Global dynamics of the pulp and paper industry – 2013

Richard B Phillips

The pulp and paper industry is one of the most global in nature. Trees are most productively grown in scattered pockets of forest, but demand is dispersed by a different set of factors. Decisions made in Singapore, Memphis and Auckland have a significant effect on markets elsewhere. There are three factors behind global demand for forest products –

- The rise in standard of living in large parts of China, Brazil and India creates discretionary income which their citizens can apply to products which are read, such as newspapers and magazines, and those that are packaged such as manufactured goods, agricultural products and fast foods
- Print media and business forms are rapidly being abandoned in North America and Western Europe, leading to a major realignment of business strategies
- Energy security and climate change, where liberal and conservative philosophies have an uncommon alliance, are creating an unmet demand for bioenergy and bioproducts from biomass.

Global forest resources are adequate or can be profitably expanded in the major forest regions to meet the need for biomass for biofuel. Each of the factors above is discussed and then analysed collectively.

Paper and packaging demand in developing economies

Paper industry economists have, for a long time, observed a relationship between growth of wealth and the demand for paper among developing economy populations. The chart below shows the history of the growth of wealth along with paper and board demand

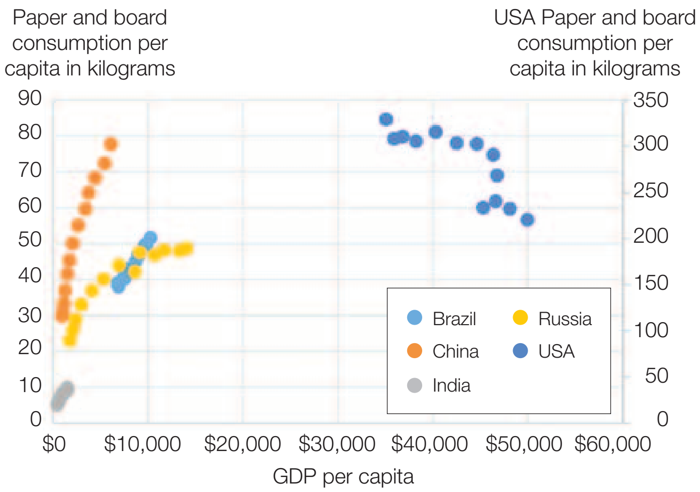

Figure 1. Relationship between per capita demand for paper and board, and GDP

for Brazil, Russia, India and China, the BRIC countries, and contrasts the trends against the United States.

Collectively the data includes 46 per cent of the world's population, 42 per cent of GDP and 51 per cent of paper and board demand. As developing country populations obtain more discretionary income, it is used for buying food and goods in packages, tissue and towel products, and reading materials. In the United States, paper and board consumption reached record levels in 2000 and has declined since the peak, as shown in Figure 2. This indicates that peak demand is achieved when consumers are fully supplied with the paper and board they require, followed by erosion of demand when substitution begins to take place.

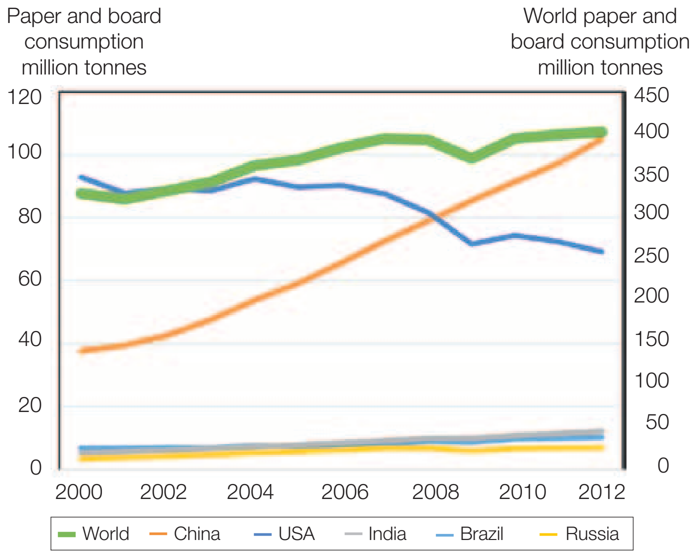

Figure 2 Paper and board consumption in BRIC countries, the United States and the world

The contribution of the developing economy in towards paper and board demand, and the specific grade growth, leads to important implications for virgin pulp fibre and demand and from forests. Outside North America, packaging board, especially corrugated containers from linerboards, are produced with greater than 90 per cent recycled fibre from recovered paper. In packaging, the original fibres were mainly softwood – thick-walled loblolly and radiata pine. Tissue, the other growth product, is premium with almost equal parts northern softwood and eucalypt fibres, along with southern softwood kraft.

Among the BRIC countries, Russia and Brazil are fibre export nations and are more than self-sufficient with respect to virgin fibre, but still produce containerboard with recycled fibres from recovered paper. China is the largest growth area for demand for all products, but especially packaging.

Two main questions with respect to China are –

- When will demand for paper and board in China begin to moderate?
- What quantities and types of fibres will China demand?

Figures 4 and 5 display the author's upper limit of demand growth based on Trendline, which is approximately eight per cent compound annual growth of GDP. Equally probable would be four and six per cent GDP growth, leading to even lower forecast of future volumes. Figure 4 reflects the earlier discussion that demand per capita will decline with GDP per capita. If the rate of change of GDP can be accurately forecast, then the change in demand can be predicted. Economists' forecasts for China vary widely, but most are in the range of four to six per cent a year.

