



Paper Consumption and Environmental Impact in an Emerging Economy

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Abstract: Some 25 years ago, it was thought that the use of paper would decrease with increasing digital technology but it has rather increased through the printing of emails, web pages and reports. In addition, the use of paper for packaging, facial and toilet tissue products as well as newspapers, shows how important paper usage has become. Emerging economies like Cameroon, rely on imported and locally produced paper and paper products with no available paper recycling opportunities leading to significant discernible environmental impacts such as pollution, increased deforestation and greenhouse gas emissions. This study used a life cycle analysis (LCA) to ascertain paper consumption and its ensuing environmental impacts in Buea District of south west Cameroon. It observed that, over 1087919kg of paper are consumed annually. The study concluded that, the digitalization of government and para-public services is necessary to curb this upsurge of paper use as well as reduce the resulting environmental impact.

Keywords: Environmental Impact, Paper, Recycling, Forests, Buea

1. Introduction

Paper is traditionally identified with reading and writing but packaging now accounts for over 41% of all global paper use (MacFadden and Vogue, 2006; EPN, 2007; Tilman, 2008; Judson, 2011). Some 400 million tons of paper and paperboard are produced globally with growth being fastest in Asia, due to China's rapidly-expanding industry (FAO, 2014). Production of paper and board in the year 2000 totaled 323 296 000 tons and per-capita consumption averaged 53.8kg. By 2010, the production total had climbed to 393.917.000 tons while consumption per head got to 57.7kg (Giampiero, 2010).

Estimates suggest that, global paper consumption in 2025 will amount to 500 million tons, which is about 1.6% growth a year (Forestindustries, 2013; FAO, 2014). According to a World Bank (2014) analysis, internet penetration significantly decreases aggregate paper consumption for the paper categories that are more likely to be affected by the

diffusion of the internet (paper used to print newspapers and books and magazines). Their analysis further posits that, the growth of the internet does not have a significant impact on a paper category unlikely to be affected by the internet (such as sanitary and packaging papers).

Several studies (Sonnenfeld, 1999; EU, 2006; World Resources Institute, 2010; EPN, 2011; Skogsindustrierna, 2013; FAO, 2014), show North America at the top of the annual global paper consumption table with over 230kg while Africa at 8kg occupies the bottom in kg/capita, for a world average of 55kg, table 1.

With this worldwide annual consumption, paper manufacturing is the largest industrial user of water per pound of finished product (Judson, 2011; Smith, 2011) as about 324L of water is required to produce a kilogram of paper (Judson, 2011; FAO, 2014). Over 50% of the world's industrial logging is transformed into paper, hence it is the third most energy-intensive of all manufacturing industries (EPN, 2007; Smith, 2011). Though paper recovery rates in

the developed world have increased in recent years (Giampiero, 2010), paper still represents one of the biggest components of solid waste in landfills with over 26 million tons (EPN, 2007; Smith, 2011; Forestindustries, 2013). When paper decomposes in a landfill, it releases methane which is a greenhouse gas 23 times more potent than carbon dioxide (Auer, 1996; EPA, 2006; Asi and Busch, 2011; Skogsindustrierna, 2013). This makes the paper and pulp industry the fourth largest emitter of greenhouse gases in the manufacturing sector (EPN, 2007; Smith, 2011; Skogsindustrierna, 2013).

Table 1. Global paper consumption by region in 2013 in kg/capita, proportionate to population in each country/region.

World Zone	Paper consumption kg/capita
North America	221
Japan	215
Korea, Taiwan Hong Kong, Singapore and Malaysia	159
European Union	156
Oceania	126
Rest of Europe	52
China	75
Latin America	47
Rest of Asia	23
Africa	8

Buea is an academic hub complimented by booming administrative, religious and commercial activities leading to lots of paper consumption. The paper littered streets of Buea, Ndongo stream and the Ekona landfill are just evidences of high paper usage within the district. The different methods of waste disposal in Buea have varying degrees of negative environmental impacts with adverse environmental and health risks if improperly disposed.

