving VERs because they carry no guarantee of future creditability as the seller's contractual obligations are fulfilled only at the time of generation, verification and delivery. (Ellerman, Joskow, & Harrison, 2003)

3.3.2.2 Governments' Endorsement of Voluntary Programmes

The role of governments in promoting and rewarding voluntary action can be both supplementary in speed and effectiveness and support the continual re-designing of the regulatory structure. Individual countries' commitments to different carbon markets depend on how the **educational utility** of voluntary schemes as **precursor** is envisioned, in addition to the political will required to overcome any potential **cultural resistance**. In that sense, synergies between mandatory and voluntary markets occur when offset programmes become a learning experience for those sectors which are not yet regulated but are expected to become so in the near future as aviation (cf. section *3.2.2.1*). (Bayon, Hawn, & Hamilton, 2007) While learning-by-doing is important though, the time might not be equally early for governments to head off emerging problems such as the serious constraints faced by poor smallholders in developing countries in accessing market opportunities. As the market for forest carbon offsets is taking off by now, governments need to comprehensively exercise their essential role of putting in place those policies and regulations that would ensure efficient and equitable climate change mitigation. (Landell-Mills & Porras, 2002) Moreover, the intent of forest carbon projects is sometimes not only to induce project developers to adopt certain forestry measures, but more broadly to catalyse the transformation of neighbouring areas by implementing similar measures, as happened for the Rio Bravo Carbon Sequestration Pilot Project

Amongst policy-making representatives and the scientific community, conservation and development assistance organisations are the best placed to play a strategic role ranging from brokerage to the provision of intermediary services for community-based forest carbon projects. As sustainable development is the most argued component of projects, these entities can become important allies for farmers and indigenous organisations in enabling legislation and regulation that safeguard local livelihoods and reduce transaction costs of livelihood-enhancing forest carbon projects. Likewise, research organisations can help to improve the cost-effectiveness of forest projects by developing low-cost methods for assessing dynamic baselines and projected carbon performance, by improving the productivity of forest management and agroforestry systems, and by examining the effectiveness and costs of alternative institutional arrangements to reduce transaction costs. (J. Smith & Scherr, 2002) One such conservation institution is undoubtedly the IUCN – the World Conservation Union. In fact, ever since IUCN decided to play an important role in influencing UNFCCC decision-making on conservation-related issues, they have been continuously working on refining and adapting criteria and definitions applicable to forest carbon projects. The ultimate vision of the organisation is to appoint a person who could be part of the next UNFCCC negotiations as so that the participation of IUCN itself would somehow increase the credibility of the discussion over delicate issues such as avoid deforestation. Moreover, contributing to knowledge building with respect to climate change for the sake of the whole scientific community is the underlying goal of IUCN. In particular, the World Conservation Union's profile concerning carbon forestry projects is to keep a policy position and working on the emission reduction side. It is therefore under this rationale that IUCN is currently working on environmental and socio-economic baselines and indicators for some of the BFC projects in Africa. The special focus on the tropics comes from the belief that forest assets enhancement could be a major opportunity especially for least developed countries. As poverty alleviation is now seen as a leverage point for the removal of depleting and degrading practices, the creation of economic incentives is also deemed necessary to date in the field of nature conservation. The projects are to take place in six different African countries (Mali, Niger, Kenya, Uganda, Ethiopia and Madagascar) at sites where the BCF is already provided for carbon finance (cf. section *3.2.1.2*).

3.4 Scenario Construction

The two core elements of FSA are Formative Scenario Analysis are the impact matrix (cf. *Appendix VII*) and the consistency matrix (cf. *Appendix X*). Here is where the operating agents (the author in the specific case) contribute the most to the scenario modelling with their own subjective choices. Therefore, the main beneficial outputs of the impact matrix and some instances of the logic in the consistency ratings are respectively reported in the following two sections. The so-called impact matrix analysis is applied to determine the relationship between aspect area specific socio-economic variables and technology variables. Consistency analysis is employed to assure that the overall cornerstone scenarios are based on pair-wise ratings of the consistency of the levels of all impact variables within demand, supply and 'in between'.

Notwithstanding the systemic perspective assumed in both filling in the impact matrix and apportioning consistency measures to all pairs of variables' levels, all kinds of ratings potentially bear biases. For instance, the sole direct impact of one variable on another is not deemed simple to assess because distinguishing between causalities and mere correlations might be a rather difficult task. However, the matrix has been completed as in a more informative and consistent fashion as possible, namely by balancing the rating of activity values with passivity values as so that e.g. only certain pairs of values could be allowed in the end. For instance, when two variables are independent and thus score 0 both in activity and passivity, the only consistency measure allowed is 1 for all the four combinations of levels as all states are equally possible but none is favoured more than others (compare *Table 3-2*).

Table 3-2 Example of two independent impact variables

Impact of d_{15} on d_1	**Level of d_1**	**1st variable (d_1)**	**Level of d_{15}**	**2nd variable (d_{15})**	**Consistency measure**	**Impact of d_1 on d_{15}**
0	Flexible	Stringency of additionality	Robust	Market infrastructure	1	**0**
	Flexible	Stringency of additionality	Weak	Market infrastructure	1	
	Inflexible	Stringency of additionality	Robust	Market infrastructure	1	
	Inflexible	Stringency of additionality	Weak	Market infrastructure	1	

Another recurring example which is likewise displayed in *Table 3-3* is when the four combinations of levels comprise two 1s and two 3s. That usually means that the influence the two variables have on each other is not unique. Therefore, the consistency rating of 1 translates in possibility due to other factors besides the variable compared, whereas a consistency rating of 3 is apportioned to the most likely situation. As a result, judgement shifts in the course of the filling out of the matrixes led to logically equivalent corrections in the rest of the table. Similar attention to coherence was paid with respect to consistency measures as well. The full working documents are however displayed in *Appendix VII* and *Appendix X*.

Table 3-3 Example of two highly dependent impact variables

Impact of d_{12} on d_3	**Level of d_3**	**1st variable (d_3)**	**Level of d_{12}**	**2nd variable (d_{12})**	**Consistency measure**	**Impact of d_3 on d_{12}**
2	Large	Delivery of cobenefits	High	Liquidity of financial resources	3	**2**
	Large	Delivery of cobenefits	Low	Liquidity of financial resources	1	
	Small	Delivery of cobenefits	High	Liquidity of financial resources	1	
	Small	Delivery of cobenefits	Low	Liquidity of financial resources	3	

3.4.1 Dynamic and Structural Characteristics of Forest Carbon Markets

In this section, an insight into the assessment of the relative importance and mutual relationships of all impact variables is provided through the visualization of the case architecture. The knowledge about the direct impact that each variable has on other ones is important in order to accurately forecast where, how many and how big the consequences can be when intervening on a specific aspect of the system. In order to simplify their representation, the impact variables defined in the rest of *Chapter 3* have been abbreviated as listed in the following *Table 3-4*. To facilitate the following discussion, as well as the interpretation of *Figure 3-10* below, the Table summarizes the total values of activity and sensitivity/passivity for all impact variables Activity is the summation of all the direct impacts that the variable has on the rest, with 2 and 1 representing strong and weak impacts, respectively. In contrast, sensitivity/passivity is the summation of all the direct impacts that the variable undergoes from the rest.

To briefly illustrate these properties, it can be noticed that *Additionality* has a low passivity value (equal to 5) because it is not affected by any other variable but *Artificial Demand* (which causes a strong impact = 2 because the wider the regulatory regimes, the stricter the additionality rules), *Preferences* (which causes a strong impact = 2 because the more consumers are free to select projects, the more the criteria for selection can be based on additionality rules) and *Endorsement* (which causes a weak impact = 1 because some trading schemes can become more flexible as some governments create incentives for other additionality rules than Kyoto-compliant). On the other hand, *Additionality* influences directly other sixteen variables as it is somehow reflected in the relatively high score of 28. For an overview of all variables' partial apportionments, please compare *Appendix VII.*

Table 3-4 Activity and passivity values of forest carbon offset impact variables

Variable	Activity	Passivity		Variable	Activity	Passivity
Additionality	28	5		Standard diversity	28	13
Leakage	7	19	Standardisation►	Infrastructure	11	10
Co-benefits	18	21	◄Project quality	Additional services	7	17
Cost-effectiveness	13	22				
Credibility	15	25		Artificial demand	33	6
			Demand	Expectations	10	14
Eligibility	33	8	activity►	Preferences	23	10
Acceptability	16	13	◄Project	Participation	30	11
Portfolio	24	24	innovation			
Actors	25	21		Market dynamics	24	12
			Market price►	Transaction costs	5	28
Technical skills	8	25		Contractuality	9	24
Local labour	13	19	◄Project costs			
Financial resources	12	27		Depth and liquidity	12	22
Project pipeline	7	17	Complement. ►	Endorsement	16	14

Source: (Barchiesi, 2007)

3.4.1.1 Systemic Significance of Impact Variables

The variables **Actors**, **Portfolio** and **Co-benefits** are above average in both sensitivity and activity, i.e. they are placed in the top-right <u>Ambivalence</u> quadrant (light grey background in *Table 3-4*). The *variety in project Portfolio*, for instance, has a high impact (rate 2) on eight variables and a medium impact (rate 1) on eight more, whilst it is affected heavily (rate 2) by nine variables and in an average way (rate 1) by other six. In fact, the more diverse the projects the more the probability of e.g. delivering ancillary co-benefits, retrieving local labour to source, attracting consumers' preferences, and increasing market depth and liquidity. At the same time, a large variety of projects decreases the probability of having enough technical support to tackle LULUCF shortcomings and covering the whole project pipeline being one firm. Moreover, also the costs and the degree of contractuality of transactions are decreased by diversifying the sources of credits. On the other hand, the *variety in project Portfolio* is hindered by several factors e.g. less flexible regimes which restrict additionality rules, low degrees of project eligibility, little engagement of market actors, limited diversity of standards, scarcity of buyers within the regulated demand and customary preferences within the voluntary demand, lack of beyond-compliance attitude and governments' indifference for new kinds of voluntary initiatives, etc.

Seven variables (**Artificial Demand**, **Eligibility**, **Participation**, **Additionality**, **Standard diversity**, **Market dynamics**, **Preferences**) are both above average in activity and below average in passivity because they are located in the top-left <u>Active</u> quadrant (white background in *Table 3-4*). The *extent of the Artificial Demand* and *degree of Eligibility*, for instance, ended up with the highest values in activity, meaning they will have quite a few non-negligible effects on several other variables. Still, the former is the one determining the size of the regulated markets and thus the number of participants. As a consequence, voluntary markets are influenced as well in that the larger the programmes, the larger the eligibility for projects other than under the CDM. Although not exclusively, project variety and market actors engagement are likely to increase when voluntary offset are wide spread. In contrast, additionality is likely to get stricter if more sectors were included within the Kyoto Protocol regime because of the dwindling of non business-as-usual opportunities. Likewise, technical competencies and investors will become less difficult to source due to economy-of-scale when compliance markets are extended. In addition, the whole process of standardization is highly dependent on artificial demand in that it cannot be completed as long as voluntary schemes keep their own protocols. Trade operations and market liquidity are as well negatively affected by the scope of carbon regulation as any extension will result in lower transaction costs and increased market depth. However, the *extent of the Artificial Demand* also determines some passive relationships: firstly, the voluntary participation of certain market actors may imply lobbying attitudes aiming at influencing the design of expected regulation design; secondly, a satisfactory level market maturity may be the signal to enact the end of the experimental phase for regulated markets, thus leading to substantial enlargements; lastly, governments may endorse voluntary initiatives by creating incentives for the committed corporations, thus mimicking the economic leverage of mandatory carbon regulation to some extent.

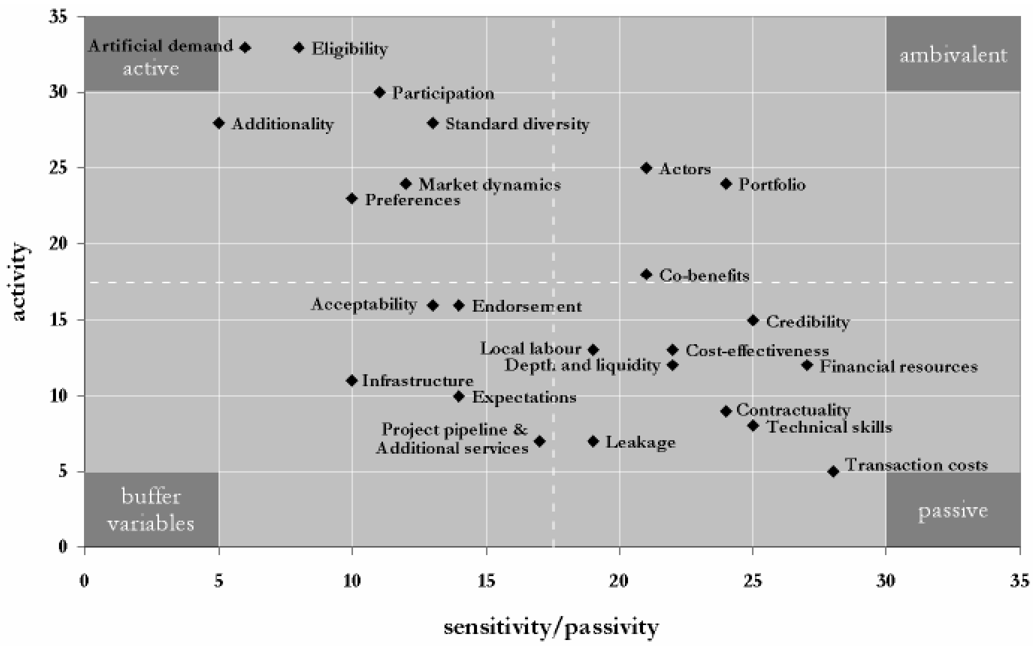


Figure 3-10 System grid of forest carbon markets

Source: (Barchiesi, 2007)

As a consequence of the active variables having little dependencies from others but a few causal impacts, nine variables (**Credibility**, **Local labour**, **Cost-effectiveness**, **Depth and liquidity**, **Financial resources**, **Contractuality**, **Technical skills**, **Leakage**, **Transaction costs**) are found in the bottom-right Passive quadrant (black background in *Table 3-4*), namely below average in activity but above average in passivity. In particular, **Transaction costs** have many dependencies besides the one from the *extent of the Artificial Demand*, the *degree of Eligibility*' and the *variety in project Portfolio* as mentioned above. High credibility and acceptability, broad actors' participation in project supply, increased standardization, less volatility and contractuality are all decisive factors for the dwindling of market price due to decreased transaction costs. The overall passivity of *response to Leakage* is a less clear example of interlinks between variables. However, one reason is that the effectiveness in response may be increased by e.g. the *Contractuality of transactions* through the management of validation risks. Likewise, *Contractuality of transactions* entails some subtler impacts as well, e.g. impacts on the *Expectations on the supply chain*. In fact, more attention can be paid to responsibility and reliability aspects when fewer risks have to be managed, but also if the average contractuality is reduced due to an increase in the share of voluntary markets.

Finally, **Acceptability**, **Endorsement**, **Infrastructure**, **Expectations**, **Project pipeline** and **Additional Service** (six variables) are called Buffer Variables (dark grey background in *Table 3-4*) because they are below average in both activity and sensitivity/passivity. The best example of neutrality amongst them is given by the robustness of *market Infrastructure* which causes only three strong impacts (activity rate of 2) while undergoing four (passivity rate of 2). In particular, the *valuation of Additional services* e.g. certification and brokerage would be understandably enhanced by a more robust platform for emission trading endowed with custodial registries for all carbon assets; analogously, market volatility (inherent to *Market dynamics*) and *Transaction costs* would be reduced. On the other hand, similar effects due to increased market robustness could be observed as the *degree of Eligibility* and *extent of the Artificial demand* let scope and volumes scale up while the number of standards is reduced as so to reasonably unify counterparty and settlement risks management practices. For what concerns the sensitivity to other variables, it is remarkable how *Market dynamics* may have a mutual effect on *market Infrastructure* because the more the structure matures the more reliable the financial management of carbon assets gets and *vice versa*. Finally, it is worth mentioning the impact of *Transaction costs* on the ability to cover the *Project pipeline* by single contractors. In fact, the opportunity of pooling for market entities during both project development and credit trading has the potential to trigger overall cost reductions. In the particular case of trade pooling, risk can be partially eliminated without *de facto* implying any work division within the same project. (Streck, 2006)

3.4.1.2 Graphical representation of forest carbon offsets

Because a system graph with 25 variables would have been rather confusing, it has been split in two different graphs according to impact areas (displayed in *Appendix VIII* and *Appendix IX*, respectively) which are in turn synthetically reported in *Figure 3-11* below according to decisional criteria. Differently bordered boxes represent the impact area (demand, supply and cross-cutting aspects) criterion that each impact variable belongs to. The network visualization has further been supplemented by inserting the activity (on the top-right corner) and passivity (on the top-left corner) values of the variables and displaying the impact variables in differently coloured boxes. Green is for **Project quality**, violet is for **Project innovation** and yellow is for **Project costs**; blue is for **Standardisation**, red is for **Demand activity**, orange is for **Market price** and grey is for **Complementarity.** In addition, the larger arrows symbolise the stronger impacts. White background is for Active variables; light grey background is for Ambivalence variables; dark grey is for Buffer variables; black is for Passive variables.

The same colour code of *Figure 3-11* applies to the system graphs reported in *Appendix VIII* and *Appendix IX* which respectively depicts the relative importance and mutual interlinks among the 13 supply-side impact variables and the 12 demand-side and market-wide factors altogether. On the supply side of the market, the *variety in project Portfolio* and *engagement of carbon economy Actors* are confirmed to act as main hubs for dependencies, while on the other side, the *diversity of commercial Standards* and *market Participation and attitude* are only slightly inferior. In contrast, both the *coverage of Project pipeline* and the *response to Leakage*, as well as the *valuation of Additional services* and *Expectations on the supply chain* on the other, seem to have the least relevance in terms of leverage for steering action on the system. Hence, all these variables are candidates for further consideration within the following discussion. Criterion-wise, ***Project quality*** and ***Project innovation*** display the highest relative importance and number of interdependencies passing through them.

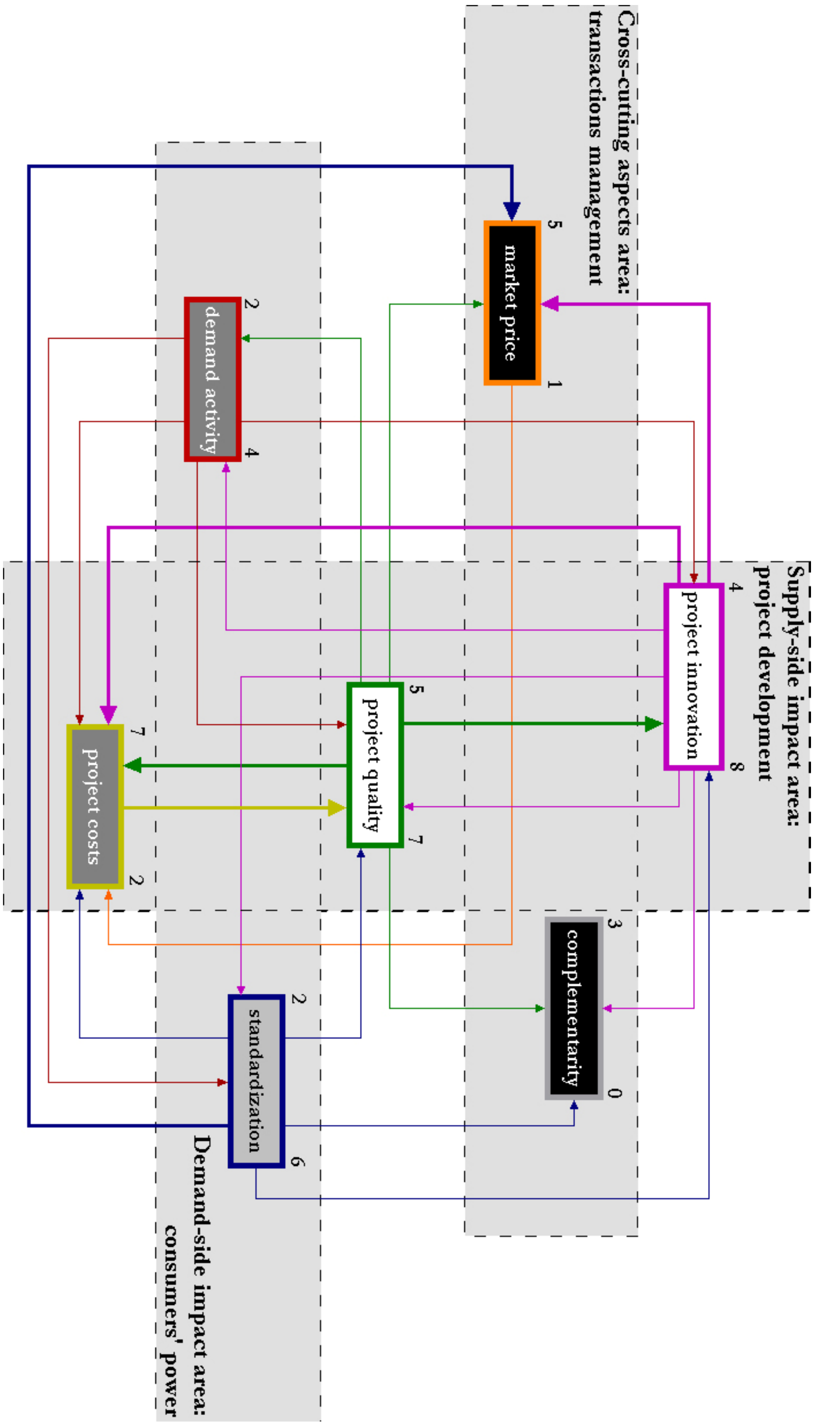


Figure 3-11 System graph of forest carbon offsets [See the text for discussion and a detailed description]

Source: (Barchiesi, 2007)

The analysis of the impact matrix through system grid and system graph has so far fulfilled the goal of identifying different dynamic and structural characteristics of the system such as the systemic significance of impact variables. Other intuitive considerations regard the existence of potential subsystems and only the area of project development seems to carry inside variables which are mutually impacting as so to be legitimately defined as such. Concerning the importance of indirect impacts and dynamic system behaviours, the following loop is worth commenting.

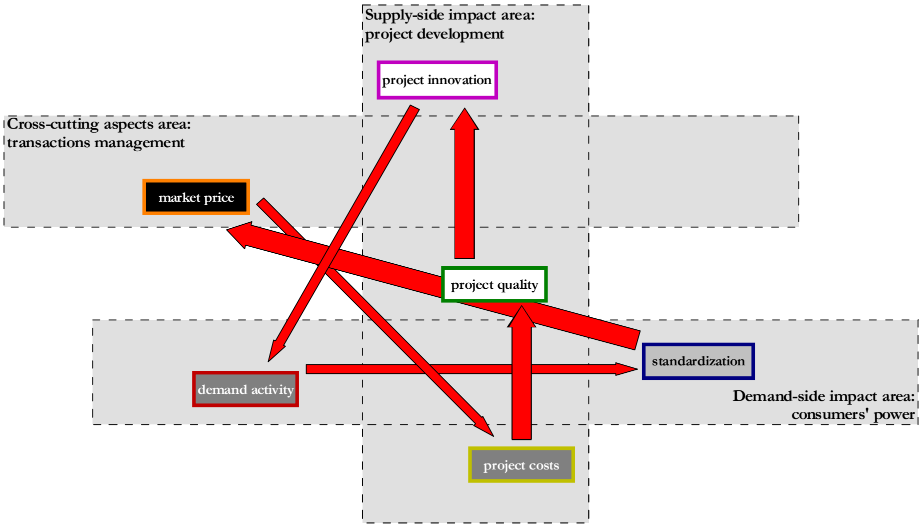


Figure 3-12 Example of feedback loop in the system for forest carbon offsets

Source: (Barchiesi, 2007)

In order to increase project quality, for instance by betting on offset credibility, seeking for more project innovation is one clear way that is possible to undertake. When project portfolios are enlarged and diversified though, the level of activity within credit/offset buyers is triggered upwards because other motives than compliance may drive the willingness to pay premium price for high sustainable development projects. At that stage, market prices will start decreasing due to lower transaction costs but still to the extent to reflect the larger demand. At the same time, project costs will dwindle mainly for large-scale projects like plantations, while the more community-inclusive and agroforestry-oriented small-scale projects will suffer competition on prices. Where the carbon commodity is one like in Kyoto-compliant regimes, the price-based criterion makes no distinctions between high and low sustainability benefits while project quality may differ from one project to the other. Yet, the complementarity between schemes does not intervene in the considered chain of events which therefore appears a negative feedback loop all in all.

