The Carbon finance market: financial mechanisms and potential implications for greenhouse gas (GHG) mitigation in the fishery and aquaculture sector.

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Contents

Glossary/acronyms

AAUs	Assigned Amount Units
CER	Certified Emissions Reductions
CDM	Clean Development Mechanism
ERUs	Emission Reduction Units
ETS	Emissions Trading Scheme
EUAs	European Union Allowances
GtCO2e	Giga tonnes of Carbon Dioxide Equivalent
HFCs	hydroflourocarbons
ILD	International linkage directive
JI	Joint Implementation
REDD	Reducing Emissions on Deforestation and Degradation
UNFCCC	United Nations Framework Convention for Climate Change
VERs	Verified Emission Reductions

1. Introduction

As global emissions continue to rise, the accelerating impact of a changing climate is becoming increasingly visible throughout the world and the urgent need for focused mitigation strategies crossing various scales and sectors is apparent. A common challenge across most sectors is to recognize their respective levels of GHG emissions and to find the means to reduce these, and identify effective incentives for doing so. Where there are no direct means to promote GHG reduction such as regulation or consumer incentives, one of the primary approaches, created under the Kyoto Protocol in 2005, is through the carbon market and its various financing mechanisms which enable payments to countries, companies and projects for reducing GHG emissions.

This short review focuses specifically on the fisheries and aquaculture sector, exploring the potential to use carbon financing mechanisms as an incentive for GHG mitigation. To date, the sector has featured relatively little in the broad theme of carbon accounting and financing, and so far does not have access to specific carbon reduction markets. Global fisheries however, account for approximately 1.2% of oil consumed in the world (Tyedmers, 2005, Fig 1), and the GHGs associated with emissions. Likewise, the aquaculture sector has important GHG implications, primarily though not exclusively associated with feeds. Although overall GHG levels are small relative to major economic sectors, there is notable potential for GHG reduction along the fisheries supply chain, also including post-harvest processes, distribution and consumption.

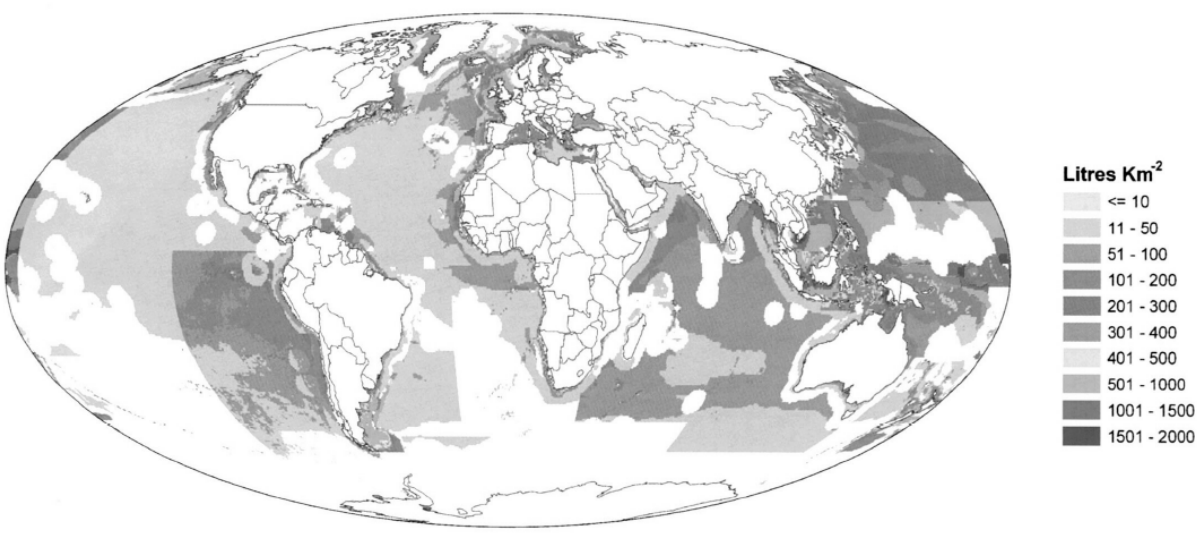

Figure 1. - Fuel distribution and intensity by marine fisheries in 2000, adapted from Tyedmers (2005)

A variety of approaches exists for reducing GHG emissions in the fisheries and aquaculture sector, from fuel incentives and reductions, to changing fishery and aquaculture management or using alternative fuels (Driscoll and Tyedmers, 2009). This review however focuses less on how carbon will be mitigated, and more on the possibilities for incorporating the sector within carbon financing mechanisms, and thereby creating the conditions and incentives for doing so (Badjeck et al, 2009; Holopainen, 2010).