2. Methodology

The present study examined paper consumption practices at various sectors of the Buea Municipality (located on the eastern slopes of Mount Cameroon 4°10'0"N 9°14'0"E). Based on primary data survey using questionnaires and personal histories, a total of 13 tertiary schools, 17 secondary schools, 22 financial houses, 13 Law firms, 24 government offices; 7 private offices and 61 small businesses were assessed in 2013. Simple random sampling was used to identify individuals for the focus group discussions and personal histories as described by Ellis, (2000; Sallu *et al.*, 2010). Each focus group, consisted of a maximum of five individuals or a single person for personal histories, all of who were at least 18 years old (as required by Cameroon Law). We verified their National Identity Cards and in cases where this was unavailable, they were not interviewed.

Using this method, some 97 questionnaires were distributed and 65 personal history interviews conducted. The questions focused on how often paper was required and average daily use. The questions helped us make an assessment of the rate and quantity of paper consumption within the Municipality. The questionnaires for schools

targeted both students and teachers while those for financial houses targeted both customers and workers. Furthermore, this method benefits from triangulation, since it involves choosing different methods based on their individual strengths and compatibility (O'Donoghue and Punch, 2003; Rothbauer, 2008). Triangulation, also addresses issues arising from construct validity because, the multiple sources of evidence essentially provide multiple measures of the same phenomenon (Altrichter *et al.*, 2008; Rothbauer, 2008).

A life cycle analysis (LCA) was then applied to assess the environmental impacts of this paper consumption as described by Wargo, (2009) and Smith, (2011) which are sourcing of materials, manufacturing and disposal of the finished product. Due to the environmental degradation and human health risks associated with disposal (World Bank, 2002), the life cycle assessment for paper aims at finding solutions to this problem. Disposal was the main LCA basis of this study within Buea municipality, south west Cameroon.

All experimental protocol were approved by the ethical research committees of Community Service for Environmental Protection (COSEP), Cameroon and Beijing Forestry University, China.

3. Results

3.1. Paper Consumption Within Educational Institutions

3.1.1. Admission into Secondary and High Schools

All new secondary and high school students admitted into first year (Sixth Form, Form One for English speakers and Sixième and Seconde for French speakers) submit three documents and a file folder. 11000 new students were registered in 2013/2014 school year (MINESEC, 2014) giving some 33000papers or 66rims or 165kg. *This study assumed the weight of a rim of paper containing 500 papers to be equivalent to 2.5kg.*

3.1.2. Admission into Universities and Professional Schools

In 2013/2014 school year, the University of Buea (the region's largest and most populous higher academic center) during the registration and enrollment period, received over 5000 admission files (Mukete *et al.*, 2014). Each file is composed of 10 official documents (registration process) and 20 documents (enrollment process). Therefore on average, each student consumed about 30 papers and for some 5000 students, it sums up to over 150000 papers; 300 rims or 750kg for that year alone (Mukete *et al.*, 2014).

The Buea municipality is an academic hub with several lay-private, religious and public tertiary schools such as the Catholic University, Local Government Training Centre (CEFAM), Government Teacher Training College (GTTC), St Francis Higher Nursing School, Pan-African Institute for Development-West Africa (PAID-WA), National Survey School, Posts and Telecommunications School, School for Penitentiary Administration (ENAP) and the Mount Zion Nursing School. We used cumulative figures for admissions for these tertiary schools for 2013/2014 school year (about 9000 students for 17 tertiary schools). It was observed that,

each student consumed on average 20 papers during admission and enrollment, giving about 180000 papers; (360 rims or 900kg) for 9000 students.

Summing up our results, admissions for tertiary schools consumed 1650kg or 660 rims of papers and 66 rims or 165kg for secondary and high schools.

3.1.3. Project Reports and Examinations at Universities and Professional Schools

This survey looked at paper consumption during examinations and presentation of reports in universities and professional schools. Over 16000 students annually prepare project reports of 120pages and consume 90 during examinations (Mukete et al., 2014). Summed up, this gives a total of 210papers per student; 3360000 papers; 6720rims or 2688kgs.

