**Logging v Recycling: Problems in the Industrial Ecology of Pulp Manufacturing in South-East Asia**

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Environmentalists around the world have argued that pulp and paper manufacturing can become more ecological by using more post-consumer waste paper, logging fewer native forests and producing less waste. For decades, South-East Asian paper manufacturers drew much of their fibre from waste paper and agricultural wastes, but have been moving rapidly to embrace wood-based pulp production. What underlies the shift from waste and non-wood to wood-based pulp production in South-East Asia, and what are its implications for theory and practice of industrial ecology? What are the prospects for revitalised non-wood pulp and paper manufacturing in the region? This paper addresses such questions, drawing on field research in South-East Asia from 1993 to 1996, archival research in Australia and the USA, and follow-up correspondence.

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**Introduction**

Among the most often-cited principles of industrial ecology are ‘dematerialisation’ and ‘decarbonisation’—using fewer raw materials and contributing less to global warming (cf. Ausubel 1994). Environmentalists around the world have argued that pulp and paper manufacturing can become more ecological by using more post-consumer waste paper, logging fewer native forests and producing less waste (cf. Kroese 1991; TWS 1992; WALHI and TMBH 1992; Smith 1997).

Until recently, South-East Asian pulp manufacturers drew much of their fibre from waste paper and agricultural wastes (see Fig. 1). Encouraged by decades-old development policies of international development agencies such as the Food and Agriculture Organisation (FAO) of the United Nations (cf. ECAFE and FAO 1962), many South-East Asian pulp producers have now moved to embrace the dominant ‘Northern’ paradigm of wood-based pulp production.

Establishment and operation of new wood-based mills and fast-growing tree plantations have resulted in the clearing of millions of hectares of primary and secondary tropical rainforest in South-East Asia, with great impact on peoples dependent on those resources for sustenance, and on people throughout the region.
region who have suffered severe smoke and haze from forest clearing. Serious questions have been raised regarding the environmental and social sustainability of such practices (see Carrere and Lohmann 1996; Marchak 1995; Mayer 1996). What underlies the shift from waste and non-wood to wood-based pulp production in South-East Asia? What are its implications for theory and practice of industrial ecology? What are the prospects for revitalised non-wood pulp and paper manufacturing in the region? This paper addresses such questions, drawing on field research in South-East Asia from 1993 to 1996, archival research in Australia and the USA and follow-up correspondence.

Use of Non-Woods

South-East Asian pulp and paper production was limited before the 1960s. As was the case in most developing countries and regions of the world, the mills were small (around 5,000 admm³ of pulp per year) and utilised agricultural wastes, especially rice straw and bagasse,¹ waste paper,² and pulp imported from Canada, the US and Scandinavia (cf. Marchak 1995: 239). South-East Asia’s forest resources were remote, inaccessible and costly to use for producing pulp and paper. Several larger-scale pulp mills utilising non-woods commenced operations in South-East Asia beginning in the late 1960s. These included Siam Kraft and Phoenix in Thailand, and PT Kertas Leces in Indonesia (see Fig. 2).

Siam Kraft

Siam Kraft, one of South-East Asia’s earliest larger-scale³ pulp and paper companies, commenced operations in Ratchaburi, Thailand, in the late 1960s. Initially, the company’s Thai–USA management team⁴ planned to use ‘Thailand’s extensive pine forests in the mountainous north’. They soon discovered ‘transportation and harvesting costs [to be prohibitive]’, however, and instead built their pulp mill to utilise bagasse from local sugar mills. ‘Eucalyptus and native pine plantations’ were seen as ‘potential’ resources for ‘the foreseeable future’ (Pollitzer 1968).

Three decades later, the mill, now owned by the Siam Pulp and Paper Co., a subsidiary of the Siam Cement Co., continues to make pulp from bagasse.⁷ Today, the mill is unable to find enough

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1. The author visited wood- and non-wood-based pulp mills in Indonesia, Malaysia and Thailand; interviewed company and governmental officials, research scientists and representatives of non-governmental organisations; attended industry trade shows and conferences; and drew on archival materials available at the Australian National University, Canberra, and University of California, Berkeley. During the research period, the author was a member of the Technical Association of the Pulp and Paper Industry (TAPPI) and attended a TAPPI-sponsored short course on pulp and paper technology. As a young adult, he worked as a labourer for a wood-based pulp and paper firm in the Pacific Northwest, USA.

