FINANCE AND FORESTRY:
"WHERE'S THE DATA?"

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Contents

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1. Management Summary

Introduction

1.1 The Natural Environment Research Council (NERC) asked Z/Yen Group Limited (Z/Yen)[1] to explore and report on the financial services sector's needs for environmental data to support investment decisions. The report was also to provide recommendations on what sorts of data were most likely to be in demand; and on how ongoing interaction between the financial community and NERC and the National Centre for Earth Observation (NCEO) might best be pursued.

1.2 The general scope of the project was to provide NERC with a global overview of the broad requirements of the financial services community. As such, the report reflects the interests of industry professionals rather than a complete scientific inventory of forestry metrics and issues. In this context, the report concentrates primarily on illegal logging, certification, commercial wood use, forest ownership and the measurement of the carbon content of living wood. The last subject is covered in particular depth because of the financial sector's interest in the development of a regulated and liquid market in timber-related carbon credits, which could be integrated with the existing emissions trading regime.

1.3 Between June and August 2010 Z/Yen ran a discussion workshop with financial services professionals and members of the scientific community, conducted personal interviews with key members of the forestry investment community, and held a symposium to present an overview of initial research findings to a mixed stakeholder audience.

1.4 One objective of NERC is to engage its science assets in academia and research centres (such as the NCEO) with financial services professionals in order to maximise the use of current data sets and modelling expertise, and to anticipate future market demand for new data. This project has thus been undertaken not only as a vehicle for alerting the financial services sector to the existing modelling capabilities and data resources of NERC, but also to stimulate the exchange of information between the scientific and financial communities in the future.

Background

2.1 Historically, the incentive to invest in forestry was as a timber and pulp-paper producing resource. In recent years a new incentive has appeared in the form of trees as 'carbon storage' units with the potential to mitigate the negative effects of climate change. Since the Kyoto agreement, discussions of finance and forestry have focused on potential emissions trading, and incentives have been put in place to facilitate investment in carbon credits. To date, however, a combination of the difficulty in collecting accurate and consistent data on forest carbon content, and related shortcomings in regulatory and market infrastructure, has meant that forestry investment remains concentrated in conventional wood products.

2.2 The timber market itself is well-established but, over the last several decades, an increasing emphasis on sustainable harvesting has significantly changed industry dynamics. In most developed countries, sustainable forestry practices are established and regulated. In

[1] A delivery partner of the Financial Services Knowledge Transfer Network (FSKTN)

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less developed markets - where the threat of mass de-forestation looms largest and many high value hardwoods are concentrated - an increasing array of international certification schemes, many of them backed up by legal sanctions, are being put in place to squeeze out illegal logging. Considerable progress has been made but the world still suffers from net de-forestation, with non-sustainable land clearance and logging in the developing world being the prime culprits.

2.3 The financial services industry is already making limited use of some forestry data sets. However, the wide distribution of varied forest species and shortcomings of data on both forestry stock and harvesting in many parts of the world have all combined to limit the scope for valuation, forecasting and risk assessment. Trees, simply stated, are not a conventional commodity.

Discussion

3.1 Within the financial services community investment managers, insurance providers, credit risk analysts and banks (both commercial and investment) all have a range of interests in forestry assets. Professionals in different financial services require different types of data sets and different models. There is a broad distinction to be made between:

- 'direct investors'- those who directly own forestry assets.
- 'guarantors' - insurers and related risk analysts;
- 'traded markets' - in which assets or related derivatives can be traded either on exchanges or 'over the counter' (OTC).

'Direct investors' and 'guarantors' require detailed data at a geographical level, directly related to the asset or risk being priced. The 'traded markets' tend to be interested in data sets offering wide coverage at a global level with consistent but relatively low resolutions and measurement criteria.

3.2 The financial services sector is rapidly developing an appetite for forestry data from the scientific research and earth observation communities. While much of this interest is still latent, existing investments and interest in future investments will drive market professionals forward in search of both more comprehensive data sets, and more sophisticated metrics. Two forces are likely to play an important role in stimulating an appetite for accessible data: maturing interest in investment sustainability; and the development of viable metrics and markets for forest carbon.

3.3 The above developments will require a more open and fluid exchange of information between the financial and scientific research communities. While this exchange will become self-sustaining with time, it is not there yet. The scientific community will accelerate progress if it becomes more pro-active, and seeks both potential end users in the financial services sector, and a more prominent position from which to advertise and disseminate its data.

Conclusions

4.1 Sustainability has become a key theme within the investment community and is of particular pertinence to forestry investment. Carbon capture is increasingly likely to influence investment in, and valuation of, forestry assets. There is an urgent need for the scientific community to agree a standardised methodology (with a standardised modelling error range) for estimating the carbon content of forests; and for legislators and regulators to provide a

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suitable market infrastructure to allow forest carbon credits to become tradeable assets in their own right.

4.2 Tying investment decisions to environmental assessments will require consistent, regular, reliable and robust scientific data. The overriding concern from a market perspective is not that the data reflects the latest advances in scientific modelling (which will be subject to ongoing debate and modification), but that it is produced to an agreed consistent standard which is only revised at medium-term intervals (i.e. three to four years).

4.3 There is considerable potential for collaboration between the scientific and financial services communities on a global forestry data resource which we describe as a 'Global Snapshot'; this would in turn accelerate direct and indirect investment in forestry assets, and provide further stimulus to a more holistic approach to sustainability.

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2. Introduction

Introduction
The Natural Environment Research Council (NERC) funds and manages research in environmental sciences. Its earth observation capabilities provide the foundation from which the National Centre for Earth Observation develops further research on climate conditions, the carbon cycle and hazardous weather. NCEO comprises 100 scientists in over 26 universities and research establishments.

