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REVIEW

# Plastic problem in Africa

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### Detoxify or Die

"Air pollution and water pollution are only a small part of the toxicity story. There are thousands of harmful environmental toxins, some of which we're aware of—such as pesticides, chemicals, household cleansers, fertilizers—and others, which seem perfectly innocent, such as those ubiquitous: plastic water bottles, styrene cups, dental fillings, and plastic wrap. Plastic bags These are just a few small examples of the alarming amount of harmful toxins our bodies are absorbing every day." Dr. Sherry Rogers

## 1. INTRODUCTION

Plastics are a subspecies of a class of materials known as polymers. These are composed of large molecules, formed by joining many, often thousands, of smaller molecules (monomers) together. Plastics are made from low-molecular-weight monomer precursors, organic materials, which are mostly derived from petroleum, that are joined together by a process called "polymerization." Plastics owe their name to their most important property, the ability to be shaped to almost any form to produce articles of practical value. Plastics can be stiff and hard or flexible and soft. Because of their light weight, low cost, and desirable properties, their use has rapidly increased and they have replaced other materials, e.g. metals and glass. Plastics are used in millions of items, including cars, bullet-proof vests, toys, hospital equipment, and food containers. More than a 40 billion kg of plastic were produced in 2000. Their increased use has resulted in concern with (1) the consumption of natural resources such as oil, (2) the toxicity associated with their manufacture and use, and (3) the environmental impact arising from discarded plastics.

## 2. COMMON PROBLEMS IN AFRICA

The African population is already suffering from the following: famine, human capital, literacy rate, infrastructure, deforestation, desertif-ication, loss of soil fertility, dramatic decline and loss of biodiversity, air pollution, water pollution, diseases, food toxicants & contaminants, clean drinking water, poverty, and corruption. As with many other pollution issues in Africa, the plastic bag problem is rooted in widespread poverty, corruption, environmental injustice, and residues of colonialism.

By tying together aspects of fundamental survival, e.g. acquiring drinking water and food and disposing of human waste, with high poverty rates and vested economic interests, a suite of tools will need to be applied to attempt to solve this critical environmental issue.

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## 3. CONTAMINANTS

The very common contaminants are industrial pollutants, pesticides, fertilizers, persistent Organic pollutants (POPs), persistent Toxic Substances (PTS), heavey metals, mycotoxins, petroleum spills and plastics. They contaminate food, water, soil, air, etc.

## 4. PLASTICS AS CONTAMINANTS

Contaminants that can affect the quality and usefulness of water and others are chemical, physical or biological. Primary contaminants affect the health of humans or the health of aquatic life, e.g. fisheries, aquatic plants and insects. Secondary contaminants affect the taste, smell, color, and comfort of water, for example. Primary contaminants do pose a threat to health. Therefore, we must be aware of the degree of toxicity of them (dose-response relationship). The length of exposure and the concentration of the contaminant may result in either acute or chronic toxicity to the organism.

Industrial practices in plastic manufacture can lead to polluting effluents and the use of toxic intermediates, the exposure to which can be hazardous.

Most plastics are relatively inert biologically, and they have been employed in medical devices, such as prosthetics, artery replacements, and “soft” and interocular lenses. Problems with their use largely result from the presence of trace amounts of nonplastic components, e.g. monomers and plasticizers. This has led to restrictions on the use of some plastics for food applications. For example, the use of polyacrylonitrile for beverage bottles was banned, because the traces of its monomer, acrylonitrile, were a possible carcinogen. There has been concern about endocrine disruption (ED) from phthalate-containing plasticizers used for plastics, e.g. PVC.. When exposed to high temperatures, some plastics decompose or oxidize and produce low molecular weight products that may be toxic.

Trillions of plastic bags have been produced since their introduction over 30 yr ago. The production of plastic bags depletes our earth’s non-renewable resources (viz. chemicals, energy, and petroleum-based products). The U.S. alone uses over 100 billion bags annually. This is equivalent to throwing away over 12 million barrels of oil /yr. Over 85 billion bags are thrown away each yr in the U. S. alone. South Africa uses 8 billion plastic bags a year.

Once a plastic bag is disposed of, it takes over 1,000 yr to degrade. They do not biodegrade, instead they photo degrade. The sun breaks down the plastic into smaller and smaller toxic particles. The degradation releases toxic waste into the environment, polluting land, air, and water. Hundreds of thousands of these bags are inhaled or eaten by animals each year. Cows, sheep, goats, sea turtles, fish, sharks,, whales, birds, and other animals fall victim to plastic bags each year. Over 100,000 animals were killed by entanglement over a 3 yr period.

In countries such as South Africa, discarded plastic bags are a major eyesore. Often carried from land fills by the wind, discarded plastic bags are often seen hanging in bushes, floating in lakes and rivers, flapping from fences, spoiling landscapes and choking innocent animals. Plastic They are mockingly referred to as the “national flower”. Uganda, and South Africa, have banned “single use” plastic shopping bags. Africa now “charge” for the use of plastic bags. Other countries, e.g. Kenya, are considering a bag tax or plastic bag ban.

Plastic bags collect around the city, choking drains, threatening small animals, damaging the soil and polluting beaches. Plastic waste has had a terrible impact on tourism (e.g. the beaches east of Accra), give tourists the impression that Ghana is a filthy country.

## 5. THE PROBLEM OF PLASTIC POLLUTION: The Downside

Most plastic has an indefinite life span and will probably still be mixed in the soil of this planet thousands of years from now. Ships at sea toss garbage bags and plastic products overboard. Garbage scows carrying refuse from major cities also are disposing of their loads in the world's oceans.