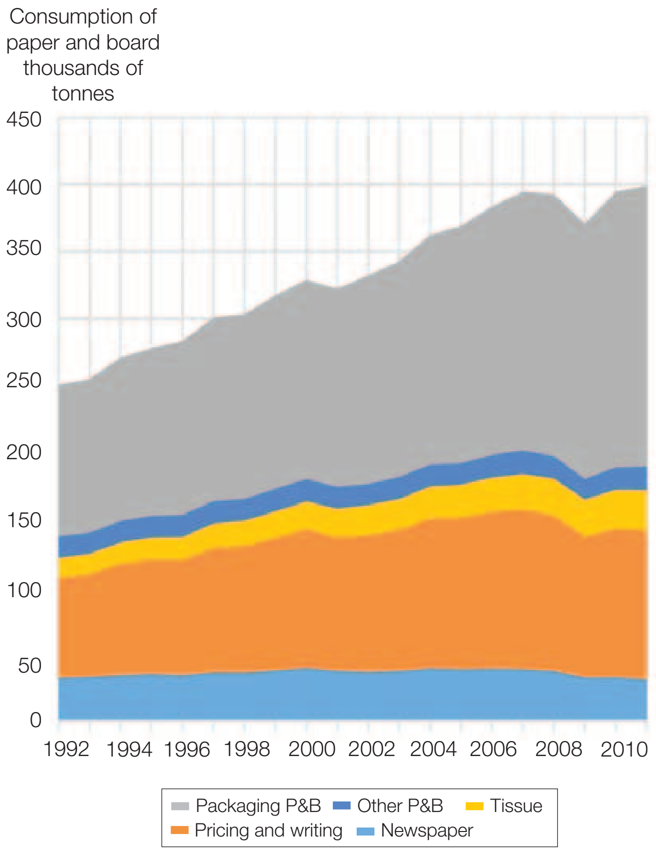

Figure 3. Global paper and board consumption

Considering the Trendline forecast for packaging paper and board along with trends with respect to Chinese demand for recovered paper, the forecast demand for long fibre is reinforced. Figure 6 displays the author's forecast for Chinese packaging paper and board, along with demand for recovered paper, domestic collection and imports. If the forecast is correct, China will be importing 60 per cent of all the waste paper in the world, a level that is not probable without creating price pressures which will cause the imports to level out.

Fibre needed

China is then faced with a dilemma. Where will the fibre come from in the future to manufacture its packaging? Options might be –

- Increase domestic recovery, already levelled out at a high level
- Produce packaging with virgin fibre manufactured in China, not probable with scarcity of domestic long fibre
- Import liner or bleached pulp from softwood-rich countries.

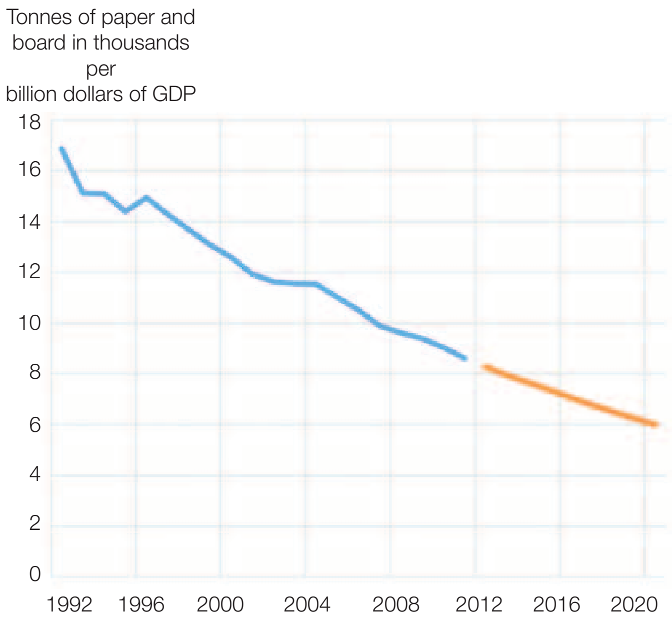

Figure 4. Relationship in China of paper and board consumption as a function of GDP

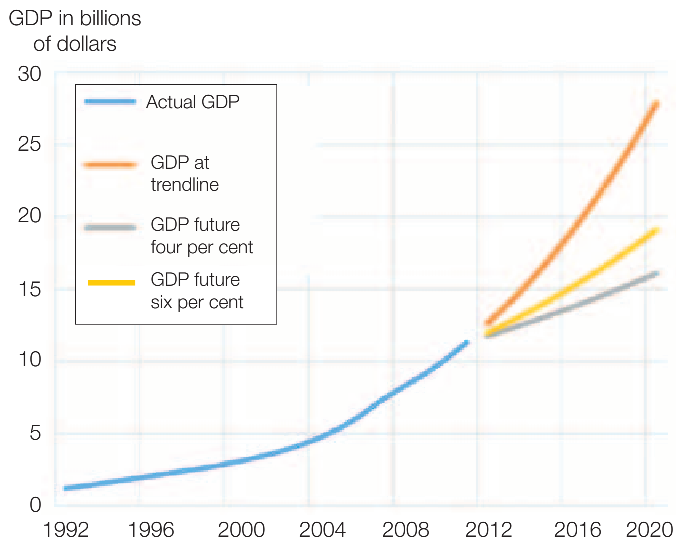

Figure 5. Paper and board consumption in China at trendline, four per cent and six per cent GDP growth

Figure 7 is a chart which shows the gap between production and consumption of recovered paper. Major excess for export is in the United States, a smaller surplus