Objectives
The objectives of this paper are as follows: to explore the means by which NERC and its research assets, specifically NCEO and related academics, can engage directly with financial services professionals; to suggest means by which the exploitation of current data sets can be maximized; and to provide a general overview of how demand for further data will develop in the near future (two to four years).

Work Proposed and Undertaken
This paper is being delivered by Z/Yen, a delivery partner for the Financial Services Knowledge Transfer Network, on behalf of NERC. NERC's expectations of the outcomes of the project are as follows:

- to improve working processes between research centres and industry;
- to impact on industry;
- to influence government policy;
- to develop more joint research publications; and
- to foster industry enquiries that NERC might fulfil.

The project began with a workshop attended by key financial services professionals and members of the scientific research community. Issues identified at this meeting were pursued through individual interviews with other members of the financial services community, including financial information service providers, and specialists in forestry management, insurance and re-insurance, asset management, banking, forest products, the pulp and paper industry, and certification bodies. Preliminary conclusions were presented five weeks after the workshop at a symposium attended by fifty finance and science professionals.

The workshop, subsequent interviews and symposium addressed data concerns in relation to the following topics:

- sustainability: deforestation, climate change, biodiversity and carbon storage;
- investment: Clean Development Mechanisms (CDMs) and emissions trading insurance, sovereign debt (forest bonds) and land ownership;
- industry: illegal logging, certification schemes, monitoring & security and standards & regulation; and
- data collection and dissemination: crowd sourcing, CISCO mapping, a proposed 'Global Snapshot' tool and the use of third party information providers.

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3. Observations

Resource Availability and Trends

Forests cover approximately 31% of the earth's surface[2]. The most recent assessment produced by the Food and Agriculture Organisation (FAO) of the United Nations is based on national reports from participating countries, following a standardised process. The FAO provides the most comprehensive general assessment available, but it is widely accepted that it is subject to major data and reporting inconsistencies and that there is a considerable error margin. There is continued uncertainty about the precision of the various metrics of forestry, including forest cover and density; and, critically, the calculation of the embedded carbon in the forest stock, particularly in the developing world. There is a particular lack of data relating to the calibration of species, both in terms of their relative presence in given foreign areas, and in their varying growth, yield and carbon capture properties. These problems are made more acute by inadequate data on rates of deforestation and partial control over illegal logging.

Forests are classified into four climactic zones: temperate, boreal, sub-tropical and tropical. Within these zones different types of species predominate; broadly these can be classified as either hardwoods or softwoods. The different characteristics of each species dictate the value and use of the wood from a particular region. This can vary significantly. Consequently, forests in certain regions are under more stress than others. Where the market value of the wood is greater (for example tropical hardwoods such as mahogany), the risk of deforestation due to illegal logging is higher. Furthermore, even a relatively high value hardwood forest is at risk of clearance if there is the potential to plant a higher value plantation there. One of the most common examples of this is the clearance of rainforest to plant palm oil plantations; another is clearance for cattle ranching. Forests comprising trees whose wood may be less valuable as a commodity are also at risk. Global population increase continues to drive land use change for construction and agriculture throughout the world, as a result of which more forested land is cleared for economic and demographic expansion. Population growth is the key factor as it creates the need for both more land for housing and infrastructure, and for greater agricultural output.

Deforestation of virgin forest is particularly harmful as it disrupts the environmental processes to which the forest contributes: particularly the water-cycle, soil preservation and other biodiversity and ecosystem services. The damage done to forest communities is equally severe and deforestation occurring in virgin forests thus destabilises socio-economic systems as well as ecosystems. According to a 2010 study, illegal logging over the previous decade fell by between 50% and 75%[3]. International initiatives such as the EU prohibition of the import of illegal timber (to come into force in 2012) and the voluntary partnership agreements (VPAs) agreed under the EU's Action Plan for Forest Law Enforcement, Governance and Trade (FLEGT), will help to improve the extent to which timber-exporting countries export only licensed wood to the EU. These kinds of measures, however, require robust, internationally agreed frameworks. As a result progress has been, and will remain, slow, with the ultimate onus resting with the governments of developing world which have limited means for (and sometimes limited interest in) addressing illegal logging issues.

[2] Food and Agriculture Organisation, "Global Forest Resources Assessment Key Findings 2010" (FAO, 2010)
[3] Sam Lawson, *Illegal Logging and Related Trade: Indicators of the Global Response* (The Royal Institute of International Affairs, 2010)

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International negotiation and regulation is made all the more difficult by data deficiencies. Improving both the quantity and the quality of forestry data is thus vital to accelerating action against deforestation.

In parallel with the campaign against deforestation, increasing resources are being devoted to reforestation and afforestation. Reforestation involves planting trees on land that was originally forested but was subsequently cleared; afforestation involves developing forests on land that has either never been forested or not been forested in the recent past. According to the most recent complete FAO report (2005) the highest rate of reforestation (of more than 20 million hectares) was seen in China, followed by an increase of 1.4 million hectares in Spain[4]. Afforestation accounts for an increasing percentage of the global forest area - in 2010 it is estimated that 7% of global forest cover comprises afforested land[5]. Afforestation, however, requires particularly careful planning and implementation as it has the potential to harm other natural habitats and ecosystems. Some of the most important economic incentives for reforestation are off-setting programmes relating to industrial emissions, but both reforestation and afforestation are also driven by wider concerns such as resource creation, related industry development and sustainability programmes.

Two critical issues are the power and will of governments to pursue sustainable policies, and the extent to which they can devise effective enforcement and incentive tools. Reforestation and afforestation are also driven by political imperatives, but investors require an additional economic rationale. While the net change in global forest area over the period 2000 to 2010 was negative, the rate of change was lower than that recorded for the previous decade, indicating that reforestation and afforestation initiatives, as well as anti-deforestation campaigns, are having positive results[6]. Nonetheless, the world is still losing tree cover and remedial action will need to be intensified in the decade ahead to protect forests from further depletion whether it be motivated by timber harvesting or land conversion.

