Climate Change and Forest Policy in the Asia-Pacific

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Executive Summary

While many forests of the Asia-Pacific are vulnerable to anticipated impacts of climate change, forests also represent an opportunity to sequester atmospheric carbon, provide renewable resources, and improve livelihoods. Policies within the Asia-Pacific region that are relevant to climate change and forests are as diverse as the cultures they represent. Policies include those of international scope, such as the United Nations Framework Convention on Climate Change's (UNFCCC) policies, including the *1997 Kyoto Protocol* from which a number of Asia-Pacific nations, including Australia, Canada, Japan and the United States, withdrew. Other policies are continental in scale such as North America's *Western Climate Initiative* (WCI) or Asia's *Asian Co-benefits Partnership* (ACP).

There are also national, state- or province-wide policies to mitigate or adapt to climate change that include sustainable forest management practices, promote the use of long-lived forest products, or substitute forest biomass for fossil fuel. Most developed Asia-Pacific nations, including China, have developed some sort of climate policy that involves forests, while many developing nations rely on global initiatives such as the United Nations Collaborative Programme in *Reducing Emissions from Deforestation and Degradation* (REDD).

In a time of emerging global change, it is of crucial importance that policies are developed at global, national, regional and local scales to combat, or at minimum ease, climate change and the impacts it will have (and is having) on our society. Nevertheless, it is not enough for those policies to simply exist. They must be effective, and based on sound science. They must account for the various economies and social differences between and within countries. They must be enforceable, yet flexible to changing perceptions and knowledge.

Although national and local policies appear effective for the regions that develop them, in times of global change it is important that global and transboundary policies exist. The *Kyoto Protocol* may have failed to accommodate the interests of some of its parties, and consequently witnessed failure, but that does not make such a policy unachievable. The mitigation of, and adaptation to, climate change is for the common good.

The mechanisms in place to reduce and sequester emissions have an ultimate impact on global and national economies; and consequently, many of the policies that have been developed focus on market mechanisms, rather than sound scientific principles that would ensure the policies' effectiveness. Economic changes evoked by climate policies can be viewed as positive, for instance by maintaining forests and innovating with new technologies; the alternative is to continue with business as usual in a carbon producing, rather than conserving, economy. Many Asia-Pacific nations and communities are taking action and co-benefits are arising as a result. Forests provide a unique opportunity in this respect and with effective science-based management and legislation, forests may provide some of the climate change mitigation solutions we so urgently require. Although existing policies appear insufficient in effectively mitigating climate change in the Asia Pacific region, or globally, the integration of scientific research with effective forest management principles will enable the region's inhabitants and

forest managers to adapt their practices and limit the impacts of climate change on forests and the communities that depend on them.

1. Introduction

Since the realisation of the causal link between anthropogenic emissions of greenhouse gases (GHG) and rising global temperatures, there have been numerous policies developed to both mitigate and adapt to climate change. Some policies are international in scope, but despite their intentions may be doomed for failure. Other policies may exist at the national, state or provincial, and sometimes municipal level. Still others represent efforts of a more local nature and are enforced at the community level.

Some policies attempt to affect climate change directly by reducing GHG emissions. Other policies act to influence the changing climate indirectly through carbon sequestration and other management techniques. There are also policies that offer guidance on climate change adaptation, acknowledging that some change is inevitable, and realising that many of our practices must change in order to keep up with a changing climate.

Forestry represents a unique opportunity for climate change research, mitigation and adaptation. Forests are not only vulnerable to a changing climate, but take up and sequester carbon, offering a unique tool for climate change mitigation and management. Growing forests, afforestation, reforestation and improved forest management can all provide net GHG sinks. Therefore effective forest policy shows promise as a tool for climate change mitigation and adaptation.

People of the Asia-Pacific (AP) region rely heavily on forests and the services or products they provide. For instance, an estimated 60 million indigenous people in the region are directly dependent on forest resources as a source of income, fuel or food (Asia Development Bank 2009). Furthermore, the Asia-Pacific is predicted to be particularly vulnerable to climate change outcomes when compared to the rest of the world (Vickers et al. 2010), adding to the challenges already faced by the region's forest-dependent communities. This review of public policy in the Asia-Pacific region therefore focuses on public policy as it relates to climate change and forestry. It aims to determine whether existing policies can enable the region's inhabitants and forest managers to adapt their practices in order to limit climate change and its impacts on forests and the communities that depend upon them.

2. Global policies

2.1 The United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is an international treaty that was formed in 1992 as a way for nations to cooperatively limit temperature increases arising from climate change. The *Convention's* 'Commitments' under Article 4 s. 1 c) call for the development of practices and processes that: "control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the

Montreal Protocol in all relevant sectors", including forestry. The *1989 Montreal Protocol on Substances that Deplete the Ozone Layer* does regulate some GHG that are also stratospheric ozone-depleting halogenated hydrocarbons containing chlorine or bromine, such as chlorofluorocarbons (CFC) and hydrofluorocarbons (HFC). These and other ozone depleting substances have been, and are being, phased out under the *Montreal Protocol*. The UNFCCC applies to all other GHG, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tetrafluoromethane (CF_4) and sulphur hexafluoride (SF_6). Water vapour and ozone (O_3) are also GHG but due to the commonness of the former, and the secondary formation rather than direct emission of the latter, neither of these are usually regulated by climate change policies.

Another Commitment under Article 4 s. 1 d) of the *Convention* is to promote the conservation and enhancement of carbon sources and sinks, including forests and biomass. Further, s. 8 of Article 4 states that implementation and response measures must consider the needs of developing countries, specifically in "countries with arid and semi-arid areas, forested areas and areas liable to forest decay" (s. 8 c)). Low-lying coastal areas and areas prone to drought or desertification are also to be given special consideration in terms of technology measures and mitigation actions.

The United Nation Environment Programme (UNEP) and the World Meteorological Association established the Intergovernmental Panel on Climate Change (IPCC) in 1988. Since 1992 the IPCC, through its various Working Groups, has been developing methodologies and guidelines to assist parties to the UNFCCC and its associated protocols, in producing accurate and comprehensive GHG inventories. Some of the most important work of the IPCC is the development of various emission scenarios to be used in climate models, and in 2010 a Memorandum of Understanding was developed between the IPCC and the Integrated Assessment Modelling Consortium (IAMC) that helped to define the links between IPCC Working Groups and the scientific community as a whole (IPCC 2012). The work of the IPCC is used not only by parties to the UNFCCC and its associated protocols and instruments, but also in other global, regional and national agreements of various scopes and scales.

There are now 195 parties to the UNFCCC; and in 1995 the *Kyoto Protocol* was drafted in order to deal adequately with the pressing issues of climate change. Unlike the *Convention*, the *Kyoto Protocol* laid out the details of emissions reduction and prescribed the means by which they could be achieved.

2.1.1 Kyoto Protocol

In order to be successful, climate change policies and any associated forest policies need not only to be relevant, practical and scientifically sound, but enforceable and widely accepted. The *1998 Kyoto Protocol to the UNFCCC* ('*Kyoto*') is perhaps the most notorious example of a climate change policy that although relevant and scientifically sound, has not been well accepted or enforced. Adopted December 11, 1997 (UNFCC 2012a), the goal of the Protocol was to reduce GHG emissions from participating industrial nations by an average of 5% from 1990 levels over the five-year period from 2008–2012 – the 'first commitment period'. This 'average' meant that while most nations had to reduce their emissions over 1990 levels to satisfy the Protocol requirements, others were allowed to maintain, or even slightly increase their emissions over the

'base year' while still maintaining the 5% reduction averaged over all signatories. The GHG that are regulated by the Protocol include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphurhexafluoride (SF6s). Initially thirty-eight industrialised nations plus the European community signed the 1988 Protocol as listed in its Annex B (also known as "Annex I" countries, including the Asia-Pacific nations of Australia, Canada, Japan, New Zealand, Russian Federation, and the United States of America (Annex B, *1998 Kyoto Protocol to the UNFCC)*.

In addition to *Kyoto's* 'flexibility mechanisms' of Emissions Trading, Joint Implementation (JI) and the Clean Development Mechanisms (CDM) (Harrison 2007), the Kyoto Protocol included provisions for reducing net GHG emissions from "direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period" (Article 3.3, *1998 Kyoto Protocol to the UNFCC).* However, Article 3.7, which is commonly referred to as the "Australian clause" (e.g., Hamilton and Vellen 1999; Crowley 2007), allows:

> "Those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount."

Figure 1. Plantations such as these post-1990 eucalypts in the western Tasmania, Australia, can play a role in carbon balance calculations.

This means that Australia, which in 1990 emitted 89.8 Mt CO_2e (carbon dioxide equivalents) from land-use practices alone (Hamilton and Vellen 1999), was able to show national reductions in emissions simply by reducing land conversion, rather than reducing industrial emissions. Furthermore, Article 3.7, although triggered by both forestry and land-use change practices, required only the emissions from land-use change to be accounted for in the base year (1990) calculation, not emissions from forestry (a sink). Article 3.7 therefore substantially increased Australia's base year emissions estimate making it easier to show subsequent reductions. Australia argued for this clause to be included prior to signing *Kyoto* in 1997, despite having the highest per capita net annual GHG emissions of any Annex B nation (27.5 t) (Crowley 2007). This is in addition to an already lenient "quantified emission limitation or reduction commitment" of 108% of base year (1990) emission levels by 2012. Australia is essentially the only industrialised Annex I nation of the Protocol that Article 3.7 applied to because Australia was the only developed country with significant GHG emissions from land conversion in the 1990 base year (Hamilton and Vellen 1999).

In essence *Kyoto* allows for Annex I countries (listed in Annex B) to account for forest carbon sources and sequestration from the perspective of that country's individual emission goals. Conversely, non-Annex I parties (considered "developing" at the time of ratification), must rely on the Protocol's Clean Development Mechanisms, which reward qualifying projects – such as reforestation and afforestation – with Certified Emissions Credits that can then be sold to Annex I nations to offset their own GHG emissions. However, because these credits are awarded to the project developers, rather than to the host nations, there is little incentive for non-Annex I countries to develop far-reaching national forest policies (Baldwin and Richards 2011). Non-Annex I parties to the convention in the Asia-Pacific include Afghanistan, Bangladesh, Bhutan, Cambodia, China, the Democratic People's Republic of Korea, Fiji, Georgia, India, Indonesia, Lao People's Democratic Republic, Malaysia, Maldives, Pakistan, Philippines, Republic of Korea, Samoa, Tajikstan, Thailand, Uzbekistan and Vietnam. These are countries that are considered by the UNFCCC to be particularly vulnerable to climate change from either a geophysical or economic perspective and are given unique consideration based on those vulnerabilities. Non-Annex I parties still inventory and report GHG emissions but are exempt from particular aspects of the Protocol such as firm emissions reduction targets.

The Protocol came into force on February 16, 2005 (UNFCC 2012a) and was ratified last of all by the Russian Federation on June 16, 2005 (Hamilton 2007). Australia, Norway and Iceland are the only three Annex I countries whose "quantified emission limitation or reduction commitment" were greater than 100% (Table 1). Australia and the United States withdrew from the protocol, as permitted by Article 27, before ratification. The United States decided to withdraw from the protocol first, in March 2001, citing costs to the economy, the exclusion of developing nations, and uncertain science, as the reasons for withdrawal (Hovi et al. 2003, Harrison 2007). Australia withdrew in 2002, then citing the cost of reducing energy sector emissions and the abandonment of carbon sink credits in the second commitment period (i.e. after 2012), as reasons for its departure (Crowley et al. 2007). Many blame the powerful lobbying of the fossil fuel industry for the withdrawal from *Kyoto* by the United States and Australia (respectively, Harrison 2007 and Crowley et al. 2007).