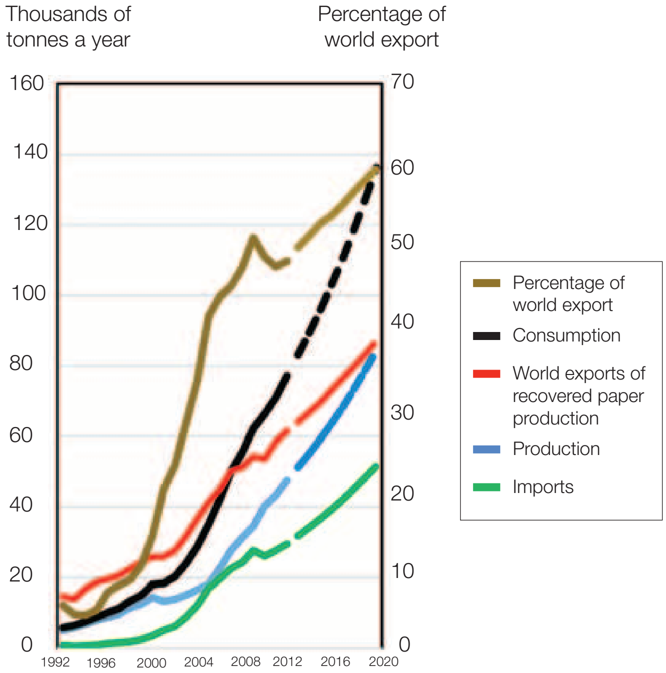

Figure 6. Recovered paper recovered paper production, consumption and imports and estimated percentage of total world exported recovered paper

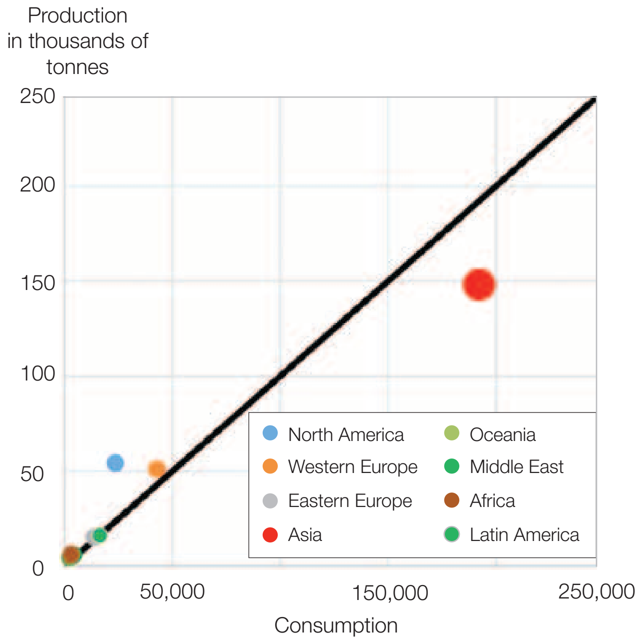

Figure 7. Gap between recovered paper consumption and production in Asia stretches the available supply from recovered paper exporters

in Western Europe and a significant deficit in Asia. The significance of this gap is that it can only be bridged by either paying a premium for old corrugated containers, already at historic highs, or reducing dependence on recovered paper by importing more long fibre in the form of linerboard or softwood pulp.

The dependence by China on recovered paper, and their own lack of domestic softwood forests, draws the attention of major softwood forest owners who have the forest base, wood cost and priority for meeting the likely demand for softwood pulp our model predicts for China in 2020.

For bleached softwood pulp, Asia will have a gap of almost 17 million air-dried tonnes a year by 2020, while North America and Western Europe will have an excess of 13 million tonnes. Like all forecasts, this one has built-in assumptions and speculation, but a market opportunity as large as suggested here should be filled somewhere. The candidates can be identified from the collection of countries which ship softwood chips and sawlogs to Asia – the United States, Canada, Australia, New Zealand, Brazil and Chile.

Paper to pulp

Another major United States south east driving force is the further change from bleached softwood kraft from paper markets to absorbent pulp markets. Included in the 17 million tonne production from North America are five million tonnes of absorbent pulp, with very little left for export. Recent acquisitions of Canadian NBSK pulp mills in Canada by Chinese tissue producers appears to be aimed more at supply security than based on financial returns.

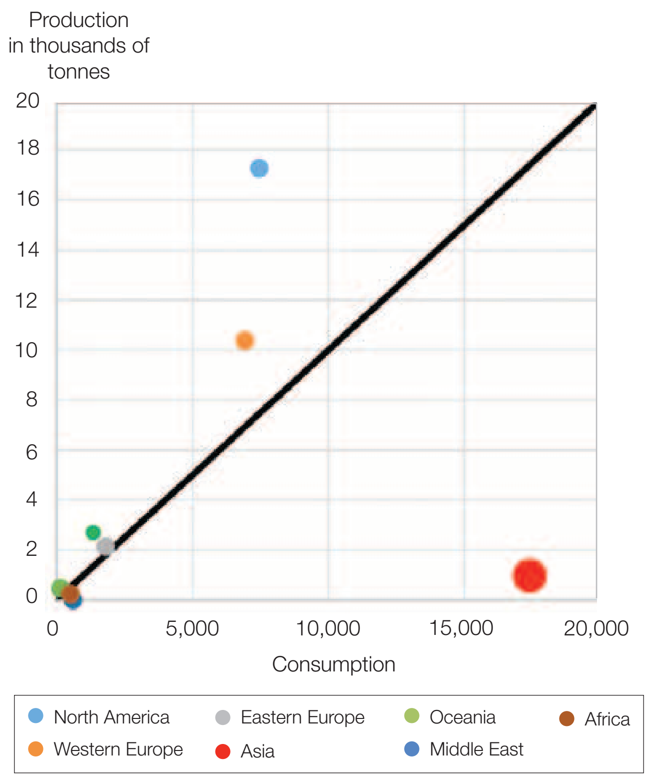

Figure 8. Asia will require around 17 million air dried tonnes of bleached softwood by 2020, leaving a gap of four million tonnes above projected supply

Developed economies in North America and Western Europe are rapidly abandoning print media and business forms in favour of electronics, leading to major changes in business strategy. The growth of paper and board in the developing economies is impressive, but the declining consumption in this region suggests major changes in the production base and grade mix in the countries which have supplied the world with high quality newsprint, coated papers and market pulps.