3.4.2 Consistency Ratings in the Scenario Construction

In this analysis, each scenario is a mathematical vector, which expresses a certain combination of the two possible levels of all 25 impact variables. In order to get and intuitive understanding of the function of consistency measures and of the rationale for the pair-wise rating of system variables, the following table is a 21-fold simplification including only 4 'macro-criteria' instead of 25 impact variables. Amongst the 2^4 possible combinations, the alternatives n° 4, 5, 9, 10, 13, and 14 are not plausible as really high carbon sequestration yields are only possible with a high commoditization of forest carbon offsets in compliance markets and *vice versa*. Those six scenarios are therefore discarded from the set and only ten scenarios are left which can bring about major contribution to climate change mitigation. By contrast, high sustainable development benefits can be attained in either regime. Only when both the carbon yield and benefits are simultaneously verified though, climate change mitigation is significantly aided because only long-term developments assure that the carbon sequestration will not be reversed. Please note that scenarios n° 1, 11, 12, and 16 are the four extreme situations as envisioned in the *Problem Statement* (cf. sect. *1.1.1*)

Table 3-5 Simplified 2-level combination of 4 criteria

#	Carbon sequestration yield	Sustainable development benefits	Commoditization of forest carbon assets in compliance markets	Commoditization of forest carbon assets in voluntary markets	Contribution to climate change mitigation
1	**High**	**High**	**High**	**High**	**Yes**
2	High	High	High	Low	Yes
3	High	High	Low	High	Yes
~~4~~	~~High~~	~~High~~	~~Low~~	~~Low~~	N/A
~~5~~	~~High~~	~~Low~~	~~High~~	~~High~~	N/A
6	High	Low	High	Low	No
7	High	Low	Low	High	No
8	High	Low	Low	Low	No
~~9~~	~~Low~~	~~High~~	~~High~~	~~High~~	N/A
~~10~~	~~Low~~	~~High~~	~~High~~	~~Low~~	N/A
11	**Low**	**High**	**Low**	**High**	**No**
12	**Low**	**High**	**Low**	**Low**	**No**
~~13~~	~~Low~~	~~Low~~	~~High~~	~~High~~	N/A
~~14~~	~~Low~~	~~Low~~	~~High~~	~~Low~~	N/A
15	Low	Low	Low	High	No
16	**Low**	**Low**	**Low**	**Low**	**No**

In addition to *Table 3-5*, a list of the 32 strong inconsistencies attributed among the 1 200 possible combinations of variables' levels is hereinafter provided along with the logic for their lack of plausibility. Although the consistency rating has implied three more measures for different degrees of possibility which are reflected in the final ranking of scenarios, one of these conditions of impossibility alone is sufficient to invalidate the occurrence of the whole scenario in question. In fact, every scenario whereby any of these combinations is verified has been excluded from further consideration in the discussion due to inherent disruption. The following extract from *Appendix* X is to make the process of scenario construction as transparent and objective as possible.

Table 3-6 The 32 strong inconsistencies in the 25-varible model

	Level of 1st variable	1st variable	Level of 2nd variable	2nd variable	
1	*Flexible*	*additionality*	*Limited*	*artificial demand*	↓↓
2	Inflexible	additionality	Indifferent	Preferences	↑↓
3	Adequate	leakage (response to)	Low	Credibility	↑↓
4	Inadequate	leakage (response to)	High	Credibility	↓↑
5	Inadequate	leakage (response to)	High	Eligibility	↓↑
6	*Inadequate*	*leakage (response to)*	*Limited*	*artificial demand*	↓↓
7	Large	cobenefits	Low	Credibility	↑↓
8	Small	cobenefits	High	credibility	↓↑
9	Large	cobenefits	Narrow	engagement	↑↓
10	Small	cobenefits	Broad	engagement	↓↑
11	Small	cobenefits	Careful	preferences	↓↑
12	Moderate	Cost-effectiveness	Mature	market dynamics	↓↑
13	Low	credibility	Strong	endorsement	↓↑
14	High	eligibility	Small	portfolios	↑↓
15	Low	eligibility	Large	portfolios	↓↑
16	Large	portfolios	Reactive	attitude	↑↓
17	*Long*	*pipeline*	*High*	*expectations*	↑↑
18	Short	pipeline	High	expectations	↓↑
19	*Long*	*pipeline*	*Careful*	*preferences*	↑↑
20	Short	pipeline	Careful	preferences	↓↑
21	*Considerable*	*standardisation*	*Robust*	*market infrastructure*	↑↑
22	*Reduced*	*standardisation*	*Weak*	*market infrastructure*	↓↓
23	Considerable	standardisation	Low	transaction costs	↑↓
24	Reduced	standardisation	High	transaction costs	↓↑
25	Weak	market infrastructure	Comprehensive	artificial demand	↓↑
26	*Robust*	*market infrastructure*	*High*	*transaction costs*	↑↑
27	*Weak*	*market infrastructure*	*Low*	*transaction costs*	↓↓
28	*Favourable*	*additional services*	*Comprehensive*	*artificial demand*	↑↑
29	Favourable	additional services	Indifferent	preferences	↑↓
30	*Comprehensive*	*artificial demand*	*Proactive*	*participation*	↑↑
31	Comprehensive	artificial demand	Shallow	market liquidity	↑↓
32	Comprehensive	artificial demand	Weak	endorsement	↑↓

The last column shows which logical inconsistency is dependent on one variable level increasing against the other variable level decreasing and which is dependent on both variable levels varying in the same direction at the same time. The additional selection that follows is to highlight the least straightforward situations unlike the cases n° 7, 8, 9, and 10 (the broader the engagement of diverse market actors, the larger the delivery of ancillary cobenefits, the higher credibility for projects) or n° 23, 24, 26, and 27 (the more reduced the diversity of commercial standards available, the more robust the market infrastructure, the lower the transaction costs) which are fairly clear cause-effect groups of variables:

(1) the more limited the extent of artificial demand, the more active the demand in voluntary markets, the more likely to maintain the current additionality rules (inflexible);

(6) the more limited the extent of artificial demand, the more active the demand in voluntary

markets, the less adequate the response to leakage;
(17) the longer the coverage of project pipelines by one contractor, the more the control over project quality, the lower the expectations of consumers on the supply chain;
(19) the longer the coverage of project pipelines by one contractor, the more the control over project quality, the more indifferent the preferences of consumers for different criteria;
(28) the more comprehensive the extent of artificial demand, the more intermediaries are institutionalised, the more indifferent the valuation of the additional services they provide;
(30) the more comprehensive the extent of artificial demand, the more reactive the participation to markets because of compliance with reduction obligations.

4. Results and Discussion: Market Developments for Forest Carbon Offsets

Although the analysis comprised many aspects which are not traditionally referable to market development, rather to technological and socio-political issues, the system description has been set up with a focus around demand and supply. Therefore, future states of the system, i.e. scenarios, will be referred to as market developments.

4.1 Scenario Interpretation

The analytical procedure intended to clean up the set of 33 554 432 scenarios from the discrepancies described in section *3.4.2* has produced 384 specific combinations of levels which are logically consistent. All pairs of impact variables have been in fact rated in such a way that the apportionment of the consistency indicator of -999 to the 32 illogical combinations is such to nullify almost 999.99‰ of the whole set[18]. During consistency analysis though, no attempt is made to go beyond the assessment of the logical possibility of occurrence for each hypothetical future state of the system. Consistency is a necessary, but not sufficient, prerequisite for the actual likelihood of the constructed scenarios. Still, pure probability calculations for the case are not significant for the scenario-analytic approach adopted here. Probabilistic evaluation would moreover have been prohibitive due to the number of potential combinations between 25 variables and all their levels. Therefore, considerations on scenario favourability in that sense are left to the following MAUT step and stakeholder analysis principles. Nevertheless, scenario selection allows to eventually assigning an intelligible meaning to all the formally assessed sequences of numbers and interactions between the different aspects as described in *Chapter 3* and thus provides a realistic picture of the future.

The discussion is devised in such a way to go through a small number of significantly different, reliable scenarios that real decision-makers would be qualitatively interested in. In the first place, the situations which have been prefigured in the *Problem statement* around forestry and carbon credits are further commented prior to knowing their actual level of coherence. In particular, the two opposite configurations envisaged in such a hypothetical manner whereby ideal conditions are compared against the worst desirable scenario are here deliberately selected. The idealness or undesirability of the diametrically opposed hypotheses rests on the mere summation of each impact's individual utility alone. Therefore, no hint is given as to the overall sustainability of either of these two mirrored set of attributes. For the tradeoffs inherent to the broadest definition of sustainability, the aim is in fact to provide an initial insight into how single characteristics behave in relation to others. In addition, section *5.1.1* is meant to demonstrate how neither of the two theoretical extremes of the case, in which the overall utility for the full array of stakeholders is either maximum or minimum, are possible or, indeed, sustainable. However, the greatest uncertainty rests on where to locate the optimal equilibrium for all variables at once as so to set the most sustainable configuration. Initial indications in that sense come from section *5.1.2* through the analysis of the principally possible cases. Whereas the latter is targeted to single out the most efficient scenarios in terms of internal stability, namely the most consistent scenario out of computer elaboration, the additional 'stakeholder variable' is discussed in section *5.2*. After the

[18] Although the consistency indicator of -999 has been used additively in the summation with the other measures of 0, 1, and 3, its weight is basically equivalent to a multiplicative factor 0 (Scholz & Tietje, 2002; Tietje, 2005)

narrative case description of some selected alternatives which concludes the first part of comments over differences, genesis, relations to criteria and perspectives of the possible scenarios for forest carbon offsets, a discussion of the influence of stakeholders over consistency within a group of similar scenarios will introduce the conclusions to this study.

4.1.1 Hypothetical Systems: Ideal Conditions and Worst-Case Scenarios

In the first theoretical case, which is still part of the same set of alternatives as provided by the Formative Scenario Analysis performed, the levels of the impact variables belonging to ***Project quality***, ***Project innovation***, ***Standardisation***, ***Demand activity*** and ***Complementarity*** are kept at their maximum state equal to 1. On the contrary, minimum levels (equal to 0) have been assumed for ***Projects costs*** and ***Market price*** impact variables since the system utility is deemed inversely proportional to such unfavourable economic factors (*Table 4-1*). For the second theoretical case, the conditions are precisely reversed as so that the situation depicted is meant to verge on the proverbial 'worst-case scenario (Table 4-2). For these extreme scenarios, the criterion-wise utility function of the broadest array of stakeholders is assumed to add up to 100% and 0% respectively.

Table 4-1 The 'ideal' scenario and the strong inconsistencies in it (as indicated by the red arrows)

Decisional criteria	**Attributes**		
	Impact variables		**Levels**
Project quality	Stringency of additionality	Inflexible	1
	Response to negative leakage	Adequate	1
	Delivery of ancillary cobenefits	Large	1
	Cost-effectiveness of the offset	Extreme	1
	Credibility of the offset	High	1
Project innovation	Degree of eligibility	High	1
	Degree of acceptability	High	1
	Variety in project portfolios	Large	1
	Engagement of diverse actors	Broad	1
Project costs	Support of technical competencies	Systematic	0
	Capacity in local labour sources	Sufficient	0
	Liquidity of financial sources	High	0
	Coverage of project pipeline	Long	0
Standardization	Diversity of commercial standards	Reduced	1
	Market infrastructure	Robust	1
	Valuation of additional services	Favourable	1
Demand activity	Extent of artificial demand	Limited	1
	Expectations on the supply chain	High	1
	Consumers' preferences and motivations	Careful	1
	Participation and attitude	Proactive	1
Market price	Market dynamics	Mature	0
	Transaction costs	Low	0
	Contractuality of transactions	Lax	0
Complementarity	Market depth and liquidity	Deep	1
	Governments' endorsement	Strong	1

Neither the first scenario nor its reciprocal, conveniently labelled 'ideal' and 'worst-case' respectively, turned out to be consistent (measures equal to - 3 389 and – 1 420; the detailed spreadsheets of the scenarios discussed in the following are included in *Appendix XI and Appendix XII.*) since they include one or more impossible conditions to their realization (compare red arrows in the tables). Surprisingly or not, the 'worst' conditions are more consistent on the whole than the 'ideal' scenario, thus showing a better assortment of impact performance in terms of system stability. Either way, these results hint at both best and worst conditions being very seldom likely to occur both in nature and human society.

When looking at the causes of impossibility, it can be seen in Table 4-2 that the arbitrarily tailored scenario with maximum-level characteristics contains two strong inconsistencies between *Project pipeline* and both *Expectations* and *Preferences*. It is noteworthy that such a condition of impossibility is anyway maintained regardless of a short or long coverage of *Project pipeline*. One possible explanation can be found in that maximising the length of the *Project pipeline* coverage would result in one single actor managing the whole project cycle up to the end, thus excluding any intermediary's involvement. Such situation does not leave much room for particular *Expectations* or *Preferences* concerning the sustainability of the supply chain as the number of market players that could otherwise be chosen or influenced vanish to zero. On the other hand, the scenario where each and every stage of the project cycle is outsourced to many different entity (*Project pipeline* level = 1) is not consistent with extremely demanding *Expectations* and *Preferences* because stakeholders may look at many other aspects of the supply chain besides project development, e.g. how information is passed on or credit buyers retrieved. This in turn reflects how the utility for *Project pipeline* was assumed to be maximum when the project developer covers the whole pipeline because outsourcing in this particular field typically involves hiring a consultant and thus no significant savings in the company's productivity.

Variations in *Project pipeline* levels have thus proved to have a small effect on producing significant changes to the system. Forgoing the possibility to simultaneously keep high degrees of *Expectations* and *Preferences* at the condition that ***Projects costs*** remain moderate (but for *Project pipeline* perhaps), the very same variables' levels should be possibly unblocked first in order neither to stray too much from the 'ideal' scenario nor to increase the number of logically impossible occurrences. By playing with these contradictory pairs of either/both *Expectations* or/and *Preferences*, it might be possible to increase the overall level of coherence going progressively through 'neighbour' scenarios whose impact factors are more synergic. When intervening on *Preferences* alone by allowing a less careful attitude in the markets, the situation seems to get even worse rather than change in a more positive direction. Besides leaving unsolved the issue with *Project pipeline*, *consumers' Preferences* cannot be indifferent while the regime is utterly inflexible with respect to additionality because the available offset options would be rather limited. For the same rationale, the *valuation of Additional services* is very unlikely to be favourable or *Expectations on the supply chain* high as long as indifference is dominant since project selection. On the contrary, *Expectations* can still be low alongside careful *Preferences* because too much focus on offset development can end up in overlooking the fairness of ancillary services after middlemen. As a result of this latter change, considerable improvements will be made in terms of logical coherence as the scenario score soars to -404, leaving only a strong inconsistency.

Similar comments could have been made starting from the 'worst-case' scenario as well. When switching the level of either *Artificial Demand* or *Infrastructure* i.e. the first two variables producing the 'waterfall' of level incongruence, the above scenario becomes related to less unrealistic consequences. Because it is a much more active variable, it is possible that the bigger number of changes induced by *Artificial Demand* increases the probability of more consistent combinations. On the contrary, *Infrastructure* is a buffer variable which implies it will have less causality. As a consequence, by limiting the extent of the *Artificial Demand* while keeping an inflexible regime concerning *Stringency of additionality*, a relatively more consistent scenario results (with a score of - 1 398). Although similar alternatives seem restrained from producing high measures of consistency, several scenarios with low-performing attributes can still be constructed which rank higher than the top-utility 'ideal' case. The other way around, theoretical paths can be attempted towards more efficient states of the system starting from the 'ideal' scenario and then adjusting illogical combinations of variables.

Table 4-2 The 'worst-case' scenario and the strong inconsistencies in it (as indicated by the red arrows)

Decisional criteria	Attributes		
	Impact variables		Levels
Project quality	Stringency of additionality	Flexible	0
	Response to negative leakage	Inadequate	0
	Delivery of ancillary cobenefits	Small	0
	Cost-effectiveness of the offset	Moderate	0
	Credibility of the offset	Low	0
Project innovation	Degree of eligibility	Low	0
	Degree of acceptability	Low	0
	Variety in project portfolios	Small	0
	Engagement of diverse actors	Narrow	0
Project costs	Support of technical competencies	Disorganised	1
	Capacity in local labour sources	Insufficient	1
	Liquidity of financial sources	Low	1
	Coverage of project pipeline	Short	1
Standardization	Diversity of commercial standards	Considerable	0
	Market infrastructure	Weak	0
	Valuation of additional services	Indifferent	0
Demand activity	Extent of artificial demand	Comprehensive	0
	Expectations on the supply chain	Low	0
	Consumers' preferences and motivations	Indifferent	0
	Participation and attitude	Reactive	0
Market price	Market dynamics	Volatile	1
	Transaction costs	High	1
	Contractuality of transactions	Strict	1
Complementarity	Market depth and liquidity	Shallow	0
	Governments' endorsement	Weak	0

Yet, the remarkable point to point out here is that the 'worst-case' scenario is only 1-variable distant (*Expectations*) from the starting hypothesis, where the distance between two scenarios is the number of impact variables which are simply different. (Tietje, 2005) In addition, the first attempt to modify two variables and thus achieve a distance of 2 from the 'ideal' state resulted in a dramatic drop in consistency (- 3 411). Hence, no linear correlation seems to exist between distance and the local efficiency of scenarios, namely the number of neighbour scenarios with a lower consistency. Moreover, the situation proves that more sophisticated methods of analysis than mere human speculation are required for discerning the adequate adjustments within similar complex systems.

4.1.2 Selection of the Most Consistent Scenarios

In order to finally obtain a reasonably sized set of scenarios to serve as an effective decision-support tool, a local efficiency procedure was selected, among three alternatives proposed, as the more efficient and less time-consuming in identifying a small, reliable and comparable number of different possible future states of the system. (Tietje, 2005) In particular, the local efficiency procedure was chosen because fewer final scenarios that generally result from the selection are more suitable for the second part of the discussion. In addition, the three alternative procedures that were compared (i.e. local efficiency, distance-to-selected, and min-max selection) show a good degree of convergent validity. The forecasting model developed is yielding more than a single prediction to take into consideration. In fact, sound comments on the contingent system changes are qualitatively recommended for best-reply strategies.

The assessment presented here was based on the previously performed consistency analysis as well as subsequent scenario selection beyond the minimum consistency level of 0. The latter implies none of the strong inconsistencies as listed in section *3.4.2*

In practice, the remaining number of 384 'positive' scenarios was considered too large and the range was thus filtered further with the help of the three-grade scale of consistency indicators employed (i.e. 0, levels hindering each other; 1, uncorrelated relation; and 2, supporting occurrences). The aim was to trim out the 9 least consistent scenarios (i.e. those allocated the highest number of '0' indicators) as so to attain a round number of 375 scenarios. Then, the maximum local efficiency was determined as previously defined. In particular, the local efficiency procedure calculates the consistency of a scenario together with the consistencies of all its neighbours. The number of neighbours is constant and depends on the number of both impact variables and possible levels of each impact variable. In this case, only two levels are allowed, resulting in a maximum of 25 neighbours for any given scenario. Thus, a scenario is locally efficient, if its level of consistency is greater than (or equal to) the level of each of its 25 neighbours. As a result, 15 locally efficient scenarios were singled out, among which no pairs. Pair scenarios are two very similar scenarios which differ because of only one variable and are equally efficient. This situation when 'twin scenarios' have the same efficiency is also defined as broader local maximum. Unfortunately, 8 scenarios among the previously selected 15 were still too similar with a distance of only 1. Therefore, every second scenario with the lower consistency among closest pairs was cancelled. By reiterating this operation, the following three scenarios eventually resulted with a minimum distance of 4.

Table 4-3 illustrates what are the differences between the most consistent scenario (consistency measure = 567) and two other scenarios which are comparably efficient (consistency measure = 519 and 554 respectively) but also not too similar (distance = 4 and 5 respectively). As distance refers to the similarity between scenarios, the present three-some demonstrates how the property of consistency does not vary in linear correlation to how close neighbouring scenarios are after they have been sorted in either ascending or descending order. In fact, if compared to both the first and third situation in *Table 4-3*, the second set of conditions is more inconsistent than it is different from the other two. The three individual scenarios have been named after the levels which represent a significant variation from the 'ideal' case. In particular, Scenario # 16 059 395 was labelled according to a pair wise comparison according to which it shows both a higher level of A*cceptability* and better performances concerning ***Project costs*** and ***Complementarity***. In addition, the name 'Legitimacy' was deserved because of the impacts on market price such as low *Transaction costs* and lax C*ontractuality* which hint at a fairly mature and risk-managing market. As a trade-off between all this characteristics, the scenario produces an overall utility value of 71%. On the contrary, the second alternative (54% overall utility) was called 'Higher prices' because, ***Project costs*** being equally distant to the previous state as the third scenario, the two inverted levels within ***Market Price*** imply much higher variations. Since ***Project costs*** and ***Market prices*** are not so significant for the last scenario, the apparently less distinctive differences in ***Project innovation*** and ***Complementarity*** contributed in a predominant manner to both the name and 52% utility for the scenario.

Table 4-3 Three scenarios and their characteristics obtained from 384 filtered scenarios using local efficiency selection

Impact variable	**Scenario # 16 059 395 "Legitimacy"**	**Scenario # 16 096 279 "Higher prices "**	**Scenario # 15 846 417 "Limited innovation & complementarity"**
Stringency of additionality	Flexible	Flexible	Flexible
Response to negative leakage	Adequate	Adequate	Adequate
Delivery of ancillary cobenefits	Large	Large	Large
Cost-effectiveness of the offset	Extreme	Extreme	Extreme
Credibility of the offset	High	High	High
Degree of eligibility	Low	Low	Low
Degree of acceptability	High	High	Low
Variety in project portfolios	Small	Small	Small
Engagement of diverse actors	Broad	Broad	Broad
Support of technical competencies	Systematic	Disorganised	Disorganised
Capacity in local labour	Sufficient	Sufficient	Insufficient
Liquidity of financial resources	High	High	High
Coverage of project pipeline	Long	Short	Long
Diversity of commercial standards	Reduced	Reduced	Reduced
Market infrastructure	Robust	Robust	Robust
Valuation of additional services	Indifferent	Indifferent	Indifferent
Extent of artificial demand	Comprehensive	Comprehensive	Comprehensive
Expectations on the supply chain	Low	Low	Low
Consumers' preferences and motivations	Indifferent	Indifferent	Indifferent
Participation and attitude	Reactive	Reactive	Reactive
Market dynamics	Mature	Volatile	Volatile
Transaction costs	Low	Low	Low
Contractuality of transactions	Lax	Strict	Lax
Market depth and liquidity	Deep	Deep	Shallow
Governments' endorsement	Strong	Strong	Strong
Consistency	**567**	**519**	**554**
Distance (difference in variables' levels)	-	**4**	**5**

4.1.3 Bonds and Degrees of Freedom

The above sets of impact levels represent three plausible future states of forest carbon offsets; each 25-fold combination, though, entails slightly different conditions in terms of system stability. Concerning the latter point, it is noticeable that 16 impact variables did not show any variability throughout the full set of 384 meaningful scenarios. In other words, 64% of the variables as developed in the model appear stuck into either their maximum or minimum level (8 variables respectively). Simply put, the system does not seem to support the simultaneous occurrence of certain conditions whatever case may be. In particular, inflexible regimes concerning *Additionality*, high degrees of *Eligibility*, large variety in project *Portfolio*s, favourable valuation of *Additional services* to the supply chain, comprehensive extents of *Artificial demand*, high *Expectations* on the supply chain, careful *Preferences* and motivations by consumers, active *Participation* and attitude, are even more critical conditions as higher levels of their relative utility do not seem to be compatible for tradeoffs. Furthermore, the 9 variables that show some degree of variability are distributed in a fairly sharp way, i.e. 6 of them are 66% inclined to the top conditions while the remaining 3 to the bottom. The 16 'bound' variables are split 50% between the best and bottom conditions (cf. *Figure 4-1*).