Natural disasters are another major factor which put forests at risk. The two most common catastrophic events, storms and fires, are difficult to predict, and only partially amenable to preventative measures. Climate change is already increasing the number and unpredictability of natural catastrophes. The prolonged high temperatures recorded in Russia during the summer of 2010 and the subsequent drought have, for example, contributed to a series of particularly severe forest and peat fires which burnt in the central and western regions for weeks and threatened to overwhelm fire-fighting services. Over 200,000 hectares of forest were affected[7].

[4] Rhett A. Butler, *Rich Countries Gain, Poor Countries Lose Forest Cover*, Mongabay.com (2007)
[5] Food and Agriculture Organisation, *Global Forest Resources Assessment Key Findings 2010*
[6] Food and Agriculture Organisation, *Global Forest Resources Assessment Key Findings 2010*
[7] Telegraph.co.uk, "Russian Forest Fires Leave Dozens Dead" (30 July 2010)

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Resource Use

Forests produce a wide range of resources. Trees are used as a source of pulp for the paper and packaging industry; timber for the construction industry; and biofuel for the energy sector. All of these uses involve harvesting the trees themselves. Other industries do not harvest trees, but rather the organic matter that grows on them. These range from fruit and nuts to oils used either in the food industry or as lubricants, cleaning products or cosmetics. Wood itself, and all of the products that come from trees are a critical mainstream resource supporting continued economic and demographic growth. With the UN predicting that the planet will be supporting 9 billion people by 2050[8], demand will inevitably increase. As wood is the primary material used in house building, the demand for timber will continue to grow. Equally, more land will be required for agricultural production to feed a growing population. The overall result is that forestry resources will be exposed to increasing stress, and sustaining even existing levels of forest cover will become more and more difficult.

According to the most recent FAO study timber production[9] is responsible for the largest demands on the world's forests. The five countries making the largest contribution to global wood volume removals in 2005 were the United States (18%), Brazil (10%), Canada (7%), Russian Federation (6%) and China (4%)[10]. These are also the five countries with the largest forest area; and all except China are in the top five countries with the largest growing stock[11] (the fifth is Democratic Republic of Congo). The top five forest, paper and packaging companies are all based in the United States, Finland and Sweden[12]. The greatest proportion of plantation forests is in China, while the United States is the leader in solid wood[13] production, use and imports. Industrial wood use has remained constant over the past twenty years, but a number of studies suggest that demand will be met increasingly from plantation forests[14]. Other studies indicate that climate change will actually increase the long-run global supply of timber[15] due to the increase in temperature improving growing conditions for tropical hardwoods. Once again, there are many gaps in the data, and the need to address the problem is acute, as economic and demographic forces will, if not counterbalanced by aggressive sustainability measures, further reduce the global forest stock.

In a heavily industrialised global society the function of trees as carbon stores which mitigate the negative effects of carbon emissions is attracting increasing attention. During photosynthesis, trees convert carbon dioxide and water into sugar molecules and oxygen

[8] United Nations, *World Population Prospects: The 2008 Revision* (UN Department of Economic and Social Affairs, Population Division, 2009)
[9] Timber production is the process of managing stands of trees to maximise woody output.
[10] Food and Agriculture Organisation, *Global Forest Resources Assessment 2005* (FAO, 2005)
[11] Defined as 'volume over bark of all living trees more than X cm in diameter at breast height. Includes the stem from ground level or stump height up to a top diameter of Y cm, and may also include branches to a minimum diameter of W cm' in *Global Forest Resources Assessment Update 2005 Terms and Definitions* (FAO, 2005)
[12] Price Waterhouse Cooper, *Global Forest, Paper and Packaging IndustrySurvey* (PWC, 2008)
[13] Defined as 'wood as it is observed in a tree, log, or piece of lumber and hence free of manufactured voids as would occur between chips or free of nonwood materials such as resins and other additives' in *Wood Products Glossary* – available at http://www.woodproductsonlineexpo.com/glossary.php/s.html
[14] Easterling, William and Aggarwal, Pramod, *Food, Fibre and Forest Products*, Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., (Cambridge University Press, 2007)
[15] Balgis Osman-Elasha and John Parrotta, *Adaptation of Forests and People to Climate Change*, Risto Seppälä, Alexander Buck and Pia Katila. (eds.) (IUFRO World Series Volume 22, 2009)

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through a series of oxidation and reduction reactions. While some sugar is stored, the majority is used for energy and to form cellulose which provides the structure of the tree. The end result of this process is that carbon is embedded in each tree, most of it captured during the tree's early growth stages. Beyond their carbon storage function, forests also contribute to wider environmental sustainability. They are a key element in the water cycle, and also play an important role in supporting biodiversity and preventing soil erosion. Standing forests thus contribute not only to existing timber, construction and food products markets but also to wider economic sustainability.

With conventional energy prices continuing to rise as hydrocarbon resources are depleted, renewable energy sources such as forest biomass and wood waste are becoming increasingly attractive. A recent assessment of the productivity of a market leader in co-firing biomass in the Netherlands concluded that an extension of biomass firing would not only be profitable, but would also reduce the carbon intensity of the overall portfolio (with marginal costs reduced to €48/MWh and a net carbon saving of 0.8g/MWh).[16] It does need to be noted that the results depend on subsidies currently granted to the renewable energy sector. Nonetheless, with oil, gas and coal prices only likely to increase further, biomass is likely to remain an attractive alternative even if such subsidies are withdrawn.