Figures 9 and 10 show consumption of major categories for North America and Western Europe contrasted with the consumption for the rest of the world. Consumption parity was reached in 2004, whereas a two-to-one difference in demand of this region was seen as recently as 12 years earlier. The developing economies are growing at four per cent a year, but North America and Western Europe are declining at about the same rate. In this region, only tissue shows an increase in consumption, and even then a paltry one per cent a year.

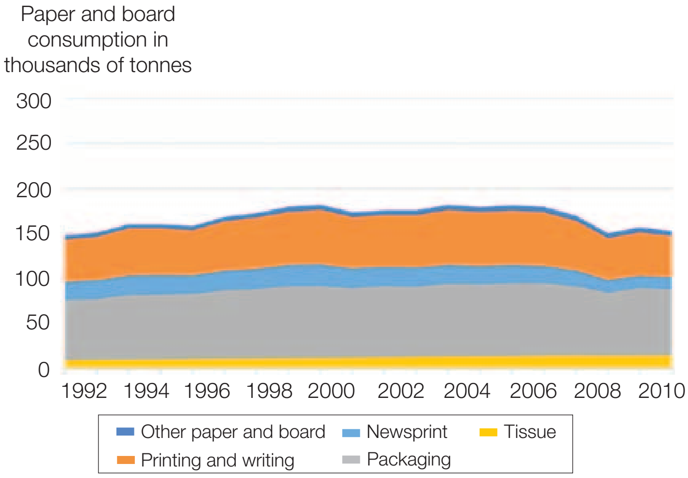

Figure 9. Consumption by major category of paper and board in North America

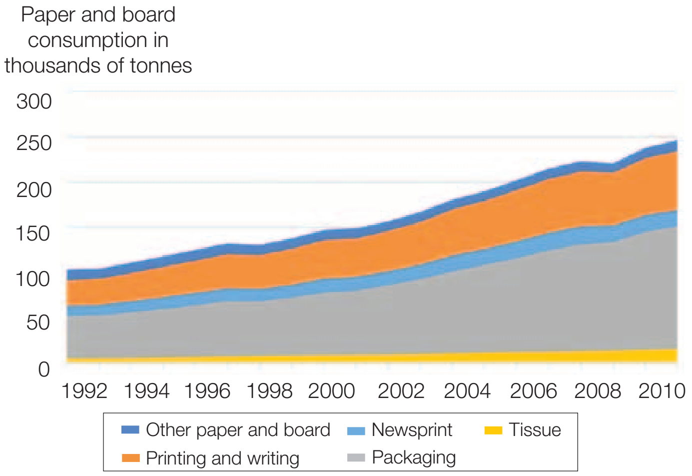

Figure 10. Consumption by major category of paper and board in the rest of the world

It is tempting to write off the region as future contenders in the global pulp and paper industry dynamics. That may be true for Western Europe, where the economy has been chronically underperforming, and Canada, which has experienced forest infestations and high wage rates in recent years, but it is not the case for the United States.

Four factors will underpin the survival of the paper and board industry there –

Figure 11. Comparison of major cost elements among major pulp and paper producing countries

- Low cost wood fibre, paper and board production in the south eastern region
- Long fibre quality suitable for packaging grades and absorbent pulp applications
- Symbiotic relationship with China where their goods are imported to the United States in corrugated containers manufactured in China, recovered at a rate over 75 per cent in the United States and sold back to China
- Opportunities to integrate biofuel technologies into pulp and paper mills.

Cost and strategy

Figure 11 collects major production cost elements from pulp and paper producing countries. It shows low cost softwood pulpwood and chip costs, highly competitive labour rates compared to Canada and Western Europe, and transport costs to China better than all but western Canada and Russia. While asset quality in the United States is not equal to Scandinavian competitors, overall cash costs and delivered cash costs to Beijing are superior for indicative grades, such as linerboard and softwood pulp, as shown in Figures 12 and 13.

These comparisons indicate that the 50th percentile United States producers of liner can match delivered costs with the best Chinese domestic producers and all SBSK producers are superior to Chinese producers. The proper interpretation of these comparisons is to show that exports represent a market opportunity for United States producers, in softwood-rich grades, to compensate for loss of markets at home. That opportunity does not exist with Canadian or Scandinavian producers due to their cost structure.

Figures 14 and 15 show the effect of the United States cost position on the two softwood-rich grades in increasing the export volumes in recent years. A main strategic point for every major United States printing and writing grade producer has been managing the decline in uncoated paper demand. International Paper at Franklin, Virginia and Domtar at Plymouth, North Carolina have converted more than a million tonnes of fine paper production to softwood fluff pulp over the past five years. Newsprint producers have fewer options, but most are studying machine conversions to linerboard.

Profitability

Cost position inevitably shows up in the corporate bottom line. As a global commodity industry, earnings tend to go up and down together, but overall you can see in Figure 16 that cash flow margins are greatest for the low cost Latin American companies, with the United States in second place. In Figure 17, it can be seen that return on capital employed is highest in the United States, a result of both cost position and management of capital investment.

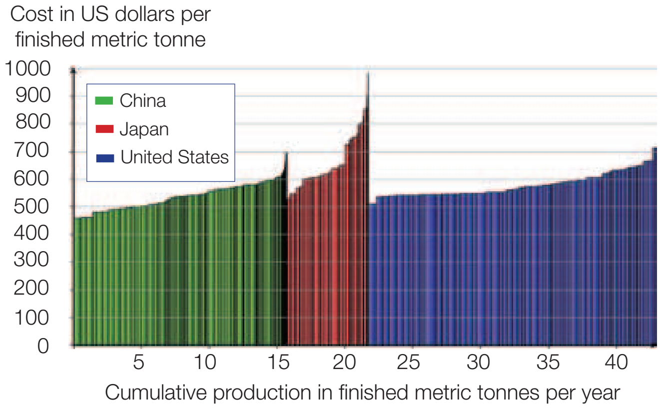

Figure 12. Linerboard delivered cost in dollars per tonne to Beijing for Chinese, Scandinavian and US producers