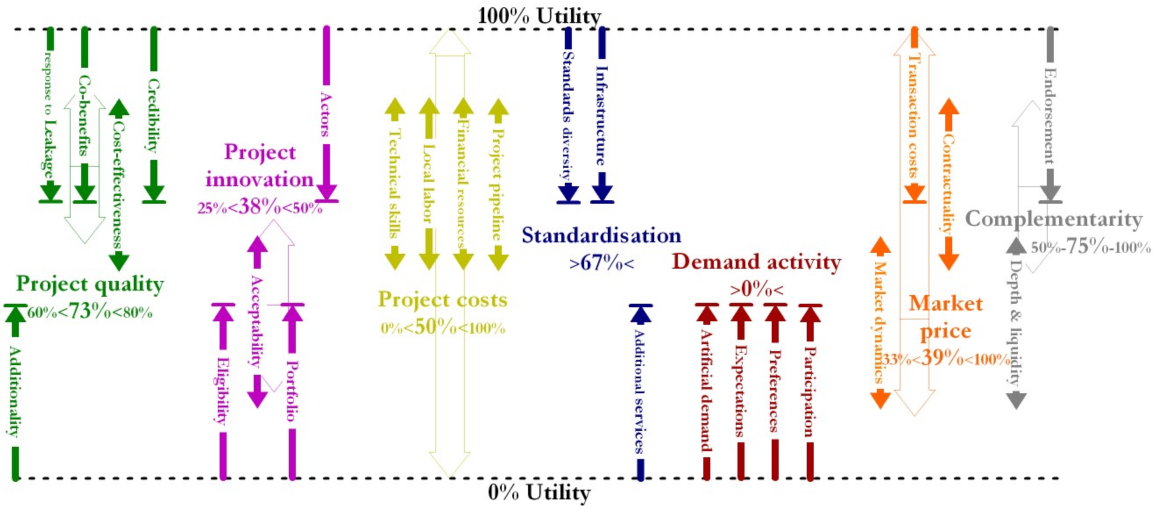


Figure 4-1 Bonds and degree of freedom as tradeoffs in forest carbon offsets

(Mean and extreme values of utility are reported for decisional criteria in smaller and bigger font respectively)

Such distribution is a logical consequence of the system bonds previously described whereby only a finite number of combinations are possible for the interdependencies highlighted in section *3.4.1.2: Graphic representation of forest carbon offsets*. As a result, the in-all trade-offs of the system are depicted in *Figure 4-1* according to how the variability displayed by the 25 sub-components is dispersed across the whole set of possible scenarios. In addition, all elements are descendingly sorted to apply the same assumption of 100% and 0% utility conditions as in section *4.1.1: Hypothetical Systems: Ideal Conditions and Worst-Case* . Based on this, it can be inferred that:

1. ***Standardisation*** with a quite high average value of utility and ***Demand activity*** with a very low average value of utility do not vary across different scenarios. Such stability can be linked to the low sensitivity displayed in section *3.4.1.2: Graphic representation of forest carbon offsets* by the individual impact variables composing the two decisional criteria. In summary, the medium-high level of standardisation and extremely low demand activity in forest carbon markets is a recurring condition for the system development possibly because of the few direct influences from other aspects of the system.

2. ***Project costs*** and ***Market price*** have the widest range of variability thanks to the degrees of freedom of their impact factors except for *Transaction costs*. This behaviour can be linked to the low activity displayed in section *3.4.1.2: Graphic representation of forest carbon offsets* by the individual impact variables composing the two decisional criteria. In summary, the several direct influences which other aspects have on ***Project costs*** and ***Market price*** make them more subject to change rather than they are prone to producing any.

3. ***Project quality***, ***Project innovation*** and ***Complementarity*** show average ranges of variability which seems in turn proportional to only one variable for each criterion being free to forego change. Such quality can be once again linked to low sensitivity as previously under point 1. In summary, *Cost-effectiveness*; *Acceptability*; and *Depth and liquidity*, are all passive enough to induce lower utilities into ***Project quality***, ***Project innovation*** and ***Complementarity*** respectively from apparently unrelated impacts.

4.2 Multi-Criteria Analysis as Scenario Evaluation

Besides intrinsic measures of scenario consistency, system stability is dependent on the dynamics of stakeholders' forces of influence in that they can determine the occurrence of the conditions encompassed by one scenario instead of another. By interpreting different interest groups' preferences, the assessment of scenario probability may gain a new access key beyond the mere possibility provided by consistency analysis as above. While defining impact variables, also various market players' functions have been thus incorporated as more thoroughly as possible. Different stakeholders represent a continuous input of potential perturbation to future developments in terms of how surprise-free or surprise-rich constructed scenarios can be. The ultimate purpose is thus to allow the identification of those relevant actors to address once that a specific strategy is built in consistency with the target scenario which is deemed more desirable than its possible alternatives. The leverage being how actors operate on impact levels, stakeholder multi-criteria analysis is thus deemed crucial to understand what combination of preferences is related to a particular scenario and subsequently enable decision-makers predict the suitable steering interventions required to either support or oppose the stakeholders' deviating behaviour (cf. *Figure 1-1*). In fact, market actors may not be in accordance with the conditions dictated by the most consistent scenario. Even being in accordance though, some unaware stakeholders might unintentionally strive to lead the system away from the same desirable outcomes.

Preferences have been linked to system factors through transforming groups of impact variables into decisional criteria (cf. *Appendix I*). *Table 4-4* illustrates a concrete proposal for how scenario analysis could be integrated with multi-criteria assessments with the purpose of solving further uncertainties within complex *problematiques*. In the intentionally explorative sketching of the MAUT set-up that follows, each criterion relative utility was assumed as collective measure for sake of simplicity and no breakdown of utility was considered at variable level. Moreover, importance weights have been associated to the alleged preferences of the three groups of perspectives. In order to keep a certain level of validity though, the percentages reported were inferred from Sell et al.'s (2006) survey respondents. In fact, two project alternatives (business-oriented and sustainability-oriented) proposed in that study which are respectively referable to perspective a) and c) as outlined in the *Problem statement* and *Research justification*. Thirdly, the conservation agency' viewpoint (perspective b) in *Problem statement* and *Research justification*) stems from section *2.3* objectives and function as devised to approach the overarching research question reported in the title to the present thesis. In summary:

- Forestry for carbon credits → business-oriented perspective
- Forestry AND carbon credits → sustainability-oriented perspective
- Carbon credits for forestry → conservation-oriented perspective

Table 4-4 Tentative performance matrix of the "legitimacy" scenario with the preference groups' (business, sustainability, conservation) inferred importance weights corresponding to three of the four overarching perspectives outlined in the problem statement

Decisional criteria	Impact variables	Levels		Ci	Ui	Wbusiness	Wsust	Wcons
Project quality	Stringency of additionality	Flexible	0	36	80%	28%	37%	33%
	Response to negative leakage	Adequate	1	45				
	Delivery of ancillary cobenefits	Large	1	39				
	Cost-effectiveness of the offset	Extreme	1	53				
	Credibility of the offset	High	1	48				
Project innovation	Degree of eligibility	Low	0	37	50%	22%	18%	20%
	Degree of acceptability	High	1	50				
	Variety in project portfolios	Small	0	38				
	Engagement of diverse actors	Broad	1	50				
Project costs	Support of technical competencies	Systematic	0	46	100%	5%	10%	8%
	Capacity in local labour sources	Sufficient	0	46				
	Liquidity of financial sources	High	0	66				
	Coverage of project pipeline	Long	0	53				
Standardization	Diversity of commercial standards	Reduced	1	49	67%	6%	4%	5%
	Market infrastructure	Robust	1	45				
	Valuation of additional services	Indifferent	0	39				
Demand activity	Extent of artificial demand	Comprehensive	0	49	0%	19%	18%	19%
	Expectations on the supply chain	Low	0	40				
	Consumers' preferences and motivations	Indifferent	0	45				
	Participation and attitude	Reactive	0	36				
Market price	Market dynamics	Mature	0	45	100%	12%	1%	6%
	Transaction costs	Low	0	48				
	Contractuality of transactions	Lax	0	46				
Complementarity	Market depth and liquidity	Deep	1	44	100%	8%	12%	10%
	Governments' endorsement	Strong	1	41				
		Scenario consistency		**567**	**71%**	**Overall Utility**		
	Consistency - Utility - business-oriented stakeholders' importance Weight					**161**		
	Consistency - Utility - sustainability-oriented stakeholders' importance Weight						**194**	
	Consistency - Utility - conservation-oriented stakeholders' importance Weight							**176**

In addition, *Figure 4-2* at the end of this section is meant to help visually with respect to interest groups' contributions to market development. As inferable from there, if each stakeholder's impact was equitably balanced, the geometrical resultant would precisely point at the overall utility for the conditions in place. Yet, it is rather unlikely that different stakeholders with different institutional power have comparable effects on the system. According to *Table 4-4*, for instance, the business- oriented (forestry-for-carbon-credits) perspective would produce a 72% swerve (in a proportion between 161 and 567) from the equilibrium line while the conservation-oriented (carbon-credits-for-forestry) perspective would contribute to a 69% deviation (in a proportion between 176 and 567) according to the combination between their relative preferences for and the actual consistency performance of that scenario. The sustainability-oriented (forestry-AND-carbon credits) position would affect the average trajectory to a lesser extent (66% in a proportion between 194 and 567), thus showing a higher degree of satisfaction for the conditions forecasted by the stability of the system. The same kind of analysis performed over other scenarios e.g. those of *Table 4-3* would result in proportionally similar divergences amongst the three set of preferences but still with no linear correlation between scenario consistency and utility.

Therefore, the mathematical resultant of different stakeholders' impacts on scenario likelihood of realization has been decomposed into two additive vectors in order to describe the cumulative directions that the future can take in terms of both utility and consistency. On the one hand, the vertical component will eventually correspond to decision-makers' assessment of the most equitable utility (which may differ from the highest one for various political reasons). In fact, why and whether each future alternative of market development is sustainable is a function of the chosen utility for the forest carbon system in relation to the whole universe of society's problems and affairs. On the other hand, the question whether these markets can be truly sustainable might not be so important in the absence of any knowledge about how decision-makers can channel appropriate measures towards relevant policy areas. Therefore, the horizontal component corresponds to those stakeholders that decision-makers may or may not want to assist in response to their sustainability assessment. In fact, through whom market development is to be steered is a function of the occurring consistency because of the cognitive analogy between impact variables and actors' functions in the system. All in one, different combinations of impact levels lead to different measures of system stability; as a consequence, different degrees of satisfaction by different market actors may reveal to specific leverage points to be addressed by policy makers. Scenarios which are located at the edge of the 'possibility funnel' entail only part of the new system trajectories which would follow perturbation. Unfortunately, the multi-vector composition of stakeholders' influences results in such a 'storm of probabilistic clouds' of effect that the determination of the direction and magnitude of the resultant vector cannot be resolved here, but must be addressed through further research and dedicated negotiation.

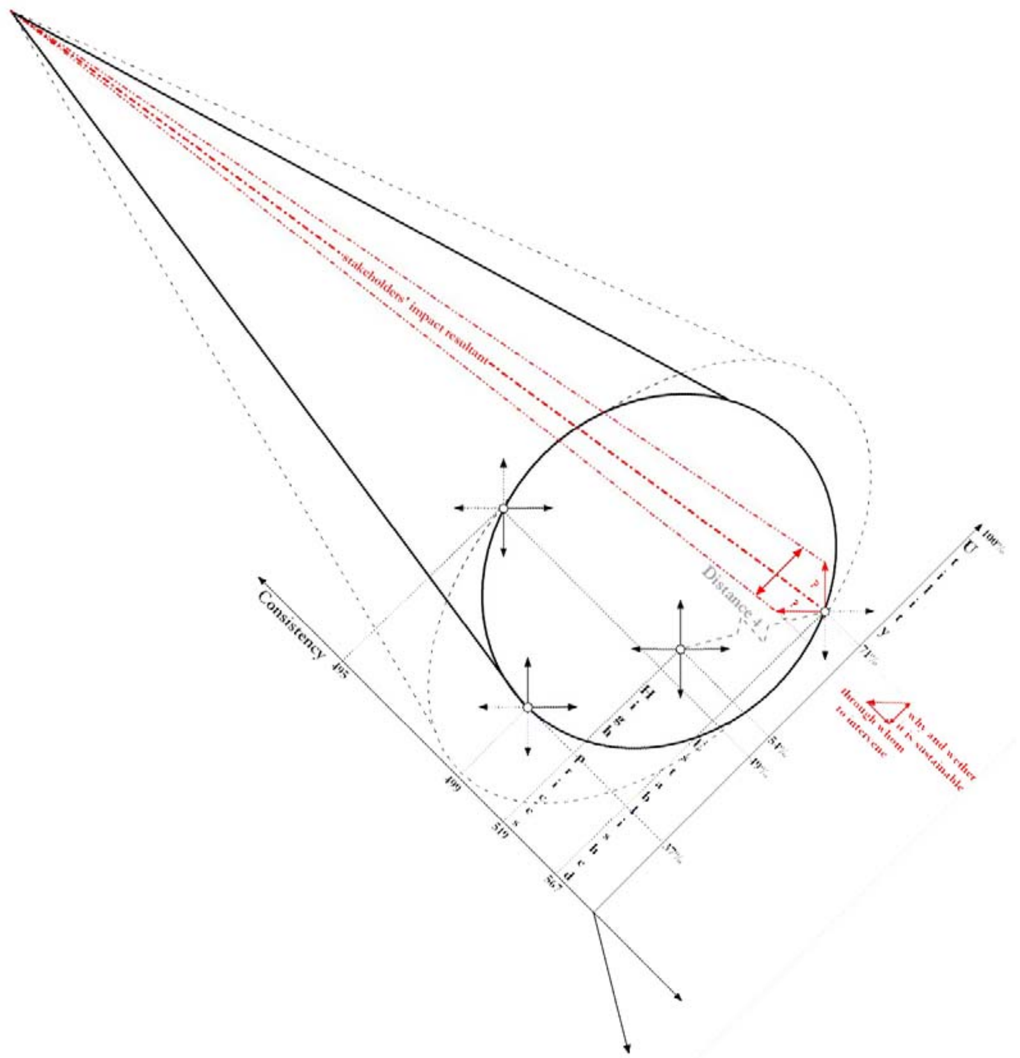


Figure 4-2 Three-dimensional 'trumpet' representation of scenarios with stakeholders' perturbation as vector addition of utility plus consistency

(The principles of scenario consistency and distance, utility maximisation, and stakeholders' disturbances are also all in all synthesised.)

Source: (Barchiesi, 2007)

5. Conclusions

5.1 The Most Stable Market Development

Forest carbon offsets have been represented as a complex system which was initially decomposed into 25 impact variables for a better understanding of the possible market development. The first finding from scenario interpretation confirms that the complexity of the case under study does not allow for all variables to shift unanimously, or in other words, the different aspects which the system comprises in its inner dynamics do not operate in the same direction. Moreover, these impact factors are seldom equal in terms of relative magnitude as previously shown in section *3.4.1.2: Graphic representation of forest carbon offsets*. In analogy to natural ecosystems where the slightest action may cause unpredictable feedback loops in the entire system, the existence of both abrupt and sheer differences across the future states of market development for forest carbon offsets testifies to the difficulties in regulating the LULUCF sector. Concerning the most stable market development, the scenario analysis foresees a situation where:

1. <u>Standardisation is fairly progressed</u>. The number of commercial standards for forest carbon offset will be fairly reduced, meaning that chiefly the voluntary market segment is likely to face a progressive standardisation outside formal regulations. Nonetheless, the process seems to have already begun with reference to the latest releases by, for example, the ISO 14 064-5 complementary series, Voluntary Carbon Standard and TÜV SÜD's Blue Registry initiative which are going to add to the older and more established guiding protocols and certifying programmes already in place like the voluntary market version of the Gold Standard. Likewise, the market infrastructure will become more robust, thus continuing the trend set up by the early-moving market intermediaries and more recently facilitated by the establishment and linkage of new exchange platforms. However, the findings indicate that this should be happening regardless of the consumers' valuation of such additional services. The indifference of credit buyers in that sense might be related to the market sophistication being mainly driven by actors belonging to the brokerage, consultancy, certification, asset management, and credit business. Rather than waiting for additional shares following further market enlargement, these categories of professionals might primarily be looking for larger profits through the diversification of their services and the enhancement of the existing structure at first.

2. <u>Demand relates only reactively to project supply</u>. The demand requirements for forest carbon offsets are destined to settle down as credit consumers will eventually change their proactive attitude towards the existing project supply and, consequently, the drive for change from their side will decrease. Very low levels of expectations on the supply chain will probably be shown when a higher degree of satisfaction is achieved by means of market infrastructure (compare the previous point) with regards to uniformity, risk management or transactions inclusiveness. Likewise, preferences will become rather indifferent concerning project performance and the motivations to support forestry projects will also be limited besides compliance as sufficiently high levels of credibility will be acknowledged. In addition, market participation will regress to a prevailingly reactive environment as the scope of the regulated markets is extended to as many sources and emitters as it is possible to enforce. The more comprehensive the compliance-led demand becomes, the less forest carbon credits are expected to be proactively requested as a consequence of

reduction costs competitiveness being a much more compelling motive than the focus on the value added that positive public opinion adds to the offsetting of residual GHG emissions.

3. Project costs as accessibility to the market from the supply side tend to be moderate though subject to wide variability. In particular, the expertise in project development will tend to be systematically applied in such a way to adequately respond to the majority of LULUCF shortcomings e.g. saturation, non-permanence and baselines. Then, local human resources can also prove sufficient e.g. to provide the marketing instruments required by sound communication of the project performance in reply to consumers' preferences. Moreover, liquidity and financial resources will be progressively increased by the development of investment appraisal methodologies and purchase agreement standardisation. Finally, the almost full coverage of the whole project pipeline by single contractors will reflect the trend whereby forestry carbon projects are becoming core business through the 'departmentization' rather than the outsourcing of, for example, capacity building and information management functions within the company.

4. The market price of the standard forest carbon unit tends to be reasonably high without excluding much better ratings. As a direct consequence of the abovementioned strengthening of the market infrastructure, the rise of the average market price is also justified in light of an increasing project quality amongst others. Concerning the inherent market dynamics, volatility will prove the major destabilising factor, negatively affecting forest carbon prices despite any market maturing over time. On the contrary, the improved drawing of contracts in project-based transactions will help by hedging the manifold risks which LULUCF offsets may entail in the first place, such as expiry liabilities. However, the sky-rocketing of these assets will be most likely prevented by both the discount price temporary credits should at least benefit and stabilised transaction costs. In fact, the difficulties for buyers and sellers to meet and share all the necessary information determining considerable discrepancies between project costs and market price are in principle overcome once instruments, for example, exchange platforms are set in place.

5. Forestry projects display established levels of quality. Whereas the response to negative leakage, the delivery of ancillary co-benefits for sustainable development and scientific credibility will reach recognition, for example, in analogy to the best available practices for the LULUCF sector, additionality rules for forestry projects look like they will go through an unavoidable 'softening process'. If, on the one hand, additionality is closely bound to project quality and overall credibility for many actors on the market, others perceive such stringency of rules as the main hurdle for the most 'humble' to equitably participate in the CDM contribution to sustainable development. In order for either the Kyoto mechanism not to lose its appeal entirely with regards to LULUCF projects or voluntary initiatives to gain some more respect from the scientific community, some tradeoffs must be met in terms of average flexibility across different trading regimes. If offsets credibility is still assured in relation to the extremely important issue of permanence as addressed by both technical skills and contractuality in project costs and market price respectively, additionality will play a minor role in that sense. As a result, the overall flexibility will be increased outside compliance regimes where sometimes it is a matter of legal and procedural complications. Although the cost-effectiveness will be limiting the overall

top utility in project design, the levels for this particular attribute are consistent with moderate project costs and reasonably high market prices for carbon removal units.

6. Project innovation as product differentiation is moderately restrained. The main reasons for this are low degrees of eligibility and few diverse carbon economy actors. Besides quality aspects or the ways these are achieved by project developers, the eligibility of projects is mainly related to the wider extent of compliance markets which requires host countries setups and methodology approvals. In contrast, the relatively narrow engagement of actors within the project supply can be partly ascribed to many market participants being involved in more than one business activity. Those special projects which are run by research institutions in order to overcome the most enduring uncertainties or produce useful guidelines (e.g. on co-benefits delivery) are in fact usually limited to the kick-start stage. In contrast, the large variety in project portfolios as outlined is a strong indicator of how the full potential of different offset options and their combinations is at present under used in all regimes. Hence, a scenario with enlarged portfolios may advance the opportunity for averted deforestation to be included, though with equivalent limitations in future amendments of the CDM. The only factor which does not look to be definitive for project innovation is acceptability, perhaps in relation to the different cost-effectiveness of same-quality projects across countries which may or may not divert national economic priorities as so to put off international aid packages or get ahead of other multi-lateral environmental agreements.

7. Complementarity between compliance and voluntary is fairly high. The endorsement of non-mandatory initiatives by governments will be strong since the educational function especially for those countries and industrial sectors which have or are preparing to have their own reduction targets will probably not be ignored any longer. In contrast, some degree of interaction in terms of liquidity will be allowed to overcome periodical crises and thus safeguard the functioning of the flexibility mechanisms. Nevertheless, market depth will most likely be kept under control in order to prevent the flooding of too cheap credits into the regulated markets where cost-effectiveness should not exceed real global change objectives.

5.1.1 Forestry for Carbon Credits or Carbon Credits for Forestry?

For the outcomes of the scenario analysis as performed by the author, the starting question on whether vegetation could contribute to major climate change mitigation efforts seems now more feasible to answer. The first indications certainly come from the sub-issue whether adapting best forestry practices for yielding carbon credits is better than availing of carbon credits for enhancing sustainable forestry. By triangulating the above findings concerning the characteristics of the most stable market development with their relative importance and mutual interdependencies as shown in section *3.4.1.2: Graphic representation of forest carbon offsets*, it can be inferred that project quality affects market price both directly and indirectly through project innovation while in turn market price affects project quality only through project costs. Based on such interpretation and the alleged importance weight allocations of the three perspective groups selected in section *4.2*, the results suggest that project quality will be faster in bringing about change than market price because of its bigger leverage of influences. Hence, it seems that the system conditions will be matching the carbon-credits-for-forestry perspective more than its reciprocal would do. However, since standardisation is another distinctive criterion for the more business-oriented positions and has a larger influence on market price than on project quality, the difference could be reduced depending on the role that the demand-side attitude would simultaneously play. In fact, it is believed that the concerns which are currently hindering project supply with respect to transparency, accountability and participation could be solely solved once equitable solutions were able to come from more diversified consumers of the full bundle of additional benefits. At its extremes, standardisation can be assuring credibility either against carbon criteria of credits reliability or sustainable development criteria. In the first instance, standardisation would affect market price as so to trigger a commoditization process in opposition to project quality (cfr. the negative feedback loop as shown in *Figure 3-12*). In the second instance, standardisation would instead turn the same influence into a positive feedback loop as market price will be attributed a minor weight in comparison to project quality also directly. However, the latter appears bound to the scarce level of demand activity sustained by the future developments (cfr. point 2 in section *5.1*) Therefore, the commoditization of carbon assets appears doomed to exclude forests from the major efforts to climate change mitigation as the specific demand for LULUCF credits is plausibly relegated to less proactive conditions and attention to the whole project cycle.