Canada, Russia and Japan removed themselves from the agreement in December of 2011, immediately before the commencement of the second commitment period, deciding not to sign the *Kyoto* extension for another term (Glomsrød et al. 2012). Canada's withdrawal was later than some would have expected based on the imbalance that the Protocol would have imposed on the United States – Canada free-trade relationship (Harrison 2007). Also, like Australia and the US, Canada's withdrawal from the agreement was blamed on a powerful and lucrative oil industry (Doelle 2012). However, unlike these other industrialised Asia-Pacific nations, New Zealand remains committed to the Protocol and its associated accords and conventions, despite the country's emissions having increased since the 1990 base reporting year (UNFCCC 2012b).

Figure 2. Afforestation in Xining City, Qinghai Province, China. As a non-Annex 1 country, China cannot gain carbon credits for such projects under the Kyoto Protocol.

The 17th Conference of Parties (COF17) in Durban, South Africa, in December 2011 marked the beginning of the next commitment period for the Kyoto Protocol – the date when a new international agreement was to be negotiated and ratified. The lack of participation from large industrialised emitters like the United States, Canada, and Australia is being blamed for some of the difficulties encountered in developing common goals and global commitments from the international community for the next decade(s). Another contentious issue is whether or not emerging economies that are also large emitters, such as China, should be required to develop legally-binding emission reduction targets (Hu and Monroy 2012). This concern closely resembles that of the United States 1997 Byrd-Hagel resolution, which states that the Senate will

not make any commitments to reduce GHG emissions unless developing nations are required to make similar commitments over the same period (Harrison 2007). Unfortunately, this and other issues could not be resolved, and no detailed future commitments were made at COF17. Therefore the future of *Kyoto*, and global GHG emission reductions, remains uncertain.

The largest and most industrialised *Kyoto* signatories of the Asia-Pacific region (Australia, Canada, the United States, Japan, New Zealand and Russian Federation) continued to report their emissions up until at least 2009. Except for Japan and the Russian Federation, all of these Asia-Pacific nations increased their emissions of GHG between 1990 and 2009 (Table 1). There are also substantial differences between the change in GHG emissions with and without the consideration of Land-use, Land-use Change and Forestry (LULUCF). In fact, the inclusion of LULUCF in emissions calculations, actually increased emissions in both Canada and New Zealand meaning that in these two countries, forests represented a net source of GHG from 1990–2009 (Table 1). In Australia, the United States, Japan and the Russian Federation, forestry and other land-uses, represented a net sink. In accordance with Article 3.3 of the Protocol, parties need only report human-induced emissions resulting from land-use change and forestry, not natural emissions from sources such as decomposition or wildfire.

Figure 3. The massive mortality of Lodgepole Pine (*Pinus contorta*) in western Canada caused by the Mountain Pine Beetle (*Dendroctonus ponderosae*) has turned Canada's forests from a net sink to a net source of carbon.

Following the discussion of *Kyoto's* "Australian clause" above, Article 37 was able to

substantially increase Australia's base-year (1990) emissions through the inclusion of LULUCF. The fact that the country's emissions still increased, but that the inclusion of LULUCF marginally decreased this increase (by 0.5%) illustrates that while land-use and forestry were a net source of GHG in 1990, Australia slowed its rate of land clearing and conversion, making land-use and forestry a net sink by 2009. On the other hand, the inclusion of forest and land-use practices increased emission estimates in Canada and New Zealand, meaning that in both of these countries forestry and land-use (combined) were a net source of GHG over the period from 1990–2009.

2.1.2 Copenhagen Accord

The post-2012 *Kyoto* accord now applies only to European nations and no longer has any relevance to countries of the Asia-Pacific. However, on December 18, 2009 at the 15th session of the Conference of Parties (COP15), the UNFCCC took note of the *Copenhagen Accord*, which established that GHG emissions must be reduced in order to keep mean global temperatures from increasing by more than 2ºC. Following the development of this accord, countries made their own pledges to reduce their GHG emissions or carbon intensities by 2020 (Glomsrød 2012). A total of 114 nations initially agreed to the accord and that number later increased to 141 (UNFCCC 2012c). Despite having withdrawn from the Kyoto Protocol, the United States, Canada, Japan and the Russian Federation each made pledges under the *Copenhagen Accord*, as did China and India, officially joining the ranks of industrialised nations in the battle against climate change. Other Asia-Pacific nations that have agreed to the accord include Cambodia, Fiji, Indonesia, Lao People's Democratic Republic, Nepal, Republic of Korea, Samoa, Singapore, and Vietnam. Each nation's responsibilities under the *Copenhagen Accord* differ by base year and emission reduction target.

2.1.3 Cancun Agreements

In December 2010, parties to the UNFCCC signed the *Cancun Agreements*, a set of decisions by the international community to collectively and comprehensively address climate change and to take action to speed up the global response to its threats. A major objective of the Agreement was to "protect the world's forests, which are a major repository of carbon" (UNFCC 2012d). They included an agreement on LULUCF, which calls for the development of a broader climate change agreement that would include sources and sinks of carbon from the forests of developing nations

Because pledges under both the *Copenhagen Accord* and the *Cancun Agreements* are fulfilled by each individual country's climate policies, discussion of individual Copenhagen pledges take place in the following sections for individual countries. However, other international policies and their instruments that may be of relevance to the region's forests are first discussed.

2.1.4 REDD and REDD+

'REDD' stands for Reducing Emissions from Deforestation and Degradation (in developing countries). REDD was developed as a positive incentive by the UNFCCC to help mitigate climate change. In addition to simply reducing deforestation and degradation, the term REDD+ includes incentives for sustainable forest management, forest conservation and the enhancing of carbon stores and forests' capacity to store carbon (Vickers et al. 2010; Lederer 2011). REDD+ includes a diverse suite of climate change initiatives in addition to the UN-REDD programme, such as the World Bank's Forest Carbon Partnership Facility and the Forest Investment Program (UN-REDD 2009a). Both REDD and REDD+ represent mechanisms for mitigating GHG-induced climate change through carbon sequestration in living biomass, rather than through anthropogenic emissions reductions. Growing forests are able to take up and sequester large amounts of carbon. Some forests of the Asia-Pacific have been shown to be exceptionally efficient and effective at taking up and storing carbon. For instance the cool temperate eucalypt forests of Australia are thought to be capable of more carbon uptake in above-ground-biomass than any other forests in the world (Keith et al. 2009), and the boreal forests of northern North America (Banfield et al. 2002) and Russia (Stolbovi and Stocks 2002) store immense amounts of carbon in belowground biomass as peat. This gives the Asia-Pacific and many of the region's nations an enormous competitive advantage in terms of carbon trading and REDD (or REDD+) responsibilities.

Figure 4. A major objective of REDD is to prevent conversion of forest to agricultural land, as is happening here in the Crocker Mountains of Sabah, Malaysia.

However, for the period from 1850–1995, an estimated 75% of total carbon emissions from Asia and Southeast Asia were the result of deforestation for agricultural conversion (Houghton and Hackler 1999). Therefore a reduction in the region's deforestation through incentives such as REDD is a key to reducing GHG emissions. Asia-Pacific governments widely recognise the importance of REDD and its mechanisms as elements of climate change mitigation policy, and as sources of income for the nations they represent. Programmes in developing nations include sponsorship and collaboration with both the private and public sectors. The UN-REDD programme is building capacity and readiness in countries such as Cambodia, Indonesia, Nepal, Papua New Guinea, the Philippines, the Solomon Islands and Vietnam (Vickers et al. 2010). Each of these nations has a UN-REDD National Programme and receives direct support from the programme; other than Nepal, which is a 'partner country' and therefore receives only "targeted support" for "national actions" while also benefiting from the unique knowledge sharing opportunities of the programme (UN-REDD 2009b).

Full-scale REDD projects are yet to be initiated. Instead, "demonstration" and "readiness" activities are taking place, and more than half of these 'demonstration activities' take place in the Asia-Pacific nation of Indonesia (Myers Madeira 2009). In addition to readiness management and capacity-building activities, in countries such as Cambodia UN-REDD has established monitoring programmes and completed assessments of existing land-use related activities and policies. A programme executive board has also been developed that is in the process of gaining participation from indigenous peoples and community members in addition to the Cambodian government entities already involved (UN-REDD 2010).

Until recently, REDD activities were carried out on a concession basis and contracts negotiated with those already holding forest tenure rights, leaving little room for small-holder or community participation in the decision-making process. Many have been calling for more synergy between REDD and schemes such as Payment for Environmental Services (PET) which can help elevate communities and aid in poverty alleviation – a main driver of deforestation (Myers Madeira 2009). In addition, concession-based forestry can have severe social and economic impacts at the local level. For instance in northeastern Cambodia, the granting of such concessions in the 1990s has led to extreme deforestation and forest degradation and has restricted the access of indigenous people to the non-timber forest products on which they depend (Asia Development Bank 2009). However, in the past two years, the REDD programme has developed, allowing for more participatory multi-stakeholder governance in projects and for additional pilot projects to be initiated, particularly in Indonesia (UN-REDD 2012). The CDM under *Kyoto* has provided capacity building and training at the national and project level for REDD programmes particularly in Cambodia, Indonesia and Papua New Guinea (Japan-MOE 2011). In addition to directly conserving forests and reducing deforestation, other REDD projects may involve the restoration of previously deforested peatlands because peat stores significant carbon as belowground biomass. Such a REDD pilot project is being undertaken in the central Kalimantan province of Indonesia (Vickers et al 2010).

2.2 Emission Trading

Although emission trading began as a flexibility mechanism of *Kyoto*, which allowed parties to "participate in emissions trading for the purposes of fulfilling their commitments under Article

3" (*1998 Kyoto Protocol*, Article 17), the concept of an openly-traded carbon market has evolved greatly since 1998. There are two different types of emission credits. One type of credit is given to a nation, company, individual, etc. for reducing GHG emissions beyond required reductions (for instance those reductions specified in Annex B of the Kyoto Protocol, see Table 1). Another type of credit can be gained through atmospheric carbon uptake and sequestration, for instance through the (re)planting of forests. Estimates suggest that forestry has the potential to reduce an average of 6.7 billion tonnes of CO_2e emissions annually, with much of this potential originating in the tropical forests of Southeast Asia. Furthermore, the inclusion of forestry in carbon trading schemes lowers the price of carbon (per tonne) significantly, allowing for more investment in other low-carbon technologies (Sohngen 2009).

Various emission-trading schemes exist as part of climate change mitigation programs. Carbon markets have been introduced at the international level (e.g., *Kyoto* discussed above), and at multinational, national and even provincial or state levels. In 1997 the *International Carbon Action Partnership* (ICAP) was established by the leaders of more than fifteen governments; including North American members of the Western Climate Initiative (discussed below), Australia, New Zealand, and the Tokyo Metropolitan government, along with numerous members of the European Union. Japan and the Republic of Korea are Asia-Pacific observers of this partnership. The political declaration of ICAP not only acknowledges, once again, the need for urgent action on climate change, but also the need to develop a low-carbon economy, market-based solutions in the form of cap-and-trade arrangements, and a system of linked regional and national markets for the development of a global carbon market.