[16] Ashley Thomas, *Comparing Wood: Visit to Essent's Amercentrale biomass co-firing plant*" (Daiwa Capital Markets, 2010)

Finance and Risk

There are two basic ways of investing directly in forestry: firstly investing for yield and secondly investing for specific abstractive use, such as pulp and paper. Forests are complex organic structures and investment in different types of forests produces different opportunities and risks. For example, a virgin forest containing tropical hardwoods which maintains a diverse ecosystem and is situated in a politically volatile country will quite clearly represent a very different type of investment to a managed softwood forest in northern Europe. The risk associated with each depends both on geo-political and on environmental factors. Political risk poses a threat to legal infrastructure such as land ownership, the enforcement of regulation and extraction rights, potentially leaving forests open to exploitation through illegal logging and land clearance. The catastrophic events to which forests are exposed are primarily high winds and fire. Certain steps can be taken to mitigate these risks, involving climate modelling; but it appears certain that climate change is altering the landscape and increasing the risk of both fire and weather damage. Forestry investment is, therefore, going to require ongoing upgraded and sophisticated data, which keeps abreast of the impact of climate change in order to maintain adequate risk management, be it via insurance or re-thinking the geographical location of investments.

As a result of the embedded carbon in the forestry stock, there are two components to their value as assets. The most obvious, and most transparent is their value as either a source of timber or their yield as a source of produce. The other is their value as a carbon sink. However, there is still considerable uncertainty about the extent to which trees act as carbon sinks, largely because common models and metrics to measure this carbon have yet to be agreed. With the development of the European Union Emissions Trading Scheme (ETS) carbon can now be priced. Given that trees represent potential positive carbon credits, it is quite likely (depending on commonly agreed metrics, and liquidity of the carbon asset itself) that the carbon in a forest will be worth a significant amount. As forestry credits cannot be traded as part of the ETS, a new market and regulatory framework is required. This will need to be underpinned by a standardised scientific model for measuring the carbon content of forests in a conservative and consistent manner. If this can be achieved, the scope for carbon-driven investment in forests is immense. Not only could the market be integrated into an emissions off-setting infrastructure, but investors would have a strongly enhanced economic rationale for contributing to an increased and sustainable forestry asset base.

Some of the most forest-rich areas of the world are within developing economies where unstable currencies and fluctuating economic growth exacerbate the difficulties of addressing sovereign debt through the issuance of government bonds. There is considerable potential to use these countries' forestry assets as the collateral on which to issue 'forest bonds'[17]. Given adequate metrics, the maintenance of tight control over sovereign land rights and the protection of the related forest stocks, a combination of the yield from sustainable management and the underlying value of the assets, both as produce sources and carbon stores, should allow for the creation of a bond with an attractive yield and significant potential for capital growth. The scientific community has a key role to play in providing the models and metrics to underpin valuation, while the City should be taking the lead in approaching the

[17] Organisations which have previously explored the potential of forest bonds include Institute for Sustainable Forestry who have published an online concepts paper *Working Forest Bonds: A New Concept to Protect Working Forests* (ISF, 2006) and Forum for the Future (http://www.forumforthefuture.org/projects/forest-backed-bonds)

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relevant governments to provide the financial advice, underwriting and distribution capacity to make the bonds a viable and liquid proposition[18].

[18] For discussion of a similar approach (carbon bonds) see Mainelli et al, *Index Linked Carbon Bonds – Gilty Green Government* (London Accord, 2009)

Managing Sustainability

Independent of the commercial value of wood products, forests play two very important roles. In an environmental context they regulate the ecosystem; and from a socio-economic perspective they are the source of fuel and food on which many communities, particularly in developing nations, rely. Sustainable management of forestry resources has become a major international policy concern and has produced a number of initiatives to combat the unsustainable use of wood products and the destruction of forests. The two primary types of initiative are the implementation of sustainable tree harvesting programmes; and the imposition by the developed world of certification schemes which permit only the import of legally sourced wood products from the developing world. The successful implementation of these policies requires robust infrastructure – particularly commonly agreed standards and intensive monitoring as well as robust and consistent data on forestry stocks and harvest yields. All of this data must be underpinned by multi-lateral government co-operation at a global level.

Wood and carbon are integrated in a variety of complex relationships in the supply chain of many products. While embedded carbon may be identified and traced relatively easily in some instances – for example in a building – in others the identification of the wood/carbon component is far more difficult, as is the case when wood itself is burned as part of an industrial process. Equally, timber from a single source is more easily identifiable than an end product such as plywood which is made from a combination of different types of wood, which could be sourced from different countries. The introduction of policies to improve sustainability means that the carbon content of a product becomes both a legal and an environmental issue. In the case of illegal logging, the EU has recently passed a directive to ban the import of illegally sourced timber into EU territories. The law will come into force from 2012, and violations can incur criminal prosecution. In order for companies to comply with this law, the importer will be required to prove that the timber entering the EU was acquired from a certified, sustainable harvesting regime.

Global initiatives such as FLEGT, the Lacey Act amendment in the United States and the new EU directive are attempts to find robust and practicable ways to halt illegal logging. A reduction in illegal logging was also the aim of forest certification schemes which date back to the early 1990s. Progress here, however, has been slow. Only 3% of global forests are certified, with 93% of all certified forests situated in the Northern hemisphere[19]. The failure to extend certification schemes globally is in part due to the fragmented nature of the forestry industry as a whole, a substantial part of it consisting of small, independent producers (in Maryland, USA alone there are over 130,000 forest owners[20]). In less developed countries this is further aggravated by a lack of control over land rights and resources, which continues despite initiatives such as the Sustainable and Participatory Energy Management Project (PROGEDE) initiated by the government of Senegal to implement the sustainable community management of 300,000 hectares of forest land[21]. However, most high value tropical

[19] Jacek P. Siry, Frederick W. Cubbage, Miyan Rukunuddin Ahmed, *Sustainable Forest Management: Global Trends and Opportunities*, paper submitted to the XII World Forestry Congress (2003)

[20] Irland Group with Seneca Economics and Main Street Economics, *Forest Production, Industry and Retention Assessment* (presentation by Steven W. Koehn) (2005)

[21] World Bank, *Sustainable and Participatory Energy Management Project (PROGEDE) 1997 – 2004 Project Brief* – available at http://siteresources.worldbank.org/INTGENENERGY/Resources/SenegalPROGEDEBRIEF.pdf

hardwood products are sourced from large suppliers making the product more susceptible to successful certification if local political support can be achieved.