3.1.4. Printing of Books and Newspapers

Commercial, administrative and academic center, religious and business activities lead to lots of paper consumption. These are in the form of books, reviews, brochures, leaflets, posters and newspapers. Collected data showed the annual consumption of paper in this category to be over 12000kg.

3.2. Paper Consumption in Government and Private Institutions

This survey enumerated 74 government offices including the post office and municipal council. It found out that, on average, each of these government offices consumed 30kg of paper a year or 2220kg for the 74 offices. The Buea judiciary consists of about 300 judges, prosecutors, registrars, advocates and solicitors with each consuming on average 80kg of paper a year. This gives about 24000kg of paper consumed per year within the Buea judicial system of over 300 members.

Buea is headquarters to 47 local, national and international arms of non-governmental organizations (NGOs) as well as the Cameroon General Certificate of Education (GCE)

Board. The GCE Board prepares prints, distributes and corrects all Cameroon General Certificate of Education Examination scripts (both technical and general versions). A lot of paper is being used by the GCE board to print hundreds of thousands of question papers and answer sheets. For instance, 164,789 students wrote the GCE in 2014 (Cameroon web, 2014)

The GCE A level and O level general have 81 subjects broken into parts (papers) 1 & 2 and 3 in some subjects while GCE technical has 101 subjects broken down into papers 1 & 2 and sometimes paper3. Given that not all students sat for all subjects, we estimate that each subject had at least 100,000 reprints. Each print has an average of 10 papers including question paper and answer sheets. This implies that 100,000 prints of 182 subjects containing 10 papers each gives a total of 182,000,000 papers (364,000 rims or 910,000kgs) for that year. The number of students writing the GCE has been increasing with a corresponding increase in paper usage. It is therefore thought that, information on their paper use would have gone a long way to complete these results and make it experimentally falsifiable to potential challengers.

Recently, the government of Cameroon imposed a ban on the use of plastic papers paving the way for paper bags. This study was conducted before the ban came into force and did not take into consideration the current circulation of the new paper bags.

Buea is home to 593 paper or copy centers that offer documentation services such as printing and photocopy. These are in the form of computer maintenance shops, cyber cafés and book stores. Annual data obtained from these copy centers showed that, on average 212kg of paper are used per copy center or 125716kg for different purposes.

Some 73 financial houses are located in Buea with over 2000 transactions per day giving some 730,000 (2000 x 365 days) transactions. Each transaction consumes on average 3 papers or about 2190,000 (730,000 x 3 papers) papers annually (4380 rims or 10950kg).

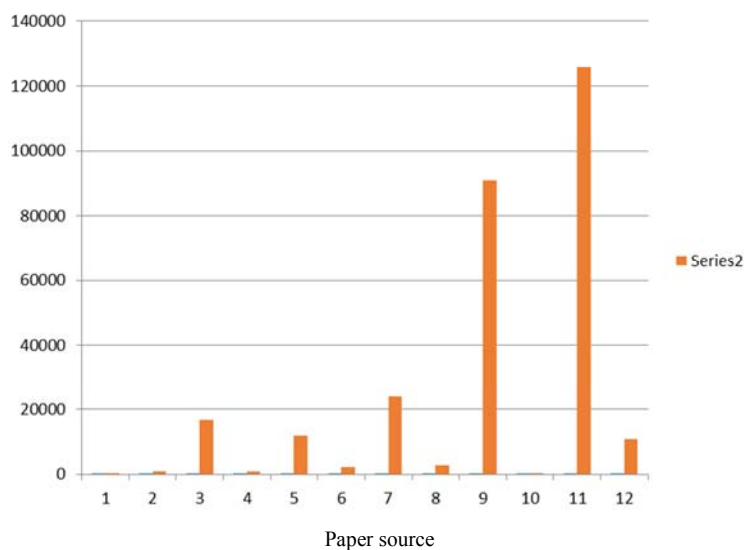


Figure 1. Comparison of the quantity of paper consumed by various establishments involved in the survey.