2. Air-dried metric tonnes. 1 metric tonne = 1000 kg = 2,200 lbs = 1.1 English tons.

3. Bagasse is the pulp left over from the manufacture of cane sugar.

4. Surprisingly to many, the Thai pulp industry obtains approximately 70% of its raw materials from waste paper, both domestic and imported from overseas.

5. Initial pulp production was approximately 25,000 tonnes/year (PP 1970b).

6. Led by Parsons & Whittingmore of New York, a one-third owner of the firm.

7. Interview with Mr Kanung In-Dratreesch, Siam Pulp and Paper Co., Ratchaburi, Thailand, 19 August 1994.

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Figure 2: Non-Wood Pulp Production in South-East Asia

Source: Miller Freeman 1991; Thai Pulp and Paper Industries Association 1993

Plate 1: Bulldozing Bagasse, the Fibrous By-Product of Sugar Cane Processing, Siam Pulp and Paper Co., Ratchaburi, Thailand, August 1994

Photograph: David A. Sonnenfeld
bagasse to run year-round, however, as local sugar mills are burning the fibre in their power plants to generate electricity. When bagasse is unavailable, Siam Pulp and Paper uses eucalyptus chips, even though the latter require 25% more chemicals for pulping and bleaching.

When expanding virgin pulp production in the early 1990s, Siam Pulp and Paper designed new mills to use eucalyptus as primary raw material. By then, eucalyptus had been planted throughout the region on public and company-owned and leased lands. Even with substantial transportation costs, eucalyptus was cheaper than bagasse, given limited availability of the latter.

**Phoenix Pulp and Paper**

The Phoenix Pulp and Paper Company, in Khon Kaen, Thailand, is South-East Asia’s second largest producer of non-wood pulp (see Fig. 2). It started production in the late 1970s, using kenaf as its raw material—one of the first production-scale pulp mills in the world to do so (Susangkarakan 1971). The company was seen by government officials and its USA–Indian investors as an ideal rural development project—providing a new market for tens of thousands of small farmers. It received the personal endorsement of Thailand’s prime minister, General Chomanand (Kothandapani 1994).

Soon after Phoenix commenced operations, however, local farmers switched to growing cassava, the latest boom crop. Phoenix management was forced to search for new raw materials. They settled on bamboo, fast-growing and available in local forests, and eucalyptus, which would take several years to establish, but which could be used to produce a globally recognised market pulp.

**Kertas Leces**

South-East Asia’s largest non-wood pulp producer, PT Kertas Leces, in East Java, was one of Indonesia’s earliest integrated pulp and paper mills. Established by the Dutch in 1939, the mill underwent major expansions in the late 1970s and early 1980s, with German–Austrian and French financing, respectively. In 1992, the government...

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8. Ironically, the sugar mills have improved their industrial ecology through waste minimisation or use, at the expense of diminished availability of the same resource for pulp and paper firms.
9. Interview with Mr. Kanung In-Distance, 19 August 1994.
10. Operated as the Siam Cellulose Company Ltd.
11. When visited in 1994, the mill was using 90% eucalyptus and 10% bamboo (interview with Miss Orawan Panichjarern, Siam Cellulose Co., Kanchanaburi, Thailand, 19 August 1994).
12. *Hibiscus sabdariffa var. alissima.*