The Chicago Climate Exchange (CCX) was formed in 2003 and operated as the largest cap and trade programme in North America until 2010. Accounting for approximately 700 million tonnes of carbon dioxide, participants included major corporations, electrical utilities, financial institutions and even farmers, ranchers and foresters operating in all fifty US States, and eight Canadian provinces. The CCX established a market-based price on legally binding emissions reduction commitments and facilitated the development of new technologies and innovations. Each member was issued an emission baseline – if the member emitted less than the baseline, they banked offset credits. If a member emitted more than their baseline, they were required to purchase verified offset credits. Emission baselines were reduced each year of the programme from 2003 to 2010, to correspond to an overall 6% emission reduction by all members. In July 2010, the CCX was acquired by the Intercontinental Exchange (NYSE: ICE) – a leader in regulated global future exchanges. The ICE had already provided the electronic trading platform for CCX and the Chicago Climate Futures Exchange (CCFE) since their launches in 2003 and 2004, respectively. The ICE also co-developed the European Climate Exchange (ECX) with traded carbon masses of three-times those of CCX. The ICE also owns and represents clearing houses for carbon futures in Europe and North America. In 2011 CCX formed the CCX Offsets Registry Program for the registration of verified emission reductions. Participants can acquire or purchase these offsets by registering an account (CCX 2011).

The CCX maintains a project protocol entitled 'Forestry Carbon Sequestration'. Eligible projects include afforestation, reforestation and 'widely spaced tree planting' projects that consist of establishing forests on land that has not had forest cover for at least ten years prior. These activities usually occur in areas where forest cover has been lost as a result of natural

disturbance, rather than as a result of management or negligence. 'Sustainably managed forest projects' can also qualify for offset credits, assuming they involve either the maintenance of, or net increases in, forest carbon stocks, and that they receive certification from a CCX approved standard. Exchange offsets are also made available for 'long-lived wood products' (LLWP). However to qualify, providers must also enrol their forest carbon stock in the 'sustainably managed forest protocol'. Participants must maintain the land as forest for at least 15 years from the date of enrolment. In addition to LLWP, which include products such as timber used in furniture and building materials or pulpwood for long-lived paper products, eligible carbon pools include above- and below-ground biomass, soil organic carbon, standing or downed dead trees and wood, and forest floor portions including root biomass. Project owners must make voluntary, but legally binding, commitments to sequester additional carbon over the baseline inventory year carbon stores. This additional carbon storage makes up the offset credits to the project owner. Eligible projects cannot be a requirement of any other law or legally binding framework, including another carbon trading scheme (CCX 2009). The protocol contains calculation tables and growth rates of various species to aid project participants in determining the amount of carbon sequestered by enrolees.

Both Australia and New Zealand have developed their own emission trading schemes, and the WCI developed a regional carbon market for parts of North America. These and other climate change mitigation and adaptation policies are discussed, with a focus on forests of the Asia-Pacific, in the sections below.

3. Multi-national and Continental Policies

3.1 Western Climate Initiative (WCI)

The WCI, originally the Western Regional Climate Action Initiative, was founded in April of 2007 and developed as a cross-border North American initiative that initially included the western states of the USA: Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington; the western Canadian province of British Columbia; and the more central Canadian provinces of Manitoba, Ontario and Québec. Hosted by the Western Governor's Association, the WCI also included various aboriginal nations and Mexican states as observers. The initiative began as an independent collaboration of member jurisdictions aimed at developing and implementing emissions trading policies and tackling climate change at a regional level, while providing net economic benefits to partner jurisdictions and the region as a whole.

Set for implementation in 2012, the WCI established regional GHG emission reduction targets at 15% below 2005 levels by 2020 (WCI 2012). Central to the initiative was a flexible market-based cap-and-trade mechanism, under which qualifying facilities emitting greater than 10,000 t CO_2e yr^{-1} must report (WCI 2009). The programme was anticipated to represent two-thirds of member jurisdiction GHG emissions by implementation in January 2012; and by full implementation in 2015, the program was expected to encompass 90% of those emissions. A single offset under the programme is equal to the removal or reduction of 1 metric tonne of CO_2e using a broad and diverse range of reduction opportunities.

Although the WCI began with 11 member state/provincial jurisdictions from the US and Canada, many of those members have since suspended or ended their participation in the programme, leaving only five of those jurisdictions currently active: California (as the only state) and the provinces of British Columbia, Manitoba, Ontario and Québec. Furthermore, since 2012, the WCI has morphed into a new entity "WCI Inc.", focused on the implementation of regional cap-and-trade programmes that only California and Québec have yet to implement regulations for (Lee Alter *Personal Communication*, May 2013).

The new entity WCI Inc. follows the same guidelines and principles of the original initiative despite the loss of its members and affiliation with the Western Governor's Association. This includes the offering of credits or offsets through forests activities and exemptions from emissions caps for these same industries. For forestry (and agriculture) sequestration projects, performance standards (baseline values) are based on 'proportional additionality' – the modelling of sector activity as an aggregate across the partner jurisdiction or the entire region to determine an existing or 'business as usual' baseline value (WCI 2012).

The WCI has considered the development of a 'forest protocol', and other protocols under review include those for manure management, ozone-depleting substances, coalmine methane, and small landfills (WCI 2012). Emissions from forests are not reported in emission totals due to the difficulty and cost associated with accurately calculating forest emissions. However, the emissions from fuels used in forestry activities, and pulp and paper manufacturing, are required to be inventoried by active member partners (WCI 2009).

Biomass fuels, which often consist of scrap wood and other forest-sector wastes, are excluded from the voluntary WCI GHG reporting up to a maximum of 15,000 t CO_2e yr^{-1} for "pure solid biomass fuels", provided that total (biomass) emissions are less than 25,000 t CO2e yr^{-1} including those "from solid biomass fuel" (WCI 2009). The word "pure" is defined as "consisting of at least 97 percent by mass of a specified substance". Further "solid biomass fuel" is defined as "plants or parts of plants, in their natural state that have been mechanically or chemically separated, but not chemically altered from the natural state". In this case solid biomass fuel that is not "pure" is likely to contain plant matter that has not been either mechanically or chemically separated. By (this) definition, solid biomass fuels can include pulp and paper wastes such as kraft black liquor. The WCI's biomass threshold only applies to partner jurisdictions of the WCI as long as those jurisdictions have not yet developed their own "determination regarding the carbon neutrality of any biomass fuels", after which time emissions from biomass used as fuel need no longer be reported. Some parties have determined such neutrality, namely California and Québec, and although the western state of California's policies are described below, Québec is in eastern Canada and not considered to be part of the Asia-Pacific for the purpose of this report.

The WCI also includes mechanisms to deal with the 'permanence' of carbon sequestration. For instance, while a forest is growing it stores carbon in live biomass, and in dead biomass as woody debris or soil. But this storage is impermanent and the carbon will be released to the atmosphere when that biomass is decomposed, or combusted as solid fuel. Projects are expected to consider and account for potential impermanence when offset accounting. For the purpose of

WCI, permanent sequestration is that which continues for more than 100 years, in accordance with UNFCCC definitions (WCI 2010). The 100-year time interval is also used in radiative forcing calculations of Global Warming Potential (GWP) for GHG other than CO_2. The concept of permanence is especially important when considering credits or emissions in terms of forestry and associated biomass.

Figure 5. Previously considered as waste to be burnt on-site, slash piles such as this one in coastal British Columbia, Canada, have acquired new value as society seeks to replace some fossil fuels with renewable sources of energy.

The new WCI Inc. follows a more corporate model than its predecessor, providing a compliance tracking system, administering (carbon emission) allowance auctions, and providing market monitoring for offset credits. The collapse of the WCI's original framework represents another example of climate change policy's inability to simultaneously appease members and achieve targets. The future of WCI or, WCI Inc., and its ambitious GHG emission targets, remains to be seen. However, the remaining members that have implemented WCI-related regulations, namely California and Québec, continue to follow WCI's initial regulations and protocols, and it is possible that WCI Inc. may regain support with its new business model.

3.2 The Climate Registry

The Climate Registry is a non-profit collaboration that includes every Canadian province and territory other than Nunavut, every western state in the USA other than Alaska, and six provinces in Mexico. The purpose of the registry is to provide a consistent and transparent methodology for the calculation of GHG emissions, and a repository for those estimates. The registry is completely voluntary and is not legally binding.

Although the registry does not include any forest-specific mechanisms, it does provide guidelines for reporting biomass emissions – which by definition include residues and wastes from the forest industry. Emissions from biomass are accounted for only when the biomass is combusted as a fuel source. Biogenic emissions on the other hand are excluded from the GHG Protocol Corporate Standard used by the registry, but they are tracked and reported separately in accordance with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

3.3 The Asia-Pacific Partnership on Clean Development and Climate

The Asia-Pacific Partnership on Clean Development and Climate is a United States led initiative that includes partnership with China, India, South Korea, Australia and Japan to develop and promote "cleaner energy technologies" (The White House 2006a). These six Asia-Pacific nations represent 50% of the world population and 50% of global GHG emissions. The energy, mining, manufacturing and construction industries are the target of this Partnership (The White House 2006b). Although the partnership does not appear to include any provisions for forestry, forest sequestration or biomass, because it represents a number of Asia-Pacific nations, it was included here. From the perspective of China, this Partnership is considered complimentary to UN climate mechanisms, but is preferable over *Kyoto* and other UNFCC mechanisms that are viewed as a potential threat to economic development (Heggelund and Buan 2009).

3.4 Asian Co-benefits Partnership

The *Asian Co-benefits Partnership* (ACP) was announced at the "Better Air Quality 2010" meeting in Singapore in November 2010. It was developed in response to outcomes of a seminar entitled the "Promotion of Co-benefits Approach" held in Bangkok, Thailand, in March of the same year (Japan-MOE 2011). Co-benefits are actions taken to reduce climate change that also lead to improvement in other areas, such as promoting human health, or alleviating poverty. The purpose of this *Partnership* is to 'mainstream' international climate change co-benefits in policies, projects, and developments plans (particularly urban development) across Asia (Japan-MOE 2011; ACP 2012). Examples of co-benefits include issues of non-GHG emissions that affect air quality, sometimes in addition to climate change. Although some of these emissions are related to forestry, such as black carbon from the combustion of wood biomass for fuel, because most of the co-benefits are development-based, without sequestration provisions (ACP 2012), they are not discussed any further here. However, biodiversity and conservation could be considered the co-benefits of climate change policies that view forests as assets in reducing atmospheric CO_2 concentrations. In addition to providing carbon sequestration and ecosystem services, forests provide wood and non-wood forest products that may provide social or economic co-benefits as well.

Figure 6. Firewood being carried to a market in Ramnagar, Uttarakhand, India. Firewood is the major source of fuel for heating and cooking in many Asia-Pacific countries. However, it can also be an important source of indoor pollution.

4. National and Domestic Policies

A number of countries have developed their own domestic emissions trading schemes and climate change policies in addition to international partnerships and UNFCCC-based agreements and policy instruments. Some of these initiatives in Asia Pacific countries are discussed below.

4.1 Canada

Although Canada removed itself from *Kyoto* before the 2012 extension and failed to meet its commitments under the Protocol, Canada vows (under the Copenhagen accord) to reduce its GHG emissions to 17% below 2005 levels by 2020 (Environmental Canada 2012; Glomsrød 2012). This is less than the 6% reduction in emissions over 1990 levels as specified in the *Kyoto Protocol* when considering that the country's GHG emissions increased nearly 30% between 1990 and 2009 (Table 1).