Such initiatives go some way towards mitigating the incidence of illegal logging. The increasing effectiveness and sophistication of labelling systems and databases will facilitate further progress. Such policies, however, focus on banning imports of illegally sourced timber and are not, by themselves, sufficient to meet sustainability concerns. Policy decisions can also be local. To give just one example, the relatively low level of forestry product imports into the EU from South East Asia has resulted in this area being pressed much more lightly to implement certification schemes than the forest-rich countries in Africa. Land ownership is often a further complication, with clearly defined land rights being more often the exception than the rule in many developing countries.

The other major initiative to combat climate change and deforestation is a proposed global mechanism to incentivise better management of forest resources in developing countries in order to reduce emissions from deforestation and forest degradation (REDD). REDD came into being as a result of the conviction of the extent to which deforestation contributes to global carbon emissions. The Intergovernmental Panel on Climate Change (IPCC) estimated the proportion to be approximately 20% of total emissions in the 1990s[22]. Currently, organisations required under the Kyoto Protocol to reduce their emissions can fund projects in developing countries under the Clean Development Mechanism (CDM) in order to obtain Certified Emissions Reduction (CER) credits which can be traded on the EU ETS. Although afforestation and reforestation projects are accepted under CDM, and a number are already underway[23], existing forests are not eligible and so the financial incentives offered under this scheme do not help with the prevention of deforestation. REDD+[24] strategies attempt to use market mechanisms, as CDMs do, to incentivise investment in activities which extend beyond reforestation and afforestation projects to conservation and sustainable management of existing forests; and enhancement of forest carbon stocks. As with other global initiatives the success of REDD+ strategies will depend to a large extent on international cooperation and agreement on definitions and protocols. At this point, REDD+ strategies have not been implemented. One factor in this delay, discussed in a recent report[25], is the still unresolved issue of how to attract private sector investment in such credits; so although REDD+ credits have the potential to play a significant role in reducing deforestation and forest degradation there is some way to go before this can be realised via market based mechanisms. Furthermore, although significant funds have been earmarked for the implementation of REDD+ strategies by the United Nations, it is by no means clear how the money will actually be allocated to countries or what will be the requirements for developing and carrying out REDD+ strategies.

[22] IPCC, *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., (Cambridge University Press, 2007)
[23] CDM: Project Activities - available at http://cdm.unfccc.int/Projects/projsearch.html
[24] REDD refers to the mechanism by which better management of forest resources in developing countries can be incentivised; REDD+ refers to the individual strategies being developed in order to achieve this goal.
[25] O'Sullivan, R., Streck, C., Pearson, T., Brown, S. and Gilbert, A, *Engaging the Private Sector in the Potential Generation of Carbon Credits from REDD+; An Analysis of Issues, Report to the UK Department for International Development (DFID)* (2010)

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4. Analysis

Data Considerations and Constraints

The current data on forests is produced using a variety of technologies and metrics. Although huge forward steps have been taken, it is still far from being an exact science. Information is predominantly generated through a combination of satellite observation and ground based observations. Radar and LiDAR (light detection and ranging) technologies are used to provide higher granularity at the local level. Data from these sources is combined with geographical and species distribution information to produce estimates of change in land cover and species calibration. The constraints on accurate estimation are related to the scale on which that data is required. There are, as yet, no globally agreed criteria or standards for assessing forestry resources, with the results that figures for large parts of the world are still broad approximations with a significant margin for error.

Figure 1 Summary of data needs per sector

Forestry data	Industry	Energy Sector	Direct Financial Investors	Insurance Industry	International Accreditation and Reforestation schemes
Forest Cover	√		√	√	√
Forest Species	√	√	√		
Carbon Content	√	√	√	√	√
Ownership Rights			√		√
Vulnerability to Deforestation	√		√	√	√
Weather	√	√	√	√	

With the supply of consistent and reliable forestry data, progress on a number of the issues which are currently inhibiting investment in forests – such as carbon and biomass levels, forest density, forest area and the likelihood of catastrophic events occurring - could be accelerated. NERC is a repository of environmental data sets. These embrace direct and indirect measurements of biomass, forest structure and vegetation using ground based measurements, coupled with highly sophisticated earth observation technologies, including satellite, radar imaging and optical and remote sensing. NERC also funds new research in environmental science including projects relating to carbon, natural hazards, species calibration and forest cover.

Remote sensing - the use of airborne and satellite measurements – is being used by NERC scientists to map, monitor and improve understanding of forests and forest use. Research is aimed at developing ways of measuring the structural properties of a forest including forest height, forest biomass, and structural complexity. High spectral resolution satellite-based optical imaging and airborne thermal infrared imagery are also used by NERC scientists to assess forestry and land use change.

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Other technologies include optical sensing and hyperspectral[26] remote sensing to monitor vegetation. Calibration and validation of multispectral and hyperspectral datasets, VIS-SWIR (visible and shortwave infrared) remote sensing for mapping and monitoring of vegetation and development of vegetation stress monitoring systems are all being carried out at both a ground-based and airborne level. Research is being carried out to develop and validate a new remote sensing approach (using observation of the radiative energy emission from fires, from low earth orbit using satellite-based sensors) to provide observational assessments of forest fire intensity variations, and direct estimates of the carbon flux release during fire.