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13. (Interview with Mr. S.K. Mittal, Phoenix Pulp and Paper Co., Khon Kaen, Thailand, 9 August 1994.) Kenaf had been planted widely in north-east Thailand and elsewhere in the 1950s and 60s under internationally agricultural development schemes. The world market for the plant collapsed in 1967, resulting in abundant crops and low prices (Subhachandra and Samart 1984 in Hurst 1990: 233-34; personal correspondence with Dr. Suwit Lachaphiwong, Khon Kaen University, May 1995).
14. (Interview with Mr. S.K. Mittal, 9 August 1994.) The price of cassava, used in animal feed, boomed along with the global livestock industry (Subhachandra and Samart 1984 in Hurst 1990: 234; personal correspondence with Professor R. Thomas Schotzko, Washington State University, February 1997).
15. (Interview with Mr. S.K. Mittal, 9 August 1994.)
owned company produced around 200,000 tonnes each of pulp and paper, all from bagasse and rice straw (APKI 1993: 68; Miller Freeman 1991, PPI 1981). These three firms, Siam Kraft, Phoenix and Kertas Leces, important early players in the modernisation of South-East Asia’s pulp and paper industry, represent the ‘high-water mark’ of non-wood pulp production in the region. All major pulp mill development projects in South-East Asia since these firms’ first efforts have been wood-based.

### Wood-Based Pulp Production

A new era in South-East Asian pulp and paper production began in the mid-1980s with construction of the first large-scale wood-based mills (see Fig. 3). Notable among these are Indah Kiat and Indonoyon in Indonesia; Sabah Forest Industries in Malaysia; and three new mills in Thailand.

#### Indah Kiat

Operations at the Indah Kiat Pulp and Paper (IKPP) company’s pulp mill in Perawang, Riau, Indonesia, on the island of Sumatra, began in 1984. The Sinar Mas Group, agro-business giant and Indah Kiat’s majority owner, had gotten into paper-making just a few years before, through the purchase of a paper firm in West Java. After making paper using pulp imported from its Taiwanese partners, Indah Kiat decided to manufacture its own pulp. Its partners contributed Indah Kiat’s first pulping equipment, floated from Taiwan on a barge.

The Government of Indonesia supported the pulp-making venture by granting IKPP exclusive use of an extensive timber concession. The company made pulp from native, mixed tropical hardwoods cleared from the concession, replanting fast-growing tree species. Although the company paid a nominal fee, use of timber from the native forest was, in essence, a government subsidy for the start-up operation. Villagers in the concession area without documented land claims were forced to abandon traditional areas and practices.

#### Sabah Forest Industries

In Sipitang, Malaysia, on the island of Borneo, Sabah Forest Industries (SFI) opened its new wood-based pulp mill in 1986, after more than a decade of planning (PPI 1970a, 1980). Developed by the Sabah state government and financed with commercial loans, SFI makes pulp and paper from mixed tropical hardwoods from a 300,000 ha timber concession (Pappens 1993). It took several years for SFI to make consistently high-quality paper from mixed tropical hardwoods (Pappens 1993). With assistance from international consultants, SFI’s engineering staff ultimately succeeded. The Swedish International Development

<table>
<thead>
<tr>
<th>Start date</th>
<th>Company</th>
<th>Country</th>
<th>Capacity (thousand tons)</th>
<th>Fibre source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>Indah Kiat #1</td>
<td>Indonesia</td>
<td>120,000</td>
<td>MTH</td>
</tr>
<tr>
<td>1987</td>
<td>Sabah Forest Industries</td>
<td>Malaysia</td>
<td>100,000</td>
<td>bamboo</td>
</tr>
<tr>
<td>1988</td>
<td>PT Inti Indorayon Utama</td>
<td>Indonesia</td>
<td>180,000</td>
<td>pine</td>
</tr>
<tr>
<td>1990</td>
<td>Indah Kiat #2</td>
<td>Indonesia</td>
<td>180,000</td>
<td>MTH</td>
</tr>
<tr>
<td>1992</td>
<td>Siam Cellulose</td>
<td>Thailand</td>
<td>50,000</td>
<td>eucalyptus</td>
</tr>
<tr>
<td>1994</td>
<td>Phoenix II</td>
<td>Thailand</td>
<td>100,000</td>
<td>eucalyptus</td>
</tr>
<tr>
<td>1994</td>
<td>Indah Kiat #8</td>
<td>Indonesia</td>
<td>380,000</td>
<td>MTH</td>
</tr>
<tr>
<td>1994</td>
<td>Wira Karya Seki</td>
<td>Indonesia</td>
<td>380,000</td>
<td>MTH</td>
</tr>
<tr>
<td>1995</td>
<td>Riau Andalan Pulp &amp; Paper</td>
<td>Indonesia</td>
<td>750,000</td>
<td>eucalyptus</td>
</tr>
<tr>
<td>1996</td>
<td>Advance Agro</td>
<td>Thailand</td>
<td>175,000</td>
<td>eucalyptus</td>
</tr>
<tr>
<td>1997</td>
<td>Kian Kertas</td>
<td>Indonesia</td>
<td>472,000</td>
<td>MTH</td>
</tr>
</tbody>
</table>