After arguing that the latent synergy between carbon credits and forestry is facing dichotomy rather than integration, it is besides suggested that the current regime for LULUCF, and the consequent transaction volumes entailed, remain the closest projection to any possible market development. This is moreover confirmed by the forestry-and-carbon-credits position being the least affecting scenario realisation trajectory during the preliminary testing of different importance weights for the same decisional criteria in section *4.2*. In particular, the future for forest carbon markets appears to be being qualitatively characterised by:

- Slightly higher levels of commoditization within compliance market segments because of the still scarce understanding of the socio-ecological system and weakly credible claims about the appropriateness of the timescale of sinks, with no substantial modification to the current limitation to A/R activities due to the insurmountable accounting difficulties for e.g. avoided deforestation; and

- Premium offsets in the voluntary market segments where the appeal for either/both environmental or/and social ancillary benefits is made more visible, for example by brand labelling, but with no significant large-scale purchases of standardized climate neutral solutions or embedded products.

5.1.2 Policy Recommendations

The analytical decomposition of the case performed by means of modelling on the system subcomponents was also able to identify some key policy areas of intervention. First, no efforts should be spent to improve the system beyond the relative utility of those aspects which are limited by consistency bonds. According to this rationale, a simultaneously cost-effective and allocative-efficient policy with regards to forest carbon offsets should address the different aspects following a descending variability criterion of priority, i.e. project costs as accessibility to the market from the supply side, market price of the standard carbon unit, complementarity between compliance and voluntary segments, project quality, and project innovation. In this way, the probability for the allocated resources to have both a beneficial effect and the most synergic impact on the system will be higher. On the contrary, standardisation and demand activity should be neglected as these are areas which do not require particular steering because they are inherently directed to their most stable conditions.

Their higher attribute hierarchy alike, only those impact variables which have some degree of freedom should be addressed to bring about the most effective change to the system.

Concerning project costs as a whole, knowledge management is perhaps the first function to develop within the project pipeline and subsequently diffuse through the different categories of expertise required. In that respect, application-specific knowledge appears certainly related to forestry management and carbon sequestration accounting. However, pooled labour and exchangeability of staff recruitment rather than division and specialization are deemed more relevant for reducing costs within the case at hand. Then, the influence that the preferred forest carbon options may exert on the entire toolbox available is likewise deemed important. In particular, the number of actors entering the market and the kind of project type to become predominant will depend on several factors to be aware of, e.g. sectoral expectations, market incentives and carbon prices, country-wise growth and the international climate debate, consumers' leading choices and perceptions of the relevance of different types and sources of carbon removals, regulations and policy, technical bottlenecks like accounting methodologies, and crises in other emission reduction classes. Closely related to the previous function, entrepreneurial experimentation is essential to assure that the potentially best solutions are attempted and then pursued concerning project innovation. More straightforward recommendations in that respect would possibly be to enlarge and diversify the knowledge base and the number of project type experiments within the project development and up through the whole supply chain by, for example, promoting experience-sharing forums amongst contracting forestry companies, consultants and certifiers so that the project cycle becomes more time and resource efficient. It is moreover advisable to cultivate the belief in growth potential when sound offset options are pursued while perverse incentives are removed.

Linking project costs with cost-effectiveness as a distinctive attribute of project quality, resource mobilization can be enhanced in terms of human capital through education in both technical competencies, i.e. to respond to LULUCF shortcomings, and finance management, i.e. to recognize market opportunities and adequately organize the supply. In addition, resource mobilization regards financial capitalization and every other kind of complementary asset that is able to improve adaptive management within project cycles. For what concerns carbon market dynamics and contractuality, it seems reasonable to simply assist the market in its natural transition from the current bridging phase to the maximum capacity of the forecasted slightly higher levels of commoditization. When it comes to acceptance, the broadest legitimacy for the surviving voluntary programmes as well seems hindered by the limited number of market participants, at least in volumes, which is envisaged outside regulations. This latter aspect is particularly important because a low degree of institutional acceptability would eventually turn negative for e.g. project costs optimisation and market maturing, and thus confer a lower overall utility to the system. However, it is noteworthy that those market actors which place their business across the migrating border between compliance and voluntary markets might prove to be more prone to display some sort of manipulative behaviour rather than submissive acceptance and institutional alignment. Hence, complementarity may be fostered by private forces leaning on additional market depth and liquidity. Some variables in particular seem more decisive in urging variations from the achievement of the most stable configuration. Because they are distinctive attributes of very similar scenarios, they represent the least-consequence, most likely deviations from efficient combinations of levels. As highlighted by the scenario analysis, it is important to be aware of the risk that interdependencies can trigger negative feedback loops.

5.2 Stakeholders Mediation for Area Development Negotiation

5.2.1 Methodological Findings

Compensatory techniques in multi-criteria analyses can provide a balanced measure of the overall performance of a forest carbon system with regards to the stakeholders' preferences because they make it possible for groups of disregarded attributes to be compensated by one particularly desirable characteristic. In contrast with this, non-compensatory techniques can alert decision-makers that particularly poor-performing individual criteria are present in the system which may cause contingently fatal flaws to be overlooked. For instance, additionality rules are such a constituting criterion of both the CDM and the principles it implies that they are hardly preferable to other attributes below a certain threshold of flexibility. No matter how unprofitable and doubtful LULUCF projects look today for what concerns sustainable development, these projects are steadily founded on methodological credibility. Voluntary offsets show instead a much greater appeal to NGOs engaged in the social sector for both economic reasons and with regards to the attention paid in delivering environmentally sound and equitable cobenefits alongside carbon sequestration. Therefore, least developed communities' eligibility, the window-dressing of project portfolios, the information conveyed by retailers to consumers, the amount of expenditures returned to the ultimate producers or the proactive attitude of the demand in shaping community-based project supply are most likely more decisive criteria to those interest groups. Nevertheless, voluntary offsets are more and more facing the urgent need to prove wrong the growing criticism against their validity by means of both scientific advisors and third-party verification organisations.

For the results of the scenario analysis which highlighted a number of limiting factors, it is important to spread the information to the participants in the market that relative efforts directed beyond consistency trade-offs can become a pointless use of resources. Therefore, it is believed that compensatory and non-compensatory techniques should be complementarily aggregated in order not to lose detail of specific areas of concern which could result in poor decisions with respect to the wider society. In addition, preferences are not always mutually independent as they should be to assure straightforward applications of multi-criteria analysis. Section *3.4.1.2: Graphic representation of forest carbon offsets* demonstrates how the decisional criteria as aggregated from the underlying characteristics of forest carbon offsets are all interlinked each other to some extent. However, such attributes partly overlap with the few previous studies' criteria which were elicited through participatory encounters. They moreover represent the system in the most holistic manner as allowed by the principle of vicarious mediation as described at the beginning of *Chapter 3*. Therefore, more attention should be paid on mutual independence of criteria when stakeholders' decisional criteria are either elicited or inferred by the study team.

5.2.2 Areas for Further Research

Since at the end of the day the final likelihood of future market alternatives is dependent on different agents' conflicting interests and power of influence over the case dynamics, the actual level of both cumulative and relative stakeholders' utility should be investigated at first to refine the preliminary insight provided by the exploratory MAUT discussed here. Secondly, more comprehensive surveys in both quantitative and qualitative terms should assess how exactly stakeholders would rate decisional criteria like the ones developed in the present study in order to pinpoint where and how disturbances to surprise-free market developments will appear. The retrieval of quantitative data on this subject seems to require both significant financing, and to be carried out by authoritative institutions. Qualitative data refer to the broader scope that this study undertook than existing literature with respect to cross-cutting issues beyond project development or demand. Stemming from the results of a survey, concrete market actors could be made match to the information compiled in the above policy recommendations as so to target the most appropriate measures.

In response to the uncertainties as expressed for what concerns the identification of system agents of perturbation, it is moreover suggested to explore the opportunity to conduct a more accurate and targeted process of mediation following the characterisation of conflicting interest groups e.g. by means of an extensive survey. In fact, stakeholder arbitration in that sense can produce a dual outcome. First, participants could be additionally asked about others' viewpoints in order to verify the existence of wrongful perceptions which may prove even worse off for the overall system dynamics. Then, negotiation and bargaining could be used in a second stage to inform market actors about the existence and location of both system tradeoffs and bonds and thus prevent inefficiencies.

Bibliography

Books and articles:

Ananda, J., & Herath, G. (2003a). Incorporating stakeholder values into regional forest planning: a value function approach. *Ecological Economics, 45*(1), 75-90.

Ananda, J., & Herath, G. (2003b). The use of Analytic Hierarchy Process to incorporate stakeholder preferences into regional forest planning. *Forest Policy and Economics, 5*(1), 13-26.

Bayon, R., Hawn, A., & Hamilton, K. (2007). *Voluntary Carbon Markets*. London: Earthscan.

Bernoux, M., Eschenbrenner, V., Cerri, C. C., Melillo, J. M., & Feller, C. (2002). LULUCF-based CDM: too much ado for . . . a small carbon market. *Climate Policy*(2), 379-385.

Binder, C.R., Hofer, C., Wiek, A. & Scholz, R.W. (2004). Transition towards improved regional wood flows by integrating material flux analysis and agent analysis: the case of Appenzell Ausserrhoden, Switzerland. *Ecological Economics, 49*(1), 1–17.

Brown, K., Adger, W. N., Emily Boyd, Corbera-Elizalde, E., & Shackley, S. (2004). How do CDM projects contribute to sustainable development? [Electronic Version]. *Tyndall Centre for Climate Change Research Technical Report*, 16.

Brown, K., & Corbera, E. (2003). Exploring equity and sustainable development in the new carbon economy. *Climate Policy, 3*S1, S41-S56.

Brown, S., Swingland, I. R., Hanbury-Tenison, R., Prance, G. T., & Price, N. (2003). Changes in the use and managment of forests for abating carbon emissions: issues and challenges under the Kyoto Protocol. In R. S. Ian (Ed.), *Capturing carbon & conserving biodiversity - the market approach*. London: Earthscan.

Cowie, A. L., Kirschbaum, M. U. F., & Ward, M. (2007). Options for including all lands in a future greenhouse gas accounting framework. *Environmental Science and Policy, 10*(4), 306-321.

Haldi, P.-A., Frei, C., Beurskens, L., & Zhuikova, N. (2002). Multicriteria/multi-stakeholders comparative assessment of electricity generation scenarios in the sustainability context: A Swiss case study. *International Journal of Sustainable Development, 5*(1-2), 102-124.

Heywood, S., Spungin, J., & Turnbull, D. (2007). Cracking the complexity code. *The McKinsey Quarterly*(2), 84-95.

Jeffreys, I. (2004). The Use of Compensatory and Non-compensatory Multi-Criteria Analysis for Small-scale Forestry. *Small-scale Forest Economics, Management and Policy, 3*(1), 99-117.

Jotzo, F., & Michaelowa, A. (2002). Estimating the CDM market under the Marrakech Accords [Electronic Version]. *Climate Policy*, 2, 179-196. Retrieved July 18, 2007.

Kiss, A., Castro, G., & Newcombe, K. (2003). The role of multilateral institutions. In R. S. Ian (Ed.), *Capturing carbon & conserving biodiversity - the market approach*. London: Earthscan.

Kotler, P., Gary, A., Sanders, J. & Wong, V. (1999) *Principles of Marketing* Upper Saddle River, New Jersey, USA: Prentice Hall, Inc.

Saint-Laurent, C. (2005) Optimizing Synergies on Forest Landscape Restoration Between the Rio Conventions and the UN Forum on Forests to Deliver Good Value for Implementers. *Review of European Community International Environmental Law, 14*(1), 39.

Schlamadinger, B., Bird, N., Johns, T., Brown, S., Canadell, J., Ciccarese, L., et al. (2007). A synopsis of land use, land-use change and forestry (LULUCF) under the Kyoto Protocol and Marrakech Accords. *Environmental Science and Policy, 10*(4), 271-282.

Scholz, R.W., Mieg, H.A. & Oswald, J.E. (2000). Transdisciplinarity in groundwater management: Towards mutual learning of science and society. *Water, Air, and Soil Pollution* (123), 477–487. Also published in: Environmental Challenges by S. Belkin & S. Gabbay (Eds.)

Scholz, R.W., Bösch, S., Stauffacher, M. & Oswald, J. (Eds.). (2001). Zukunft Schiene Schweiz: Oekoeffizientes Handeln der SBB. [Future of railway systems: Ecoefficient treat of the Swiss Railway Company]. Zürich: Rüegger Verlag.

Scholz, R. W., & Tietje, O. (2002). *Embedded Case Study Methods. Integrating Quantitative and Qualitative Knowledge.* Thousands Oaks, California: Sage Publications, Inc.

Scholz, R.W., Stauffacher, M., Bösch, S. & Wiek, A. (Eds.). (2003). Appenzell Ausserrhoden – Umwelt Wirtschaft Region. ETH-UNS Fallstudie 2002 [Environment Economy Region. ETH-UNS Case Study 2002]. Zürich: Rüegger und Pabst.

Scholz, R.W., Stauffacher, M., Bösch, S. & Wiek, A. (Eds.). (2002). Landschaftsnutzung für die Zukunft – Der Fall Appenzell Ausserrhoden. ETH-UNS Fallstudie 2001 [Utilization of landscape for the future: the case of Appenzell Ausserrhoden]. ETH-UNS Case Study 2001]. Zürich: Rüegger und Pabst.

Scholz, R.W., Kåberger, T., Koucky, M., Engwall, Y. & Månsson, M. (2004a). Mobilitet och Hållbar Stadsutveckling – Lundby på Gång [Mobility and Sustainable Urban Development – Lundby on the Move]. Gothenburg: Institution för tillämpad miljövetenskap, Göteborgs Universitet, Gothenburg, Sweden [ISBN91 88376 23 0].

Scholz, R.W., Stauffacher, M., Bösch, S. & Krütli, P. (2004b). Mobilität und zukunftsfähige Stadtentwicklung: Freizeit in der Stadt Basel. ETH-UNS Fallstudie 2003 [Mobility and sustainable urban development: Leisure in the City of Basle. ETH-UNS Case Study 2003]. Zürich: Rüegger und Pabst Verlag.

Scholz, R.W., Stauffacher, M., Bösch, S. & Krütli, P. (2005). Nachhaltige Bahnhofs- und Stadtentwicklung in der trinationalen Agglomeration: Bahnhöfe in der Stadt Basel. ETH-UNS Fallstudie 2004 [Sustainable railway-station and city development in the tri-national agglomeration: Railway-stations in the City of Basle. ETH-UNS Case Study 2004]. Zürich: Verlag Rüegger.

Scholz, R.W. & Wiek, A. (2005). Operational Eco-Efficiency - Comparing Companies' Environmental Investments in Different Domains. *Journal of Industrial Ecology, 9*(4), 155-170.

Scholz, R. W. & Stauffacher, M. (2007). Managing transition in clusters: area development negotiations as a tool for sustaining traditional industries in a Swiss prealpine region. *Environment and Planning A, 39*, 2518-2539.

Schwarze, R., Niles, J. O., & Olander, J. (2003). Understanding and managing leakage in forest-based greenhouse-gas-mitigation projects. In R. S. Ian (Ed.), *Capturing carbon & conserving biodiversity - the market approach*. London: Earthscan.

Sell, J., Koellner, T., Weber, O., Pedroni, L., & Scholz, R. W. (2006). Decision criteria of European and Latin American market actors for tropical forestry projects providing environmental services. *Ecological Economics, 58*(1), 17-36.

Sell, J., Koellner, T., Weber, O., Pedroni, L., & Scholz, R. W. (2007). Ecosystem services from tropical forestry projects - The choice of international market actors. *Forest Policy and Economics, 9*(5), 496-515.

Smith, M., Groot, D. d., & Bergkamp, g. (2006). *Pay - Establishing payments for watershed services*. Gland, Switzerland: IUCN.

Spielmann, M., Scholz, R. W. ,Tietje, O., de Haan, P. (2005). Scenario Modelling in Prospective LCA of Transport Systems: Application of Formative Scenario Analysis. *International Journal of LCA, 10*(5)*,* 325-335.

Steiner, G. & Posch, A. (2006) Higher education for sustainability by means of transdisciplinary case studies: an innovative approach for solving complex, real-world problems. *Journal of Cleaner Production, 14,* 877-890.

Sullivan, J., Aggett, J., Amacher, G., & Burger, J. (2006). Financial viability of reforesting reclaimed surface mined lands, the burden of site conversion costs, and carbon payments as reforestation incentives [Electronic Version]. *Resources Policy*, 247-258. Retrieved May 29, 2007.

Tietje, O. (2005). Identification of a small reliable and efficient set of consistent scenarios. *European Journal of Operational Research, 162*(2), 418-432.

Wise, R., & Cacho, O. (2005). Tree–crop interactions and their environmental and economic implications in the presence of carbon-sequestration payments [Electronic Version]. *Environmental Modelling & Software*, 1139–1148. Retrieved May 29, 2007.

Conference and workshop proceedings:

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2005). *Analyzing the Dynamics and Functionality of Sectoral Innovation Systems – a manual.* Paper presented at the DRUID Tenth Anniversary Summer Conference 2005 on "Dynamics of Industry and Innovation: Organizations, Networks and Systems" held on June 27-29, 2005, Copenhagen, Denmark.

Dalhammar, C., Kogg, B., & Mont, O. (2003). *Who creates the market for green products?* Paper presented at the Towards Sustainable Product Design 8th Conference, 27-29 October 2003, Stockholm.

Forner, C. (2005). *LULUCF and climate change: a field for battles?* Paper presented at the Workshop "Options for Including LULUCF Activities in a Post-2012 International Climate Agreement. An Expert Meeting to Brainstorm on Objectives of LULUCF, Options for Inclusion of LULUCF in a Climate Agreement, and Implications of these Options", Graz, Austria.

Harris, E. (2006). *The Voluntary Carbon Market: Current & Future Market Status, and Implications for Development Benefits.* Paper presented at the IIED & nef round-table discussion "Can Voluntary Carbon Offsets assist Development" on 26 October 2006.

Landell-Mills, N. (2002). *Watershed markets – Forests & Water linking land managers and water users to raise welfare.* Paper presented at the International Water Conference, 14-16 October 2002, Hanoi, Vietnam.

Loukopoulos, P. & Scholz, R.W. (2004). Sustainable future urban mobility: using 'area development negotiations' for scenario assessment and participatory strategic planning. *Environment and Planning, 36*(12), pp. 2203–2226.

Malhi, Y., Meir, P., & Brown, S. (2003). Forest, carbon and global climate. In R. S. Ian (Ed.), *Capturing carbon & conserving biodiversity - the market approach*. London: Earthscan.

Maxwell, J. (1996). *Qualitative Research Design: An Interactive Approach*. Thousand Oaks, California: Sage.

Munier, N. (2006). Economic growth and sustainable development: could multicriteria analysis be used to solve this dichotomy? *Environment, Development and Sustainability, 8*, 425–443.

Nagai, H. (2005). *How cost-effective are carbon emission reductions under the Prototype Carbon Fund?* , Linacre College, University of Oxford, Oxford, UK.

Niles, J. O., Brown, S., Pretty, J. N., Ball, A. S., & Fay, J. P. (2003). Potential carbon mitigation and income in developing countries from changes in use and management of agricultural and forest lands. In R. S. Ian (Ed.), *Capturing carbon & conserving biodiversity - the market approach*. London: Earthscan.

Palm, C., Tomich, T., Van Noordwijk, M., Vosti, S., Gockowski, J., Alegre, J., et al. (2004). Mitigating GHG Emissions in the Humid Tropics: Case Studies from the Alternatives to Slash-and-Burn Program (ASB) [Electronic Version]. *Environment, Development and Sustainability*, 6, 145-162. Retrieved July 17, 2007.

Pearce, D., Putz, F. E., & Vanclay, J. K. (2003). Sustainable forestry in the tropics: panacea or folly? *Forest Ecology and Management, 172*, 229-247.

Pearce, F. (2007, 10 March). Look, no footprint. *NewScientist, 38*.

Pohjola, J., Kerkelä, L., & Mäkipää, R. (2003). Credited forest carbon sinks: how the cost reduction is allocated among countries and sectors [Electronic Version]. *Climate Policy*, 445–461. Retrieved May 30, 2007.

Scherr, S. J., Smith, J., & Robledo, C. A. (2000). *Promoting Positive Local Livelihood Impacts Through Land Use, Land Use Change and Forestry Projects Under the Clean Development Mechanism.* Paper presented at the "Capturing the Value of Forest Carbon for Sustainable Local Livelihoods" Conference, Bellagio, Italy.

Governmental and intergovernmental publications:

European Parliament and Council. (2003).Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC.

Third Ministerial Conference on the Protection of Forests in Europe. (1998). Annex 1 of the Resolution L2. Pan-European Criteria and Indicators for Sustainable Forest Management.

United Nations. (2001). Decision 11/CP.7 Land use, land-use change and forestry.

Web and electronic sources:

Bioclimate Research & Development. (2004). The Three Conventions Partnership 2004-2008. Retrieved August 4, 2007, from http://www.brdt.org/content/fx.brdt/resources/3Conventions_Partnership_Background.pdf

Bird, D. N., Dutschke, M., Pedroni, L., Schlamadinger, B., & Vallejo, A. (2007). Should one trade tCERs or lCERs? Retrieved August 28, 2007, from http://www.joanneum.at/encofor/publication/Should_one_trade_tCERs_or_lCERs-ENCOFOR_policy_brief.pdf

Bosquet, B., Streck, C., Janson-Smith, T., Haskett, J., & Noble, I. (2006). Reasons for Excluding Forest Carbon Credits in the EU ETS. Retrieved April 5, 2007, from http://carbonfinance.org/docs/TechWorkshopForestsinCarbonMarketMarch2006Brussels_Presentations_BackgroundPapers.zip

Capoor, K., & Ambrosi, P. (2006a). State and trends of the Carbon Market 2006 - Presentation at May 12, 2006 CarbonExpo in Cologne. Retrieved June 5, 2007, from http://www.defra.gov.uk/environment/climatechange/internat/pdf/presentations/1000-state-trends.pdf

Capoor, K., & Ambrosi, P. (2006b). State and Trends of the Carbon Markets 2006. Retrieved June 5, 2007, from http://carbonfinance.org/docs/StateoftheCarbonMarket2006.pdf

Capoor, K., & Ambrosi, P. (2007a). State and Trends of the Carbon Markets 2007. Retrieved July 10, 2007, from http://carbonfinance.org/docs/Carbon_Trends_2007-_FINAL_-_May_2.pdf

Capoor, K., & Ambrosi, P. (2007b). State and Trends of the Carbon Markets - Presentation at the Center for Economic & Environmental Partnership for the March 14, 2007 Carbon Call. Retrieved July 10, 2007 from http://sknworldwide.net/channels/partner-channels/ceep/communities/carboncall/events/march-event-state-and-trends-of-the-carbon-market/Carbon%20Markets%20State%20%20Trends%20-%20March%2007.ppt

Capoor, K., & Lecocq, F. (2002). State and Trends of the Carbon Market(s) - Presentation of the work of the PFC *Plus* Research. Retrieved June 4, 2007, from http://carbonfinance.org/docs/StateTrendsCarbonMarket.ppt

The CarbonNeutral Company. (2007). CarbonNeutral Flights Calculator. Retrieved August 11, 2007, from www.carbonneutral.com

CCBA. (2005). *Climate, Community and Biodiversity Project Design Standards (First Edition)*. Retrieved June 15, 2007, from http://www.climatestandards.org/images/pdf/CCBStandards.pdf.