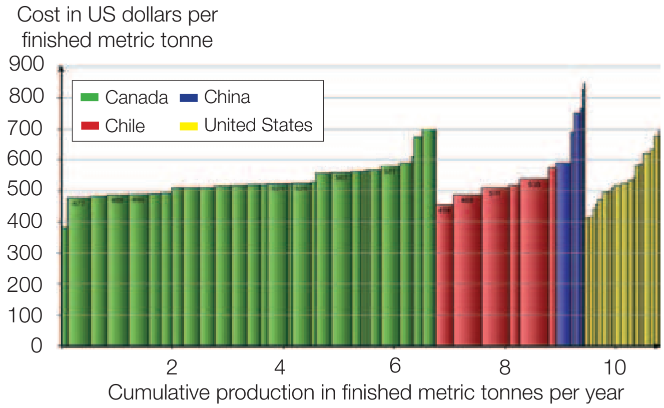

Figure 13. Bleached softwood pulp delivered cost in dollars per tonne to Beijing for Chinese, Canadian, Chilean and US producers

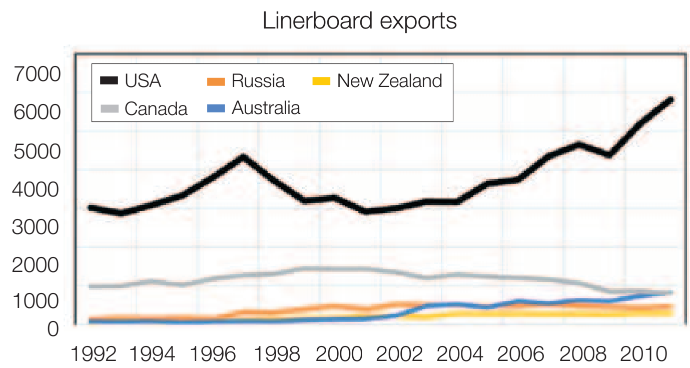

Figure 14. Trend of US linerboard exports

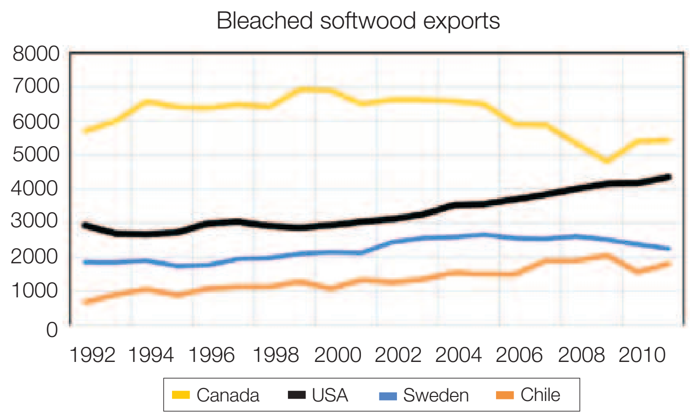

Figure 15. Trend of US softwood pulp exports

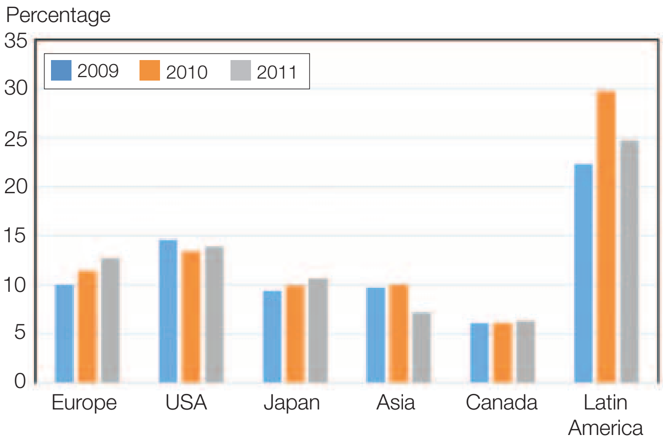

Figure 16. Margin on earnings before income tax, depreciation and amortisation by region

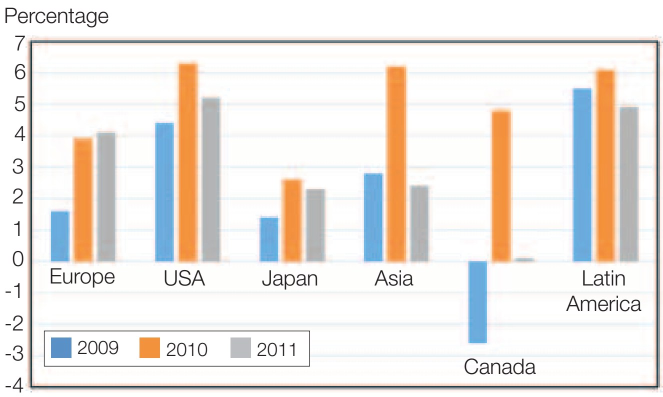

Figure 17. Return on capital employed by region

Climate change, sustainability and bioenergy implications

It has often been said that perception is reality. Four perceptions are influencing a reallocation of land and forests –

- Most people believe that man-made greenhouse gas emissions are leading to global climate change
- Most people believe the world is running out of fossil fuels
- In the United States, many people believe that our supply of oil and gas rests in the hands of people who do not like us very much
- Many people worldwide believe that biofuel development is part of the solution to the first three points.

The first point will be hotly debated until, or if, global temperatures increase as they have not done over the past 10 years.

The information in Figure 18 should partially answer the second point, at least with respect to oil. Proven reserves have hovered at around 50 years for the past 30 years, and are trending upward with new discoveries in Latin America and United States.