Numbers in parentheses indicate total current capacity, including expansion projects. MTH = mixed tropical hardwoods.

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16. Today, the company uses hardly any rice straw, and *Albizia falcataria*, a fast-growing plantation species, is being used in partial replacement of bagasse in one of the newsprint lines. Marchak (1995: 240) describes *Albizia* as ‘possibly the fastest-growing’ [plantation] species in the world: from seedling to full size takes only four to five years.

17. Interview with Mr Eddie E-Tak Shaw, Executive Vice-President Director, Indah Kiat Pulp and Paper Co., Jakarta, 11 July 1994.

18. Interview with Mr Eddie E-Tak Shaw, 11 July 1994.

19. Interview with Mr Wong Kong Min, Sabah Forest Industries, Sipitang, 14 December 1993.

Under the terms of the concession, SFI operations were to be supported by revenue from logging of commercially valuable species, remaining trees were to be felled and replanted with fast-growing pulp species.
Agency (SIDA) trained SFI's engineers in Sweden. SIDA and the Japanese Overseas Development Agency helped SFI establish its plantation.

For years, SFI operated at a loss, utilising 'logging residue'. In late 1993, mill management was terminated by the Sabah state government, and the mill placed under the day-to-day supervision of international accounting and management consulting firm, Price Waterhouse. Rumour had it that the former mill management, through ties to logging contractors, had profited handsomely on the logging, even while operating the mill in the red. Price Waterhouse investigated such claims and surveyed the concession in preparation for selling a majority stake in the firm.

Like IKPP, SFI and its logging contractors cleared extensive portions of its forest concession, replanting fast-growing exotic trees. As in Indonesia, the forest concession was intended by the Sabah state government to help capitalise the pulp mill's start-up. At SFI, too, villagers in the concession area were forced to abandon traditional livelihoods. Once international development assistance funds ran out, SFI suspended replanting; logging continued unabated.

Indorayon
In 1987, in North Sumatra, Indonesia, the Raja Garuda Mas (RGM) group commenced operations at the PT Inti Indorayon Utama pulp mill. RGM had been a successful bidder for a Government of Indonesia project to use pine planted in the 1960s with Japanese assistance in the Lake Toba highlands region. RGM's prior experience had been in manufacturing plywood, rather than pulp. This was not a barrier to RGM's entry into pulp manufacturing, however, as the group was well connected to former President Soeharto, Indonesia's head of state for three decades (PRI 1986, 1991, 1992; Abubakar and Sutton 1988; WIM n.d.).

Although the company was to use plantation pine, it had to construct logging roads to access it. In the rainy season, heavy rains turned those roads to mud, causing serious erosion and mud slides. In one case, a mud slide from a poorly constructed logging road buried a village. Local residents strongly protested the company's logging and road-building methods. Villagers protested again later, when the company attempted to establish new plantations in places used for growing crops and grazing animals.

The decision to build the mill in an area of traditional agricultural practices and lifestyles was made by central government authorities in conjunction with investors and international agencies. Local residents were not consulted, yet suffered the consequences. The Indorayon mill has been involved in a continuing series of community and environmental conflicts since its conception.