Chomitz, K. (2000). Evaluating Carbon Offsets from Forestry and Energy Projects: How do they Compare? [Electronic Version]. *World Bank Policy Working Papers*, 2357. Retrieved May 30, 2007, from http://wbln0018.worldbank.org/Research/workpapers.nsf/5ade973899c86086852567310068 34d5/d92de72e3c60be77852568f9004b40e3/$FILE/wps2357.pdf

Climate Action Network. (2007). Mandatory Climate Change Policy. Retrieved July 15, 2007, from http://www.climatenetwork.org/uscan/turning-the-tide/1-0-mandatory-climate-change-policy/

Costa, P. M., Stuart, M., Pinard, M., & Phillips, G. (2000). Elements of a certification system for forestry-based carbon offset projects [Electronic Version]. *Mitigation and Adaptation Strategies for Global Change*. Retrieved June 13, 2007 from http://www.ecosecurities.com/ecows-common.nsf/pr/6/$File/ESLForestryCarbonOffset.pdf.

EcoSecurities. (2006). Should Temporary CERs be Included in the EU ETS Linking Directive? and other questions concerning the potential demand for CDM Forestry CERs. Results of a survey of demand-side actors. Retrieved April 6, 2007, from http://climate-standards.org/images/pdf/EcoSecurities-demand-survey-March06.pdf

Ellerman, A. D., Joskow, P. L., & Harrison, D. (2003). Emissions trading in the U.S. - Experience, Lessons, and Considerations for Greenhouse Gases. Retrieved July 15, 2007, from http://www.pewclimate.org/docUploads/emissions_trading.pdf

Elzen, M. G. J. d., & Moor, A. P. G. d. (2001a). The Bonn Agreement and Marrakesh Accords: an updated analysis [Electronic Version]. *National Institute of Public Health and the Environment (RIVM).* Retrieved July 18, 2007 from http://rivm.openrepository.com/rivm/bitstream/10029/9703/1/728001017.pdf.

Elzen, M. G. J. d., & Moor, A. P. G. d. (2001b). Evaluating the Bonn Agreement and some key issues. [Electronic Version]. *National Institute of Public Health and the Environment (RIVM).* Retrieved July 18, 2007 from http://www.rivm.nl/bibliotheek/rapporten/728001016.pdf.

European Union. (2004). Evaluating Socio Economic Development, Sourcebook 2: Methods & Techniques: Multicriteria analysis. *EU Regional Policy, Evaluation of Socio-Economic Development Unit Sourcebooks* Retrieved June 19, 2007, from http://www.evalsed.com/downloads/sb2_multicriteria_analysis.doc

Eyckmans, J. (2001). On the farsighted stability of the Kyoto Protocol [Electronic Version]. *Leuven Faculty of Economics and Applied Economic Sciences, Center for Economic Studies, Energy, Transport & Environment - Working Papers Series n° 2001-03.* Retrieved July 18, 2007 from http://www.econ.kuleuven.ac.be/ew/academic/energmil/downloads/ete-wp01-03.pdf.

Food and Agriculture Organisation. (2000). Carbon sequestration options under the Clean Development Mechanism to address land degradation. *World Soil Resources Reports* Retrieved May 28, 2007 from http://www.fao.org/clim/docs/998_carb%20seq%2011.pdf

Fenhann, J. (2007, July 18). CDM pipeline overview. Retrieved August 17, 2007, from http://cdmpipeline.org/publications/CDMpipeline.xls

Finnish_Ministry_of_Agriculture_and_Forestry. (2001). The State of Forestry in Finland 2000. Criteria and Indicators for Sustainable Forest Management in Finland. Retrieved June 14, 2007, from http://www.mmm.fi/attachments/5enfdAPe1/5ghUuLHAT/Files/CurrentFile/MMMjulkaisu2000_5a.pdf

Frémont, R. (2005). CO_2 emission exchanges and the functioning of trading systems - The various CO2 emissions exchanges in Europe. Retrieved July 15, 2007, from http://www.caissedesdepots.fr/IMG/pdf/research_report_3.pdf

Gold_Standard. (2006a). The Gold Standard: Manual for CDM Project Developers. Retrieved June 16, 2007, from http://www.cdmgoldstandard.org/uploads/file/DeveloperManual_GS-CER.pdf

Gold_Standard. (2006b). The Gold Standard: Voluntary Emission Reduction (VERs). Manual for Project Developers. Retrieved June 16, 2007, from http://www.cdmgoldstandard.org/uploads/file/GS-VER_Proj_Dev_manual_final%20.pdf

Gommes, R. (2007). Observation requirements of the three Rio Conventions in the light of the Terrestrial Carbon Observation Initiative. Retrieved April 7, 2007, from http://www.fao.org/sd/EIdirect/EIan0016.htm

Hooijer, A., Silvius, M., Wösten, H., & Page, S. (2006). Assessment of CO_2 emissions from drained peatlands in SE Asia. *Delft Hydraulics report Q3943* Retrieved May 14, 2007, from http://www.wetlands.org/getfilefromdb.aspx?ID=b16d46c5-ea7b-469a-a265-408b59aab5d1

International Emissions Trading Association (IETA). (2006). Greenhouse Gas Market Report 2006: Financing response to climate change. Retrieved September 10, 2007, from http://www.ieta.org/ieta/www/pages/getfile.php?docID=1938

ILK. (2004). ILK Statement on Sustainability Evaluation of Nuclear Energy and other Electricity Supply Technologies. *ILK Publications* Retrieved May 29, 2007, from http://www.ilk-online.org/download/en/ilk-16_en.pdf

International Panel on Climate Change. (2000a). Land Use, Land-Use Change, and Forestry - A Special Report of the Intergovernmental Panel on Climate Change. *IPCC Special Reports on Climate Change* Retrieved May 30, 2007, from http://www.grida.no/climate/ipcc/land_use/index.htm

International Panel on Climate Change. (2000b). *Land Use, Land-Use Change, and Forestry: Summary for Policymakers - A Special Report of the Intergovernmental Panel on Climate Change.* Retrieved May 30, 2007, from http://www.grida.no/climate/ipcc/spmpdf/srl-e.pdf.

International Panel on Climate Change. (2001a). Climate Change 2001: Mitigation: Technological and Economic Potential of Options to Enhance, Maintain, and Manage Biological Carbon Reservoirs and Geoengineering. *Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change* Retrieved July 20, 2007, from http://www.grida.no/climate/ipcc_tar/wg3/pdf/4.pdf

International Panel on Climate Change. (2001b). Climate Change 2001: The Scientific Basis: radiative Forcing of Climate Change. *Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* Retrieved July 18, 2007, from http://www.grida.no/climate/ipcc_tar/wg1/pdf/TAR-06.PDF

Jacobsson, S. (2005). Formation and growth of sectoral innovation systems – 'functional analysis' as a tool for policymakers in identifying policy issues. *Industrial Development Report Background Paper Series* Retrieved April 14, 2007, from http://www.unido.org/file-storage/download/?file_id=44919

Jung, M. (2003). *Baselines and Additionality.* Paper presented at the FAO/UNEP/IUCN Regional Workshop on Forests and Climate Change: Preparing for Decisions on Land Use and Forestry at COP9, Manila, Philippines, 16-17 October 2003. Retrieved May 29, 2007, from http://www.adb.org/Documents/Events/2003/Reg_Workshop_Forests_Climate_Change/baseline-Jung.pdf.

Jung, M. (2004). The History of Sinks - An Analysis of Negotiating Positions in the Climate Regime. Hamburg Institute of Environmental Economics (HWWA) Discussion Paper No. 293. Retrieved October 18, 2007 … from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=588649#PaperDownload

Kemfert, C. (2001). Economic impact assessment of alternative climate policy strategies [Electronic Version]. *Scientific Pool of Environmental Economic Disciplines (SPEED), University of Oldenburg, Oldenburg, Germany.* Retrieved July 18, 2007, from http://www.uni-oldenburg.de/speed/xdocs/pdf/Climate.pdf.

Kill, J. (2003). Plantar: The saga continues [Electronic Version]. *World Rainforest Movement Bulletin*, 72. Retrieved August 26, 2007, from http://www.wrm.org.uy/bulletin/72/index.rtf.

Landell-Mills, N., & Porras, I. T. (2002). Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor. *Instruments for sustainable private sector forestry series.* Retrieved June 25, 2007, from http://www.iied.org/pubs/pdf/full/9066IIED.pdf

Lang, C., & Byakola, T. (2006). *"A funny place to store carbon": UWA-FACE Foundation's tree planting project in Mount Elgon National Park, Uganda.* Retrieved August 11, 2006, from http://chrislang.blogspot.com/2006_12_30_chrislang_archive.html.

Lohmann, L. (2006). *Carbon Trading: a critical conversation on climate change, privatisation and power.* Retrieved August 12, 2007, from http://www.thecornerhouse.org.uk/pdf/document/carbonDDlow.pdf

Lumicisi, A. (2006). I Boschi nel Protocollo [Forests in the Protocol] [Electronic Version]. *QualEnergia*, 1. Retrieved May 20, 2007, from http://qualenergia.it/view.php?id=30&contenuto=Articolo

Lutzeniser, L. (1993). Social and behavioral aspects of energy use. [Electronic Version]. *Annual Review Energy Environment*, 18, 247-289. Retrieved May 17, 2007, from http://www.stanford.edu/class/cee320/CEE320B/Energy.pdf.

Maginnis, S. & Jackson, W. (2005) Restoring forest landscapes: Forest landscape restoration aims to re-establish ecological integrity and human well-being in the degraded forest landscapes. Retrieved September 7, 2007, from http://www.iucn.org/themes/fcp/publications/files/restoring_forest_landscapes.pdf

Magni, C. M. (2005). *Analisi dei mercati: l'evoluzione del prezzo e accesso ai mercati del carbonio* [Market analysis: price evolution and accessibility to carbon markets]. Presented at September 30, 2005 CO2EXPO in Rome. Retrieved June 6, 2007, from http://www.relight.it/pdf/Carlo%20Maria%20Magni%20-%20presentation.pdf

Manguiat, M. S. Z., Verheyen, R., Mackensen, J., & Scholz, G. (2005). *Legal Aspects in the Implementation of CDM Forestry Projects.* Retrieved May 28, 2007, from http://www.iucn.org/themes/law/pdfdocuments/EPLP59EN.pdf.

Moles, P., & Terry, N. (1997). *The Handbook of International Financial Terms.* Retrieved July 1, 2007, from http://www.oxfordreference.com.ludwig.lub.lu.se.

Muukkonen, P. (2007). Methods to estimate and quantify forest carbon balance. Retrieved May 15, 2007, from http://www.helsinki.fi/geography/research/research_Petteri_Muukkonen.html

Muys, B., Emmer, I., Garcia-Quijano, J. F., Orshoven, J. V., Schwaiger, H., Schlamadinger, B., et al. (2007). ENvironment and COmmunity based framework for designing afFORestation, reforestation and revegetation projects in the CDM (ENCOFOR): a decision support framework for environment and community based

CDM afforestation/reforestation projects. Retrieved August 11, 2007, from http://www.joanneum.at/encofor/publication/ENCOFOR_poster_Giessen.ppt

Neeff, T., & Henders, S. (2007). *Guidebook to Markets and Commercialization of Forestry CDM projects*. Retrieved May 25, 2007, from http://www.proyectoforma.com/Documentos/GuidebooktoMarketsandCommercializationofCDMforestryProjects.pdf.

Nicholls, M. (2007). Energy giants lead the way on emission trading [Electronic Version]. *Environmental Finance - Report Summary*. Retrieved July 14, 2007 from http://www.environmental-finance.com/2003/0302feb/bpshell.htm.

Orlando, B., Baldock, D., Canger, S., Mackensen, J., Maginnis, S., Manguiat, M. S., et al. (2002). *Carbon, Forests and People: Towards the integrated management of carbon sequestration, the environment and sustainable livelihoods*. Retrieved May 31, 2007, from http://www.unep.org/themes/climatechange/PDF/Forests_People_Climate.pdf

Pfund, J.-L., & Stadtmüller, T. (2005). InfoResources Focus No 2/05 - Forest Landscape Restoration (FLR). Retrieved September 7, 2007 fro m http://www.inforesources.ch/pdf/focus_2_05_e.pdf

Pronove, G. (2002). The Kyoto Protocol and the Emerging Carbon Market [Electronic Version]. *United Nations Conference on Trade and Development (UNCTAD) Publications*, Magazine article. Retrieved July 5, 2007 from http://r0.unctad.org/ghg/download/publications/Emerging_Carbon_Market.pdf

Regional_Greenhouse_Gas_Initiative. (2007). Retrieved July 15, 2007, from www.rggi.org

Rosenzweig, R., Varilek, M., & Janssen, J. (2002). The Emerging International Greenhouse Gas Market. Retrieved June 28, 2007, from http://www.pewclimate.org/docUploads/trading.pdf

Smith, J., & Scherr, S. J. (2002). Forest Carbon and Local Livelihoods: Assessment of Opportunities and Policy Recommendations. *Center for International Forestry Research (CIFOR) Occasional Paper No. 37* Retrieved June 22, 2007, from http://www.cifor.cgiar.org/publications/pdf_files/OccPapers/OP-037.pdf

Smith, K. (2007). *The Carbon Neutral Myth*. Retrieved August 2, 2007, from http://www.carbontradewatch.org/pubs/carbon_neutral_myth.pdf.

Streck, C. (2006). JI and CDM in Practice: Projects and Market Developments. *Presentation on behalf of Climate Focus at Mallensons, Hong Kong, on 31 October 2006* Retrieved May 10, 2007, from http://www.climatefocus.com/newspubs/downloads/publications/JI_CD_in_practice.pdf

Sudo, T. (2006). Japanese Voluntary Emissions Japanese Voluntary Emissions Trading Scheme (JVETS) Trading Scheme (JVETS) - Overview and Analysis Overview and Analysis - Presentation at the March 22-23, 2006 US-Japan Workshop on Climate actions and Co-benefit Retrieved July 15, 2007, from http://www.iges.or.jp/en/cp/pdf/activity06/07.pdf

Taiyab, N. (2006). Exploring the market for voluntary carbon offsets [Electronic Version]. *Report for the International Institute for Environment and Development (IIED), London*. Retrieved May 9, 2007 from http://www.iied.org/SM/eep/documents/MES8.pdf.

Trexler Climate & Energy Services. (2006). A Consumer's Guide to Retail Carbon Offset Providers prepared for Clean Air Cool Planet. Retrieved June 13, 2007, from http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf

UK Department for International Development. (2001). *Sustainable Livelihoods Guidance Sheets*. Retrieved June 13, 2007, from http://www.livelihoods.org/info/info_guidancesheets.html#1.

UK Department for Transport, L. G. a. t. R. (2000). *Multi-criteria Analysis Manual*. Retrieved May 29, 2007, from http://www.communities.gov.uk/pub/252/MulticriteriaanalysismanualPDF1380Kb_id1142252.pdf.

United Nations Framework Convention on Climate Change. (2002). Report of the Conference of the Parties on its Seventh Session, held at Marrakesh from 29 October to 10 November 2001. Part two: Action taken by the Conference of the Parties - Volume II. Retrieved July 31, 2007, from http://unfccc.int/resource/docs/cop7/13a02.pdf

United Nations Framework Convention on Climate Change. (2004). Report of the Conference of the Parties on its Ninth Session, held at Milan from 1 to 12 December 2003. Part two: Action taken by the Conference of the Parties at its Ninth Session. Retrieved July 31, 2007, from http://unfccc.int/resource/docs/cop9/06a02.pdf

United Nations Environmental Programme. (2000) Decisions adopted by the Conference of the Parties to the COnvention on Biological Diversity at its Fifth Meeting in Nairobi, 15-26 May 2000. Decision V/6. Retrieved October 5, 2007, from http://www.cbd.int/doc/meetings/cop/cop-05/official/cop-05-23-anx3-en.pdf

World Business Council for Sustainable Development & World Resource Institute. (2003). *The Greenhouse Gas Protocol for Project Accounting*. Retrieved June 29, 2007, from http://www.ghgprotocol.org/DocRoot/m1Tv5lnUuFTjYZx3x1ev/GHG_Project_Protocol.pdf.

World Business Council for Sustainable Development & World Resource Institute. (2006). *The Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting*. Retrieved June 29, 2007, from http://www.ghgprotocol.org/DocRoot/m1Tv5lnUuFTjYZx3x1ev/GHG_Project_Protocol.pdf.

Wetlands International. (2006). Peatland degradation fuels climate change. An unrecognized and alarming source of greenhouse gases. Retrieved May 14, 2007, from http://www.wetlands.org/getfilefromdb.aspx?ID=c21487d6-6ca6-4dbb-8432-0a9fd3346ae3

The World Bank. (2000). Biodiversity and Environmental Assessment Toolkit. Retrieved June 17, 2007, from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2002/09/07/000094946_02082204120010/Rendered/PDF/multi0page.pdf

The World Bank. (2006). Summary of the Technical Workshop on Using Forest Carbon Credits in the Carbon Market - Focus on the European Emission Trading Scheme, Brussels, March 29, 2006. Retrieved May 1, 2007, from http://carbonfinance.org/docs/March29WorkshopSummaryFinal041806.doc

World Rainforest Movement. (2006). Ecuador: Zero community benefits from FACE PROFAFOR certified plantations [Electronic Version]. *World Rainforest Movement Bulletin*, 108. Retrieved August 26, 2007 from http://www.wrm.org.uy/bulletin/108/bulletin108.pdf.

Wunder, S. (2005). Payments for environmental services: Some nuts and bolts [Electronic Version]. *Center for International Forestry Research (CIFOR) Occasional Paper*. Retrieved June 22, 2007, from http://www.cifor.cgiar.org/publications/pdf_files/OccPapers/OP-42.pdf

Informants:

Broderick, J. (2007) *E-mail survey (digital recording)* PhD student at Manchester Business School, Manchester, United Kingdom. July 19th, 2007

Dornau, R. (2007) *E-mail communication (digital recording)*. Director Climate Change Programme, SGS Société Générale de Surveillance SA, Geneva, Switzerland. July 4th -5th, 2007

Jung, M. (2007). *Telephone communication (digital recording)*. Consultant, Energy & Climate Strategy, Ecofys, Cologne, Germany. May 29th, 2007.

Jung, M. (2007). *E-mail communication*. Consultant, Energy & Climate Strategy, Ecofys, Cologne Germany. June 20th, 2007.

Häger, N. (2007). *Personal interview*. Project Manager, Forest Conservation Programme, IUCN - The World Conservation Union, Gland, Switzerland. June 25th, 2007.

Lumicisi, A. (2007) *Telephone communication*. Policy expert for climate mitigation and adaptation in the forestry sector, BioCarbon Fund of the World Bank Focal Point , Italian Ministry of the Environment, Rome, Italy. June 12th, 2007.

Pettenella, D.(2007). *Personal interview*. Associate Professor, Agro-forestry System Department, Padua University, Legnaro, Italy. June 8th, 2007.

Riche, B. & Häger, N. (2007). *Telephone communication*. Junior Programme Associate & Project Manager, Forest Conservation Programme, IUCN - The World Conservation Union, Gland, Switzerland. June 6th, 2007.

Schröder, M. (2007) *E-mail mini-survey(digital recording)*. Project Manager, Carbon Management Service, TÜV SÜD Industrie Service GmbH, München, Germany. July 8th, 2007.

Sell, J. (2007). *E-mail communication (digital recording)*. Project Manager, Factor Global, Zurich, Switzerland. July 5th, 2007

Smith, M. (2007). *Personal interview (digital recording).* Water Management Adviser, Water Programme, IUCN - The World Conservation Union, Gland, Switzerland. June 26th, 2007.

Abbreviations

AAU Assigned Allocation Units

A/R Afforestation/Reforestation

BCF Bio Carbon Fund

CCAR California Climate Action Registry

CCBA Climate, Community, and Biodiversity Alliance

CCBS Climate, Community, and Biodiversity Standards

CCX Chiacago Climate Exchange

CDM Clean Development Mechanism

CELB Centre for Environmental Leadership in Business

CER Certified Emissions Reductions

CERUPT Certified Emission Reduction Unit Procurement Tender

CI Conservation International

CO_2 Carbon dioxide

CO_2e Carbon dioxide equivalent

COP Conference Of the Parties

CSR Corporate Social Responsibility

DEFRA Department for Environment, Food and Rural Affairs (UK)

DFID Department for International Development (UK)

DOE Designated Operational Entity

EAU European Allowance Unit

ECCM Edinburgh Centre for Carbon Management

ERUPT Emission Reduction Unit Procurement Tender

EU ETS European Union Emissions Trading Scheme

ERPA Emission Reduction Purchase Agreement

ERU Emissions Reduction Unit

FERN Forests and the European Union Resource Network

FLR Forest Landscape Restoration

FF Future Forests

FSC Forest Stewardship Council

GEF Global Environmental Facility

GHG Greenhouse gas

GWP Global Warming Potential

HFC Hydrofluorocarbon

IPCC International Panel in Climate Change

IUCN International Union for the Conservation of Nature and Natural Resources

JI Joint Implementation

LDC Least Developed Countries

LULUCF Land Use, Land Use Change, and Forestry

MAUT Multi-Attribute Utility Theory

MCA Multi-Criteria Analysis

MSP Medium-Scale Project

NGO Non-governmental organisation

NSW New South Wales

OECD Organisation for Economic Co-operation and Development

PCF Prototype Carbon Fund

PDD Project Design Document

PES Payments for Environmental Services

PDD Project Design Document

RGGI Regional Greenhouse Gas Initiative

RMU Removal Unit

SFM Sustainable Forest Management

SLM Sustainable Landscape Management

SWOT Strengths, Weaknesses, Opportunities and Threats

UK ETS United Kingdom Emissions Trading Scheme

(UN)FCCC (United Nations) Framework Convention on Climate Change

VCS Voluntary Carbon Standard

VER Verified Emission Reduction

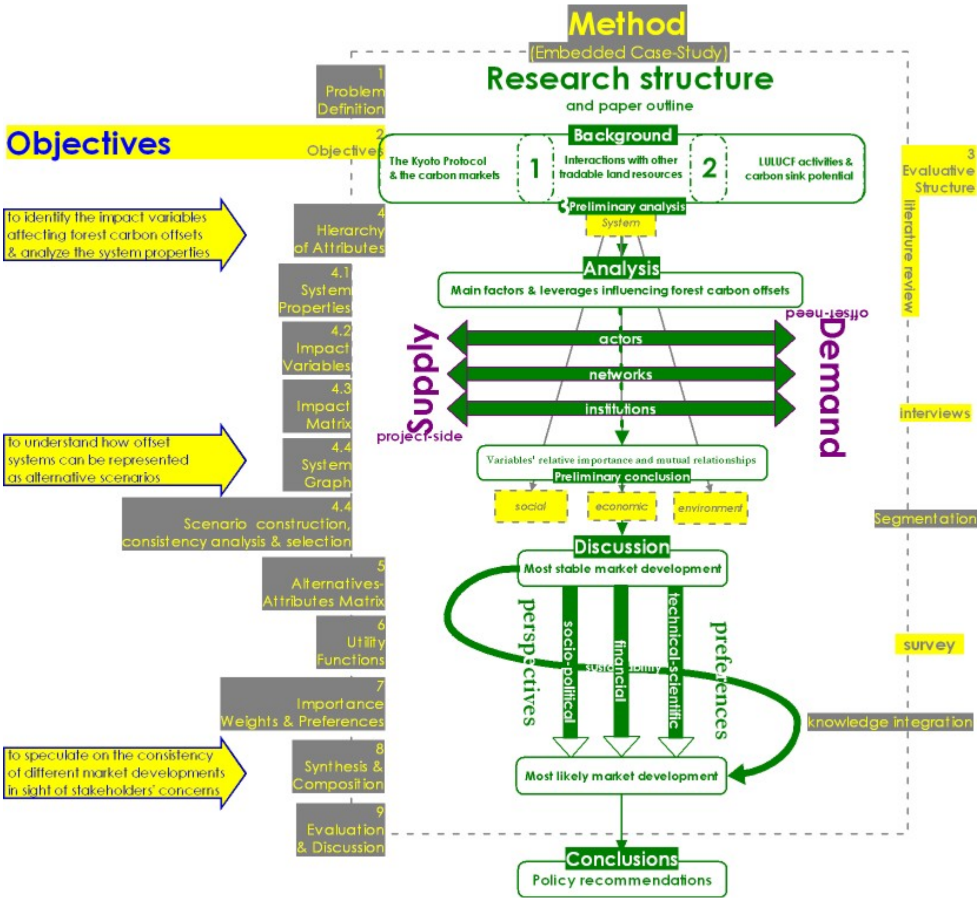
WWF World Wildlife Fund

WRI World Resource Institute

WRM World Rainforest Movement

Appendix I: Formative Scenario Analysis Step by Step

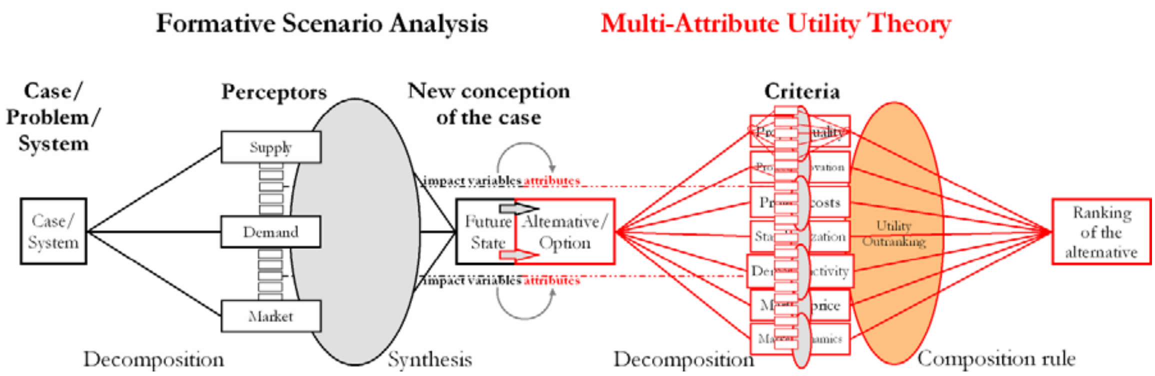
When comparing with the figure below, the ascending steps of the methodology can be followed along the grey and yellow numbered items. Firstly, the problem definition as presented in *Problem* represents the analysis of the decision situation for the case. Besides envisioning who and why should evaluate the results which is made straightforward by the decision-makers addressed by scope and purposes for the research, this paper aims at solving contingent problem constraints surrounding the decision-making of the subject at issue. In addition, the references cited in *Purpose and* to this piece of research may provide additional knowledge for an even sounder evaluation of the case besides the here presented decision-support model as expected to facilitate the complex problem solving. Secondly, the objectives of MAUT application are made match the overall research objectives, i.e. that the alternatives to be judged are to be identified in the most likely market developments. Thirdly, the evaluative structure is the choice of the empirical evidence as above reported.