This review outlines current and projected trends in the carbon market, to indicate opportunities for adoption within the fisheries and aquaculture sector. It sets out the key principles and methods of carbon financing, the various mechanisms and funds available, methods of pricing carbon and critiques of carbon market systems thus far. Subsequent policies and implementation mechanisms such as the regulatory and voluntary carbon markets are then described. The specific methods, benefits and critiques of applying carbon financing in natural resource sectors are presented, using the forestry-based REDD (Reducing Emission on Deforestation and Degradation) and the agricultural sector as examples of established and growing carbon trading schemes. These highlight the importance of accurate measuring systems for carbon accounting and issues of leakage, permanence and additionality.

Finally the review addresses most recent trends in carbon financing, as it has been under considerable pressure and criticism from investors concerned for excess market capacity and falling prices.. The potential spatial and temporal areas for adoption within the global fisheries and aquaculture sector is also shown, with new instruments such as the Green Climate Fund created under the Durban Accord, along with new country commitments and investments in carbon trading.

2. Concepts and principles of carbon markets

The carbon market, established under the Kyoto Protocol enforced in 2005, has become an important mechanism through which countries and companies can meet agreed reductions in GHG emissions. Under the first commitment phase, countries who have adopted the Protocol must collectively reduce GHG emissions by 5.2% below 1990 levels between 2008-2012 (UNFCCC, 2008). The first commitment phase ended in 2012, with an agreed date of January 2013 to commence the second phase, set to end in 2017. As concerns to reduce GHG levels increase, so reduction commitment levels are likely to increase further in subsequent UNFCCC rounds.

The carbon market is split into two main sectors, the regulatory compliance market and the voluntary market, each having their own targets, size and entry criteria. The regulatory market predominately includes countries that have legally agreed to reduce their GHG emissions under the Kyoto Protocol and thus accepted a specific level at which to 'cap' carbon emissions. Based on this target, allowances are provided to participants, which can be traded between them. The traded price of carbon emission allowances will depend on the agreed cap level and the demand by participants for emitting carbon. Those participants which emit less carbon than their allowance can sell this balance on the carbon market at the prevailing price, while the purchaser can use the carbon credits to carry out their intended activities. In some cases, the excess can also be purchased by the country concerned to reduce their overall carbon emission levels, as national commitments to reduce GHGs increase. The financial exchanges generated by the system create the incentives to reduce carbon emissions by participants, and the higher the exchange price the greater the incentive.

By far the largest cap and trade system is the European Union Emissions Trading Scheme (EU ETS), whose value has grown to a total of $148 billion dollars (World Bank, 2012). However, many countries have not ratified the Kyoto protocol and have instead created their own GHG cap and trade schemes, such as the Australian state of New South Wales (NSW) GHG Abatement Scheme adopted in 2003.

A variant on the cap and trade scheme is the baseline and credit system, which unlike the former does not have a finite limit of carbon allowances. New carbon credits can be created through carbon sequestration or reduction projects, offsetting carbon emissions elsewhere, which buyers can use in the cap and trade system. Additionality is a key component in regulating this system, whereby carbon offsets are only legitimised and generate monetary value if the projects and subsequent reductions would not have happened anyway. A significant example of a baseline and credit scheme is the Clean Development Mechanism (CDM), established under the Kyoto Protocol and only applicable to developing countries. The CDM aims to not only reduce GHG emissions but also help foster investment within developing countries and strengthen global cooperation (CDM Policy Dialogue, 2012).

The Voluntary Market predominately uses the baseline and credit system, and provides an alternative market to the regulatory one, often through investments from private investors and companies. The voluntary market is currently much smaller in size and compared to the regulatory market commonly has less stringent entry and operational requirements. The voluntary market has attracted attention for a variety of carbon projects, in particular Reducing Emissions from Deforestation and Forest Degradation (REDD) and a number of agricultural schemes (Peters-Stanley et al, 2011).

The global carbon market is currently valued at $176 billion with an average annualised growth of 11%. It has grown to become a recognized method for trading emissions, shown in the total transaction volume for 2011/12 of 10.3 billion tons of CO_2-eq (World Bank, 2012). The pricing of carbon is a crucial factor in the functioning of these markets and is connected with the size of the market and the agreed level at which to incentivise investment. Hence the price of carbon may differ between various mechanisms. Formally, two types of carbon units are defined for quantifying and valuing markets; allowances, formed under the cap and trade system and; carbon credits, produced in the baseline and credit system (Kollham, 2008). One unit or credit of carbon is equal to one ton of Carbon Dioxide (CO_2) or Carbon Dioxide equivalent (CO_2- eq). As discussed later, the measurement and attribution of carbon reduction in the chosen system or process is a critical issue in the effectiveness of defining and operating an effective carbon market.

3. Practical functions of regulatory and voluntary markets

3.1 Cap and trade schemes

The European Union Emissions Trading Scheme (EU ETS) forms the largest emission trading scheme in the world and is specifically targeted towards the industrial sector, to a degree also towards intensive food and drink sectors. The EU ETS is about to begin phase 3 of their trading scheme in 2013, where the agreed cap will be set at 2,039 million tons of CO2e, which represents 81% of EU traded emissions on an annual basis (World Bank, 2012). The recognized unit of traded carbon is the EU allowance (EUA), with participants in the scheme also able to buy these or purchase Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs).

