Letter to the Editor

Van Berkel, R. 1998. **Industrial Ecology of Pulp and Paper: Consequences for Small Scale Pulp and Paper Mills in Asia.** Letter to the editor regarding (Summer 1997) "Roundtable on the Industrial Ecology of Pulp and Paper," *Journal of Industrial Ecology* 1(3): 87–114.

With interest I read the Roundtable on the Industrial Ecology of Pulp and Paper, presented in number 3, volume 1 of Journal of Industrial Ecology. Although I largely agree with the analyses presented by the three research groups, I felt that the international dimension was somehow neglected in particular as regards implications of the industrial ecology analysis of the wood based pulp and paper industry in the Americas and Europe, for the largely non wood based pulp and paper industry in other parts of the world, in particular Asia. In the following, I would therefore like to elaborate on the question of 'what is next for those small scale non wood pulp and paper mills', and assess the possible scenarios from an industrial ecology point of view.

How structural changes in leading pulp and paper producing areas impacted on pulp and paper production in Asia

Smith (1997) presented a most interesting structural analysis of developments in US paper industry over the last two decades. And despite the fact that - to my knowledge - no similar analysis has taken place for other leading pulp and paper producing areas (e.g. Scandinavia, Central Europe, Canada, etc.), it is felt that the conclusions at least to a certain extent also hold true for these other leading pulp and paper producing areas. Intensified recycling efforts generated large volumes of high grade waste paper, which, partially due to simultaneous expansion of the wood pulp production capacity were not utilised locally in the paper industry. These structural changes in the pulp and paper industry, lead to increased availability of both bleached wood based pulp and high quality waste paper on the global market. A large part was absorbed by Asian pulp and paper industry. In particular non wood based pulp and paper mills were increasing the share of 'long' fibre both from virgin as well as recycled wood pulp in their paper compositions, to improve paper quality, and expand paper production. Except where non wood pulping was to some extent protected or fiscally favoured (as in India and China), non wood pulp production lost significant ground over the last 2 decades. This development was even favoured by environmental regulations, since pulping of non wood agroresidues (primarily rice straw, wheat straw and bagasse) generates large volumes of waste water (known as 'black liquor'), largely because of the non-availability of cleaner technologies for pulp washing nor for chemical recovery from pulping of agroresidues. Locally available agroresidues were being substituted by imported wood pulp and imported waste paper, reducing local environmental impacts in Asia at the expense of significant increases of transportation flows in the paper cycle. Increased recycling efforts thus closed the paper cycle, but at a global rather than at a local or regional scale.

Misleading facts and figures on Asian pulp and paper production

Among the contributions to the Roundtable, Grieg-Gran et al. (1997), deal most explicitly with non wood pulp and paper industry in developing countries. However facts and figures appear to be misleading.

Table 2 shows regional shares of world production capacity and emissions (for 1995). It is concluded "that less than 25 % of the world's pulp and paper capacity in Asia (excluding Japan), Russia, Eastern Europe and Latin America is responsible for about 75 %, 49 % and 38 % of the discharges of TSS, COD and AOX respectively". Although this conclusion is analytically correct on the basis of the data provided, and although the authors acknowledge that relatively large non wood fibre sectors in India and China contribute to this situation, the conclusion is highly suggestive by affirming prevailing perceptions that the pulp and paper industry in developing countries has a far lower environmental performance than pulp and paper industry in industrialised countries. An analysis of environmental performance by type of fibre source used would make more sense. According to FAO data, fibre use for paper production consisted in 1991 for 67 % of wood, 1 % non wood and 32 % recycled fibres for industrialised counties, and 29 % wood, 29 % non wood and 42 % recycled fibres in developing countries (upon citation in UNEP 1997). Although readily available data do not allow for a solid assessment at this stage, it appears most likely that apparently regional differences in environmental performance of pulp and paper production are in fact largely - if not fully - caused by differences in fibre sources being used.