NERC scientists have developed advanced remote sensing methods for measuring and classifying vegetation and land cover, particularly three-dimensional forest structure and biomass from Synthetic Aperture Radar (SAR) and LiDAR. They have also contributed to the first large-scale radar-derived forest cover map of 1 million km^2 of taiga forest with an unprecedented spatial density of 50 m resolution. NERC scientists contribute to a project to use a multi-sensor Earth Observation approach for full greenhouse gas accounting to monitor compliance with the Kyoto Protocol, including quantification of inter-annual changes in burned forest area[27].

One of the major financial constraints to providing better data-sets with satellite technology is the cost of launching and using the technology. Another major problem is cloud cover which is a particular issue in equatorial areas where the need for monitoring is most acute. Furthermore, data from satellite technologies must always be supplemented with other data from ground-based sources. One way to collect this ground-based data is to mobilise the inhabitants of the area in question to provide local knowledge and carry out basic surveys. This has already been done to positive effect in the Brazilian rainforests as part of the PRODES project, launched in 1988 to estimate gross Amazon deforestation.

While some forestry data is in the public domain – such as the data collected from the LandSat program – it tends to be at resolutions which are of limited utility to financial services to support investment decisions. NERC's technological capabilities, data archives and knowledge base are both extensive and continuing to expand. They can be mined to gain a more complete understanding of the impacts of deforestation by locating the vegetation type in which it is taking place. They can also contribute to the development of standardised metrics, classification systems and assessment methods for monitoring forests, which can be employed on a global basis. Improved forestry data is the key both to fighting deforestation effectively and to realising the full investment potential of forests as carbon stores.

[26] Hyperspectral imaging is the collection and processing of information from across the electromagnetic spectrum.
[27] Details of the scientific studies on forestry funded by NERC can be found online at http://www.nerc.ac.uk

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Data Needs

One possible structure for understanding the data requirements of the financial services is set out below. For any significant asset an auditor expects seven typical pieces of evidence:

- *accurate understanding of the Cost of the asset:* how much has it cost to build? How much does it cost to maintain? What are the indirect costs?
- *confirmation of Ownership of the asset:* do you have a clear title? Do you know what bought knowledge is crucial?
- *some Disclosure of the importance of the asset:* do we publish a value? Can we defend a minimum value?
- *ability to confirm the Value of the asset:* do we have a valuation methodology? Do we measure the increase in value?
- *evidence of the Existence of the asset:* do we audit our data for completeness, accuracy and location? Do we change control procedures which control major changes in our data? Can we point to information which is 'retired' (not just archived)?
- *clear lines of Responsibility for the asset:* can senior management find what they talk about? Is someone in charge of the value?
- *measurable Benefit from the asset:* can we demonstrate our competitive advantage or shareholder value?[28]

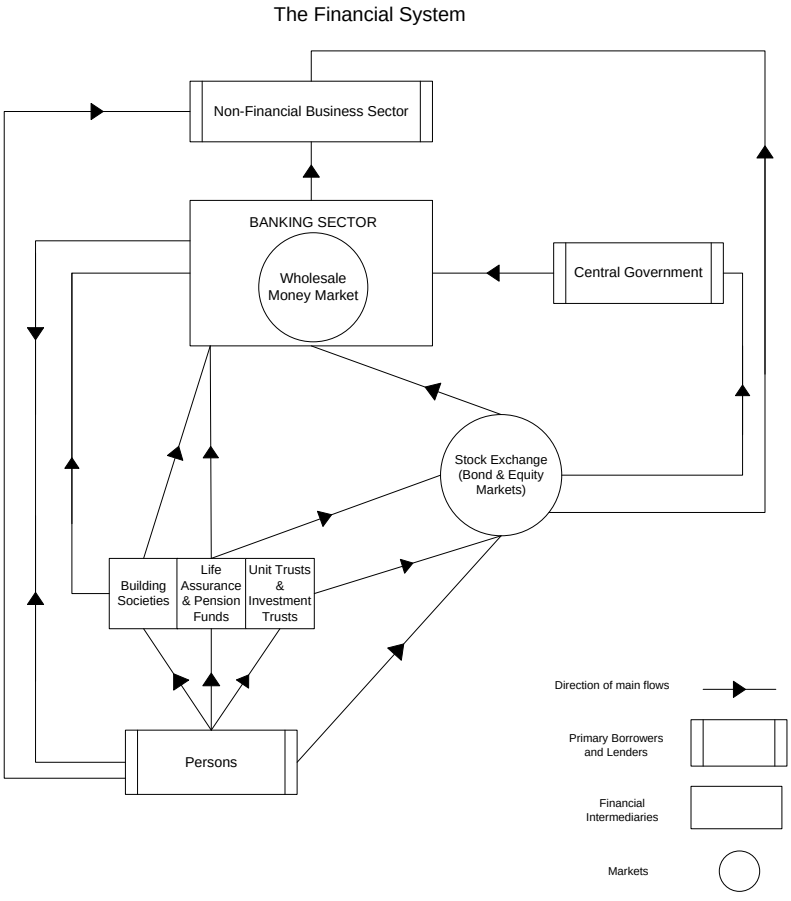
Figure 2 Example of data requirements to support evidence of asset

MARKETS	Direct Investment	Guarantors	Traded Markets
Cost	acquisition – data relating to composition of forest	acquisition – data relating to composition of forest	acquisition – data relating to composition of forest
Ownership	forestry cover imagery - sovereign debt payment potential	forestry cover imagery - sovereign debt payment potential	forestry cover imagery - continued existence of asset via satellite surveillance
Disclosure	forestry cover and watershed information - more complete costs of logging	forestry cover and watershed information	information for trading
Valuation	forestry mass changes - carbon absorption	satellite and model validation of carbon absorption	information for trading
Evidence	forestry cover imagery - continued existence via surveillance	forestry cover imagery - continued existence via surveillance	forestry cover imagery - continued existence via surveillance
Responsibility	'real-time' monitoring of assets	'real-time' monitoring of assets	information for trading
Benefit	comparative rates of forest growth	comparative risk assessments	information for trading

[28] Ian Harris and Michael Mainelli, "*All Important Information"* (Charity Finance, 2002)

While the data requirements of direct investors, guarantors and traded markets overlap to a considerable extent (see figure 3), and while there is a general need for more, higher resolution data, there are significant differences in emphasis. Traded markets and guarantors have the more completely aligned needs, the major difference being that the former are driven by identification and valuation concerns, while the primary concerns of the latter revolve around legality and risk assessment. Direct investors share the common need for data on the cost, ownership and evidence of the existence of the asset. Beyond these, their needs are specific to the investments they are making, and will be provided by a combination of the traded markets and the guarantors, and by the investor's own due diligence and management procedures.