In addition to the EU ETS are other national and regional cap and trade schemes, predominately adopted by those countries that are yet to ratify the Kyoto protocol and sign up to an agreed carbon reduction target (Table 1).

Table 1 Additional cap and trade schemes (World Bank, 2012) .

Country	Scheme	Policy and entry requirements
Australia - New South Wales	New South Wales Green house gas Abatement Scheme (NS GHGAS)	Established in 2003 and specifically targeted towards the power sector
USA	Regional Green house gas initiative (RGGI)	Starting in 2008, RGGI was the first regulatory market reducing GHG emissions in the USA. The nine participating states in north east America aim to reduce emissions of $C0_2$ in the power sector 10% by 2018.
	Western Climate Initiative (WCI)	Established in 2007, a collaboration of 7 US states and 4 in British Columbia. Covers programs for avoided CH4 from manure management, ozone depleting substances, coal mine methane and small landfills. It has an emissions target of 15% below 2005 levels by 2020.
New Zealand	New Zealand Emissions Trading Scheme (NZ ETS)	Created in 2008, New Zealand set a 10-20% reduction target by 2020 and 50% reduction target by 2050. Incorporates emissions from industrial processes, forestry, liquid fossil fuels and stationary energy.

3.2 Baseline and credit systems:

The Clean Development Mechanism (CDM)

The CDM is set have a market value post 2012of approximately $2 billion and is heralded as a key component in linking developing countries with developed countries (World Bank, 2012). CDM funds carbon sequestration projects in developing countries through investment from developed countries, who pay to implement GHG reduction projects and thus gain carbon credits or CERs, which they offset against national emissions or sell on the market. The CDM and the associated Joint Implementation (JI) scheme (see below) can also be used and traded in the EU ETS through the International Linking Directive (ILD). The chart below indicates the distribution of CERs within the CDM in 2010, showing the majority of projects are in renewables.

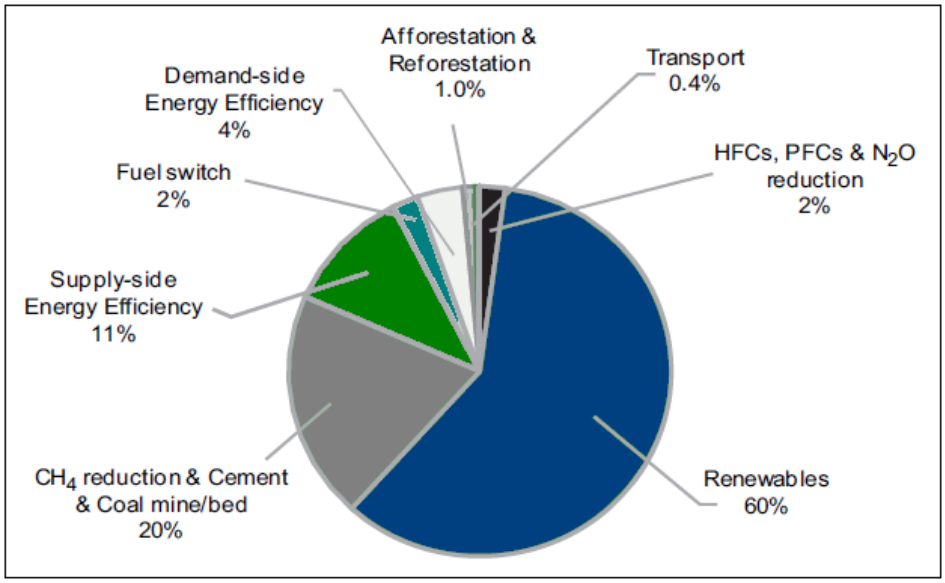

Figure 2. - Division of CDM projects, cited in FAO (2010), sourced from UNEP, Risoe (2010)

The CDM accepts all projects that reduce the six GHGs listed in the Kyoto protocol, with the exception of existing forests (including REDD), nuclear energy and HFC destruction (Kollmuss et al, 2008). To implement a CDM project, and subsequently a baseline and credit scheme, a number of requirements must be fulfilled:

- **Additionality**; requires emission reductions or sequestration to be higher than those obtained without the project having been implemented, thus GHG emissions after the project must be lower than the business as usual scenario.
- **Permanence;** when accounting for carbon credits the length of carbon storage, for example in afforestation projects, and the risk of damage or loss of reduced emissions is taken into account.
- **Leakage** ; takes into account any indirect emissions as a result of the project being implemented, for example the migration of local communities from aforestation schemes resulting in land clearance elsewhere.

CDM offset projects not only have the potential to provide cost effective GHG reduction for Annext 1 countries (those signing the Kyoto Protocol) but also development benefits for host countries.