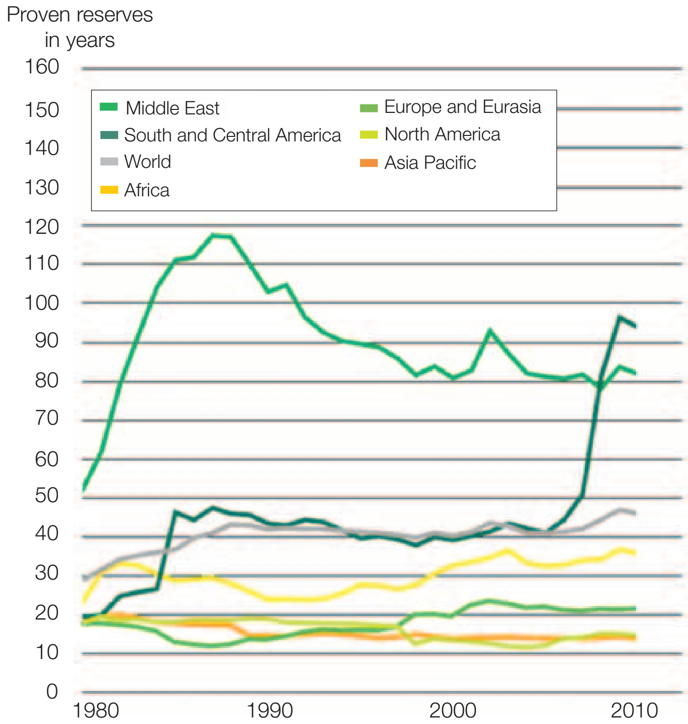

Figure 18. Proven reserves of oil in years of supply at current consumption

The third point is what is currently behind biofuel activity in the United States, and the lack of political stability in the Middle East drives most of the developed economies. Biofuel development has enjoyed more than $2 billion in research and investment over the past 10 years. Using the success of the corn-to-ethanol technology as a launching point, researchers have looked to move away from food crops to cellulosic compounds. Two main approaches to cellulosic biofuel are being pursued.

One is biochemical, where biomass is pre-treated to open up the structure to hydrolytic enzymes applied in post-treatment. Carbohydrates in the biomass are converted to glucose or xylose, both of which can be fermented to ethanol. The other approach is thermochemical. Biomass is subjected to rapid heating in the absence of air to convert the solid materials to an oil-like mixture or a synthesis gas. In one method the first step is carried out with a regenerative catalytic system. With biochemical chemical processes, biomass cost per tonne of carbohydrate is the most important indicator of success. With the thermochemical processes, lignin and carbohydrates are converted to syngas, so the cost per unit of energy is the appropriate measure. Gonzalez (2012) developed plantation models for the south-eastern United States for a variety of bioenergy plantation crops including woody biomass, agricultural crop biomass and agricultural residues.

Figure 16 indicates some superiority of woody biomass over other candidates, although agricultural crop analysis is very dependent on the assumed land value. For year-round supply of biomass to an ethanol production plant, multiple crops would be needed along with some penalty for deterioration.

The first commercial cellulosic biofuel plants are now beginning to start up in multiple locations in the world, all with significant government grants and subsidies. Our analysis of 100 options for biomass conversion technology and the context of greenfield versus co-location with another manufacturing site, points to some of the critical problems. It also demonstrates the synergy of co-location of a biofuel plant with a kraft pulp and paper complex.

Bio-ethanol to rescue printing and writing paper plants?

Figure 19 shows a simplified view of an auto-hydrolysis process. Looking very much like a kraft pulp mill, except water is the only cooking liquor, the process offers reasonable yield, simplicity and the lowest investment cost of any option studied. However, as a greenfield investment in the United States, the capital investment including land purchase, infrastructure and process equipment, is not justified financially unless ethanol would sell for 79 cents a litre, almost 20 per cent higher than the current market price.

The table shows three scenarios of investment in auto-hydrolysis of hardwood to produce bio-ethanol. The first is a greenfield location with all infrastructure, process equipment, water and waste treatment included. The second is co-location with a kraft pulp mill where infrastructure costs are reduced, shared access to wood-handling and power plant equipment. The third is also co-location except all non-sugar chemicals are dried and pelletised and sold as fuel pellets. These are shown as a deduction in energy cost, which also includes the cost of burning natural gas and purchasing power.

Figure 19 does not indicate the ultimate disposition of lignin and unfermented residues which is up to 40 per cent of the total original biomass substance. Tests have been made on the relatively unaltered lignin for applications such as carbon fibre, but it is presumed

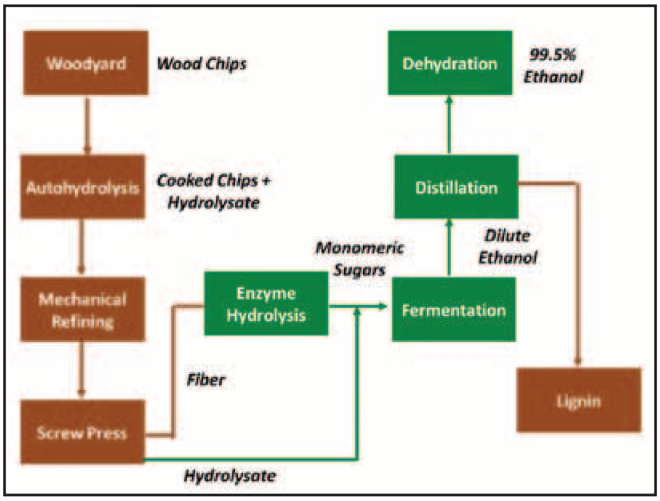

Figure 20. Auto-hydrolysis process for hardwood chips to produce cellulosic ethanol