Figure 3 The Financial System in Outline



Source: Adapted from *How the City of London Works*, William M. Clarke, (2008) 7th Edition

Global Snapshot

The quality of forestry data currently available from various public and private organisations varies at a regional, national and global level; it seems that a 'snapshot' of the global picture would be both a useful and feasible aim for the earth observation community to work towards in order to facilitate investment decisions on a broad scale. We propose that financial services professionals and NERC science assets (organisations such as NCEO) might approach this idea as an initial step to develop, in order to establish a more comprehensive communication and collaboration strategy which will enable the technology already available to be put to its

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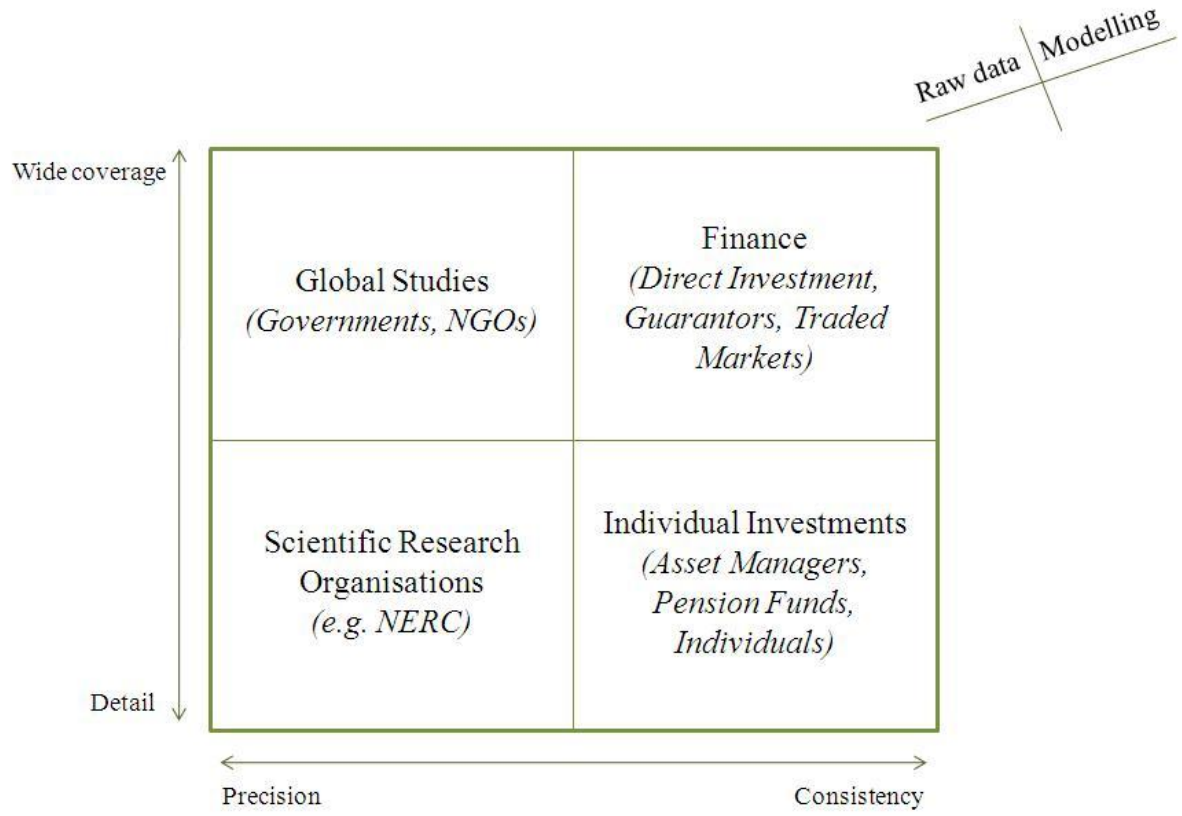
greatest practical use by the financial markets. Figure 4 (below) demonstrates the scales of time and detail required by different sectors of the research and finance communities.

Figure 4 'Global Snapshot' Matrix



The snapshot comprises a database of information on all the forested regions of the globe. The crucial significance of this tool is that it be underpinned by universal, standardised metrics, whether measuring quantities of carbon levels or the mass of a particular forest. Making consistent and comparable global data-sets both accessible and meaningful to those outside of the scientific research community would dramatically improve the potential for the data to be used effectively within the context of financial investment; and would allow the untapped *potential* value in forestry investment to be realised.

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5. Conclusion

This project has investigated the link between the appetite for investment in forestry within financial services and the provision of scientific data relating to forests and carbon. A number of observations can be drawn to influence the direction of NERC, to the benefit of both NERC and the financial investment community.

Forestry is a global industry and an investible asset class in its own right. Deforestation, illegal logging and climate change have also made forestry the centre of global political interest. The carbon capture attributes of growing trees have added a new dimension to the issue. All are potential triggers for stimulating increased financial services interest in forestry data.

Observations

1. To most market participants, environmental data (other than that closely related to the carbon market) is still perceived as belonging in the domain of sustainable responsible investment (SRI). As such, it is not considered relevant to mainstream investment and risk management activities, with the exception of flood risk forecasting for the insurance industry.