Joint Implementation Mechanism (JI)

The JI mechanism is comparable to the CDM, but only trades carbon (termed emission reduction units - ERU) between annex one countries, and not developing countries. Established in 2008 the JI is a project based mechanism that works as a baseline and credit system and is also used in cap and trade systems (UNFCCC, 2008). It applies two different tracks for verification of emissions (World Bank, 2012), the first being where the host country verifies reductions and subsequently issues the ERUs, the second is where emission reductions are verified through the Joint Implementation Supervisory Committee (JISC) and

then ERUs issued by the host country. The main projects currently in the JI are located in the Russian Federation and Ukraine, which combined account for up to 60% of projects (Figure 3).

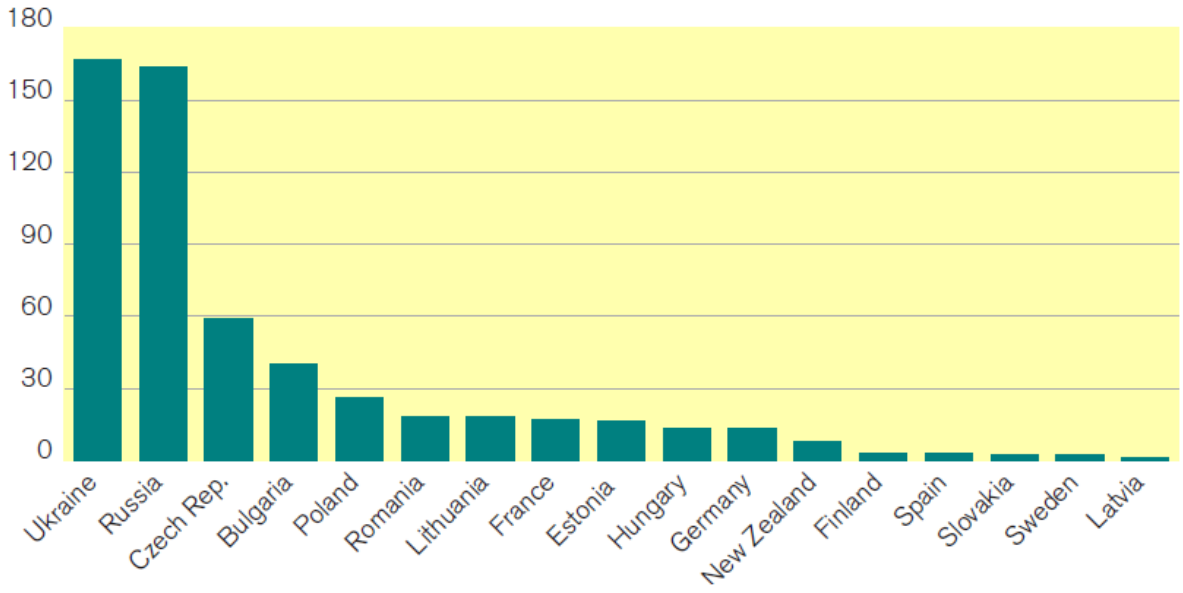

Figure 3. Projects in the JI pipeline, by country, adapted from World Bank, 2012 UNEP Risoe (2012).

3.3. Voluntary Markets

The voluntary market provides an alternative through which mainly private investors and companies can implement carbon projects, usually on a smaller scale. Kollmuss et al 2008 highlighted the role voluntary carbon markets can play in shaping future compliance markets such as the cap and trade system, *'...they can serve as a testing field for new procedures, methods and technologies that may later go into the regulatory market'*. The unit of measurement in the voluntary market is the Verified or Voluntary Emission Reduction (VER). Voluntary carbon credits or VERs are mainly purchased by private sector bodies, through corporate social responsibility programmes, highlighting the environmental and social benefits along with certification and reputation. An important element of the voluntary market is to provide high quality standards in order to boost investor's confidence, as it not under the same standards as the regulatory market. A multitude of different standards have been created over the last number of years, but none has established itself as the main industry standard (Kollmuss et al 2008).

4. Practical applications in natural resource sectors

Over the last decade there has been increasing focus and growth of carbon financing methods within the natural resources sector, such as within forests and land based activities. Although the fisheries sector is not yet incorporated into the carbon market, important lessons can be drawn from the following examples, highlighting their entry points into the market, challenges and strengths. While focusing specifically upon the forestry based REDD and on agricultural carbon programs, the concept and growth of Blue Carbon is also briefly discussed due to its potential overlap with the fisheries sector.

4.1 Reducing Emissions from Deforestation and Forest Degradation – REDD

Greenhouse gas emissions from deforestation and forest degradation are estimated to account for approximately 20% of the global annual GHG emissions, most of which is located in developing countries (Myers Madeira, 2008). Reducing emissions from deforestation and forest degradation (REDD) has gained significant attention and progress under the UNFCCC Bali Action Plan of 2007, as a solution to reduce GHG emissions. Under nationally led REDD + programmes goals of ensuring sustainable conservation of forests and community engagement are also pursued (FAO, UNDP and UNEP, 2008).