Table 3 provides an estimation for the total costs for mills to achieve 'good' environmental performance levels. The key point is of course what is to be understood as 'good' environmental performance ? Should all pulp and paper mills around the globe be brought in compliance with e.g. European Union effluent discharge standards ? Without solving that issue, I presume the authors would agree that 'good' environmental performance would at least include chemical recovery from the pulping process for all fibre raw materials. Having taken that assumption, we arrive at a difficult situation because conventional chemical recovery is still at the cutting edge of being technically proven or not proven for agroresidues. There appears to be growing consensus that chemical recovery will be technically feasible from pulp mills with capacity of at least approximately 15-20,000 tpa. China is far ahead in terms of number of chemical recovery installations built; an estimated number of 200 (conventional) chemical recovery units has been installed for non wood (most often wheat straw) pulp mills (China Cleaner Production Workshop for Pulp and Paper Industry, Nanjing, April 8-10, 1997). However, due to operational problems in the chemical recovery systems and insufficient efficiency in preceding pulp washing stages, only about 10 % of the chemical recovery systems is functioning properly. Most other systems had to be shut down after irreversible damage to the installations caused by operation and maintenance problems, or continue to operate at very low recovery rates. Alternative chemical recovery systems are being pilot tested. Presuming however that remaining technical problems with conventional chemical recovery can be solved with better operating practices and improved equipment selection and design, in particular in raw material preparation, pulping and pulp washing sections of non wood pulp mills, we need to look at investment costs. Depending on system choice, investment costs for a conventional chemical recovery system for a 15,000 tpa (50tpd) pulping mill would range between 3 and 4.5 million U$ (UNEP 1997); i.e. in the range of 200 - 300 U$ per ton pulp, well above the estimated investment cost of 95 U$ per ton used by Grieg-Gran et all in their calculations

for Asia. In summary, it is in the first place questionable whether "good" environmental performance levels can at all technically be achieved without shifting away from agroresidues, and in the second place the required investment levels are most likely at least twice as high as estimated by Grieg-Gran et al.

Industrial ecology of alternative scenarios

An important choice is either to terminate or to continue pulping of agroresidues as important fibre source for paper production in Asia. Both choices are briefly addressed from an industrial ecology point of view.

Using other fibre sources

Given the fact that wood based pulp and paper technology is far better developed, and on average more resource efficient, it may at first sight appear beneficial from an environmental point of view to terminate the use of non wood fibre sources. The obvious environmental benefit is the reduction of pollution loads, and of water and energy consumption, at pulp and paper mills.

The sustainability of this scenario is doubtful. Local wood resources are becoming scarce in several Asian countries (e.g. Pakistan, India, China, etc.) and wood consumption for pulp and paper has to compete with other wood applications (including fuel wood, construction, etc.). Moreover, global environmental concerns (biodiversity conservation and climate change) as well as local water management concerns, have increased awareness for forest conservation and are therefore not conducive for setting up a new, largely wood based industry. A transition towards the utilisation of wood based pulp from international markets is therefore more likely; as argued before, structural changes in leading pulp and paper producing regions, have increased the availability of bleached wood based pulp and high grade waste paper. A growing number of Asian mills (e.g. in Pakistan) has been and will continue to be converted into paper mills only, producing various paper varieties for the local market with imported bleached wood based pulp and high grade waste paper. In particular if local paper recycling programmes are phased in, the paper cycle can be more or less closed, at the global level, at the expense of massive transportation (albeit most often in a comparatively environmentally benign mode as sea freight).

The question that remains to be solved is an alternative treatment/disposal route for the massive volumes of agro-residues. Application as energy source would be preferred, but calls for further development and implementation of small to medium scale biomass energy technologies (either biogas installations, or direct combustion of agroresidues in specialised furnaces or boilers). Digestion in landfills or the open field should be avoided, since methane would increase net emissions of greenhouse gases. Burning in the open field is also to be avoided for local air pollution considerations (soot, dust, CO, etc.).

Environmentally sound non wood pulp and paper production

The alternative scenario is based on continuation of the use of agroresidues, in environmentally improved pulping systems. Projects in several Asian countries (including China and India) have proven that the application of Cleaner Production practices and techniques can improve the environmental performance of small scale non wood pulp and paper mills (UNEP 1996). In three Indian agroresidue based mills, it was for example

possible to reduce waste water volume, COD and TS loads per ton of finished product with 25 to 40 %, while production capacity increased by 10 - 20 %, with investments having pay back periods of less than one year (UNIDO 1995).

Albeit impressive, the Cleaner Production practices are not yet sufficient to reach 'good' environmental performance. This will call for further research and development efforts, customised to the specific features of the different types of agroresidues (in terms of fibre and silica content etc.). While chemical recovery would be crucial for achieving environmentally sound non wood pulp production, it has become evident that this will only be possible in conjunction with better material sourcing, storage and preparation practices, improved control over the pulping process and improved pulp washing systems. Meanwhile, there will remain a need for long fibre sources, to be used in conjunction with agroresidue based pulp. Surplus bleached wood pulp and surplus waste paper from the international markets can be used to this end. However, it deserves recommendation to explore the potential for locally available long fibre sources (e.g. rags (used packaging material, waste from textile processing), or fibre crops).

From an Industrial Ecology point of view, the advantages are clearly that by-products/waste is being converted into useful products, and that massive transportation of wood pulp, waste paper and/or paper products can be avoided. At least on the short term, environmental pollution from agroresidue based mills will remain a severe problem.

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