2. Despite this, there is a significant level of latent interest in environmental data. This could solidify into real demand for forestry data specifically as the increasing stress on natural resources changes investor approaches to sustainability. Sustainability concerns are currently still an adjunct to mainstream investment, but will move centre stage as environmental sustainability is re-defined to encompass full economic sustainability.

3. While any estimate of the timescale for this convergence would be imprecise, two to four years appears a fair time horizon. Individual companies are already seeking detailed data, but more general market interest is likely to develop first in the field of risk indicators.

4. The profile of both NERC as an institution and the scientific data it produces is extremely low in the financial services sector. Few of those attending seminars or interviewed separately were aware of the organisation's mission, capabilities and existing products.

5. Exposure to data should increase appetite for more data; and will stimulate both analytical innovation from within the financial services sector and the willingness to invest in data generation.

6. There is greater scope for the use of improved data to support, monitor and protect private investment in forestry assets and improve rates of return from afforestation projects.

7. The greatest potential source of demand is likely to be the ongoing development of international initiatives on reforestation and afforestation; and the related integration of forest carbon stocks into the carbon market via REDD+ strategies. Progress here, however, is heavily dependent on international political negotiations and agreements which could prove both slow and complex.

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8. Financial services professionals are likely to be customers for bespoke, high resolution imaging-related data services, while it is actually the international political community which will need to fund a more comprehensive global data collection programme. This said, initiatives by Google and Cisco indicate an appetite for low resolution data on a global scale.

9. Estimating the carbon content of forests will be critical to both individual and international forestry initiatives. It is essential that a commonly agreed model for estimating the level of carbon in a given area of forest is agreed. Investment and risk-hedging will only be possible if they can be built around an agreed conservative benchmark which is consistent, rather than at a cutting, but variable, edge of accuracy.

10. Environmental markets as a whole are nascent; if they are to become more robust and developed an end-to-end suite of services and tools is required including indices, identifiers, registries and risk management capability.

Recommendations

1. NERC can accelerate the demand for data by adopting a more pro-active approach to raising awareness of both the availability of its data and its willingness to collaborate in joint ventures to develop specific applications. Underpinning that, NERC should actively consider establishing an on-going presence in the City through a series of workshops.

2. This event-based approach should itself stimulate individual opportunities to pursue pilot projects with interested data users and investment houses, which will also increase the rate of knowledge transfer.

3. Optical and radar imaging are vital technologies for the monitoring of forest management globally and thereby accurately assessing risks relating to timber investment and the international supply-chain. NERC should seriously consider either developing its own 'Global Snapshot' product or seeking an agreement with the commercial entities cited above to improve the quality and resolution of data:

- 'Global Snapshot' would be a natural resource map of the world, capturing forest, water, plant and nominal species, soil and mineral data, overlaid by a second, more dynamic, level of data on weather patterns and demography[29];
- the level of resolution would necessarily have to be fairly low, and in parts of the developing world in particular, modelling would be as important as the data itself. It would, however, be possible to provide a 'drill-down' function for areas such as Western Europe where data exists to a relatively high level of precision;
- the 'Global Snapshot' would not support an individual investment decision, where detailed data and analysis would be required; but it could be used as an overall asset allocation tool, and as 'future risk radar' either for hedging or for portfolio redistribution;

[29] A 'Global Snapshot' tool is one that goes beyond the scope of forests alone; the development of such a tool is considered here in the context of a series of reports including *Finance and Water: Where's The Data?* (Leonor Fishman, Z/Yen Group Limited, 2010) and *Finance, Biodiversity and Ecosystems Services: Where's The Data?* (Chiara Von Gunten, Z/Yen Group Limited, 2011), which are being carried out on behalf of NERC, via the FSKTN.

- the 'Global Snapshot' would need to be updated on a regular basis to be of real value; but given the speed at which the various inputs change, a sensible initial target would be quarterly, becoming monthly as the tool was tested and refined.

4. NERC should take the lead in pushing for such a benchmark through its own modelling capabilities. To gain acceptance, set metrics should only be revised at infrequent intervals, say every three or five years.

5. NERC should pursue relationships with information service providers who could channel data effectively to underpin the infrastructure required to develop indices, identifiers and registries. Joint ventures in partnership with financial services information providers would allow data to be disseminated in a structured format.

Based on the findings of this project it is concluded that:

- *the most productive way for NERC to move forward would be to establish individual joint ventures with partners interested in developing particular indicators or products;*
- *NERC should pursue partnerships to fulfil the specific data requirements of the most interested parties from the financial services sector;*
- *increasingly, better knowledge of the data surrounding natural resources, for which demand and competition is growing exponentially, will create a market advantage for those investors who are collaborating with earth observation research centres;*
- *the rest of the sector will follow, at which time the data itself will become an essential part of the offering of the major financial services information providers and rating industries.*

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7. Appendix A

Organisations who helped this project inlcude:

3i
Acclimatise
Beetle Capital
Brewin Dolphin
BT Pension Scheme Management Ltd
Climate Exchange PLC
Carbon Disclosure Project
Carbon Markets and Investors Association
CDP Water Disclosure
Centre for Ecology and Hydrology
Chair of the Liberal Democrats' International Relations Committee
City of London Corporation
CIX
Credit Agricole Chevreux
Davis Langdon
EnviroMarkets
Environmental Finance
Forest Footprint Disclosure
ForestRe Ltd
Forest Industries Intelligence Limited
Global Canopy Capital
Herbert Smith
Hermes Equity Ownership Services Ltd
Illiquidx Ltd
Induco Consultants
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Natural History Museum
Royal Bank of Scotland
Schroders
Sindicatum Carbon Capital
Standard Chartered
Sustainable Development Unit
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