Three main multilateral schemes exist within REDD the UN-REDD programme (established in 2008), Forest Carbon Partnership Facility (FCPF) and the Forest Investment Program (FIP) established by the World Bank. Figure 4 below shows the distribution of donors and initiatives.

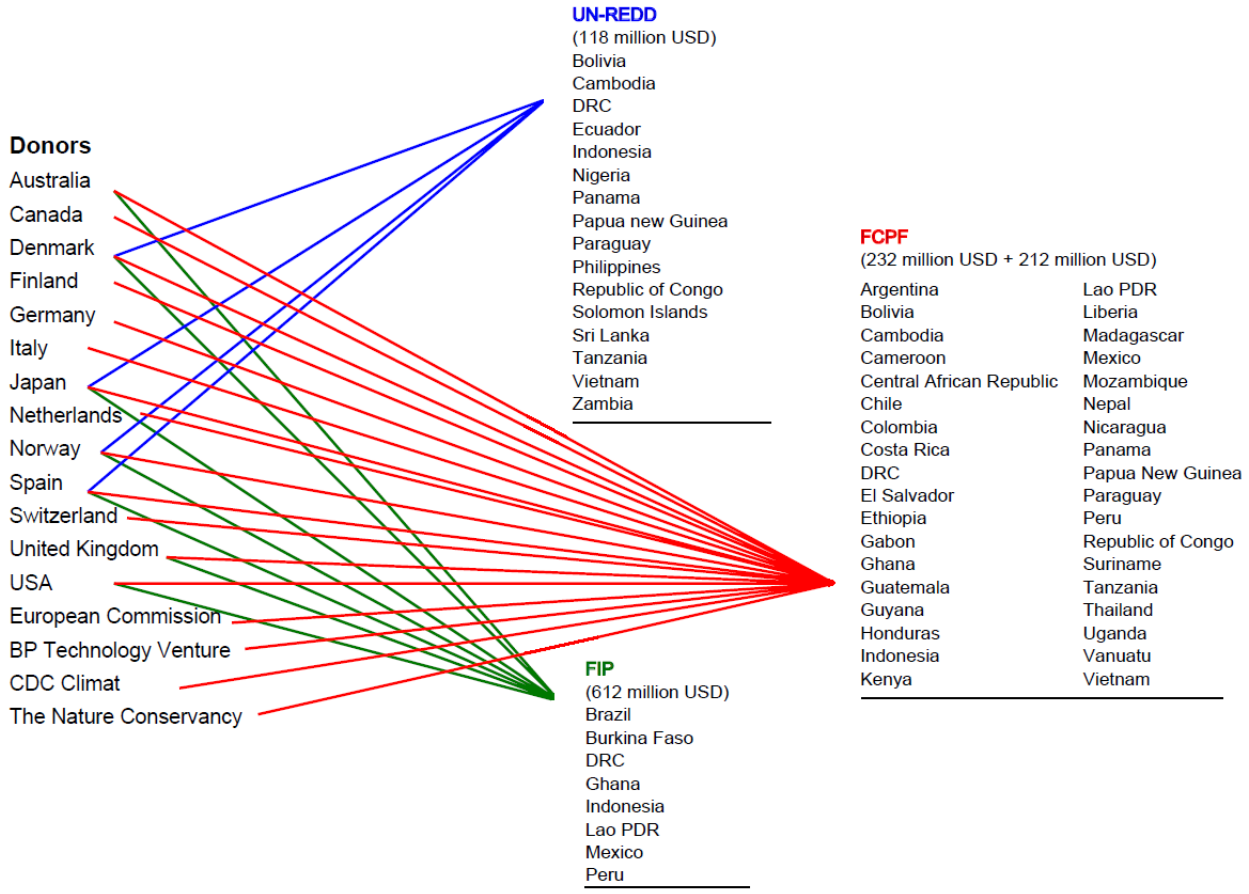

Figure 4 REDD + donors and pilot initiatives. Adapted from Westholm, Mattsson and Ostwald, (2012)

A total of $67.3 million has so far been approved for national programs under UN-REDD (Westholm et al, 2012) and readiness programs supported by FCPF, which ensure countries develop the required infrastructure and capacity through which to adopt the REDD mechanism. The other significant donor is the Norwegian Climate and Forest Initiative, established in 2007 and contributing $600 million per year. A number of accreditation schemes are also available for REDD programs such as the Voluntary Carbon Standard (VCS) and the Climate, Community and Biodiversity project standard (CCB). REDD accounted

for 29% of the total traded volume within the voluntary market in 2010, estimated to be a result of new crediting standards and potential progress in UNFCCC discussions on REDD (Peters-Stanley et al, 2011). However, since 2010 the value of the REDD market has fallen to its current level of 9%, due to low confidence in the market and absence of a binding international climate agreement for all nations (Westholm et al, 2012).