Methodology insertion into the research design along with objectives collocation (Barchiesi, 2007)

Then the analytical procedure begins with the three-level hierarchy of attributes which is functional to the definition of judgement criteria for the alternative scenarios. Whilst criteria remain the operational decision level, impact variables acted as the underlying concepts to be consistently aggregated in a top-down multi-round refining exercise. To draw the level of the system impacts in terms of variable magnitude and direction, some other parameters are provided as indicator attributes. (Haldi, Frei, Beurskens, & Zhuikova, 2002, pp. 108-109) In addition, breaking down criteria into one further sub-level of potentially more explicitly defined indicators was deemed less problematic for prospective follow-up focus groups' participants to make any particularized assessment (cf. *Appendix IV*, *Appendix V*, and *Appendix VI*). It is hence worthy pointing out that, unlike many previous works, the attributes hierarchy did not lead to the usual categorisation in the three dimensions of sustainability, although these components were nonetheless used to scan the system in search of constituting factors.

The next-coming figure portrays instead how, during the process of attribute identification, the formative scenario analysis could be incorporated in the MAUT methodology due to the analogy between second-level attributes and impact variables. This operation was possible because the outcome of the market development analysis was made overlap precisely the input for the multi-attribute model. In other words, the scenario construction was carried out not only to deliver the most accurate forecasts on market dynamics but also to feed the evaluation process of the different alternatives which share the same space and time limitation and are represented through variables' combination. Therefore, from this point on the formative scenario procedure unfolded.



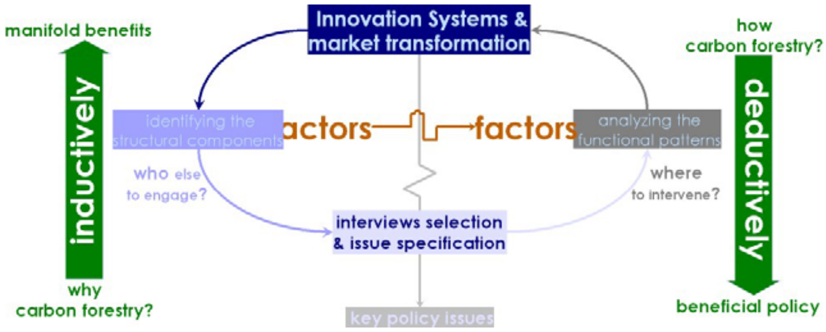
Formative Scenario Analysis and MAUT method incorporation (inspired by Scholz & TIetje, 2002)

First, system properties were preliminary scanned by means of a cycle of (SWOT-like) plus-minus analysis targeted to separate those factors which may be considered strength for regulated markets and weakness for voluntary programmes from *vice versa*. The purpose was to develop a set of impact variables which could be sufficient for a valid description and modelling of the current state of the case under scope. In addition, the plus-minus analyses summarized in *Table 3-1* proved useful to sort out consistent bundles of characteristics near enough to the decisional criteria so far to continue the MAUT procedure.

After system properties were consistently and sufficiently bundled, the formation of the impact matrix initiated the actual synthesis as reflected by the preliminary conclusions. In constructing the impact matrix, i.e. the direct impact that each variable has on another one, the author had to determine the scale for the impact on a subjective basis: 0 = no or very little impact, 1 = medium impact, 2 = high impact. Along with that operation which entailed entering 300 activity + 300 passivity values (i.e. the 25x25 table reported in *Appendix VII* where the self-comparison of the cause-effect relationship does not count), also consistency measures were assigned to each pair of variables (i.e. 1 200 times for all 25 variables have simply 2 opposite levels to be combined in 4 cases). This latter operation is functional to skim out all impossible occurrences in the later scenario construction as explained further below (step 4.4). Nevertheless, the compilation of the consistency matrix attempted to compensate the lack of analysis on indirect interdependencies (i.e. through third variables) by taking into concern system-wide changes while assessing both mutual links and consistency of the variable-level combination. The impact matrix attained at step 4.3 of the method is separately displayed in *Appendix X* whereas both system grid and the system graph (synthesising *Appendix VIII* and *Appendix IX)* are altogether reported in 3.4. Those graphical representations are used in an exploratory manner for data analysis and have been essential for triggering the discussion on scenario interpretation. A system grid is a conjoint display of the activity and passivity scores as they distribute with respect to the horizontal and vertical mean lines. In contrast, "…the system graph is a structured network that presents a structural view of the system model. It visualizes how the different variables are interlinked." (Scholz & Tietje, 2002, p. 99) Unfortunately, the system had to be split in halves during graph composing due to the little informativeness associable to 25 network hubs' entanglement. However, the relationships between supply-side factors and the demand aspects together with market-wide variables can still be inferred to the whole system from the synoptical criteria-based system graph (*Figure 3-11*).

The consistency scaling was likewise chosen in an arbitrary manner, even though according to the recommendation to adopt few levels and penalize strongly inconsistencies by assigning drastically low ratings. (Scholz & Tietje, 2002, p. 106; Tietje , 2005) The ratings applied were subsequently set as follows: 3 = complete consistency, the levels of the impact factors are coherent and support each other (i.e. a scenario including those two states is highly likely); 1 = partial of weak consistency (i.e. a scenario including those two states is less likely); 0 = inconsistency (i.e. a scenario including those two states is unlikely); -999 strong inconsistency (i.e. scenarios including combinations of logically contradictory levels of impact variables are not considered thinkable, or more simply, impossible). The triple-figure number -999 was chosen because it had got to neutralize the maximum theoretical value in scenarios' total consistency ranking, namely 3 x 300 = 900. The attempt to improve the consistency indicators by introducing such excluding factor alike multiplicative rating while conserving the compensating attitude of additive rating was made as so to lower the risk of lacking rigorousness into the scenario analysis. (Tietje, 2005) In fact, the rule is that any scenario is logically unachievable in all its conditions when even one single inconsistency is present. In order to visualize it immediately, a negative grand total must add up. At the end of the day, 1 200 possible combination between each variable's level went through the consistency screening between scenario construction and scenario selection. Formally, all the scenarios are constructed simply by combining all levels (2) of impact factors for all factors (25). It becomes immediately straightforward, therefore, that the 33 554 432 scenarios times 1 200 consistency weights resulting from combinatorial calculation required no other means than computer processing to be produced. One complete elaboration took approximately 8.5 days and was run by one I.B.M. AS/400 server platform. Technical informatics assistance for database preparation and SQL programming was likewise outsourced.

For what concerns the interdisciplinary analytical frameworks employed in between the main embedded case-study thread, one is worth special mention. The approach adopted "implies that there is a system with related components (actors, networks and institutions) working together – deliberately or in an unplanned manner – to achieve … [the] overall goal." (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2005; Jacobsson, 2005) In the specific case at issue, the goal is promoting innovation inherently to the LULUCF carbon markets. In an as equally consistent way, the goal is thus to verify whether and how much the currently achieved market patterns eventually match the ones which would otherwise to be targeted in the future. The use of such approach was meant to first identify stakeholders (i.e. actors, networks, and institutions) and, through the analysis of their function within the system, of the main factors governing the market. Secondly, the leverage of the factors was to be weighed also against potentially missing elements in influencing the current development of the LULUCF carbon market. This 'inner circle' was thus theoretically divided between a both deductive and inductive strategy. While the hypothesis of why carbon forestry is beneficial to sustainable development in a manifold manner could be tested in its veracity, e.g. during the preliminary analysis about PES, the policy means by which these benefits should be accrued had to be inferred from the later findings.



Inner analytical loop functional to stakeholder analysis

As illustrated by the previous figure, the transposition from actors to factors proved crucial to identify the system properties beyond the risk of incompleteness or inaccuracy. Hence, it can be also inferred how the abovementioned methodology did trigger an analytical loop, the beginning of which was to identify the structural components of LULUCF projects value chains. This panning view allowed in turn for interviewee selection as so to specify key issues with regards to possible policy recommendations through preliminary interviews and exploratory survey questionnaire. As a result of the latter step, more light was also shed onto the functional patterns governing the interactions between the organisations orbiting around the market under analysis, e.g. standard-developing committees and advisory boards. At the end of this process, the roles of the actors identified were finally translated into determinant factors for the system depending on the respective influence. This last stage was the key to proceed to the analysis of the impact variables as they have been identified across supply, demand and cross-cutting fields of action. The SIS approach, in fact, led to considering the impact areas of ecology, livelihood, and finance in place of the classic sustainability dimensions. Although factor identification was carried out by firstly decomposing the system in its environmental, social and economic element, the immediately manifest existence of extremely entangled interdependencies amongst impact variables drove the grouping away from the traditional aggregation of aspects in those dimensions. Moreover, the little operationality and correspondence with those categories would have been too approximate for the system characterisation which is constructed consistently with the goal of providing a few broadly comprehensive decisional criteria to feed further analysis. Besides scanning the system dynamics and functionality, Jacobsson's work (2005) aided to single out those inherent weaknesses that could be thus addressed by relevant policy recommendations. In fact, for a series of companies to change in a coordinated fashion within a systemic innovation process, advances in supply chain management are required which might not be occurring alone without state's intervention.

In addition to the Innovation System approach as presented above, the very same analytical framework is also resting onto the perspectives described by Bergek et al. (2005). Irrespective of the virtuality component of carbon credits/offsets trade, such commodities can be nonetheless pictured as a new product of the forest industry. Hence, the concept of carbon finance as artificial construction applied into the forestry sector may become a transitioning innovation within the socio-technical regime of the carbon market. In addition, it is noteworthy that technology may have a broader meaning than equipment and hardware when know-how and good practice are included. Therefore, it could be legitimately taken into account that "LULUCF project activities have the potential of transferring know-how and good practice in the area of agro-forestry, watershed management, habitat restoration, conservation agriculture, etc." (Bosquet, Streck, Janson-Smith, Haskett, & Noble, 2006) Another framework which proved to be helpful to disentangle the interwoven complexity of LULUCF projects and their stakeholder analysis, at least tentatively, has been the market transformation theory. According to that, one innovative way of managing forests in order to 'harvest carbon' credits among others may excite conservation organisation, anti-plantations activists, environmental policy makers and LULUCF project developers, for example. On the other hand, it may also represent unwanted change and risk to forest owners with secure market niches in the food, timber or paper business, their subcontractors, planning and zoning officials, appraisers and lenders. In the middle, "market intermediaries are often motivated by problem-avoidance and risk-aversion, and are influenced by the competitive, contractual, and regulatory environments in which they must operate". (Lutzeniser, 1993, p. 277)

Appendix II: Tentative Environmental and Social Indicators for IUCN's GEF MSP Proposal

Preliminary Social Indicators

1. Level of security in land tenure
2. Income sources, levels and distribution
3. Food security (food production per household or nutritional status)
4. Number of jobs created
5. Level of community involvement in decision making, project planning and activities
6. Women participation and empowerment
7. Level of land use conflicts and illegal activities inside the concerned forest reserves (or level of encroachment)
8. Number of well-functioning and solid community associations
9. Level of population out-migration
10. Non-timber forest products harvested / year / household from reforested sites
11. Community improvements (health infrastructure, education, etc.) due to carbon credit money

Preliminary Environmental Indicators

1. Level of landscape connectivity or fragmentation (or gain or loss of functional connectivity among patches of natural and semi-natural habitats)
2. Floral and faunal diversity
3. Native plant species abundance and diversity
4. Rare or endangered species abundance and diversity
5. Standing volumes of native tree species: Canopy closure and cubic meter standing tree volume/ha
6. Rate of deforestation and quality of remaining forests
7. Level of encroachment on fragile lands
8. Number of bush fires
9. Soil fertility
10. Level of soil erosion (sediment and organic material in runoff water)
11. Dry season water flows/availability

(Riche & Häger, 2007)

Appendix III: Questionnaire on PES as used at IUCN

[The following questions were formally posed to one Water Management Adviser and one Project Manager within the Forest Conservation Programme as a result of the two departments being the most related to the use of carbon finance. The former person was moreover pointed out as knowledgeable with respect to payments for environmental services. The choice of the personnel interviewed was however dependent on the availability of the highest positions to reach.

Ambitious claims have been made about the development benefits of market-based policy instruments for climate mitigation. Carbon sequestration and storage is deemed one of the four main kinds of environmental service that can get payments for on a significantly commercial scale (the other three being biodiversity protection, watershed protection, and landscape beauty). Nevertheless, some forest carbon projects may not be providing the most synergic and balanced bundle of these benefits in the attempt to maximize their carbon yield, especially through mono-cultural fast-growing plantations. In that respect, I am here to investigate under which conditions it is fair to advocate PES theory from a conservation agency's viewpoint and whether it is not illusory that even the most advanced and carefully designed forest carbon project cannot reach the satisfactory level of collateral benefits that is claimed in project idea notes. My aim is to examine the implications of forest carbon projects for different aspects of sustainable development since I will produce a stakeholder multi-criteria assessment model to explore the range of stakeholders as well as their roles, interests and perspectives.

1) What is your opinion concerning the fear that PES could decouple conservation from development by spreading multinational competence-inclusive consortia as so to be detrimental for the culturally rooted, traditionally not-for-profit way of doing conservation?

2) Do you agree upon the idea that the traditional source of funding for conservation organisations, namely donors, can feel endangered by PES when fearing the lost opportunity for improving their reputation and public relations? Is not the growth of voluntary carbon markets where purchasing motivations are other than compliance obligations, e.g. image greening and corporate social responsibility, another means of access to vast, previously-segregated bestowals?

3) Is it very unrealistic from your viewpoint that the stakes in the field of conservation may turn some NGOs and consultants who were typically dealing with integrated development against the implementation of PES? Could these actors turn and look at the carbon markets as their natural restyling way-out not to disappear from the sector?

4) How large is the niche for PES with respect to a full conservation toolbox (i.e. command and control, SFM and production, Integrated Conservation and Development, social markets, environmental taxes and subsidies, certification standards, land acquisition)? Have you experienced any problem with different definitions, e.g. what voluntary means for PES (i.e. real land-use options and rights), what the measurability of the service provided requires, how nature influences the conditionality of purchase-delivery (e.g. with regards to scientific uncertainty and those LULUCF shortcomings such as permanence and leakage)?

5) What is your experience of successful PES schemes besides carbon sequestration which comply with your own criteria and definitions? How many examples can you provide (in some order of magnitude)?

6) How can one evaluate to what extent an ES has been delivered or not in terms of efficiency?
    a. How do you account for baselines, statically (due to the historical approach) like in the CDM or more dynamically as where deforestation is increasing or has witnessed a turnaround?
    b. How are the concepts of leakage and permanence perceived in the field of the overall PES application, e.g. watershed, landscape aesthetics, biodiversity goals, namely when the benefits accrued beyond the time and space boundaries of the intervention?

7) How is the issue of measuring the actual occurrence of the environmental service dealt with/solved in watershed management (e.g. enhanced water quality or quantity)?

8) Is PES like to suit some land-use scenarios better than others? Do opportunity costs (e.g. timber) play a significant role? Up to what return (unmanaged timber, unimproved cattle ranching)?

9) Is there a trade-off between efficiency and fairness? Is the bilateral nature of many payments for environmental services (where you usually find single buyers and sellers) a shortcoming in comparison to the implementation of a properly functioning market where you have instead a competitive interaction between multiple agents? How do you deal with that? Do you mainly deal with a terminology such as reward or compensation rather than market? Do you see the rise of carbon markets as a feasible/productive way to attract/enlarge demand for local services to a global scale?

10) Who exactly should be paid and how (cash or kind)? Is PES proving useful for poverty alleviation? Is not there any contrast between the global dimension of carbon sequestration services and other locally beneficial functions?

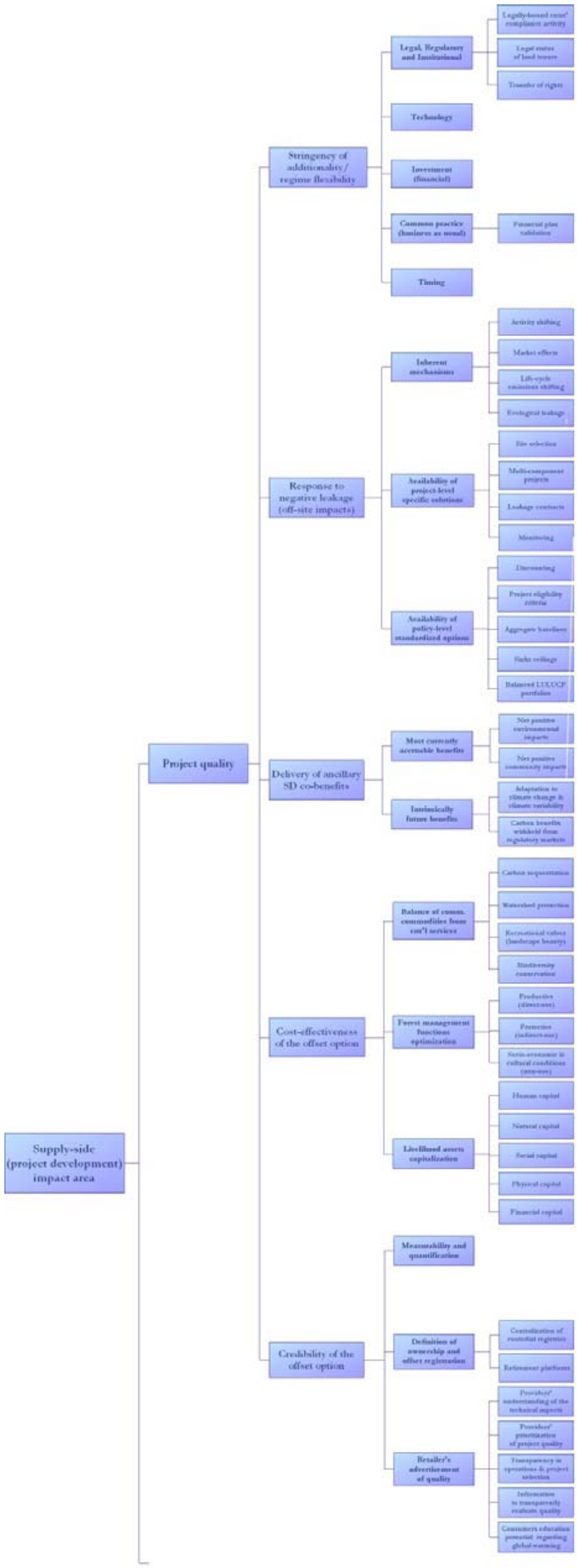
If a survey on stakeholder's relative preferences for different aspects of forest carbon markets as a whole was to be started, is the claim that so-called collateral benefits are increasing project quality actually deemed as such also by authoritative conservation agents and advisors? In other words:

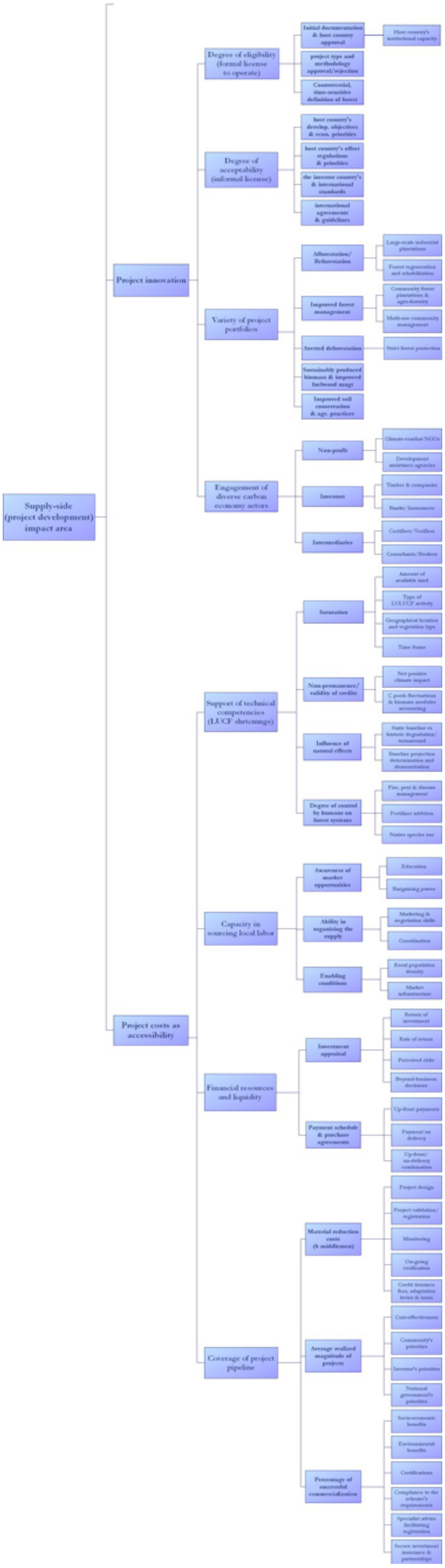
- Is the claim that many premium-price carbon offsets from forestry seeking for sustainable development tendentious and perverse from its very formulation?
- Should the same conservation objectives be pursued along traditional paths other than PES?