Some of this increase is attributed to LULUCF emissions. Canada explains the increase in emissions from LULUCF (Table 1) as emissions from natural disturbances such as forest fires

and pine beetle induced tree-mortality, and states that in accordance with UNFCCC reporting requirements, all LULUCF emissions are excluded in the calculations of national GHG emission trends (Environmental Canada 2012). However, section 3.3 of the *1998 Kyoto Protocol*, under which Canada reported its GHG prior to withdrawing in late 2011, specifies that parties must report LULUCF emissions that are the result of human activities, namely afforestation, reforestation and deforestation. Canada's LULUCF sector accounted for a net 72 Mt of GHG in 2010. Of this, 14.83 Mt was associated with deforestation, whereas afforestation/reforestation represented a net sink of only (-)0.86 Mt (Environmental Canada 2012). If Canada is to realise the benefits of forest management activities in helping to attain emission reduction commitments, this pattern will need to be reversed and the carbon sinks attributed to afforestation/reforestation should exceed emissions from deforestation. Additionally, although natural disturbances (e.g., fires, insects and disease) do not need to be reported to the UNFCCC, they still influence global GHG emissions and should be managed and limited as much as possible. Furthermore, natural disturbances can result indirectly from human activities, such as inappropriate forest or watershed management that can lead forests to be more susceptible to fires, insects, disease and other disturbances.

Overall western Canada, or the westernmost provinces of Alberta and British Columbia, saw GHG emission increases of 40.4% and 13.6%, from 1990-2010, respectively. Primary energy production was largely responsible for both provinces' increases; however British Columbia's total emissions and emissions from primary energy production decreased by 12.5% and 14.5%, respectively, between 2005 and 2010. The Yukon Territory experienced total emissions reductions of 36.6% from 1990–2010 (Environment Canada 2012b).

British Columbia includes over 27,000 km of Pacific coastline (Sebert and Munro 1972). Although a member of the WCI outlined above, the province of British Columbia has developed some of its own policy mechanisms, under its 'Climate Action Plan' for mitigating and adapting to human-induced climate change. British Columbia's *2007 GHG Reduction Targets Act* makes commitments to reduce GHG emissions by 33% over 2007 levels by 2020, and 80% over 2007 levels by 2050. Also part of this *Act* was for the province's public sector to become carbon neutral by 2010. Although efforts towards this effect have taken place, these efforts have had social impacts. The policy of carbon neutrality has left some hospitals and schools spending all of their funding dollars on "emission offsets" from oil companies (Lux 2011). On the other hand, it has stimulated some larger public bodies, such as the University of British Columbia, to install new technologies that will enable the use of renewable fuel sources. This particular piece of British Columbian policy does not mention forests, biomass, or the forestry sector.

BC's *2010 GHG Reduction (Cap and Trade) Act*, an instrument completely separate from the *2007 GHG Reduction Targets Act* that defines obligations for the public sector, does mention forests, specifically in its 'Schedule C, Biomass Exclusions' which reads:

> Wood biomass, or the wood biomass component of mixed fuels, including
> (a) wood residue within the meaning of the *Forest Act*,
> (b) wood-derived fuel, red liquor and black liquor from pulp and paper production processes, and
> (c) woody matter from agricultural trimmings, tree thinning and orchard removals, but not including wood biomass that fails to meet the criteria for carbon neutrality established by the jurisdiction in which it was produced, if any.

In terms of section (a) the *1996 Forest Act* reads that 'wood residue' "means wood chips, slabs, edgings, sawdust, shavings and hog fuel". Sources listed in Schedule C (above) are not used in the threshold calculation to decide whether or not there is a need to report. Sources listed in this schedule also do not need to be registered or reported under the *Cap and Trade Act*. In essence this exclusion means that the emissions from the combustion or decomposition of any sort of woody waste do not need to be accounted for or reduced. However these are considered as "reporting-only emissions" under the Act, and must be included for reporting years prior to 2010 where a facility's (single or linear) emissions were double or greater than the current reporting guideline of 10,000 t CO_2e (i.e. ≥20,000 t CO_2e) for any of the calendar years from 2006–2009. This exclusion has important implications for forestry, and especially for wood residue that is cleared for the purpose of land conversion from forests to something else that does not satisfy this specific reporting requirement (i.e. is after 2010 or <20,000 t CO_2e).

Figure 7. Fire damage at Mayo, Yukon Territory, Canada. Fires in the boreal forest can cover large areas, releasing large amounts of carbon in a short space of time. Such emissions complicate calculations about the carbon balance of a country's forests.

Section (c), like the WCI guidelines, speaks to "wood biomass that fails to meet the criteria for carbon neutrality", which provides a jurisdictional loophole, and allows individual jurisdictions to decide whether certain forms of biomass are carbon neutral. 'Carbon neutrality' is something that potentially encompasses a wide range of biomass. The justification for the biomass exemptions within these Acts is based on the fact that the carbon stored in biomass was once

atmospheric (within a 100 year timescale) and that therefore, unlike fossil fuel combustion, biomass does not contribute any new GHG to the atmosphere.

'Downstream' combustion sources for commercial, residential and industrial purposes are also not included in BC's cap and trade program, but are instead subject to the province's carbon tax (British Columbia 2008). Otherwise, emission factors and other reporting requirements under the *2010 GHG Reduction (Cap and Trade) Act* are defined according to the WC*I* discussed in section 3.1. BC's Pacific Carbon Trust ('Trust') began as a mechanism to carry out activities as described by both the *GHG Reduction Targets Act* and the *Cap and Trade Act*. The Trust is a crown (public) corporation developed to purchase and sell carbon offsets. These offsets are produced primarily by the forestry industry (Pacific Carbon Trust 2012) (and sometimes the energy industry) and are the source of public sector offsets in order to either gain or maintain carbon neutrality as specified in the *2007 GHG Reduction Targets Act*. The resulting transfers of funds from the public to the private sector have proven quite controversial, as have some activities of the Trust, and its future is subject to review.

4.2 The United States of America

In addition to the WCI discussed above, Washington, Oregon and California launched the *West Coast Governor's Global Warming Initiative* in 2004. The initiative calls on states to act individually and regionally to reduce GHG, while achieving economic benefits from reduced dependence on foreign oil. The initiative speaks largely to emission reductions from transportation and energy sectors and does not contain provisions for forest or biomass carbon sequestration or emission reductions from LULUCF.

Nationally there is also the *President's 2002 Emission Intensity Reduction Goal* that was drafted under the leadership of former president George W. Bush. The goal was to reduce the "greenhouse gas emission intensity of the American economy by 18% by 2012". 'Emission intensity is defined as the amount of GHG emitted per unit of economic activity (The White House 2006a). Rather than being a nationwide emission reduction, reductions in emission intensity allow nationwide emissions to increase as long as there is economic growth, but under this *Plan* emissions must increase at a slower rate than the economy. Around the same time, the United States Department of Agriculture (USDA) set targets to reduce 44 million tonnes of CO_2e from the atmosphere through land management, sustainable forest management, biomass energy and other conservation practices (The White House 2006a). In 2002 the Department of Energy's Energy Information Administration (US-EIA) developed a *Voluntary GHG Emissions Registry* available to land and forest owners to report GHG emissions, and their reduction or sequestration (The White House 2006b), and to aid in the keeping track of smaller emission sources and their decline (US-EIA 2009). However this programme was suspended in May 2011 (Melinda Hobbs, US-EIA, *Personal Communication* October 4, 2012). The United States was also a signatory of the *2009 UNFCCC Copenhagen Accord* under which they committed to reduce GHG emissions 17% over 2005 levels by 2020, assuming this reduction conformed with anticipated domestic energy and climate policies and a cap on carbon prices of 25 USD per ton to remove the need for subsidies in an indebted economy (Glomsrød 2012).

In addition and complimentary to continuing as a WCI member state, California has also adopted the *2006 Assembly Bill 32 – California Global Warming Solutions Act*. California's Bill 32 only mentions forestry in terms of being an industry that will be negatively impacted by 'global warming', and makes no mention of biomass fuels or their emissions. Rather this Bill strictly lays out the intent to adopt and enforce GHG reporting, limits, and reductions, with the assistance of market-based compliance mechanisms. Unlike the *California Climate Action Registry* that acted as a similar, but voluntary policy instrument prior to December 31, 2006, the violation of any emission limits, reporting or other rules under Bill 32 is considered a criminal offence.

California has since instated the *Cap-and-Trade Regulation* (title 17, California Code of Regulations, sections 95800 et seq) and 2010 *Greenhouse Gas Cap-and-Trade Program*, managed and delivered by the California Air Resources Board (ARB). Section 95852.2(a) of the *2010 Amendments to the Regulation for the Mandatory Reporting of Greenhouse Gas Emissions* ("*Mandatory Reporting Regulation*") defines biomass sources that are either exempt or considered to have carbon neutrality as offered by the *WCI*. Similarly, section 95131(i) of Subchapter 10 ('Climate Change') lists how biomass sources must be verified to meet the exemption criteria in the *Mandatory Reporting Regulation*. Exempt sources are applicable to a reporting entity's reporting threshold, but do not count towards that entity's compliance obligations. The types of biomass-derived fuels exempt from compliance include wood and wood wastes, such as construction or mill residues and crates. Because some of these wastes may be treated, there is concern that they may be contaminated with heavy metals or chlorinated compounds, and should therefore be considered 'waste' (UNEP 2006) rather than compliance-exempt biomass. There are numerous other compliance exemptions, but they are not particularly relevant to forestry and are therefore not discussed here in detail. However, it is worth mentioning that wood and wood wastes harvested pursuant to an approved timber management plan, or for fire fuel reduction, are also exempt from compliance obligations.

The 2010 Amendments document further defines a "Forest Buffer Account" as a holding account for "ARB offset credits issued for forest offset projects". It acts as an "insurance mechanism" for such projects as those listed in the *Compliance Offset Protocol* – any offset protocol adopted by the ARB. As of October 20, 2011 *Compliance Offset Protocols* exist for both "Urban Forest Projects" and "U.S. Forest Projects", and such a project must be verified regularly by an "accredited offset verifier". A 'forest owner' owns the real property related to a forest-based offset project, and the value of such a project can be 'reversed' if the owner wilfully harvests the forest or is otherwise negligent in terms of the offset protocol. Unintentional reversals can occur as the result of fires, disease, etc. and these are when the insurance of a Forest Buffer Account becomes applicable, if not vital, to forest owners in the programme (*Mandatory Reporting Regulation s.* 95983).

Alaska has its own *Climate Change Strategy*. This involved the creation of a climate change sub-cabinet in 2007 and guidance from a number of groups, including 'adaptation' and 'mitigation' 'advisory groups' and both 'immediate action' and 'research needs' work groups. Chapter 5 of the mitigation advisory group's final report deals with emissions from the forestry, agriculture and waste management sectors (FAW). Policy recommendation FAW-1 suggests the use of thinning to reduce the increased forest fire threat associated with climate change, the lengthening

of rotations and application of fertiliser to increase carbon storage, reforestation, and the promotion of "durable" (i.e. long-lived) forest products. FAW-2 promotes increases in the use of forestry-derived biomass fuel to help replace 10% of the state's heating oil and 5% of the electricity from fossil fuel based energy sources by 2025. In 2005 (non-fuel) forestry was responsible for 1.4 Mt of Alaska's carbon sequestration. However only those emissions from managed forests are included in the anthropogenic emissions inventory. While the state's managed coastal and interior forests are net sinks of GHG, according to the State of Alaska (2009a) unmanaged Alaskan forests are net sources of both CO_2 and CH_4, the latter of which is predicted to increase towards 2025 (State of Alaska 2009a). This illustrates that proper forest management can be used to both reduce and sequester atmospheric carbon-based GHG. Although the substitution of fossil fuel sources with biomass sources such as wood is laid out in Alaska's *Climate Change Strategy*, this biomass fuel is considered to be 'carbon neutral', as it is in other jurisdictions. However, FAW policy recommendations in Appendix H suggest that whether or not biomass is considered to be carbon neutral is something that should be more thoroughly examined due to the complex scientific nature of carbon budgets (and forest systems) (State of Alaska 2009b).