The REDD mechanism has received many critiques since its creation in 2008, due primarily to the difficulties of establishing such a large and diverse carbon financing system with many stakeholders and relatively untested institutional functions and processes. Investment in REDD peaked in 2010, and has since significantly reduced, correlating at least in part with the global market downturn. The issue of developing credible measurements of emissions within deforestation and degradation environments also resulted in concerns surrounding the ability to comply with carbon market regulations, reducing overall trust in the financing mechanism.. However, confidence is growing with the introduction and development of methods such as remote sensing to measure deforestation. A further critique is that of ensuring equitable distribution of benefits, with some arguing that powerful stakeholders may deprive communities of land and their future development aspirations. Finally there is the challenge of reducing carbon leakage within REDD programs, which is often due to displacing deforestation to other areas as a result of community relocation, land availability and changing practices (UN-REDD, 2008).

4.2 The agricultural sector

Agriculture is not only a contributor to climate change through GHG emissions from farming systems and production, but it also provides a sink through which to sequester carbon (Elverfeldt and Bistrom, 2010). As a result of the increasing awareness of GHG emissions and reduction potential in agriculture, a variety of carbon financing mechanisms have been established within the sector, and may offer useful lessons for the fisheries and aquaculture sector as the two are closely linked in regards to food and production. Various methods are available in agricultural schemes to reduce GHG emissions, mainly through carbon sinks, avoided or displaced emissions and reducing overall GHG within the farming system. Changing production practices and adopting technical changes can reduce emissions, such as increasing efficiency, for example using different animal feeds within the livestock sector or changing to organic fertilizers in crop production (Elverfeldt and Bistrom, 2010).

Although 127 agriculture-related projects are so far registered under the UN CDM (predominately focused on waste management and biomass) none so far specifically target land based Iwe production-linked) activities within agriculture, which highlights the emerging yet still limited nature of carbon financing in the sector (Muller-Lindenlauf, 2009). However a number of funds and schemes exist, the main ones of which are highlighted in Table 2. With regards to the geographical distribution of agricultural sector trading schemes within Annex 1 countries, Muller-Lindenlauf (2009) identifies markets around the world such as in New Zealand, Europe, Canada, Japan, Russian Federation and United States. In New Zealand, as of 2012 the agricultural sector is required to present GHG reporting under NZ ETS (World Bank, 2012).

Table 2 Carbon funds potentially available to the agricultural sector,

Carbon Fund	Agricultural element
Climate, Community and Biodiversity Alliance (CCBA)	Includes the IPCC AFOLU (agriculture, forestry and other land use) 2006 standards
Voluntary Carbon Standard (VCS)	Contains cropland and grassland management projects
Chicago Carbon Exchange (CCX)	Includes standards for sustainable rangeland management and conservation tillage

Source: adapted from Elverfeldt, 2010 and Muller-Lindenlauf, 2009

Similar to the challenges facing REDD mechanisms, the agricultural sector must ensure credible systems of measurement and accounting, in order to reduce leakage and ensure additionality, as required under most financing mechanisms. However due to the nature of the agricultural system, difficulty arises when attempting to measure GHG emissions, although significant steps have been made (Elverfeldt and Bistrom, 2010). The sector is also limited in its integration with carbon financing mechanisms as shown above, as although a number of schemes currently exist these are not widespread or financed at significant levels.

4.3 Blue Carbon

The concept of Blue Carbon is similar to that related to the management of carbon embodied within terrestrial organisms and ecosystems, but specifically encompasses the vast amount of carbon stored in oceans and wetland biomass and sediments (Lutz, 2011). The Blue Carbon sector has been gaining significant momentum for incorporation in the carbon market, due to its potentially very large carbon storage potential. As Blue Carbon aims are based on management of aquatic/wetland ecosystems, synergies could exist between financial mechanisms developed for these, and those potentially introduced by the fisheries and aquaculture sector. A number of areas could be seen to overlap, especially in regards to ecosystem management and approach. As yet however there are limited mechanisms and funds available for Blue Carbon to include within the carbon market, although REDD + may provide a possible entry route in the coming years (Gordon et al, 2011), and projects have already commenced for management of mangrove-based wetlands.

5. Current status and emerging trends of the carbon market

Although the carbon market has steadily grown over the last decade, it has not been without its critiques, with debates and research highlighting important issues and gaps. Kollmuss et al (2008), summarised key critiques, noting the recurring issue of 'non-additionality' within cap and trade systems, whereby some mitigation projects are actually found to add extra carbon into the atmosphere. They also note the difficulty within the voluntary market to establish credible systems of measurement and transparency. Debates surrounding fairness and equity also exist, as critics believe it provides developed nations a method to continue unsustainable practices through offset schemes in developing countries which offer uncertain benefits and may in some cases disadvantage vulnerable communities (Myers

Madeira, 2008). Finally the agreed level at which to cap emissions has created problems in regards to setting reasonable yet strict enough targets through which to provide the necessary incentives for countries and companies to reduce their GHG emissions.