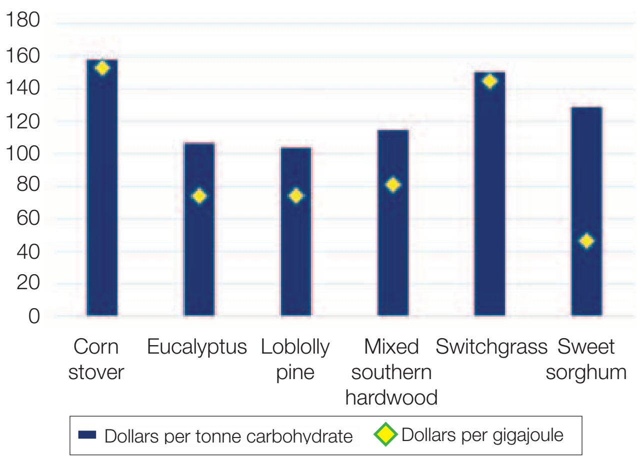

Figure 19. Biomass value as carbohydrate and fuel

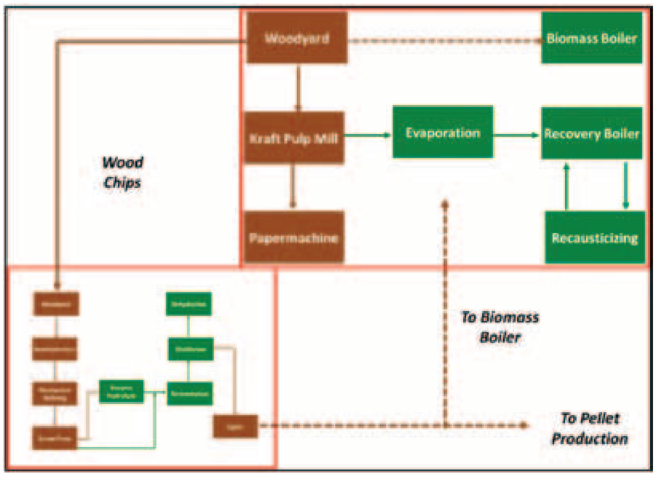

Figure 21. Integration of auto-hydrolysis process for hardwood chips to produce cellulosic ethanol with an operating kraft pulp

Case	Capital expenditure dollars per litre	Biomass cost dollars per litre	Energy cost dollars per litre	Cash cost dollars per litre	Minimal ethanol revenue dollars per litre Minimal revenue required to achieve 12 per cent internal rate of return
Greenfield Auto-hydrolysis	1.67	0.29	-0.01	0.57	0.79
Co-location biomass boiler	0.80	0.29	-.01	0.52	0.62
Co-location fuel pellets	0.91	0.29	-0.10	0.35	0.48

Table 1: Three scenarios of investment to produce bio ethanol

that the residue is burned. Alternatively, the material can be dried and pelletised to serve the lucrative pellet markets in Europe.

Considerable capital investment economies can be achieved by co-locating the ethanol plant with a kraft pulp mill where mill facilities and infrastructure are in place. This allows for a major capital reduction with savings in wood-handling equipment, power plant, waste treatment, maintenance and overheads.

Figure 20 shows the integration of the auto-hydrolysis process into the exiting kraft mill, with both options for lignin disposal. Further financial improvement can come from selling the unhydrolysed residue as fuel pellets versus burning locally in a biomass boiler.

The co-location concept is particularly well suited to manage the decline in the United States of uncoated free sheet. Generally mills have two to three paper machines with a fibre furnish consisting of around 70 per cent hardwood. Biofuel conversion offers the opportunity to use the hardwood chips for biofuel, and to reallocate the bleached softwood fibre into either fluff pulp for absorbent products or baled softwood pulp for export.

Biofuels and biomaterials in a greenfield kraft mill

A more ambitious opportunity is presented by integrating biofuels into a greenfield softwood pulp mill. New kraft mills today, mainly in Brazil, can process up to six million cubic metres of hardwood, or five million cubic metres of pine, and mainly resemble the process steps of mills built 10 to 20 years ago. Energy efficiencies that can be incorporated into new mill designs lead to mills producing excess power.

Our simulation of a new one million tonne air-dried softwood mill shows potential power production of 150 megawatts of power, with a mill process demand of approximately 100 megawatts. This leaves a 50 per cent excess that could be sold to the power grid. In some cases, this might be a good solution, but a better one might be to incorporate a number of new steps which could increase mill profitability.

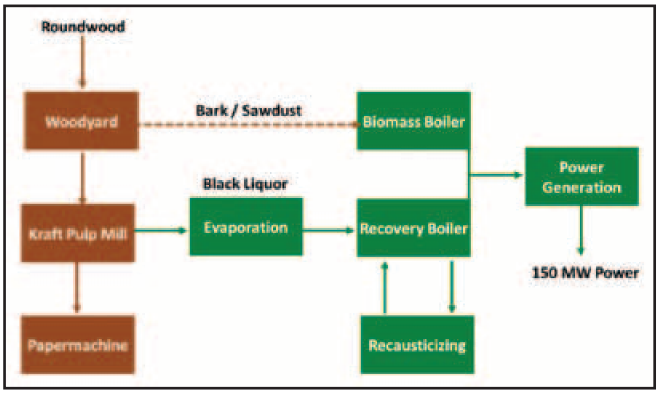

Figure 22. Integration of autohydrolysis process for hardwood chips to produce cellulosic ethanol with an operating kraft pulp

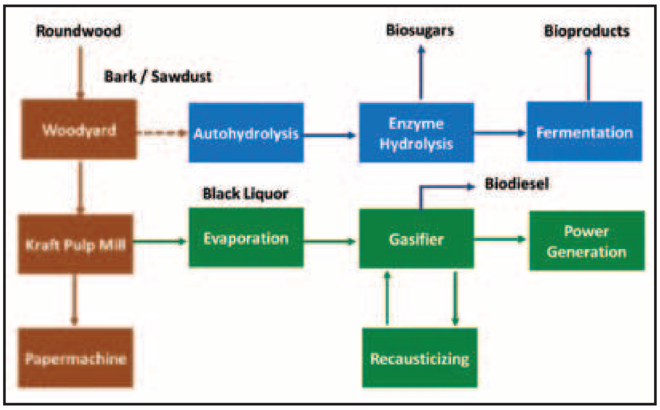

Figure 23. Integration of bioproducts and biofuels into the design of a greenfield kraft pulp mill