New Mills in Thailand
In Thailand, too, new pulp mill capacity has been based on fast-growing plantation hardwoods. Recently opened mills include the Siam Pulp and Paper Group's Siem Cellulose mill, 1992; Phoenix Pulp and Predecessors (see Table 3). At capacities of up to three-quarters of a million admt per year, the mills are as much as 150 times larger. These mega-mills utilise advanced pulping and bleaching technologies from technology firms based in Sweden, Finland, and Canada. All of the new mills use wood to make pulp—first mixed tropical hardwoods from native forests, then fast-growing plantation trees—following the path blazed by the Jari and Arcruz ventures in Brazil in the late 1970s and early 1980s (see Marchal 1995: 276-84). IKPP in Indonesia, and SFI in Malaysia in the 1980s. Meanwhile, throughout South-East Asia, tons of agricultural waste are burned at the end of growing seasons, creating severe air pollution. Why are more non-wood mills not built?

Non-wood plant fibre has been used since paper was invented in China at the beginning of the second century CE. Two centuries ago, rags were the predominant raw materials used to make paper in North America and Europe. Shortages of rags due to economic depression and war caused paper manufacturers to search for new sources of fibre. They experimented with straw, corn stalks and other agricultural wastes. The turning point came in the mid-1800s, with the invention of sulphite wood pulping (API 1987; Cohen 1983; see also Morrison 1982).

Wood has been a raw material of choice in temperate Northern countries ever since. It is of uniform quality, has greater strength and, given current technology, can be produced at a lower cost than

21. Site visit, December 1993. Subsequently, the sale did go through—to the Lion Group of peninsular Malaysia.
most non-wood pulps. Also, trees are not subject to a restricted season like most non-wood plants. Trees can grow until needed. Once harvested, wood keeps well for long periods, under even relatively adverse conditions. These properties allow pulp mills to be supplied continuously with high-quality fibre.

Agriculturally derived raw materials for making paper such as kenaf are harvested during brief periods. Such materials deteriorate more quickly than wood and must be pulped within weeks of harvesting or stored carefully for maximum utilisation. Also, non-wood raw materials have substantial impurities. Bamboo and some straws, for example, have a very high silica content, which, with current technology, limits chemical recovery, increases costs and produces more waste. In addition to storage and cleaning problems, agricultural wastes often must be transported long distances to 'feed' a pulp mill of any significant size. Raw material costs will give one manufacturer an edge over another: the greater the distance, the greater the cost of transportation, and the less profitable the manufacturing operation.

New South-East Asian mills have been built where they are, at the scale at which they are, because of the economics of raw materials costs combined with the availability of technologies and financing. The initial raw materials—mixed tropical hardwoods, i.e. native rainforests—are provided inexpensively, often as the government's or a prominent official's contribution to a joint venture. Politically easy—at least in the short run, in the context of authoritarian, military-dominated governments—such in-kind contributions have unfortunate long-term social and environmental consequences.

Nordic, Canadian, and US governments have given interest-free loans, trade credits and technical expertise to South-East Asian pulp and paper firms in conjunction with procurement of technology from national firms. In the Nordic case, governments are shareholders in many of these firms. It is no coincidence that this technology is wood-based, nor that Northern governments and firms advise Southern governments and firms to adopt a wood-based strategy. Many Northern technologies are appropriate only for wood-based production. A further factor affecting location of new pulp mills in South-East Asia is the population density of agricultural production centres. Older, smaller pulp mills in agricultural centres such as East Java operate with severe constraints. Land is expensive and situated in the midst of productive agriculture. There is no room for adequate waste-water treatment facilities. Every hectare is used to produce food. Costs of retrofitting smaller, older mills with environmental controls is prohibitive. As a result, these mills are significant polluters and were scheduled for closure (Hanafi 1994). Environmental officials would prefer production of wood-based pulp in large-scale, remote facilities, over multiple-source point pollution in heavily burdened local waterways.

As protests continue against use of native forests and displacement of forest-dwelling communities for manufacturing pulp and paper (cf. Carrere and Lohmann 1996), renewed attention is being given by NGOs, policy analysts and governmental and intergovernmental agencies to using non-woods for producing pulp and paper (cf. Marchak 1995; Smith 1997). In the 1990s, international 'green' consumerism has created a significant demand for non-wood pulps and papers. Phoenix Pulp and Paper Co. in Thailand, for example, reports it is obtaining more than twice the price for kenaf pulp than for eucalyptus pulp; it is looking at expanding kenaf production once again.