Like its far northern counterpart Alaska, Hawai'i has also developed a 2009 *Framework for Climate Change Adaptation*. Hawai'i's framework is grouped by planning areas, one of which is 'productive' which includes forestry and forest resources. Planning considerations (in terms of climate change) for forestry and forest resources include the clearing of land for the development of agriculture, invasive species, and forest decline from climate change. Forests are also mentioned in terms of water supply in the case where forest health declines may cause increased runoff (State of Hawai'i 2009). Furthermore, Hawai'i's *2007 Act 234* (*Global Warming Solutions Act*) defines emissions reductions to be achieved over 1990 baseline levels by 2020.

4.3 Australia

Although Australia decided to withdraw from the *1995 Kyoto Protocol*, domestic policies were developed to continue to meet the *Kyoto's* targets independent of the Protocol itself (Crowley 2007). For instance, Australia prepared its *National Climate Change Adaptation Framework* in April 2007 to guide decision makers in government and industry on the incorporation of climate change activities into policy and practice. Australia also has a carbon pollution reduction scheme that was designed for launch in 2011 (Vickers et al. 2010).

Australia has its own national carbon trading policy managed by a group called 'Australian Carbon Traders' (ACT) that was established in 2004.The private programme manages the *Australian Farm Abatements Registry* (*AFAR*), which allows land-owners a means of registering and managing their forest carbon sinks. As of September 2012 there were fifty-two qualifying projects, representing over 72,000 hectares and nearly 120,000 permits. The program matches buyers of carbon credits with projects, allowing partners to develop their own terms of agreement. It provides forest management and emissions trading solutions for investors and businesses, and provides landowners with a means of assessing and marketing their forest carbon sinks.

Figure 8. Ohi'a (*Metrosideros polymorpha*) dieback on Big Island, Hawai'i. While this dieback may be unrelated to climate change, carbon planning in Hawai'i currently considers the potential effects of diebacks induced by climate change.

The Australian Department of Climate Change and Energy Efficiency is responsible for nation-wide policies and regulations as they relate to a changing global climate. Their *Carbon Credits* (*Carbon Farming Initiative (CFI)) Act 2011* is a publicly run registry allowing landowners to earn carbon credits through GHG reductions and carbon storage via forest and biomass sinks. Legislation for the *CFI* was passed by parliament in August of 2011, seven years after the establishment of its private counterpart *AFAR*. The *CFI* contains a number of specific forest provisions. For instance 'Native Forest Protection Projects' are those that remove and sequester atmospheric CO_2 in native trees, and that prevent the clearing and felling of 'native forests'. Eligible carbon units for the removal, or avoidance of CO_2 emissions, can originate either within or from outside Australia to be eligible. Living biomass, dead organic matter and soil carbon all qualify under this public programme. Projects are also classified as "*Kyoto*" and "non-*Kyoto*" by their eligibility under, and timing with, the international agreement of the same name. Australia also funds a number of REDD projects and carbon initiatives in developing countries, particularly Indonesia and Papua New Guinea (Vickers et al. 2010).

In the *Clean Energy Legislation Amendment Act* of 2012, fuels used for forestry activities are eligible for a Fuel Tax Credit. This combined with the carbon credits for forests that are managed so that they take up, rather than release, net quantities of carbon helps promote a sustainable forest sector. Furthermore, the land-use changes and deforestation under which Australia became

part of *Kyoto* are not permitted under this Act; projects that involve any clearing or felling of native forests or their products are not eligible to participate. Due to the relative infancy of this legislation, its success cannot yet be evaluated.

4.4 The People's Republic of China

Despite its lack of participation in the *1998 Kyoto Protocol*, the People's Republic of China (P.R. China) has its own policies to tackle climate change by reducing GHG emissions and increasing vegetative carbon stores. For instance under the *2009 Copenhagen Accord* China pledged to increase the use of non-fossil energy and set a target for reforestation, as well as setting a per unit Gross Domestic Product (GDP) emission reduction target of 40–45% of 2005 levels by 2020 (Glomsrød 2012).

Figure 9. In 2008, China announced a new policy to protect natural forests, such as this montane sub-tropical forest in the Gaoligong Mountains of western Yunnan. The primary objective was to prevent floods associated with the deforestation of catchments, but the policy is also maintaining large carbon stocks in these forests.

In addition to stringent emission reduction policies, in 1998 China launched a *Natural Forest Protection Program* administered by the State Forestry Administration (State Forestry Administration 2010). The program was developed in response to disastrous flooding in a number of deforested watersheds (Wang et al. 2007; State Forestry Administration 2010).

However, by allowing natural forests to grow, carbon is taken up and sequestered for as long as the forests stand. In this way, the no cut policy is relevant to climate change. So while natural forests continue provide numerous recreational, environmental and ecological services, the timber and pulp and paper sectors must rely on either China's plantation forests, or on imported wood. Being the world's foremost producer of wood products such as plywood, blockwood, medium density fibreboard and furniture, China already suffers a demand gap in its wood products sector, and demand is increasing (Taylor 2010). The no cut policy puts increased pressure on other forests of the Asia Pacific. The Russian Federation is China's largest log supplier, followed by New Zealand (Taylor 2010). However in 2007 the Russian Federation imposed a 25% raw log (roundwood) export tax increasing the cost of Russian logs (BC Stats 2010), and threatened to further increase that tax to 80% (Turner et al. 2008; BC Stats 2010). As a result, Canada, one of China's largest trade partners saw raw log exports from the province of British Columbia increase 23-fold from 2000–2009 (BC Stats 2010).

However, China is also vowing to increase its forest cover, which may help to fill some of its supply gap. The government of China announced to the UNFCCC plans to increase forest cover by 40 million hectares and forest volume by 1.3 billion cubic metres by 2020 compared to 2005 levels. By 2050, China intends to have expanded its forest cover by a total of 117 million hectares. These ambitious plans to increase forest cover, together with the *Natural Forest Protection Program*, make China's forest policy is key to the country's climate change mitigation strategies (Vickers et al. 2010).

4.5 Japan

Japan developed the *Law for Promotion of Countermeasures to Global Warming* in 1998 and revised it four times in 2002, 2005, 2006 and 2008. In 2008 Japan also developed a revised *Kyoto Protocol* achievement plan. Part of these policies include mandatory GHG accounting and reporting (Oi 2012), and under its *Nationwide Forest Plan* updated in 2008, Japan set quantitative targets for carbon sequestration, including designating forests as responsible for 3.9% of the country's planned emissions reductions (Vickers et al. 2010).

Despite withdrawing from the *Kyoto Protocol* in 2011, in 2009 under the *Copenhagen Accord* Japan pledged to reduce its 1990 base-year GHG emissions by 25% by 2020 on the premise of a fair and effective international framework that includes the participation of all major world economies (Glomsrød et al. 2012; Oi 2012), in accordance with an announcement by Prime Minister Yukio Hatoyama at the September 22, 2009 UN Summit on Climate Change (Japan 2010). This target was used as the basis for the 2010 *Bill of the Basic Act on Global Warming Measures* (Oi 2012). The emission reduction goal of 25% over 1990 levels equates to a 40% reduction over 2005 levels (Glomsrød et al. 2012) because Japanese emissions of GHG increased from 1990–2005 (Japan 2006). This emission target is also more than double the reduction of 17% by 2020 over 2005 levels as committed by both Canada and the United States (Glomsrød et al. 2012).

In June 2009, a few months prior to Hatoyama's announcement, then Prime Minister Taro Aso declared an interim emission reduction of 15% over 2005 levels by 2020 (Japan 2010). However, others, such as Kang et al. (2012), continue to report Japan's GHG reduction commitment at only

6% of 1990 levels (as defined in the *Kyoto Protocol* from which Japan withdrew), of which 3.9% is supposed to come from the forest sector. This is also in agreement with 'Japan's Fourth National Communication under the UNFCCC' (Japan 2006), however in 'Japan's Fifth National Communication under the UNFCCC (Japan 2010), this percentage is reduced to 3.8, as is reported in Oi (2012). Both documents also describe *Forest Sink Measures* and targets as being defined in a *Forests and Forestry Basic Plan* that changes over time and is used to estimate the emission reduction potential of Japan's forests based on improvements to conservation and management practices. Such changes include lengthened cutting cycles, thinning, forest protection and conservation, implementing forest education and improving volunteer training, the expansion of parks, the promotion of timber and wood biomass products including energy, and other forest-related "countermeasures" (Japan 2006, 2010).

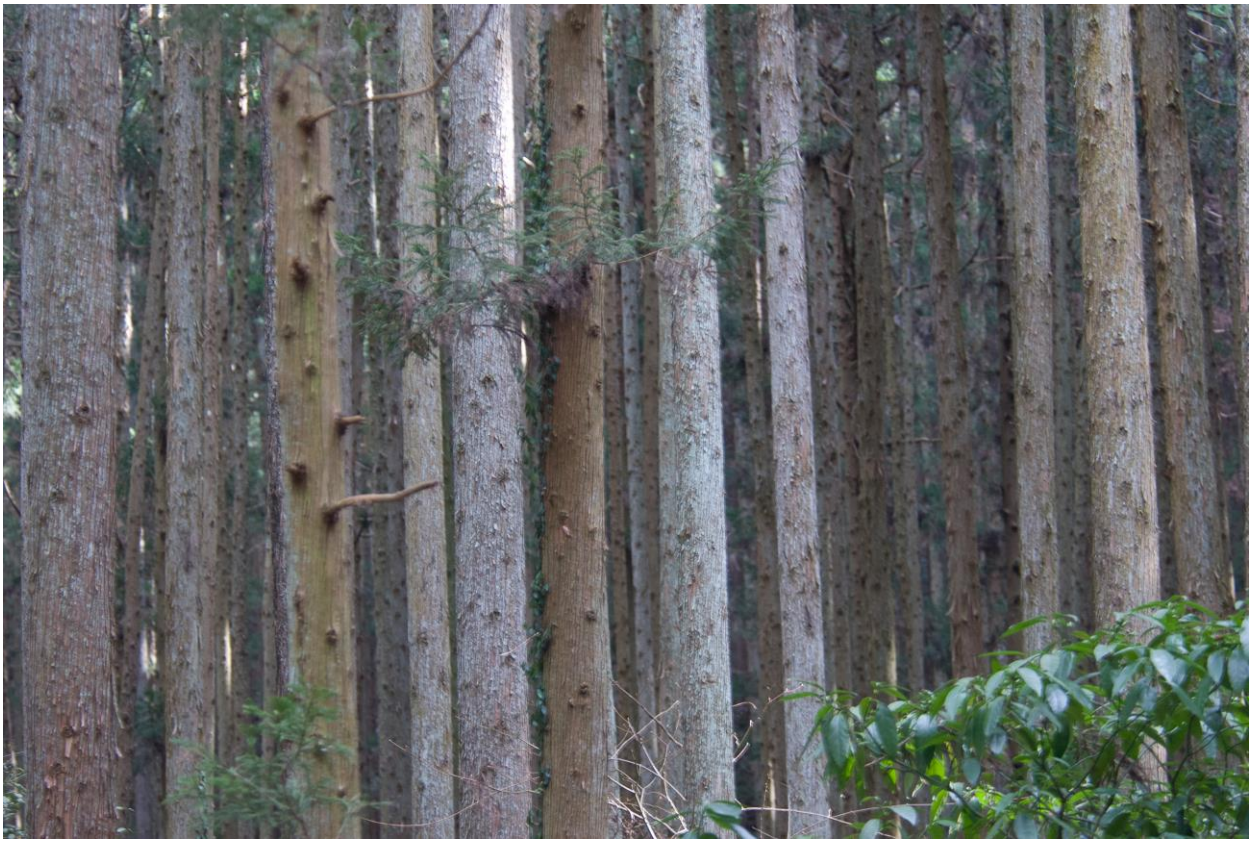

Figure 10. Many Japanese forests, such as this stand of Sugi (*Cryptomeria japonica*) in Ibaraki Prefecture offer considerable potential for carbon conservation through measures such as lengthened cutting cycles.