Or more simply, the early development of carbon finance and trade has not allowed for other environmental services markets to develop to such a scale to be competitively applied (the word "ancillary" may testify a status of subordination);

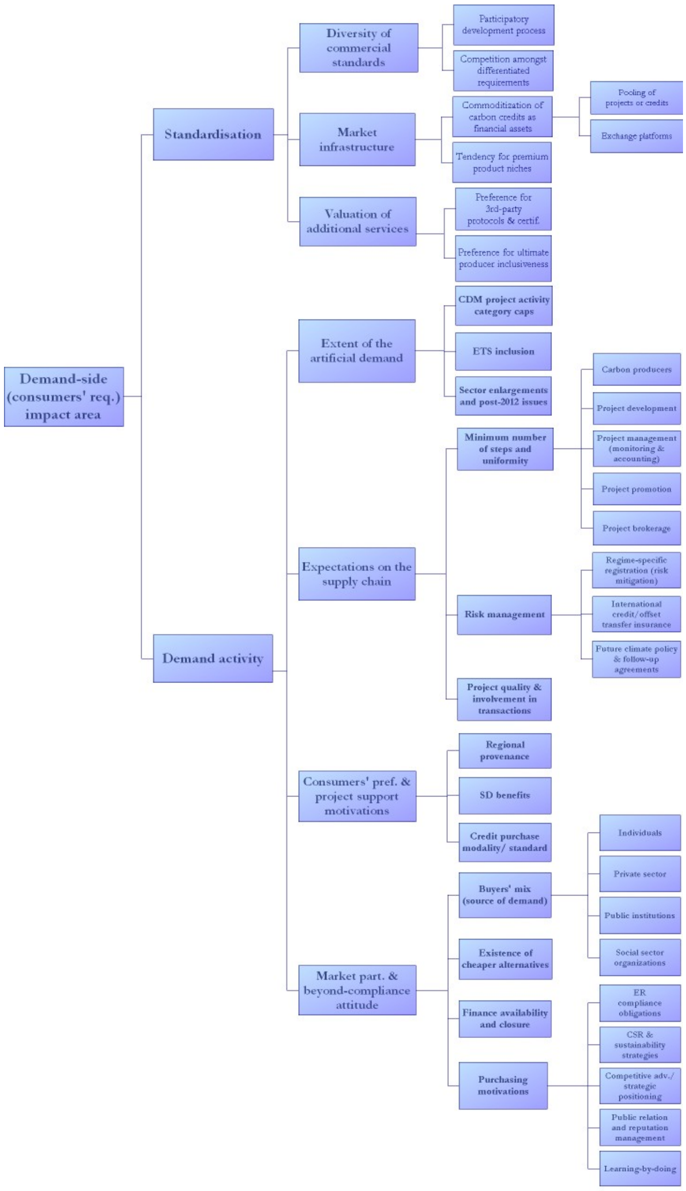
- In that sense, do you agree that the current regimes, both Kyoto-compliant and voluntary markets, may not be the best instrument to use for the purpose of attaining real co-benefits?

Appendix IV: Supply-Side Attribute Hierarchy

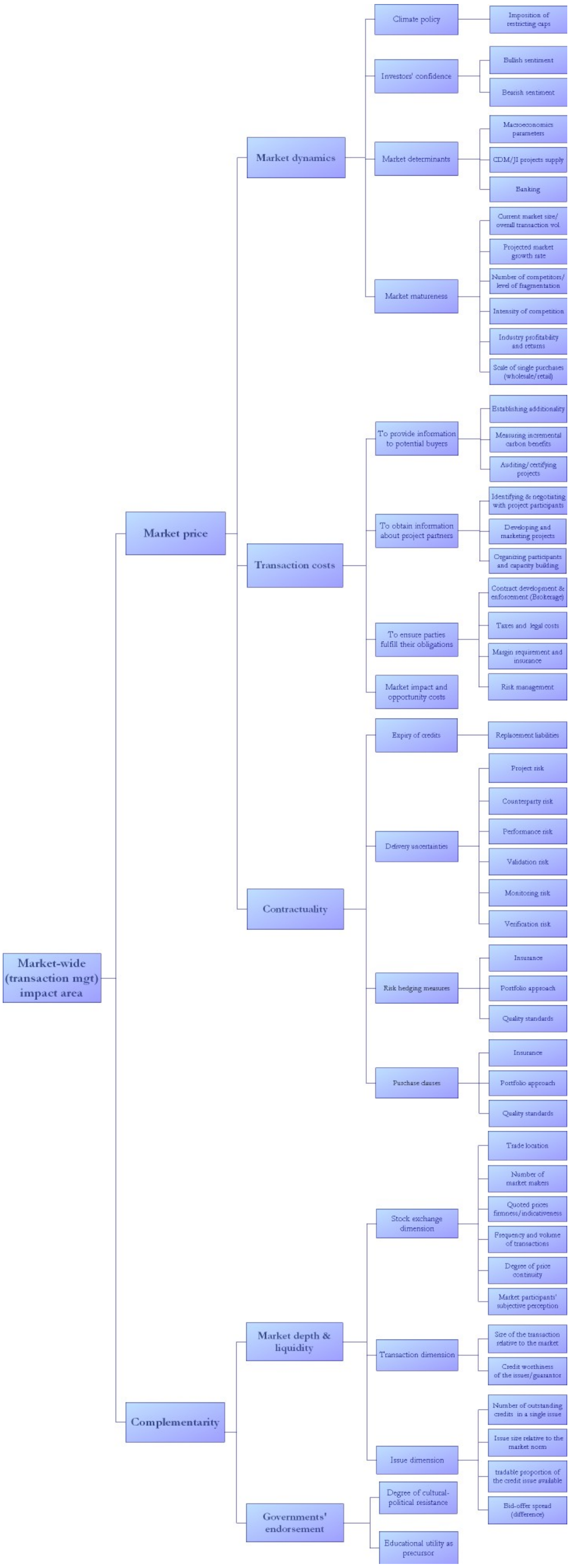



Supply-side
(project development)
impact area
Project innovation
Degree of eligibility
(formal license
to operate)
Initial documentation
& host country
approval
Host country's
institutional capacity
project type and
methodology
approval/rejection
Controversial,
time-sensitive
definition of forest
Degree of
acceptability
(informal license)
host country's
develop. objectives
& econ. priorities
host country's offset
regulations
& priorities
the investor country's
& international
standards
international
agreements
& guidelines
Variety of project
portfolios
Afforestation/
Reforestation
Large-scale industrial
plantations
Forest regeneration
and rehabilitation
Improved forest
management
Community forest
plantations &
agro-forestry
Multi-use community
management
Avoided deforestation
Strict forest protection
Sustainably produced
biomass & improved
fuelwood mngt
Improved soil
conservation
& agr. practices
Engagement of
diverse carbon
economy actors
Non-profit
Climate-combat NGOs
Development
assistance agencies
Investors
Timber & companies
Banks/Insurances
Intermediaries
Certifiers/Verifiers
Consultants/Brokers
Support of technical
competencies
(LUCF shrtcmngs)
Saturation
Amount of
available land
Type of
LULUCF activity
Geographical location
and vegetation type
Time frame
Non-permanence/
validity of credits
Net positive
climate impact
C pools fluctuations
& biomass modules
accounting
Influence of
natural effects
Static baseline vs
historic degradation/
turnaround
Baseline projection
determination and
demonstration
Degree of control
by humans on
forest systems
Fire, pest & disease
management
Fertilizer addition
Native species use
Project costs as
accessibility
Capacity in
sourcing local labor
Awareness of
market
opportunities
Education
Bargaining power
Ability in
organizing the
supply
Marketing &
negotiation skills
Coordination
Enabling
conditions
Rural population
density
Market
infrastructure
Financial resources
and liquidity
Investment
appraisal
Return of
investment
Rate of return
Perceived risks
Beyond-business
decisions
Payment schedule
& purchase
agreements
Up-front payments
Payment on
delivery
Up-front/
on-delivery
combination
Coverage of project
pipeline
Material reduction
costs
(& middlemen)
Project design
Project validation/
registration
Monitoring
On-going
verification
Credit issuance
fees, adaptation
levies & taxes
Average realized
magnitude of
projects
Cost-effectiveness
Community's
priorities
Investor's priorities
National
government's
priorities
Percentage of
successful
commercialization
Socio-economic
benefits
Environmental
benefits
Certifications
Compliance to the
scheme's
requirements
Specialist advise
facilitating
registration
Secure investment
insurance &
partnerships

Appendix V: Demand-Side Attribute Hierarchy



Appendix VI: Market-Wide Attribute Hierarchy



Appendix VII: Impact Matrix and Criteria Matrix

By completing the following impact matrix, the directional impacts between the different impact variables have been defined. The procedure included the creation of a matrix where all impact variables are defined on both one column and one row respectively, and the assessment of the **direct** impact of each impact variable in a row on the impact variables in the column using the following qualitative scale:

- **0 = no directional impact** on impact variable
- **1 = average directional impact** on impact variable
- **2 = strong directional impact** on impact variable

Impact variables → impact direction of influence

	Passivity Σ	d25 Governments' endorsement of voluntary programmes	d24 Optional market depth and liquidity	d23 Contractuality of transactions (buyer-seller relationship)	d22 Transaction costs	d21 Market dynamics	d20 Market participation and beyond-compliance attitude	d19 Consumers' preferences and project support motivations	d18 Expectations on the supply chain	d17 Extent of the artificial demand	d16 Valuation of additional services along the supply chain	d15 Market infrastructure robustness	d14 Diversity of commercial standards	d13 Coverage of project pipeline	d12 Financial resources and liquidity (investor involvement)	d11 Capacity in sourcing or starting up local labour	d10 Support of technical competencies in response to LULUCF shortcomings	d9 Engagement of diverse carbon economy actors in the project supply	d8 Variety in project portfolios	d7 Degree of acceptability (i.e. informal license to operate projects)	d6 Degree of eligibility (i.e. formal license to operate projects)	d5 Credibility of the offset option	d4 Cost-effectiveness of the offset option	d3 Delivery of ancillary co-benefits for sustainable development	d2 Response to negative leakage (off-site impacts)	d1 Stringency of additionality / regime flexibility
d_1 Stringency of additionality / regime flexibility	**5**	1	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
d_2 Response to negative leakage (off-site impacts)	**19**	0	0	1	0	0	2	1	0	0	1	0	2	2	2	2	2	2	1	0	0	0	1	0		0
d_3 Delivery of ancillary co-benefits for sustainable development	**21**	1	1	1	1	1	2	2	0	1	0	0	2	0	2	1	0	2	2	0	1	0	0		0	1
d_4 Cost-effectiveness of the offset option	**22**	0	1	1	1	1	1	2	0	1	0	0	1	1	2	1	2	1	1	0	0	0		2	1	2
d_5 Credibility of the offset option	**25**	2	1	0	0	1	0	0	1	0	2	0	2	1	0	1	2	2	0	1	2		1	2	2	2
d_6 Degree of eligibility (i.e. formal license to operate projects)	**8**	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0		0	0	1	2	2
d_7 Degree of acceptability (i.e. informal license to operate projects)	**13**	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		2	1	1	2	2	2
d_8 Variety in project portfolios	**24**	2	0	0	0	1	2	2	1	2	1	1	2	0	1	0	0	2		1	2	0	0	2	0	2
d_9 Engagement of diverse carbon economy actors in the project supply	**21**	1	0	0	0	1	2	2	1	2	0	0	0	0	1	2	2		1	1	2	0	0	2	0	1
d_{10} Support of technical competencies in response to LULUCF shortcomings	**25**	0	1	0	0	2	2	0	0	2	0	0	2	1	2	2		2	2	1	2	0	2	0	0	2
d_{11} Capacity in sourcing or starting up local labour	**19**	1	1	0	0	2	2	1	1	0	0	0	0	0	0		0	2	2	1	2	0	1	1	0	2
d_{12} Financial resources and liquidity (investor involvement)	**27**	1	2	1	1	2	1	1	1	2	0	1	1	0		1	0	1	1	1	2	1	2	2	0	2
d_{13} Coverage of project pipeline	**17**	0	0	0	1	1	0	0	0	1	0	1	2		2	1	0	1	2	0	2	0	1	0	0	2
d_{14} Diversity of commercial standards	**13**	0	0	0	0	0	2	2	0	2	0	0		0	0	0	0	2	0	1	2	0	0	0	0	2
d_{15} Market infrastructure robustness	**10**	0	0	0	0	2	0	0	1	2	0		2	0	0	0	0	1	0	0	2	0	0	0	0	0
d_{16} Valuation of additional services along the supply chain	**17**	0	0	2	0	1	2	2	1	2		2	2	0	0	0	0	1	0	1	1	0	0	0	0	0
d_{17} Extent of the artificial demand	**6**	1	0	0	0	1	1	1	1		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
d_{18} Expectations on the supply chain	**14**	0	0	1	0	0	2	2		1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
d_{19} Consumers' preferences and project support motivations	**10**	0	0	0	0	0	1		0	1	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	0
d_{20} Market participation and beyond-compliance attitude	**11**	0	0	0	1	1		1	0	1	0	0	0	0	0	0	0	0	1	1	1	2	0	0	0	2
d_{21} Market dynamics	**12**	0	0	0	0		1	0	0	1	0	0	2	0	0	0	0	1	1	1	2	1	1	0	0	1
d_{22} Transaction costs	**28**	1	2	2		2	1	0	0	2	2	2	2	0	0	0	0	2	2	1	2	2	1	1	0	1
d_{23} Contractuality of transactions (buyer-seller relationship)	**24**	1	2		0	2	2	1	1	2	0	2	2	0	0	0	0	1	2	1	1	2	1	1	0	0
d_{24} Optional market depth and liquidity	**22**	1		0	0	2	2	0	0	2	0	1	2	0	0	1	0	1	2	1	2	1	1	1	0	2
d_{25} Governments' endorsement of voluntary programmes	**14**		1	0	0	1	2	1	1	1	0	0	1	0	0	1	0	1	1	0	0	2	0	1	0	0
Σ ***Activity***	***427***	**16**	**12**	**9**	**5**	**24**	**30**	**23**	**10**	**33**	**7**	**11**	**28**	**7**	**12**	**13**	**8**	**25**	**24**	**16**	**33**	**15**	**13**	**18**	**7**	**28**

Impact matrix (Barchiesi, 2007)

The relevant arguments related to each impact assessment have not been documented due to the otherwise too extensive amount of information.

Systemic significance of impact variables is provided by their respective measure of activity, i.e. the sum of all impacts of a variable on other variables, and passivity, i.e. the sum of all impacts from the other variables on one variable.

However, a second impact matrix was constructed criterion-wise in order to simplify the analysis of the different dynamic and structural characteristics of the system. In fact, the criteria matrix was likewise attained by summing the direct impact of each impact variable criterion-wise and applying the same 0-to-2 scale as before in the way that follows:

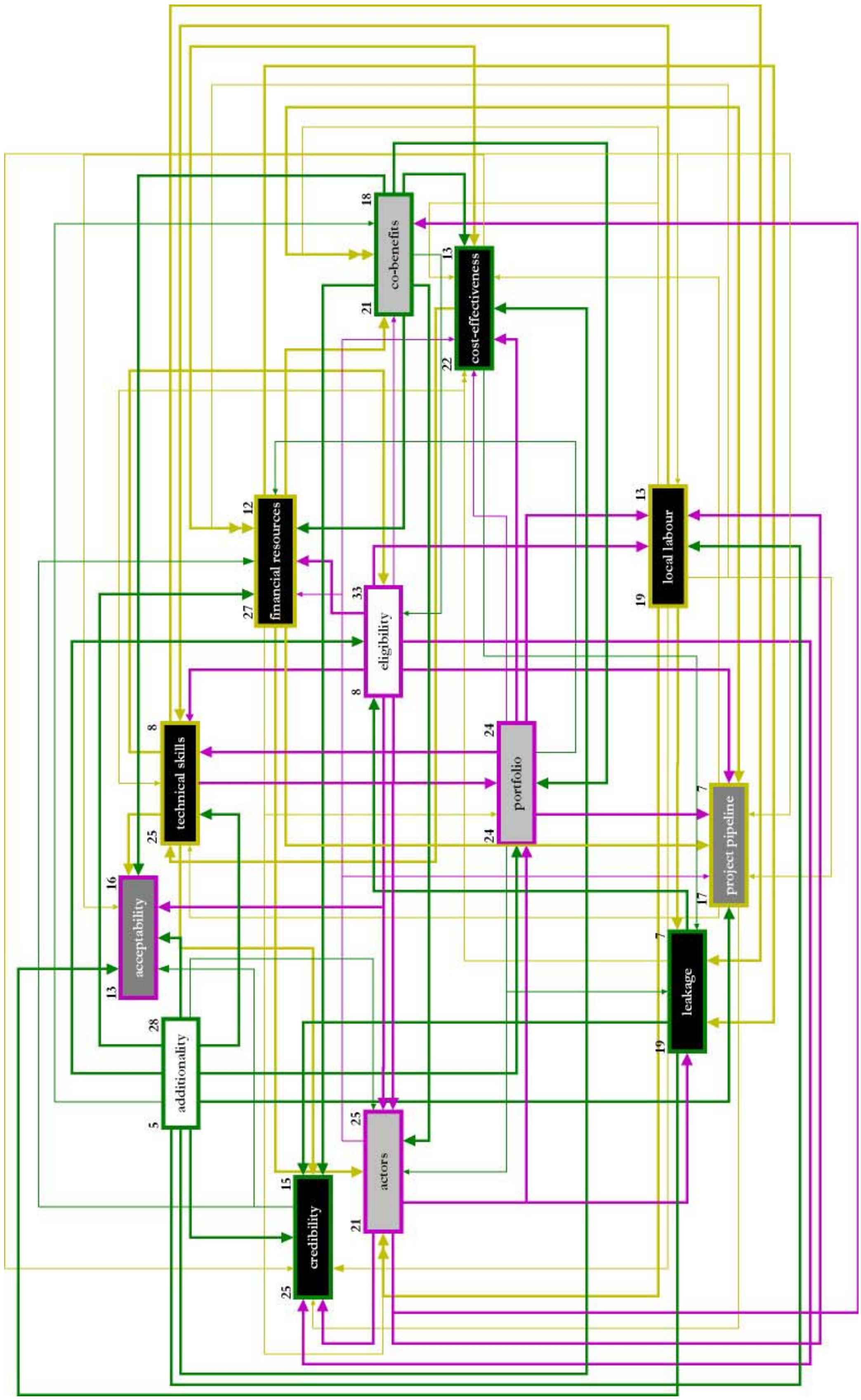
- sum < 10 → 0 = **no directional impact** on impact variable
- 10 ≤ sum < 20 → **1 = average directional impact** on impact variable
- 20 ≤ sum → **2 = strong directional impact** on impact variable

Passivity	Complementarity	Market price	Demand activity	Standardisation	Project costs	Project innovation	Project quality	Decisional criteria
5	0	0	1	1	2	1		Project quality
4	0	0	1	1	0		2	Project innovation
7	0	1	1	1		2	2	Project costs
2	0	0	1		0	1	0	Standardisation
2	0	0		0	0	1	1	Demand activity
5	0		0	2	0	2	1	Market price
3		0	0	1	0	1	1	Complementarity
28	0	1	4	6	2	8	7	*Activity*

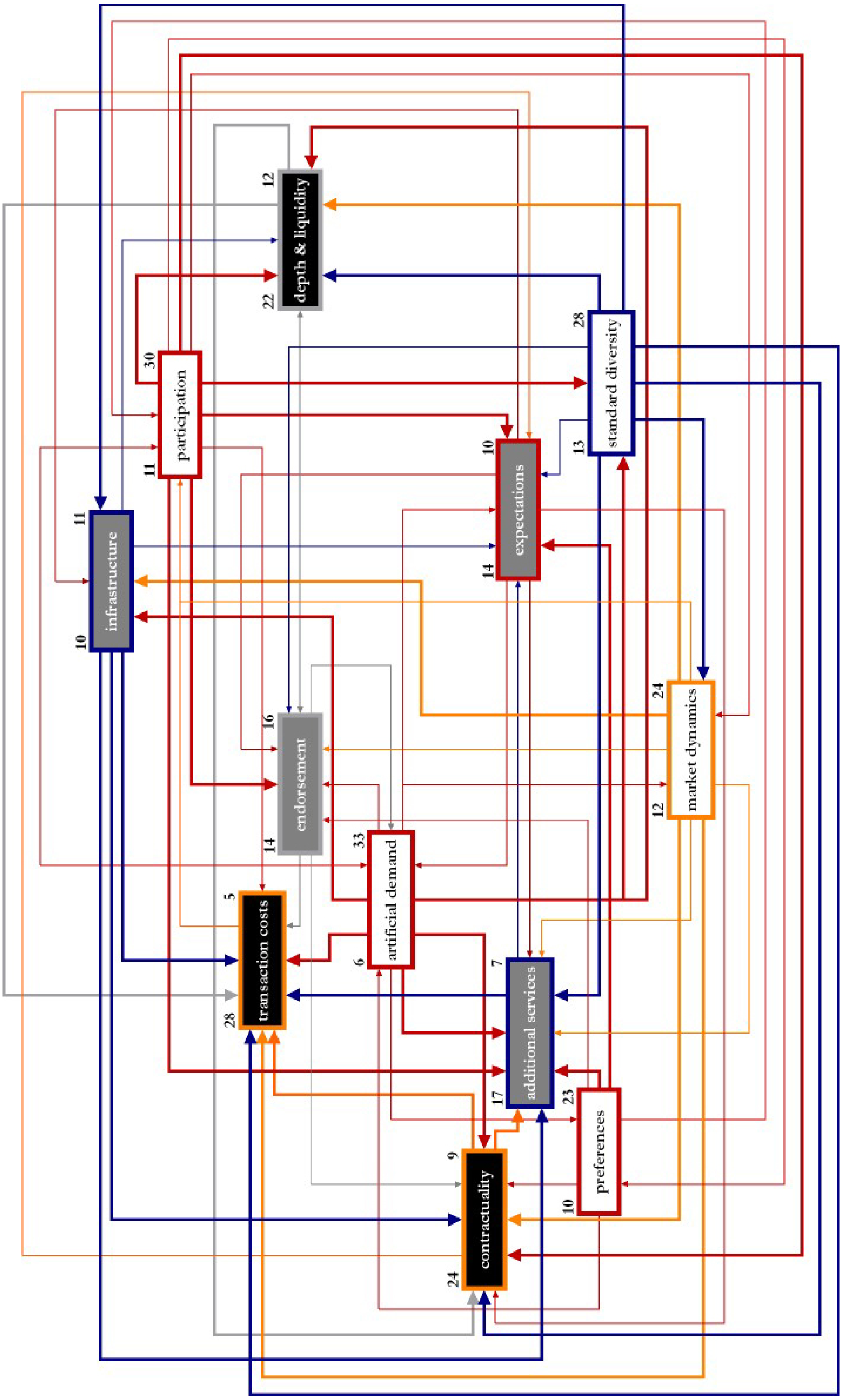
Criteria matrix (Barchiesi, 2007)

The impact matrix and the criteria matrix represent the starting point for the deductive visualisation of supply-side, demand-side, and market-wide subsystems as provided by *Appendix VIII*, *Appendix IX*, and *Appendix X* system graphs. Moreover, particular dynamic behaviours of the forest carbon system such as feedback loops could be thus identified.