Figure 22 re-allocates bark and chipper sawdust to an auto-hydrolysis line, similar to the concept of Figure 20. To provide additional scale, the wood waste is supplemented with the most available agricultural residues such as wheat straw or purpose-grown bioenergy crops such as miscanthus or giant reed. While ethanol might be the best option in some countries, much attention is being paid today to the production of green sugars – or biosugars – or alternative fermentation systems that convert monomeric sugars to a wide range of products such as acetic acid, biobutanol or succinic acid.

The black liquor gasifier-catalytic conversion to biodiesel development over the past 20 years in Sweden appears to be becoming large enough to be considered in new pulp mills, at least as a partial recovery unit for black liquor. The gap in softwood fibre in the future is significant, but filling the gap with a standard new mill design is not necessarily financially feasible.

Table 2 collects the simulation made of the financial returns on greenfield mills in the south-eastern United States, designed for export production. In neither case is the return financially acceptable based on Trendline pricing assumptions. Would incorporation of bioenergy or biomaterials make a difference? That work lies ahead, and should be done with more accurate capital investment models than those available to the author.

Conclusions and implications for New Zealand

Demand for paper and paperboard will grow rapidly in Asia and ultimately in India, as those economies continue to grow. In North America and Western Europe with half of the world production capacity, demand will continue to decline and producers will look for other applications.

Canadian NBSK mills will continue to be sold to Chinese tissue and paper producers who are concerned over future supply of premium fibre. No growth should be expected.

Scandinavian companies will continue as profitable market pulp producers, serving mainly domestic and

Greenfield 1-machine linerboard investment	
1,324,525 Air dried tonnes a year	
South eastern USA	
Wood yard	$148,658,681
Pulp mill	$177,175,760
Caustic plant	$193,919,143
Evaporation	$118,301,889
Recovery boiler	$319,992,931
Power boiler	$63,836,506
Turbogenerators	$91,600,670
Machines	$676,081,681
Sheeters	$0
Chlorine dioxide plant	$0
Infrastructure	$72,571,332
TIC (US$ 2012)	$1,862,138,593
Start up year	2019
Delivered to	China
Internal rate of return	9.4%

Greenfield pulp mill investment	
1,000,000 Air dried tonnes a year	
South eastern USA	
Wood yard	$127,124,076
Pulp mill	$331,423,715
Caustic plant	$217,346,933
Evaporation	$148,191,090
Recovery boiler	$400,839,766
Power boiler	$28,204,089
Turbogenerators	$114,743,757
Machines	$282,306,118
Chlorine dioxide plant	$109,318,542
Infrastructure	$105,181,778
TIC (US$ 2012)	$1,864,679,864
Start up year	2019
Delivered to	China
Net present value at 12 per cent	($901,835,149)

Table 2. Financial analysis of greenfield linerboard and market pulp mills, in south-eastern United States export to China

regional markets, but with a cost structure and currency valuations too high to profitably export to the demand growth areas. No growth should be expected.

Brazil and Chile continue to evaluate their investment opportunities. They appear to currently consider expansion of eucalypt plantations and pulp mill investments the best choice. Eucalypts will certainly continue to expand, and softwood probably will.

Russia, with 25 per cent of the world softwood timber, struggles to find investment opportunities attractive enough to offset very high infrastructure investments, perception of corruption and schizophrenic political leadership. No growth should be expected. Although projects will be announced in the future there will be no announcement when they are cancelled.

The south-eastern United States is moving towards a softwood pulp industry which focuses on absorbent pulp and containerboard, with a cost structure that can competitively export to any part of the world. No expansion is likely, but mill reconfigurations will become commonplace.

Asia, especially China, is overly dependent on recovered paper and will eventually drive prices up to the point where they must import softwood fibre from the softwood-rich growing areas. Expansion to meet demand will continue with expensive imported recovered paper and bleached softwood pulp, until they become too expensive and finished product will be demanded.

This leaves New Zealand. In most countries, pulpwood is harvested as thinnings to promote better sawn timber growth. New Zealand is unique among those countries for not collecting and processing thinnings, presumably considered of insufficient value. Compared to sawn timber for domestic and export conversion, that will always be true. However, with New Zealand growing 50 per cent more wood volume than it is harvesting, and attributing little value to thinnings, there must be a multi-product pulpwood project available for New Zealand, featuring some combination of wood pellets, pulp, linerboard, biofuels or biomaterials.

Someone will build it. Why not New Zealand?

References

BP Global. 2013. *BP World Energy Outlook – 2013*.

FAOSTAT, UN Food & Agriculture Organization of the United Nations. 2013. See www.faostat.org

FisherSolve. 2013. Fisher International, Norwalk, CT, US. See www.fisheri.com

Gonzalez, R. 2012. *PhD Dissertation*. North Carolina State University, Raleigh, US.

Phillips, R., Chang, H.M. and Jameel, H. 2013. *Biotechnology for Biofuels*, (6).

Price WaterhouseCoopers. 2012. *Annual Forest, Paper and Packaging Industry Survey*. Vancouver, BC, Canada.

RISI Inc, Boston, MA, US. See www.risi-info.com

World Bank. 2013. See www.worldbank.org

Richard B. Phillips is Adjunct Professor of Forest Biomaterials at North Carolina State University in the United States where he teaches and researches pulp and paper industry concerns and bioenergy developments. He retired in 2005 as Senior Vice-President Technology after 34 years with International Paper.