However, these were Japan's plans under *Kyoto*, and as of January 2012, Japan has reduced its total emissions by only 0.8 – 1.8% – in stark contrast to Japan's long-term GHG reduction goal of 80% over 1990 levels by 2050 in accordance with the *Bill of the Basic Act on Global Warming Measures*. The three major policies under the *Bill* include a renewable energy feed-in tariff, a carbon tax, and a domestic emissions trading scheme (Oi 2012). Forest biomass falls into the feed-in tariff scheme and forest sequestration is relevant to emissions trading under this *Bill*.

Many Japanese municipalities have made their own GHG emission reduction targets. Some of these targets, such as those of Niigate, Kyoto and Kobe, are as high as 80% reductions by 2050, whereas Toyota, Iida and Ehime plan on 70% reductions by 2050. The details of these individual municipal plans are available, but most only in Japanese (Japan for Sustainability 2012).

However, up until the earthquake, tsunami, and subsequent nuclear disaster that hit Japan's coast in March 2011, much of Japan's ambitious pledge to reduce GHG emissions relied heavily on the expanded use of nuclear power. Fifty-four Japanese reactors provided 30% of the country's energy in 2011, with a planned increase to 50% by 2030, including the addition of at least 14 new reactors. However, in the aftermath of Japan's nuclear crisis, the country's climate change mitigation efforts have changed direction, and there are fears that Japan's increased energy demands may be satisfied by GHG intense fossil fuels. Although biomass and other renewable less carbon intensive sources of energy may also become increasingly important sources of energy in Japan, it is doubtful that Japan is any longer in a position to meet its 80% emission reduction targets without completely redrafting its energy policy (Ogimoto and Yamaguchi 2012).

Japan is also a member of the US-led *Asia-Pacific Partnership on Clean Development and Climate* discussed previously. Additionally, Japan subsidises half of the cost of some projects under the CDM mechanism of *Kyoto*, namely REDD projects. Such co-benefiting projects have been initiated in Malaysia, Thailand and China and 50% of the credits generated by such projects are transferred to Japan (Japan-MOE 2011). Japan is considered to be in a good position in terms of using forest management instruments to aid in climate change mitigation (Vickers et al. 2010).

4.6 New Zealand

Unlike other developed nations of the Asia-Pacific, New Zealand remains dedicated to its *Kyoto* commitments. New Zealand has also developed its own *Emissions Trading Scheme* that came into force in 2008. This *Scheme* covers all industry sectors, and uses its own specific domestic units for trading – The New Zealand Unit (NZU). Despite this, the system is inherently tied to international carbon markets by allowing the importation of *Kyoto* compliant emissions units issued from other countries (NZ-MfE 2007). The system does not include any emissions caps and cannot therefore be considered a cap-and-trade scheme in the usual economic sense (Bertram and Terry 2010).

In 2008, the year the forestry sector entered the *Scheme*, New Zealand's forests removed 14.4 Mt of CO_2e from the atmosphere, representing about 19% of New Zealand's annual emissions that year. Included in these forest sector estimates are 2.8 Mt of CO_2e from deforestation, primarily in the form of forestland to grassland conversion for dairy farming (NZ-MfE 2010). In 2010, net removals under the forest sector totalled 18.3 Mt or almost 26% of the country's annual emissions. However removals from LULUCF decreased by 6.3 Mt between 2010 and 2009, resulting from an increase in the harvesting of pre-1990 planted forests. According the New Zealand's Ministry for the Environment (NZ-MfE) the first year of replanting constitutes a net emission release due to the loss of soil carbon and biomass associated with previous land-uses (NZ-MfE 2012).

Although New Zealand's total emissions were 11.9 Mt CO_2e higher in 2010 than in 1990, and emissions increased between 2009 and 2010, NZ-MfE (2012) maintains that the country is on track with Kyoto targets (NZ-MfE 2012). However, like Australia, New Zealand's forest conversion practices may hinder how quickly and effectively the targets can be met. High prices for pastoral land promote the conversion of forests to grassland. However, overall emissions reductions since 2006 are at least partially attributed to a reduction in livestock due to drought. Net removals by forests fluctuate substantially across the years. However, New Zealand's *Permanent Forest Sinks Initiative* and *Afforestation Grant Scheme* that came into effect in 2007 (NZ-MfE 2012) will likely promote the preservation of native forests and promote the replanting in areas of forest degradation.

Figure 11. In New Zealand, decisions to establish plantations such as this Radiata pine (*Pinus radiata*) plantation are affected by the relative prices of fibre and dairy products, but may also be influenced by carbon pricing.

4.7 Russian Federation

When the Russian Federation's Minister of Natural Resources Yuri Trutnev drafted a *Climate Plan* ('*Plan*') in 2009, the use of 1990 as a base year meant that the nation could increase its total emissions 30% by 2020 and still meet reduction commitments (Buhayar 2009). This was due to

the heavy industry in the country in 1990 that had since declined. However, the Russian Federation was also a signatory of the *2009 UNFCCC Copenhagen Accord* under which GHG emissions were to be reduced between 15 and 25% provided there were adequate provisions for forest sequestration potential and that all major emitters adopted the same policy. These GHG reductions were planned as a 15% reduction by 2020 using 1990 as a base year, and a 22% reduction by 2020 using 2005 as a base year (Glomsrød et al. 2012).

On April 25, 2011 the Russian Federation approved this new Climate Doctrine. Despite not being made available to public for some time after implementation (Senova 2011), the *Plan*, officially entitled "Comprehensive Plan of Implementing the Russian Federation's Climate Doctrine for the Period until 2020" (in Russian) no longer appears to contain anything about a 30% increase in emissions, or the emission reductions specified in the *Copenhagen Accord*. In terms of forests the *Plan* lays out methods for analysing and assessing the increased risk of forest and bog fires expected as a consequence of climate change and the development of both adaptation scenarios and protection measures for Russia Federation's forests and peat bogs. The document also calls for an improvement of operations in the forest sector including the protection of "forests as GHG sources and sinks, application of good forest management practices including reforestation and forest reproduction" (Russian Federation 2011). However, there are no strictly defined practices or goals and no clearly defined or quantified emission caps or reductions, merely statements about "curbing" and "reducing" emissions from specific activities and sectors, the timeframes of implementation, and the federal authority responsible.

Some of the Russian Federation's policies may have a great impact on climate change, at least from a forestry perspective. For instance, the Russian Federation is not only China's largest log supplier, but in 2005 Russia was the world's largest exporter of industrial roundwood (Turner et al. 2008). However, this changed in 2007 when the Russian Federation rewrote its *Forest Code* (Hitztaler 2011) and imposed a log export tax as a way reduce the export of raw logs and stimulate the development of its own wood processing industry (Turner et al. 2008; BC Stats 2010).

Russia's new *Forest Code* has received criticism for, amongst other things, its decentralisation, reduced forest protection and insufficient management. These factors, including an increase in corruption, may have important implications for forest sector climate change adaptation policy (Torniainen et al. 2006; Hitztaler 2011). For instance logging permits have been abandoned to give way to self-declared harvests by leasers, and the responsibility of fire protection and regeneration is now placed on leasers as well. On unleased forest lands, services such as fire protection and regeneration are competed for in auctions (Hitztaler 2011). The lack of centralised or government control may put Russian forests at risk in times of uncertain climate impacts and undermine potential mitigation measures such as carbon sequestration.

In 2007, the same year as producing its new *Forest Code*, the Russian Federation had the fourth highest net GHG emissions after the United States, China and the European Union. Despite its high contribution to global emissions and its withdrawal from the *Kyoto Protocol*, Russia's new Climate Doctrine may (or may not) be effective in limiting the country's contributions to global climate change.

4.8 India

In 2009, India made a pledge under the UNFCC *Copenhagen Accord* to reduce its emissions by 20–25% over 2005 levels, and to deviate from 'business as usual' (BAU) by a minimum of 7%. Like China, India's emission reduction commitment is based on its GDP, amounting to a 20% reduction per unit GDP by 2020 – half of China's 40% commitment (Glomsrød 2012).

India's *National Action Plan on Climate Change* (*NAPCC*), was initiated by the Prime Minister's Council on Climate Change (PMCC). The goal of the *NAPCC* is to promote growth and development in ways that also aid in climate change mitigation and adaptation. India plans to achieve this through means that are ecologically sustainable, and in developing an economy that is 'self-sustaining'. India's *NAPCC* includes 'Eight National Missions' (PMCCC 2008). The reforestation or afforestation of 6 million hectares of degraded forestland is planned under the Green India Mission (PMCC 2008; Kishwan et al. 2009) to enhance ecosystem services and carbon sinks (PMCC 2008). The enhancement of forestlands and the promotion of community-based management are being implemented in the National Mission for Sustaining the Himalayan Ecosystem (PMCC 2008). India is also a large contributor to global carbon markets through CDM (Singhal and Gupta 2012), one of the main instruments of *Kyoto*. India's contribution to CDM projects makes up 26.5% of the world total (Fenhann 2007).

Figure 12. Chir pine (*Pinus roxburghii*) in Himachal Pradesh, India. Forests in the foothills of the Himalayas are a focus of considerable attention in Indian forest policy, as explained in the text.

4.9 Vietnam

In addition to China and India, Vietnam has also initiated particularly ambitious reforestation policies. These three countries' policies together give the Asia-Pacific an overall increase in forest cover in recent years. Some of the activities in Vietnam include mangrove replanting to both sequester carbon and protect vulnerable coastlines from anticipated sea-level rise (Vickers et al. 2010). Vietnam's forest cover increased from 9.2 million ha in 1992 to 12.6 million ha in 2006 (UN-REDD 2009c). By 2008, Vietnam's forest cover had increased a total 38.3% over the heavily degraded 1990 levels (IDLO - FAO 2011). Despite these increases in forest cover, there are still high rates of deforestation in parts of Vietnam (UN-REDD 2009c), and forest conversion to commercial crops such as palm oil, as well as the use of forests for wooden furniture exports, put pressure on Vietnam's natural forests and biodiversity (Sodhi et al. 2004). Additionally, some of Vietnam's forests, particularly those in the south such as the A Luoi Valley, have still not recovered from the warfare defoliation activities of the United States in the late 1960s and early 1970s. There are continuing efforts to replant and rehabilitate (Quy 2005) these once diverse and carbon-rich forest ecosystems.

Vietnam was one of the UN's original pilot sites for REDD activities (UN-REDD 2009c), some of which have included developing the technical capacity for forest biomass estimation (Inoguchi and Maulidia 2012). In 2004 Vietnam passed a law that allowed for the transfer of close to 17,000 ha of forest to community-based management (Vickers et al. 2010). This legislation, combined with the efforts of international instruments such as REDD, may hold promise for local communities in terms of climate change mitigation and co-benefits such as poverty alleviation and enhanced biodiversity.