Appendix VIII: System Graph of Forest Carbon Supply Aspects



Appendix IX: System Graph of Forest Carbon Demand and Market-Wide Aspects



Appendix X: Consistency Matrix

Impact variables			d_{25} Governments' endorsement of voluntary schemes	d_{25}	d_{24} Optional market depth and liquidity	d_{24}	d_{23} Contractuality of transactions (buyer-seller relationship)	d_{23}	d_{22} Transaction costs	d_{22}	d_{21} Market dynamics	d_{21}	d_{20} Market participation and beyond-compliance attitude	d_{20}	d_{19} Consumers' preferences and project support motivations	d_{19}	d_{18} Expectations on the supply chain	d_{18}	d_{17} Extent of the artificial demand	d_{17}	d_{16} Valuation of additional services along the supply chain	d_{16}	d_{15} Market infrastructure robustness	d_{15}	d_{14} Diversity of commercial standards	d_{14}	d_{13} Availability of material resources (value chain add-ons)	d_{13}	d_{12} Liquidity of financial resources (investor involvement)	d_{12}	d_{11} Capacity of locally sourceable / start-up competencies	d_{11}	d_{10} Supporting competencies in response to LULUCF shortcomings	d_{10}	d_9 Engagement of diverse carbon economy actors in the project supply	d_9	d_8 Variety in project portfolios	d_8	d_7 Degree of acceptability (i.e. informal license to operate projects)	d_7	d_6 Degree of eligibility (i.e. formal license to operate projects)	d_6	d_5 Credibility of the offsetting option	d_5	d_4 Cost-effectiveness of the offsetting option	d_4	d_3 Delivery of ancillary co-benefits for sustainable development	d_3	d_2 Response to negative leakage (off-site impacts)	d_2	d_1 Stringency of additionality / regime flexibility	d_1
			0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
Stringency of additionality / regime flexibility	d_1	0	0	1	0	3	1	1	1	0	3	1	1	3	3	1	1	1	-999	0	1	1	1	1	1	3	1	3	1	3	3	1	1	3	1	3	0	3	1	0	0	3	3	1	1	3	1	3	1	1		
	d_1	1	0	1	3	0	1	1	1	0	1	3	3	1	-999	3	1	1	3	1	1	1	1	1	3	1	3	1	3	1	1	3	3	1	3	1	3	0	0	1	3	0	1	3	3	1	3	1	1	1		
Response to negative leakage (off-site impacts)	d_2	0	3	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	-999	0	1	1	1	1	0	1	3	1	1	0	1	3	1	3	3	1	1	3	3	0	3	-999	3	-999	3	1	3	1			1	1
	d_2	1	1	3	1	1	1	1	1	1	1	1	1	3	1	3	1	1	1	3	1	1	1	1	1	0	3	0	1	3	3	1	3	1	1	3	3	1	1	3	1	3	-999	3	1	3	1	3			1	1
Delivery of ancillary co-benefits for sustainable development	d_3	0	1	0	3	1	1	3	3	1	0	1	3	0	1	-999	1	1	1	3	1	1	1	1	3	1	1	1	3	1	1	3	1	1	3	-999	3	1	1	0	3	1	3	-999	1	3			3	1	1	3
	d_3	1	1	3	1	3	3	1	1	3	1	0	0	3	0	3	1	1	3	1	1	1	1	1	1	3	1	1	1	3	3	1	1	1	-999	3	1	3	0	3	1	3	-999	3	3	1			1	3	3	1
Cost-effectiveness of the offsetting option	d_4	0	1	1	3	1	3	1	1	3	1	-999	0	1	1	3	1	1	3	1	1	1	1	1	1	1	3	1	3	1	0	3	1	3	3	1	3	1	1	1	1	1	1	1			1	3	3	1	1	3
	d_4	1	1	1	1	3	1	3	3	1	0	3	3	1	3	0	1	1	1	3	1	1	1	1	1	3	1	3	1	3	3	0	3	1	1	3	1	3	1	3	1	1	3	0			3	1	1	3	3	1
Credibility of the offsetting option	d_5	0	1	-999	1	3	3	1	1	3	3	1	1	0	1	0	3	1	1	1	3	1	1	1	1	3	3	1	3	1	1	3	0	1	1	3	1	1	3	1	1	3			0	1	3	-999	3	-999	3	1
	d_5	1	0	3	3	1	1	3	3	1	1	1	0	3	1	3	1	3	1	1	1	3	1	1	3	1	1	3	1	3	3	1	3	0	0	3	1	1	1	3	3	1			3	1	-999	3	-999	3	1	3
Degree of eligibility (i.e. formal license to operate projects)	d_6	0	3	0	3	0	3	1	1	3	3	1	3	0	3	0	1	3	3	0	3	1	1	3	3	1	1	3	3	1	1	3	3	1	3	1	3	-999	3	0			1	3	1	1	3	1	3	-999	0	3
	d_6	1	1	3	0	3	1	3	3	1	1	3	1	3	1	3	3	1	0	3	1	3	3	1	1	3	3	1	1	3	3	1	1	3	1	3	-999	3	1	3			3	1	1	1	1	3	1	3	3	0
Degree of acceptability (i.e. informal license to operate projects)	d_7	0	3	1	3	1	3	1	1	3	3	1	3	1	3	1	3	1	3	1	3	1	1	1	3	1	1	1	3	1	1	3	1	3	3	1	3	1			3	0	3	1	3	1	3	0	3	0	1	0
	d_7	1	1	3	1	3	1	3	3	1	1	3	1	3	1	3	1	3	1	3	1	3	1	1	1	3	1	1	1	3	3	1	3	1	1	3	1	3			1	3	1	3	1	1	0	1	1	3	0	1
Variety in project portfolios	d_8	0	3	1	3	1	3	1	3	1	1	3	1	0	3	1	3	1	3	0	1	3	1	3	1	0	1	3	3	1	1	3	1	3	3	1			3	1	3	-999	1	1	3	1	3	1	1	3	0	3
	d_8	1	1	3	1	3	1	3	1	3	3	1	-999	3	0	3	1	3	0	3	3	1	3	1	0	1	3	1	1	3	3	1	1	3	1	3			1	3	-999	3	1	1	1	3	1	3	3	1	3	0
Engagement of diverse carbon economy actors in the project supply	d_9	0	3	1	3	1	1	3	3	1	1	3	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	1	3	1	3			3	1	3	1	3	1	3	3	3	1	3	-999	3	1	1	3
	d_9	1	1	3	1	3	3	1	1	3	3	1	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	3	1	1	3			1	3	1	3	1	3	0	1	1	3	-999	3	1	3	3	1
Supporting competencies in response to LULUCF shortcomings	d_{10}	0	1	1	1	3	1	1	1	1	1	3	1	3	1	1	1	1	3	1	1	1	1	1	3	1	1	3	0	3	3	1			3	3	3	3	1	3	3	1	0	1	1	3	1	1	1	3	1	3
	d_{10}	1	1	1	3	1	1	1	1	1	3	1	3	1	1	1	1	1	0	3	1	1	1	1	1	3	3	1	3	0	1	3			1	1	1	1	3	1	1	3	3	0	3	1	1	1	3	1	3	1
Capacity of locally sourceable / start-up competencies	d_{11}	0	3	1	3	1	1	1	1	1	3	1	1	3	1	3	3	1	1	1	1	1	1	1	1	1	1	3	1	3			3	1	1	3	1	3	1	3	1	3	1	3	0	3	1	3	1	3	3	1
	d_{11}	1	1	3	1	1	1	1	1	3	3	1	3	1	3	1	1	3	1	1	1	1	1	1	1	1	3	1	3	1			1	3	3	1	3	1	3	1	3	1	3	1	3	0	3	1	3	1	1	3
Liquidity of financial resources (investor involvement)	d_{12}	0	1	3	0	3	1	3	3	1	1	3	3	3	3	1	3	1	1	3	1	1	1	3	3	1	1	3			1	3	0	3	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	0	1	3
	d_{12}	1	3	1	3	0	3	1	1	3	3	1	0	0	1	1	1	3	3	1	1	1	3	1	1	3	3	0			3	1	3	0	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	1	3	1
Availability of material resources (value chain add-ons)	d_{13}	0	1	1	1	1	1	1	3	1	3	1	1	1	3	-999	3	-999	1	3	1	1	1	3	3	1			0	3	1	3	1	3	3	1	1	3	1	1	1	3	3	1	3	1	1	1	0	1	1	3
	d_{13}	1	3	1	1	1	1	1	1	3	1	3	1	1	1	-999	1	-999	0	1	1	1	3	1	1	3			3	1	3	1	3	1	1	3	3	1	1	1	3	1	1	3	1	3	1	1	3	3	3	1
Diversity of commercial standards	d_{14}	0	1	3	0	3	3	1	-999	3	3	0	0	1	1	3	1	3	3	0	1	3	3	-999			3	1	3	1	1	1	3	1	3	1	1	0	3	1	3	1	1	3	3	1	3	1	0	1	1	3
	d_{14}	1	3	1	3	0	1	3	3	-999	0	3	1	0	3	1	3	1	0	3	3	1	-999	3			1	3	1	3	1	1	1	3	1	3	0	1	1	3	1	3	3	1	1	1	1	3	1	0	3	1
Market infrastructure robustness	d_{15}	0	1	1	3	1	3	1	-999	3	3	1	1	1	1	1	3	1	3	-999	3	1			3	-999	1	3	1	3	1	1	1	1	3	1	1	3	1	1	1	3	1	1	1	1	1	1	1	1	1	1
	d_{15}	1	1	1	1	3	1	3	3	-999	1	3	1	1	1	1	1	3	0	3	0	3			-999	3	3	1	3	1	1	1	1	1	1	3	3	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
Valuation of additional services along the supply chain	d_{16}	0	1	1	1	1	0	3	3	1	3	1	3	1	3	0	3	1	0	3			3	1	1	3	1	1	1	1	1	1	1	1	3	1	1	3	3	1	3	1	3	1	1	1	1	1	1	1	1	1
	d_{16}	1	1	1	1	1	3	0	1	3	1	3	1	3	-999	3	1	3	3	-999			0	3	3	1	1	1	1	1	1	1	1	1	1	3	3	1	1	3	1	3	1	3	1	1	1	1	1	1	1	1
Extent of the artificial demand	d_{17}	0	-999	3	0	3	3	1	3	0	0	3	3	-999	1	1	1	1			-999	3	3	-999	3	0	1	3	1	3	1	1	3	1	3	1	3	0	3	1	3	0	1	1	3	1	1	3	3	0	1	0
	d_{17}	1	3	1	3	1	1	3	1	3	1	3	1	3	3	1	3	1			3	0	0	3	0	3	0	1	3	1	1	1	0	3	1	3	0	3	1	3	0	3	1	1	1	3	3	1	1	-999	3	-999
Expectations on the supply chain	d_{18}	0	3	1	1	1	3	1	1	1	1	1	3	1	3	0			1	1	3	1	3	1	1	3	-999	-999	3	1	3	1	1	1	3	1	3	1	3	1	1	3	3	1	1	1	1	1	1	1	1	1
	d_{18}	1	1	3	1	1	1	3	1	1	1	1	1	3	-999	3			3	1	1	3	1	3	3	1	1	3	1	3	1	3	1	1	1	3	1	3	1	3	3	1	1	3	1	1	1	1	1	1	1	1
Consumers' preferences and project support motivations	d_{19}	0	3	1	1	1	1	3	1	1	1	1	3	0			3	0	1	1	3	0	1	1	1	3	-999	-999	1	1	1	3	1	1	3	1	3	1	3	1	3	0	3	0	0	3	3	-999	3	0	3	1
	d_{19}	1	1	3	1	1	3	1	1	1	1	1	0	3			-999	3	3	1	-999	3	1	1	3	1	1	3	1	3	3	1	1	1	1	3	0	3	1	3	1	3	1	1	3	1	0	1	1	1	-999	3
Market participation and beyond-compliance attitude	d_{20}	0	3	1	3	1	3	1	1	3	3	1			3	0	3	1	3	-999	3	1	1	1	0	1	1	1	0	3	1	3	1	3	3	1	3	0	3	1	3	0	3	0	1	1	3	0	3	0	1	3
	d_{20}	1	1	3	1	3	1	3	3	1	1	3			0	3	1	3	1	3	1	3	1	1	1	0	1	1	0	3	3	1	3	1	1	3	-999	1	1	3	1	3	0	1	3	0	0	3	1	1	3	1
Market dynamics	d_{21}	0	3	1	0	3	1	3	3	0			3	1	1	1	1	1	3	3	3	1	3	1	3	0	3	1	1	3	1	1	1	3	1	3	1	3	3	1	3	1	1	1	3	-999	0	1	1	1	3	1
	d_{21}	1	1	3	3	0	3	1	1	3			1	3	1	1	1	1	1	0	1	3	1	3	0	3	1	3	3	1	3	3	3	1	3	1	3	1	1	3	1	3	1	3	0	1	1	0	1	1	1	3
Transaction costs	d_{22}	0	3	1	3	1	0	3			3	0	1	3	1	1	1	1	3	0	3	1	-999	3	-999	3	3	1	3	1	3	1	1	1	3	1	3	1	1	3	1	3	1	3	1	3	3	1	1	1	0	0
	d_{22}	1	1	3	1	3	3	0			1	3	3	1	1	1	1	1	1	3	1	3	3	-999	3	-999	1	3	1	3	1	1	1	1	1	3	1	3	3	1	3	1	3	1	3	1	1	3	1	1	1	1
Contractuality of transactions (buyer-seller relationship)	d_{23}	0	1	3	3	1			0	3	1	3	3	1	1	3	3	1	3	1	0	3	3	1	3	1	1	1	1	3	1	1	1	1	1	3	3	1	3	1	3	1	3	1	3	1	1	3	1	1	1	1
	d_{23}	1	3	1	1	3			3	0	3	1	1	3	3	1	1	3	1	3	3	0	1	3	1	3	1	1	3	1	1	1	1	1	3	1	1	3	1	3	1	3	1	3	1	3	3	1	1	1	1	1
Optional market depth and liquidity	d_{24}	0	3	1			3	1	3	1	0	3	3	1	1	1	1	1	1	3	1	1	3	1	0	3	1	1	0	3	1	1	1	3	3	1	3	1	3	1	3	0	1	3	3	1	3	1	1	1	0	3
	d_{24}	1	1	3			1	3	1	3	3	0	1	3	1	1	1	1	3	0	1	1	1	3	3	0	1	1	3	0	1	3	3	1	1	3	1	3	1	3	0	3	3	1	1	3	1	3	1	1	3	0
Governments' endorsement of voluntary schemes	d_{25}	0			3	1	1	3	3	1	3	1	3	1	3	1	3	1	1	3	1	1	1	1	1	3	1	1	1	3	3	1	1	1	3	1	3	1	3	1	3	0	3	-999	1	1	3	0	3	1	1	1
	d_{25}	1			1	3	3	1	1	3	1	3	1	3	1	3	1	3	3	-999	1	1	1	1	3	1	3	1	3	1	1	3	1	1	1	3	1	3	1	3	1	3	0	1	1	1	1	1	1	3	0	0

Appendix XI: 'Ideal' vs. 'Worst-case' Scenario

Level		1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	1	1
Impact variables		k01	k02	k03	k04	k05	k06	k07	k08	k09	k10	k11	k12	k13	k14	k15	k16	k17	k18	k19	k20	k21	k22	k23	k24	k25
		Stringency of additionality	Response to negative leakage	Delivery of ancillary cobenefits	Cost-effectiveness of the offset	Credibility of the offset	Degree of eligibility	Degree of acceptability	Variety in project portfolios	Engagement of diverse actors	Support of technical competencies	Capacity in local labour sources	Liquidity of financial sources	Coverage of project pipeline	Diversity of commercial standards	Market infrastructure	Valuation of additional services	Extent of artificial demand	Expectations on the supply chain	Consumers' preferences and motivations	Participation and attitude	Market dynamics	Transaction costs	Contractuality of transactions	Market depth and liquidity	Governments' endorsement
Consistency	-1395	Inflexible	Adequate	Large	Extreme	High	High	High	Large	Broad	Systematic	Sufficient	High	Long	Reduced	Robust	Favorable	Limited	High	Careful	Proactive	Mature	Low	Lax	Deep	strong
1	k02	1																								
1	k03	1	3																							
1	k04	1	3	1																						
1	k05	3	3	3	0																					
1	k06	0	3	3	1	1																				
1	k07	1	3	3	3	3	3																			
1	k08	0	1	3	3	1	3	3																		
1	k09	1	3	3	3	3	3	3	3																	
0	k10	3	3	1	3	3	1	3	1	1																
0	k11	1	3	3	3	3	3	3	3	3	3															
0	k12	1	3	3	3	3	3	3	3	3	3	3														
0	k13	1	0	1	3	3	1	1	1	3	3	3	3													
1	k14	3	1	1	1	3	1	1	0	1	3	1	3	3												
1	k15	1	1	1	1	1	1	1	1	3	1	1	3	3	3											
1	k16	1	1	1	1	3	3	3	1	3	1	1	1	1	1	3										
1	k17	3	1	3	1	1	0	1	0	1	3	1	1	1	0	0	3									
1	k18	1	1	1	1	3	1	3	3	3	1	1	1	-999	1	3	3	1								
1	k19	3	3	3	0	3	3	3	3	3	1	3	1	-999	1	1	3	1	3							
1	k20	1	3	3	1	3	3	3	3	3	3	3	3	1	0	1	3	3	3	3						
0	k21	3	1	0	3	1	3	3	1	1	3	1	3	1	3	3	3	3	1	1	3					
0	k22	1	1	1	3	3	3	3	1	1	1	1	3	3	3	3	1	1	1	1	3	3				
0	k23	1	1	1	3	3	3	3	3	1	1	1	3	1	3	3	0	3	3	1	3	3	3			
1	k24	0	1	3	3	1	3	3	3	3	3	1	3	1	0	3	1	1	1	1	3	3	1	1		
1	k25	1	3	3	1	3	3	3	3	3	1	1	3	1	1	1	1	1	3	3	3	1	1	3	3	

Level		0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	0	0
Impact variables		k01	k02	k03	k04	k05	k06	k07	k08	k09	k10	k11	k12	k13	k14	k15	k16	k17	k18	k19	k20	k21	k22	k23	k24	k25
		Stringency of additionality	Response to negative leakage	Delivery of ancillary cobenefits	Cost-effectiveness of the offset	Credibility of the offset	Degree of eligibility	Degree of acceptability	Variety in project portfolios	Engagement of diverse actors	Support of technical competencies	Capacity in local labour sources	Liquidity of financial sources	Coverage of project pipeline	Diversity of commercial standards	Market infrastructure	Valuation of additional services	Extent of artificial demand	Expectations on the supply chain	Consumers' preferences and motivations	Participation and attitude	Market dynamics	Transaction costs	Contractuality of transactions	Market depth and liquidity	Governments' endorsement
Consistency	-1420	Flexible	Inadequate	Small	Moderate	Low	Low	Low	Small	Narrow	Disorganised	Insufficient	Low	Short	Considerable	Weak	Indifferent	Comprehensive	Low	Indifferent	Reactive	Volatile	High	Strict	Shallow	weak
0	k02	1																								
0	k03	1	3																							
0	k04	1	3	1																						
0	k05	3	3	3	1																					
0	k06	0	3	3	1	1																				
0	k07	1	3	1	1	3	3																			
0	k08	0	1	3	3	1	3	3																		
0	k09	1	3	3	3	1	3	3	3																	
1	k10	3	3	1	3	1	1	3	3	3																
1	k11	1	3	3	3	3	3	3	3	3	3															
1	k12	1	1	3	3	3	3	3	3	3	3	3														
1	k13	1	3	1	3	3	1	1	1	3	3	3	3													
0	k14	3	1	1	1	3	1	1	0	1	3	1	3	3												
0	k15	1	1	1	1	1	1	1	1	3	1	1	3	3	3											
0	k16	1	1	1	1	3	3	3	1	3	1	1	1	1	1	3										
0	k17	0	0	3	1	1	0	1	0	1	3	1	1	1	0	-999	3									
0	k18	1	1	1	1	3	1	3	3	3	1	1	1	1	1	3	3	1								
0	k19	3	1	1	1	1	3	3	3	3	1	3	1	1	1	1	3	1	3							
0	k20	1	1	3	0	1	3	3	1	3	3	3	0	1	0	1	3	3	3	3						
1	k21	3	1	0	1	3	3	3	1	1	3	3	3	1	3	3	3	0	1	1	3					
1	k22	0	1	1	3	3	3	3	1	1	1	3	3	3	3	3	1	0	1	1	3	3				
1	k23	1	1	1	3	3	3	3	3	1	1	1	3	1	3	3	0	3	3	1	3	3	3			
0	k24	0	1	3	3	1	3	3	3	3	3	1	3	1	0	3	1	0	1	1	3	3	1	1		
0	k25	0	3	1	1	1	3	3	3	3	1	1	3	3	1	1	1	-999	3	3	3	1	1	3	3	

Appendix XII: The Most Consistent Scenario

Level		0	1	1	1	1	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Impact variables		k01	k02	k03	k04	k05	k06	k07	k08	k09	k10	k11	k12	k13	k14	k15	k16	k17	k18	k19	k20	k21	k22	k23	k24	k25
		Stringency of additionality	Response to negative leakage	Delivery of ancillary cobenefits	Cost-effectiveness of the offset	Credibility of the offset	Degree of eligibility	Degree of acceptability	Variety in project portfolios	Engagement of diverse actors	Support of technical competencies	Capacity in local labour sources	Liquidity of financial sources	Coverage of project pipeline	Diversity of commercial standards	Market infrastructure	Valuation of additional services	Extent of artificial demand	Expectations on the supply chain	Consumers' preferences and motivations	Participation and attitude	Market dynamics	Transaction costs	Contractuality of transcations	Market depth and liquidity	Governments' endorsement
Consistency	567	Flexible	Adequate	Large	Extreme	High	Low	High	Small	Broad	Systematic	Sufficient	High	Long	Reduced	Robust	Indifferent	Comprehensive	Low	Indifferent	Reactive	Mature	Low	Lax	Deep	strong
1	k02	1																								
1	k03	3	3																							
1	k04	3	3	1																						
1	k05	1	3	3	0																					
0	k06	0	1	1	1	3																				
1	k07	0	3	3	3	3	0																			
0	k08	0	3	1	1	1	3	1																		
1	k09	3	3	3	3	3	1	3	1																	
0	k10	1	3	1	3	3	3	3	1	1																
0	k11	3	3	3	3	3	1	3	1	3	3															
0	k12	3	3	3	3	3	1	3	1	3	3	3														
0	k13	3	0	1	3	3	3	1	3	3	3	3	3													
1	k14	1	1	1	1	3	3	1	1	1	3	1	3	3												
1	k15	1	1	1	1	1	3	1	3	3	1	1	3	3	3											
0	k16	1	1	1	1	1	3	1	1	1	1	1	1	1	3	0										
0	k17	0	3	1	3	1	0	3	0	3	1	1	3	3	3	3	3									
0	k18	1	1	1	1	1	1	1	3	1	1	3	3	3	3	1	3	1								
0	k19	3	1	0	3	1	3	1	3	1	1	1	3	3	3	1	3	1	3							
0	k20	1	1	0	3	0	3	1	1	1	1	1	3	1	1	1	3	3	3	3						
0	k21	1	1	0	3	1	1	3	3	1	3	1	3	1	3	3	1	3	1	1	1					
0	k22	1	1	1	3	3	1	3	3	1	1	1	3	3	3	3	3	3	1	1	1	3				
0	k23	1	1	1	3	3	1	3	1	1	1	1	3	1	3	3	3	1	1	3	1	3	3			
1	k24	3	1	3	3	1	0	3	1	3	3	1	3	1	0	3	1	3	1	1	1	3	1	1		
1	k25	1	3	3	1	3	0	3	1	3	1	1	3	1	1	1	1	3	1	1	1	1	1	3	3	