According to the annual report 'State and Trends of the Carbon Market', (World Bank 2012), market conditions have been extremely volatile over the last few years. A number of external factors such as the downturn of the global economy and the reduction in demand for carbon credits, and the closure of nuclear power stations in Germany and Japan after the Fukushima incident resulted in significant strain to the carbon market. Although the transaction volume of carbon credits has risen significantly year on year, the market itself has been heavily impacted by the dramatic fall over the last year in the price of carbon, from 15 Euros per unit in Jan 2011 to 6 Euros in Jan 2012 (see Figure 5). Price levels and volatility are an issue in many sectors, with investors seeking less risky assets and markets (World Bank, 2012). Low prices have arguably been caused by a number of factors, the first of which has been the significant surplus of credits within the EU ETS, creating an emissions gap, whereby more carbon credits had been issued than needed. However, in November 2012 the EU reported on managing the surplus, proposing to withhold 900 million carbon credit allowances that would have started in the next phase beginning in 2013 (European Commission, 2012).

Figure 5. - Carbon price Jan 2008- May 2012. EU (2012) sourced from Intercontinental Exchange.

A UN review on the CDM recently called for urgent changes to be made within the fund, the task force concluding that the CDM had *'virtually collapsed'* (CDM Policy Dialogue, 2012). However the report also notes the importance of the CDM to global GHG reductions, noting that were it to collapse a similar system would still need to be created to achieve globally recognised GHG reduction aims..

The most significant change to the geographical composition of the carbon market has been the recent announcement that Australia is joining the EU ETS, which marks the first internationally linking carbon scheme (World Bank, 2012). Australia aims to have 50% of their carbon permits in Europe from 2015 and by 2018 the EU would be able to purchase Australian carbon credits. The benefits of such

collaboration should help to strengthen the carbon market and standards, giving investor's confidence. Table 3 describes a number of new carbon schemes and projects.

Table 3. – New carbon mechanisms and schemes, adapted from World Bank (2012).

Country	New Schemes and Carbon projects
Australia	At the end of 2011 Australian Parliament passed the Clean Energy Act, brings a nationwide cap-and-trade scheme to Australia by 2015. Should cover approximately 60% Australia's emissions at 600 million ton of CO2e per year.
United States - California	Set to become the second largest cap and trade scheme after the EU ETS, the California Air Resources Board (CARB) distributed its first allowances in November 2012, selling up to 23,126,110 credits, targeting 85% of California's annual emissions.
People Republic of China	In 2013 China is expected to launch pilot emissions trading schemes in six provinces and cities, in mind to create a nationwide trading scheme by 2015.
South Korea	Estimated to start in 2015, South Korea aims to incorporate an emissions trading scheme resulting in 470 of the largest polluters (approximately 60% of South Korea's GHG emissions) to pay for CO_2 emissions.

Recent UNFCCC processes

The Durban Accord

At the seventeenth Conference of the Parties (COP) to the UNFCCC in Durban in 2011, a formal agreement was made upon the second commitment period of the Kyoto Protocol to begin in 2013 and last until 2017. At COP 17 in Durban, it was agreed that by 2015 a new legally binding agreement holding all nations accountable for their GHG emissions would be established and come into effect by 2020. This has been hailed by many to be a potential reboost to the carbon market, providing long term perspectives and structures which would build investor confidence. This agreement could also potentially enable a larger geographic incorporation of carbon financing mechanisms, thus increasing the global impact on GHG reductions. Under the Durban accord a new 'Green Climate Fund' was also established in order to ensure long term finance to developing countries, targeted to grow towards $100 billion per year by 2020 (World Bank, 2012).

COP 18 Doha, 2012

The 18th Conference of the Parties, in Doha, Qatar further amended the Kyoto Protocol to define second commitment period running from 2012 until 2020, yet to be ratified. However this was limited to some 15% of the global CO2 emissions in the absence of commitments from Japan, Russia, Belarus, Ukraine, New Zealand, or from the US and Canada, which are not parties to the Protocol in that period, and the lack of engagement of developing countries, particularly China (now the world's largest emitter), India and Brazil which are not so far subject to emissions reductions under the Protocol. Little progress on targeted funding had yet to be reported for the Green Climate Fund. Here, while mechanisms such as the purchase of offsets in carbon markets was seen as an important funding mechanism, prices of $20-25 per tonne were required to generate enough revenue.