4.10 Cambodia

Cambodia ratified the *UNFCCC* in 1995 and joined *Kyoto* in 2002. The country also established an Office of Climate Change in 2003, and a National Climate Change Committee 2006, both of which have the responsibility of coordinating and developing the nation's climate change policies (UN-REDD 2010). Cambodia also addresses climate change as part of its forest reform plan, under its "Rectangular Strategy" for Growth, Employment Equity and Efficiency Phase II (Royal Government of Cambodia 2008). Cambodia's Forestry Administration leads the nation's REDD activities and is responsible for sales of forest carbon credits (Vickers et al. 2010). Further, in 2008 Cambodia formed a Forestry, Climate Change and Innovative Financing Group, under the Technical Working Group on Forestry and the Environment, in order to facilitate the Forestry Administration's activities under REDD and the CDM (Vickers et al. 2010).

Approximately 60% of Cambodia's national land area is covered with forests (Forestry Administration 2007). However, forest cover has declined significantly over the past five decades. Therefore, for the purposes of REDD, Cambodia is considered to be both a "high forest cover' and 'high deforestation' country (UN-REDD 2010). A number of REDD pilot projects have been initiated. These projects are long-term, provide carbon offset credits and generate financial benefits for community forests and local people (Vickers et al. 2010). Cambodia is still

in the process of developing its climate policy document entitled: *Cambodia Climate Change Strategy and Action Plan*.

4.11 Indonesia

Forests provide the basis for Indonesia's climate change adaptation and mitigation approaches, and Indonesia was the first country to adopt a legal framework for its REDD activities (Vickers et al. 2010). More than half of the initial UN-REDD "demonstration" and "readiness" projects were launched in Indonesia (Myers Madeira 2009) and additional REDD pilot projects were also show-cased in this Asia-Pacific nation (UN-REDD 2012). REDD demonstration projects in Indonesia have been initiated by multilateral, bilateral and other organizations, and are carried out at local, regional and national levels (UN-REDD 2011). The Indonesian programme represents key elements of REDD including the development of a 'forestry roadmap' to aid in achieving the country's GHG emissions reduction goal of 41% by 2020, in addition to a national Measurement, Reporting and Verification (MRV) system to allow for national reporting of GHG emissions and forest carbon stores. Collaboration amongst multiple stakeholders, including industry, forest dependent communities and the indigenous people of Indonesia, has been instrumental in the policy changes required to accomplish REDD strategies (UN-REDD 2011). These REDD programme activities seem to have removed some of the barriers that once kept social forestry from becoming part of Indonesia's mainstream forest policy. Adaptive co-management of forests is another recent Indonesian success (Vickers et al. 2010).

Indonesia is the world's top emitter of GHG from deforestation and land-use change, including the greatest emitter from deforestation and the subsequent draining of peatlands for agriculture – particularly palm oil plantations. A REDD pilot project in Kalimantan Province is illustrating peatland restoration through rewetting. This restoration prevents the atmospheric emission of the carbon from the peatland, and in 2010 the Indonesian government imposed a two-year ban on new palm oil plantations on rehabilitated peatlands (Vickers et al. 2010).

Figure 13. Degraded tropical rainforest near Bogor on the island of Java, Indonesia. Forests such as these should be considered in REDD schemes.

4.12 Lao People's Democratic Republic (Lao PDR)

In late August 2012, Lao People's Democratic Republic (Lao PDR) developed a land and forest policy that gives more power back to local land management and communities or individuals. On August 28th, 2012, at an international land and forestry conference in Vientiane, Dr. Souvanhpheng Boupphanouvong, President of the Committee on Economy, Planning and Finance of the National Assembly of Lao PDR, proclaimed that the government's objective was to undergo a national process of large-scale land reform. The announcement was in response to increasingly competitive land interests, and was also related to efforts to help alleviate poverty within Laos. The new policy also aims to reduce GHG emissions from activities such as deforestation and forest degradation and meet goals in terms of climate change (Rights and Resources Initiative 2012); however it is uncertain what the details of this policy will be.

The Japanese government provides support for the Forest Strategy 2020 Implementation Promotion Project, a sustainable forest management project in Lao PDR (Vickers et al. 2010). Lao PDR also has a participatory Land and Forest Management Project for Reducing Deforestation with the goal of reducing deforestation in the northern part of the country while providing sustainable local economies (MAF Lao PDR 2010).

4.13 Additional Countries

Some additional countries in the AP have also developed their own strategies to manage either climate change or forests under the threat of climate change. For instance the Philippines has implemented mechanisms to reduce GHG despite being without any legal climate change obligations (Vickers et al. 2010). Many developing nations in the Asia-Pacific region have climate change mitigation strategies that focus on REDD. However some countries such as Singapore lack large areas of unprotected forests making forest-based instruments such as REDD more difficult to establish (Vickers et al. 2010).

Despite the efforts of countries like Vietnam, India and China to preserve their forests, parts of the Asia-Pacific, particularly south Asia, continue to experience high rates of deforestation (Vickers et al. 2010). However, other countries, such as Fiji, have adopted protection-based forest management and are in the process of developing their own climate change agencies responsible for advising nationwide policies (IDLO, FAO, 2011). In addition, countries such as Nepal and the Philippines have had community forestry programmes for decades (Vickers et al. 2010), which help to provide co-benefits along with REDD activities. Similarly in Bangladesh, social forestry programmes are used to aid in climate change mitigation and carbon reduction (MOEF 2008) and Bhutan is expanding community forestry programmes from 6% of forest lands to 20% over the long-term. In addition Bhutan has developed community-based fire protection and management systems as part of its National Adaptation Programme of Action (NAPA) (NEC 2006). Furthermore, REDD pilot projects have been initiated in Nepal where a five-year international study entitled "Reducing Carbon Emissions through Community-managed Forests in the Himalayas" is working with communities to quantify forest carbon stores that can then potentially be exchanged for REDD payments (Vickers et al. 2010).

Sustainable forest management policies with implications for climate change mitigation and carbon sequestration have also been established in Borneo (the 'Heart of Borneo Initiative') as a collaboration between Brunei Darussalam, Indonesia and Malaysia; and in Thailand, in an effort to identify a suitable model for REDD activities (Vickers et al. 2010). In general, policies relevant to climate change and forests in developing nations are founded on the principles of REDD and sustainable forest management. However like the carbon markets of their more developed Asia Pacific neighbours, these instruments have a free market aspect and can be revenue positive to those involved.

5. Analysis and Discussion

The IPCC (2007a) estimates that 17.4 % of global anthropogenic emissions stem from forestry-related activities including deforestation, post-harvest decay and peatland combustion or decomposition. Conversely, estimates suggest that 15% of global CO_2e emissions can be sequestered by forests (Sohngen 2009). Despite the contribution of forest sector sources to climate change and carbon sequestration, forest emissions and biomass-based fuels are accounted for separately in UNFCCC estimates of LULUCF sector emissions, specifying that parties must

report only those LULUCF emissions that are the result of human activities. However, LULUFC projects that store or sequester carbon can be used to gain emissions credits.

Biomass-based fuels are an important source of heat and energy throughout the AP region, especially in developing nations where biomass may provide a significant source of fuel (Vickers et al. 2010; Stockholm Convention 2004). Black liquor – a biomass fuel and by-product of the kraft pulping process – is the fifth most important fuel source in the world (Tran and Vakkilainnen 2008). Carbon neutrality for solid biomass fuels is assumed in a number of jurisdictions, most notably those provinces and states in western North America that are parties to the WCI. The idea behind this "neutrality" principle is that the carbon stored in biomass was once atmospheric CO_2. This CO_2 becomes stored as carbohydrate in biomass (plant matter) as a result of photosynthesis. When this material is combusted it is therefore releasing the same CO_2 that was already atmospheric, and in the same amount that would have been produced were the biomass allowed to naturally biodegrade. This CO_2 is then taken up by vegetation again, and there is (in theory) no net positive or negative flux of CO_2 or other GHG to the atmosphere in the process.

Figure 14. Wood pellets. These pellets were made in British Columbia, Canada, from sawmill residues. Because of current pricing schemes, it is economically feasible to ship them to Europe for use in power stations.

However, there is an issue here of time-scale and 'permanence'. Most climate policies, including those of the WCI and its members, use the 100-year time scale as described by the IPCC for both atmospheric lifetime / GWP calculations and to represent 'permanence' in terms of carbon sequestration i.e. sequestration is considered to be permanent if it occurs for 100 years or longer. But the biomass fuel emissions exclusion does not necessarily satisfy this condition. Whereas some trees may live for 100 years or more before releasing carbon stores (Peterson 1969), when combusted, biomass releases CO_2 very rapidly. The rate at which this CO_2 is emitted is much faster than either the rate at which a new tree (or other vegetation) would take it up, or the rate at which it would be released by natural decomposition. To call this process of biomass combustion "carbon neutral" requires the perspective of a 100-year time-scale. Over the period of 100 years that carbon would be released anyway. In contrast, fossil fuels store carbon that was absorbed from the atmosphere by vegetation millions of years ago, and therefore does not satisfy the 100-year rule. One could argue however that some trees live much longer than 100 years and that the biomass exclusion should not apply to biomass derived from old growth, or growth of over 100 years. The WCI, British Columbia Canada's *2010 GHG Reduction (Cap and Trade) Act* and climate change policies of the Unites States view forest biomass as a carbon neutral fuel sources. However, the scientific validity of this view can be questioned, especially on a case-by-case basis, as it is in the State of Alaska's climate change policy documents (State of Alaska 2009b).

Although there are 'biomass' tree plantations in parts of the Asia-Pacific, such as the poplar and willow biomass plantations in British Columbia, Canada (ENVINT Consulting 2010), most of the biomass used for fuel is expected to be waste stream biomass (bark, wood chips, black liquor, etc.). However, issues have been raised regarding contaminants that may be present in treated wood waste and other biomass (pesticides, heavy metals chlorinated compounds, etc.) (UNEP 2006) that can degrade air quality and impact human and environmental health. Therefore attention should be paid to the potential negative 'co-impacts' of some climate change policies in addition to co-benefits.

The combustion of biomass, whether open or in boilers, releases CO_2 and methane (CH_4) – a GHG with at least 21 times the GWP of CO_2 (WCI 2009). According to the US-EPA's (2009) GHG emission factors, the estimated CO_2 released from biomass derived fuel combustion is higher per MMBtu of energy (93.80 kg CO_2 $MMBtu^{-1}$) than almost all other fuels (except for petroleum coke: 102.04 kg CO_2 $MMBtu^{-1}$). In addition to high CO_2 emissions per energy unit, biomass-derived fuels, such as kraft black liquor and dry wood, have relatively high emissions of both CH_4 and NO_2 – even higher than coal when the US-EPA's (2009) emissions factors are used. Environment Canada (2009) has much lower kg CO_2 $MMBtu^{-1}$ estimates for CO_2, CH_4 and N_2O from biomass-derived fuel combustion than other jurisdictions, which may be in part due to the fact that Canada's GHG estimates are based on the quantity of fuel combusted, rather than the fuel's energy content (Canada 2009).

NO_2 is a GHG with 310 times the GWP of CO_2 (WCI 2009). It is also released through biomass fuel combustion much more rapidly than it would be released from natural soil or decomposition processes. Biomass fuel combustion also releases black carbon, an aerosol that has a net atmospheric warming effect due to its non-reflective surface and absorption of heat from the sun's radiation, a mechanism that is not well understood (IPCC 2001). Black carbon is also responsible for numerous negative human health outcomes. Despite the prevalence of black

carbon, and its relative importance in radiative forcing, its emissions are not included in GHG inventories. However, because these biomass fuels have such high emissions of GHG per unit of energy produced, it is advisable that their emissions be included in inventories, and be reported to the same extent as emissions from other energy-based sources. While the CO_2 may "balance" over the same scale in question, the black carbon, CH_4 and N_2O emissions do not.