S/N	Paper Source	Source type	People involved	Description	Number	# of papers consumed per person	Total # of papers consumed	Papers consumed in kg	Papers consumed in rims
1	Secondary and High Schools	Admissions and enrollments	Students	11,000 students each using 3 papers on average	11000	3	33000	165	66
2	Universities and Professional Schools	Admissions and enrollments	Students	5,000 students each using 30 papers on average	5000	30	150000	750	300
3	Universities and Professional Schools	Thesis reports and examinations	Students	16,000 students each using 210 papers on average	16000	210	3360000	16800	6720
4	lay-private, religious and public tertiary schools	Admissions and enrollments	Students	9,000 students each using 20 papers on average	9000	20	180000	900	360
5	Commercial, administrative and academic center, religious and business activities	books, reviews, brochures, leaflets, posters and newspapers	Public	Aprox. 80,000 people each using 30 papers on average	80000	30	2400000	12000	4800
6	Government and Private Institutions	Memos, activity reports, letters,	government officers	74 government offices using an average of 30kg paper each per year	74	6000	444000	2220	888
7	Buea Judiciary	Case files, rulings, memorandums, activity reports, letters,	judges, prosecutors, registrars, advocates and solicitors	300 judiciary personnel using an average of 80kg paper per year	300	16000	4800000	24000	9600

Figure 2. Breakdown of sources and quantity of paper consumed by various establishments in the Buea district.

4. Discussion

4.1. Environmental Effects

The amount of paper consumed is enormous, so the environmental impact is also very significant with great efforts needed to ensure that the environment is protected during the use and disposal of this enormous volume of

material.

4.2. Paper Pollution

This massive use of paper within Buea, has a number of adverse effects on the surrounding environment known as paper pollution (Asi and Busch, 2011). Discarded paper is a major content of many gullies, dustbins, street corners and especially pollution of the Ndongo Water (a major stream

running through the municipality). This discarded paper accounts for about 30 percent by weight of the municipality's solid waste which is being dumped at the Mussaka landfill (Asi and Busch, 2011). Also toxic inks, dyes and polymers found in paper could be potentially carcinogenic when incinerated or mixed with groundwater via traditional burial methods (Onibokun, 1997; USEPA, 2008; Asi and Busch, 2011) such as employed at the Mussaka landfill.

4.3. Deforestation During Sourcing

Following an LCA procedure, the first area to evaluate is deforestation which is the result of sourcing the primary material used for papermaking: *wood*. Deforestation is a critical environmental indicator because forests store approximately 50% of all terrestrial carbon dioxide stocks (EPN, 2007; Van der Werf et al., 2009).

4.4. Pollution During Manufacturing

Chemicals are found in paper making processes starting from the forest where pesticides and other chemicals are used to process fiber into pulp resulting to land, water and air pollution. These chemicals may include chlorine, mercury, absorbable organic halogens, nitrates, ammonia, phosphorus and caustic soda with its specific consequence for the environment differently (EPN, 2007; Smith, 2011).

4.5. Greenhouse Gas (Methane) Emission During Disposal

Disposal of vast amounts of discarded paper products generates another set of environmental problems that was uncovered through the LCA. Paper in landfills creates methane as it decomposes and it is estimated that 25 percent of all landfill waste is from paper products (EPN, 2007; Wargo, 2009; Smith, 2011). The quantity of methane produced by paper in landfills is 69 times greater than that produced by fossil fuel electricity production and has 23 times the heat trapping power of carbon dioxide (Isaacson, 1991; Sotamenou et al., 2008; Judson, 2011).

5. Conclusion

Sensitizing or creating awareness in the general public on the hazards and advantages of proper paper use would go a major leap in curbing and developing the will of the local population, policy makers and law enforcement officials in reducing paper abuse.

Finally, creating digital systems in most of our institutions, newspaper offices and government offices will help reduce paper consumption in an area already facing dire environmental challenges.

Competing Interests

The authors hereby declare that, they have no existing financial and non-financial competing interests to declare with respect to this manuscript.

Authors' Contributions

MB and MSK designed the research, collected the data and wrote the preliminary manuscript. SY, coordinated the research and edited the preliminary manuscript while EZ, performed the data analysis and wrote the final manuscript. It should also be stated here that, all authors read and approved the final manuscript before its submission.

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