For decades, Indian and Chinese centres have led in research on non-wood pulping processes and technologies. These institutions lack capital to develop and export commercially viable forms of these technologies. This knowledge has been disseminated through such vehicles as the United Nations Environment Programme's Network on Industrial Environmental Management. But this support is largely communicative.

As interest in non-wood paper has grown, Northern technology firms finally may be paying more attention. Sunds Deltibrator, of Sweden, for example, has increased non-wood research and development activities in response to increased interest among traditionally wood-based pulp manufacturers in North America and elsewhere.

Not only technological, but also geographical, social and political challenges remain.

4 Return to Non-Woods?

As protests continue against use of native forests and displacement of forest-dwelling communities for manufacturing pulp and paper, as improvements are made in non-wood pulping, e.g. in removing silica and improving environmental performance, development agencies, manufacturing firms and financial institutions must confront issues of economy of scale, location and incentive. To co-exist in populous agricultural centres, pulping operations may need to be based on a different scale of operations than today's mega-wood-based mills, i.e. on mini-mill technology. With mini-mills, pulp could be processed in areas of agricultural production, then shipped to paper-making centres. Although increasing utilisation of agricultural waste, improving air quality (through elimination of burning) and generating additional income for local producers, mini-mills may not be as profitable to timber concession holders, industrialists and technology firms as their mega-mill big sisters. A different calculation of benefits may be needed to justify mini-mills' economic viability.

Conclusion

Recent work in industrial ecology has used various units of analysis (cf. Socolow et al. [eds.] 1994). Most typically, however, scholarship in the area has focused on the micro or firm level of analysis. Analysis at multiple levels, including national and international, political, economic and technological dynamics, is necessary to understand South-East Asian
pulp industries’ movement away from more ‘industrial-ecological’ patterns of resource utilisation, as well as those industries’ prospects for dematerialisation and decarbonisation.

South-East Asian pulp and paper firms maintained complementary relationships with neighbouring firms and farms as long as pulp production was relatively small-scale, pollution was not identified as a problem, and there were surplus agricultural wastes. The industry shifted to large wood-based mills once technological advances allowed mixed tropical hardwoods to be turned into quality product, extensive forest resources were made available by authoritarian governments, and financing was provided by firms and countries anxious to develop new markets. Certainly, much is involved in putting South-East Asian pulp and paper production on a more sustainable basis. As Marchak (1995) and Smith31 point out, however, one part of that strategy may involve putting greater emphasis on pulp and paper produced from agricultural wastes and waste paper, rather than on wood from native forests or tree plantations. Growing international green consumption may help facilitate such a transition, through increased demand for paper derived from wastes and non-wood sources. South-East Asian pulp and paper producers have historical strengths and knowledge they are just beginning to use in meeting such demand. Together with government agencies, researchers and communities, these firms have considerable challenges ahead of them. Stronger backing by Northern governmental and intergovernmental agencies and technology firms will improve the likelihood of their success, while contributing to industrial-ecological goals of dematerialisation and decarbonisation.

References


Logging v Recycling


Sonnenfeld, David A. (1998b) ‘Tragedy and Innovation: Social Movements, Environment, and Technology in Indonesia’s

GMI 22 (Summer 1998)
'Zero Emissions' has become a definitive term in the debate on sustainable development in the last few years. While considered a utopian target by some, the concept clearly describes what business and industry of the future should aim to achieve.

In **UPSIZING**, Gunter Pauli, founder of the Zero Emissions Research Initiative examines how the adoption of the Zero Emissions concept not only radically reduces pollution and waste but can contribute significantly to the generation of income and jobs—specifically for those that need them most: the rural poor in less developed countries.

'Zero Emissions, industrial clustering and the other concepts and practices associated with them represent a crucial link in the gradually emerging network of ideas that can lead us out of our crisis'

Fritjof Capra, Physicist, Systems theorist and author of *The Web of Life*

'The goal is zero: zero accidents, zero waste, zero emissions'

Edgar S. Woolard Jr, Former Chairman, DuPont