Because many GHG also function as air pollutants or contribute to the formation of secondary air pollutants, and many air pollutants contribute to atmospheric radiative forcing, it is desirable that policies focus on the reduction of all anthropogenic atmospheric emissions, not just (primary) GHG. In addition, the focus on CO_2 by many government policies may mean neglecting other GHG and their potential impacts on climate. For example, reducing CH_4 emissions has the added benefit of reducing tropospheric ozone (O_3) concentrations. O_3 is in itself a potent GHG (Fiore et al. 2002; West et al. 2007), and is considered the third most important after CO_2 and CH_4 (IPCC 2001). O_3 can also cause direct injury to forests and weaken their overall resilience in a changing climate by reducing overall health, and increasing susceptibility to insects and disease (Bytnerowicz et al. 2007). Therefore at high levels O_3 can reduce a forest's ability to store and sequester carbon. In view of this, there are ample reasons and causes to focus on the reduction of CH_4.

O_3 is formed from reactions between volatile organic compounds (such as CH_4) and nitrogen dioxide (NO_2), the latter of which either originates from combustion or is formed from the oxidation of nitrogen oxide (NO) – a primary pollutant formed from the combustion of anything in a nitrogen-dominated atmosphere such as that of the Earth. Therefore, from the perspective of climate change, it is also desirable to limit the emissions of criteria air contaminants (CAC) such as NO and NO_2 that lead to the secondary formation of GHG such as O_3. Furthermore, NO_2 transforms to nitrate (NO_3^-) – the form of N used most by plants – when in contact with soil water and atmospheric gases. Therefore forests and other vegetation receive fertilisation from the atmospheric deposition of NO_2. However, when in excess, unused NO_3^- is denitrified microbially into N_2O and is released from the soil as N_2O – a potent GHG (Stoddard 1994).

Due to the interaction between many air pollutants and GHG, both in the atmosphere and in the forest or plant system, it is advisable for emissions reduction programmes to focus their efforts on reducing all atmospheric emissions, and not to focus only on CO_2 or even on GHG. Multi-emission mitigation strategies are also more cost-effective than programmes with a CO_2 only focus (Reilly et al. 1999). To a forest increased atmospheric CO_2 may be beneficial by stimulating forest growth (Ainsworth and Long 2004; Norby et al. 2005). However the climatic repercussions of increased CO_2 and other greenhouse gases puts many forests at risk of being located in an unsuitable climate that is either too warm, too dry or for coastal forests, inundated with sea water. This puts the regions' forests and forest sector at risk. Therefore co-benefits, such as the improving of air quality by reducing all emissions, and not just those of CO_2 or primary GHG, need to be realised beyond the confines of the Asia Co-benefit Partnership. If this were the case, changes would need to be seen in the biomass fuel policies of many jurisdictions. In addition full cycle approaches should be used in drafting and evaluating climate change mitigation and adaptation policies. For instance while some jurisdictions, such as Alaska, call for forest fertilisation to enhance CO_2 uptake, the GHG emissions associate with fertiliser production are not accounted for.

Demand for forest products is increasing in the Asia-Pacific – and not just in China. Although demand is fairly stable in Japan, countries such as Korea, Taiwan and Vietnam all require log imports and India is also soon expected to experience shortages of raw logs (Taylor 2010). Due to the ease of shipping, other countries of the Asia Pacific will be the first to step up and meet these increasing demands. However, it is important that we do not lose sight of additional forest values in our economic drive to increase exports. Although China's no cut policy is likely too severe for most Asia Pacific nations, it protects China's forests. This strict protection has benefits not just in terms of carbon sequestration and climate change mitigation, but also in terms of conservation and the provision of ecosystem services. Nevertheless, this policy has implications internationally (Asia-Pacific) as it increases China's demand for raw log imports. So while China's LULUFC credits increase and forests provide a net sink for atmospheric carbon, other nations' forests become net sources of GHG – such as has been seen in Canada and New Zealand from 1990–2009 (Table 1). Russia, Canada and the United States are China's three top sawn-wood and log suppliers, and China is the world's largest exporter of manufactured wood products (Taylor 2012). Malaysia is also a significant source of hardwoods for China (Xu et al. 2003). However, despite the criticism of China's forest policies, they have included land tenure reforms that have given some forest rights back to individual households and communities (Xu et al. 2010).

The shift in timber supplies from one country's forests to another's does little good in terms of the mitigation of global climate change. Different age classes and types of forests sequester carbon at different rates, and long-lived wood products, such as furniture, building materials and some paper products represent effective and long-term carbon stores. However, China's policy to reduce the logging of its own native forests without simultaneously reducing its demand for raw timber, may threaten other forests of the Asia-Pacific – unless there are policies to protect them. China's processing plants also supply many of the processed wood products, particularly items such as furniture and flooring, that other Asia-Pacific countries, principally the United States and Canada, have ever increasing demand for (Xu et al. 2003). While long-lived forest products store carbon, a portion of the world's forest products become disposable items such as sanitary tissue or paper packaging that eventually break down and emit carbon. However, much of that carbon may be maintained in a landfill. In addition, C-storage is most efficient when long-lived products result from short-lived forests, rather than short-lived products resulting from long-lived forests (Kurz and Apps 1992).

Issues of climate change and forests are intertwined across international and even village boundaries. Although forests have definable boundaries, the services they provide from carbon storage and sequestration, to slope stabilisation and water filtration, have less distinct borders, and are crucial to humanity's continued survival. We need to balance the demand for forest products with our new demand for forest services – particularly carbon sequestration. This balance may at times be delicate and require comprehensive, if not global, forest policies and initiatives.

Figure 15. Hardwood logs originating in Russia waiting to be processed at a sawmill in Suifenhe, Heilongjiang Province, China. Exports of Russian logs to China were severely curtailed following the introduction of export taxes by Russia.

It is also important that any climate driven policies take social requirements and values into account. For instance, concerns have been raised that China's reforestation policies may negatively impact farmers through a loss of agricultural land (Xu et al. 2010). Other policies have been criticised for not providing immediate economic benefits or incentives for the storage of carbon from REDD projects that may otherwise negatively impact local economies. For instance halting the conversion of forests to agriculture can drastically impact developing economies unless carbon-based incentives are realised early on (Vickers et al. 2010). It is therefore important that climate change benefits are balanced with other societal requirements, and such balance is seen in initiatives such as the Asia Co-benefits Partnership. However, others have stressed that a focus on co-benefits such as poverty reduction can lead to trade-offs with mitigation, such that climate change strategies may lose some of their effectiveness (Lederer 2011).

Similarly, climate policies should account for other climate change strategies so as not to undermine them. For instance, the transportation fuel policies that have mandated from 4–15% ethanol in fuels throughout North America, Australia, and Thailand, and on a pilot scale in China

and New Zealand, require substantial tracts of arable land. The resulting ethanol markets are being blamed for the accelerated conversion of forests to non-forested cropland in both developed and developing nations (Tyner et al. 2010), debilitating the efforts of REDD and other forest-based climate policies.

Many Asia-Pacific nations and their citizens rely profoundly on forests and their products. Forest harvesting is an especially important activity in developing nations of the Asia-Pacific whose economic growth and even subsistence may rely on forest conversion to agriculture, the use of forest biomass as fuel, or exports of rare wood. In many parts of tropical Asia rates of deforestation continue to rise (Vickers et al. 2010). Although the UN's REDD programme attempts to tackle issues of deforestation and forest degradation from the perspective of GHG emissions, REDD without the simultaneous implementation of programmes to alleviate poverty, may be bound for failure. Unless financial benefits, in the form of carbon credit revenues, are distributed fairly amongst communities and citizens at a local level, deforestation rates may continue to rise. Therefore, climate change mitigation instruments such as REDD or CDM need to involve people at local levels and be sensitive to existing and anticipated social realities. Furthermore, Asia-Pacific nations such as Canada and New Zealand whose GHG emissions from LULUCF exceed sequestration by the same sector, could benefit from some sort of REDD arrangement for developed economies.

For countries and communities of the Asia-Pacific that rely heavy on forests and their products, climate change and associated policies could mean two things: 1) communities and industry begin to manage forests and harvest their products in such a way that they are a net sink, rather than net source, of carbon and other GHG such that they can gain carbon economic benefits and rewards in terms of credits; or 2) they continue with a business as usual approach that ignores climate change and its associated causes. Of all sectors, forestry is in a beneficial position. Wood products store carbon after harvesting until they decompose or combust; forests offer a means of gaining financially valuable credits; biomass emissions are exempt from reporting and considered "neutral" in most jurisdictions; and forests are renewable and can be managed sustainably.

Although forests have the potential to be net sinks of carbon while providing timber and additional forest services, all forests are unique. In order for forest-based climate change policies to be effective, they must recognise the complexity and heterogeneity of forest function and processes. For this, policies need to be deeply rooted in science; however, our scientific understanding of the processes within forests, including their response to a changing climate and their ability to sequester carbon, is still incomplete. It is therefore essential that research be conducted to fill in these knowledge gaps, and that forest management bridge the divide between the science and policy of climate change as it relates to forests in the Asia Pacific region.

Market mechanisms such as cap and trade systems have shifted the way we view forests. Forests are now seen as having an economic value while intact and standing, not just when harvested. These sorts of incentives are essential if forests are to be conserved either for their carbon stores, or other co-benefits. However, like any other economic system, there is room for exploitation and corruption. It is not enough for climate policies to only be fiscally effective; they need to be

scientifically effective in the sense that they either reduce or mitigate global climate change when all factors are considered.

6. Conclusion

In a time of emerging global change, it is of crucial importance that policies are developed at global, national, regional and local scales to combat, or at minimum ease, climate change and the impacts it will have (and is having) on our society. Nevertheless, it is not enough for those policies to simply exist. They must be effective, and based on sound science. They must account for the various economies and social differences between and within countries. They must be enforceable, yet flexible to changing perceptions and knowledge. Although national and local policies appear effective for the regions that develop them, in times of global change it is important that we have global and transboundary policies. *Kyoto* may have failed to accommodate the interests of some of its parties, and consequently witnessed failure, but that doesn't make such a policy unachievable. The mitigation of, and adaptation to, climate change is for the common good. We will all be affected, no matter our socio-economic or export status. However, the mechanisms in place to reduce and sequester emissions have an ultimate impact on global and national economies; and consequently, many of the policies that have been developed focus on market mechanisms, rather than sound scientific principles that would ensure the policies' effectiveness. However, we can view the economic changes evoked by climate policies as positive, for instance by maintaining forests and innovating with new technologies, or we can continue with business as usual in a carbon producing, rather than conserving, economy. There is no simple answer and it may take a paradigm shift in how we view ourselves, and our economies, before GHG are reduced enough to lessen climate change. Nonetheless many Asia-Pacific nations and communities are taking action and co-benefits are arising as a result. Forests provide a unique opportunity in this respect and with effective science-based management and legislation, forests may provide some of the climate change mitigation solutions we so urgently require. Although existing policies appear insufficient in effectively mitigating climate change in the Asia Pacific region, or globally, the integration of scientific research with effective forest management principles will enable the region's inhabitants and forest managers to adapt their practices and limit the impacts of climate change on forests and the communities that depend on them.

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