5 Lessons for the fisheries and aquaculture sector

A number of issues and lessons can be drawn for potential applications in the fisheries and aquaculture sector. Here in principal, carbon credits could be sought by reducing GHGs associated with various supply chain elements, or traded in some cases to permit high market value production involving large GHG footprints. In other cases, specific management measures could enhance carbon sequestration and thereby qualify for credits within a baseline and credit system. At this stage it is clear that while the principles of engaging in carbon markets could be relatively easily definable for the sector, the practical workings of the markets themselves – their size, geographical location, the value of carbon credits, and the longer term trends of market size, structure and competition, would largely determine the ease of entry of the sector into the carbon market.

The REDD programme highlights important lessons were the sector to be included in carbon markets, including issues of ensuring good measurement, monitoring and reducing potential leakage. However, the REDD example also shows how market confidence can be improved in areas such as carbon measurement, with technical innovation such as the use of remote sensing. The fisheries and aquaculture sector would have to ensure at least similar standards of monitoring and accounting. Experience with the REDD also highlights the importance of communities and stakeholders in carbon financing mechanisms and the challenges that arise in ensuring equitable benefits to those involved. Similar issues would apply in the aquatic sector, with direct or indirect impacts on producers, supply chain participants, their communities and a wider range of stakeholders. Finally, the REDD example shows the need to build capacity and infrastructure in beneficiary countries through developing national strategies and monitoring systems.

The voluntary market appears at this stage to be the most likely starting point if the fisheries and aquaculture sector were to be incorporated within carbon markets. The example of the agricultural sector provides a relatively close link with the aquatic sector, and could indicate potential entry routes and challenges. The relevant conditions through which the agricultural sector can incorporate carbon financing mechanisms are described by Perez (2007, cited in Muller-Lindenlauf, 2009). Related implications for the aquatic sector are noted:

- Capacity of the agricultural practices to enhance C storage; here definable and scientifically verifiable mechanisms would be required to demonstrate that carbon could be reliably stored in aquatic management processes over definable periods of time. Where C reduction impacts are indirect – eg reducing GHGs associated with fuel or energy consumption, or other significant inputs or processes, definable and measurable levels of GHG change would be required.
- Capacity of farmers to adapt and maintain these practices; this would apply to relevant fishery sector supply chain participant once the C reduction/storage mechanisms are defined; short – term or temporary changes would rarely merit commitment of market monitoring resources
- Institutional capacity to aggregate C credits; particularly for the small-scale producer/supply chain system; in many cases credits would be built up in small numbers by collective individual actions, and some mechanism would be required to ratify and collate these.

- Ability to monitor C stocks; this would be required to verify storage or C reduction actions; this is potentially more complex in aquatic ecosystems and would require the establishment of standardised procedures and technically accredited measurement agents.
- Access of farmers to incentive payments; in the aquatic sector this would potentially apply to any relevant supply chain participant, and would require transparent, timely and cost-effective procedures.

Besides these functional issues, a large scale review of the CDM mechanism in 2012 noted a number of recommendations, some of which could in theory offer entry points for the fisheries and aquaculture sector. These include a larger involvement of energy technologies associated with energy efficiency, renewables and carbon dioxide reduction (World Bank, 2012). The review also suggested that countries engaging in the CDM adapt to new political settings and test a sector wide approach in order to mitigate at various scales, in line with recommendations of Baron et al (2009). This would encompass Sector Crediting Mechanisms (SCM), including policy based crediting, rate based crediting and fixed sector emission limits (Baron et al, 2009). Finally, options might also exist for creating a voluntary market mechanism specifically for the aquatic sector, with carbon credits either purchased directly by aquatic sector or related entities, or more openly marketed across all sectors. Aside from requiring the appropriate level of commitment across a range of supporting stakeholders, this would require an effective business plan and implementation schedule, demonstrating viability with realistic carbon market prices at current and projected levels.

6. Conclusions

This review has outlined the key components, mechanisms and trends within the carbon market, to explore its potential for creating incentives for the fisheries and aquaculture sector. The World Bank's annual report of 2012 and the CDM review, shows in detail the current difficulties in the carbon market, with a lack of confidence from some investors, low prices and high surplus of credits creating an unfavourable environment for longer term investment. However, new developments and mechanisms are being created, enabling a wider geographical distribution of the carbon market, as shown by Australia joining the EU ETS. In regards to the fisheries and aquaculture sector, there are no carbon funds or mechanisms currently available, but lessons can be drawn from agricultural carbon schemes and REDD, which indicate the methods, entry requirements and issues of measurement and verification.

The formation of credible standards and methods of measurement would be a critical for the fisheries and aquaculture sector to engage in carbon markets, and while market confidence is low, options for new and untested sectors, whatever their potential for carbon reduction, may be limited. However with an increasing chance that global warming will reach 4o Celsius by 2100 even if current national pledges and commitments are kept (Word Bank, 2012), the imperatives for more targeted action across all sectors are more strongly evident, and if carbon markets prove more generically to become effective incentives and drivers of reducing GHGs, they need to be as inclusive as possible of all sectors.

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