Recent studies have shown about 3,500 particles of plastic /$km^2$ in the sea off the southern African coast. In fact, surveys of 50 South African beaches from the Eastern Cape to Cape Town show an increase in plastic pollution of 190% between 1985 and 1989. "Even remote and apparently pristine layers of sand and mud are now composed partly of this microscopic rubbish, broken down from discarded waste," the report in the journal Science said.

Most samples contain a range of plastics or polymers that include nylon, polyester and acrylic. Creatures that feed on contaminated plankton have plastics inside their bodies. Thus humans who eat sea life are also consuming these plastic particles. Turtles are particularly affected by plastic pollution; many have been found dead with plastic bags in their stomachs.

Marine bird species are found to be eating and dying from consuming plastic particles. A study of blue petrel chicks at South Africa's remote Marion Island found that 90% of them had plastic in their stomachs. The plastic was apparently fed to them accidentally by their parents. Seabirds ingest belly-fuls of plastic pollution

Environmental exposure to a widespread compound used to make common plastic food containers and baby bottles and to line tin cans interferes with cell division in the eggs of female mice. If cell division is disturbed, it can result in aneuploidy, or an abnormal number of chromosomes in the eggs. This condition is the leading cause of mental retardation and birth defects in humans, including Down syndrome. Even extremely low levels of BPA, produced genetic abnormalities. BPA exhibits hormone-like properties and imitates the effects of naturally-occurring estrogens. In mice 20 ppb daily for 5 to 7 days was enough to produce effects. Mice and humans have a very similar cell division program for eggs. Moreover, exposing animals in the womb to levels of BPA similar to those found in the environment disrupts their sperm count, prostate and testicular development. It is worth mentioning that BPA was invented in the 1930s during the search for synthetic "estrogens".

## 6. CLASSIFICATION OF PLASTICS

*6.1. The Plastics Industry Classification:*

Plastic #1: Polyethylene Terephthalate (PET). Common uses: 2 L soda bottles, cooking oil bottles, peanut butter jars. This is the most widely recycled plastic.." Recycling programs and centers request that you remove caps and flatten the bottles. $n[CH_2=CH_2] \rightarrow [-CH_2-CH_2-]n$

Plastic #2: High Density Polyethylene (HDPE). Common uses: detergent bottles, milk jugs, grocery bags.: Most curbside recycling programs accept rigid narrow neck containers.

Plastic #3: Polyvinyl Chloride (PVC). Common uses: plastic pipes, outdoor furniture, shrink wrap, water bottles, salad dressing and liquid detergent containers: Recycling centers rarely take #3 plastic. $n[CH_2=CHCl] \rightarrow [-CH_2-CHCl-]n$

Plastic #4: Low Density Polyethylene (LDPE). Common uses: dry cleaning bags, produce bags, trash can liners, food storage containers. Recycling centers rarely take #4 plastic.

Plastic #6: Polystyrene (PS). Common uses: packaging pellets or "Styrofoam peanuts," cups, plastic tableware, meat trays, to-go. Many shipping/packaging stores will accept polystyrene peanuts and other packaging materials for reuse. Cups, meat trays, and other containers that have come in contact with food are difficult to recycle.

Plastic #7: Others. Common uses: certain kinds of food containers and Tupperware. This

plastic category is any plastic other than the named #1–#6 plastic types. These containers can be any of the many different types of plastic polymers. Recycling centers rarely take plastic #7.

*6.2. The Society of the Plastics Industry (SPI) Classification:*

*Type 1 – PETE: Polyethylene Terephthalate (PET)
Soda & water containers, some waterproof packaging.

*Type 2 – HDPE: High-Density Polyethylene
Milk, detergent & oil bottles. Toys and plastic bags.

*Type 3 – V: Vinyl/Polyvinyl Chloride (PVC)
Food wrap, vegetable oil bottles, blister packages.

*Type 4 – LDPE: Low-Density Polyethylene
Many plastic bags. Shrink wrap, garment bags.

*Type 5 – PP: Polypropylene
Refrigerated containers, some bags, most bottle tops, some carpets, some food wrap.

*Type 6 – PS: Polystyrene Throwaway utensils, meat packing, protective packing.

*Type 7 – OTHERS: Usually layered or mixed plastic. No recycling potential—must be landfilled.

Types 1 and 2 are commonly recycled. Type 4 is less commonly recycled. The other types are generally not recycled, except perhaps in small test programs. Common plastics polycarbonate (PC) and acrylonitrile-butadiene-styrene (ABS) do not have recycling numbers

## 7. SAFER PLASTICS

*7.1. PET or PETE – usually for soft drinks, water bottles, ketchup and salad dressing, peanut butter, pickle, jelly and jam jars*

*7.2. HDPE – used mostly for milk, water and juice bottles, yogurt and margarine tubs, cereal box liners, and grocery, trash and retail bags*

*7.3. LDPE) – bread and frozen food bags and squeezable bottles*

*7.4. PP – margarine tubs*

## 8. PLASTICS TO AVOID

*8.1. V or PVC – 2nd most commonly used plastic in the world. Many toys are PVC too, and children put everything in their mouths.*

*8.2. PS – foam & Styrofoam*

*8.3. other (usually PC) – many drinking cups are made of this, baby bottles, big water jugs. These leach as they age and mostly into fatty foods. There is a link between BP-A and phthalates and early onset of puberty. (Puberty and Plastics, Dec 2003, Mothering Magazine). This is the plastic that looks like glass; it's very stiff and doesn't have a "plastic" look to it.*

## 9. RAW MATERIALS OF PLASTICS

Plastics are made from the following materials:

- Plasticizers: improve the softening, decrease brittleness and workability of plastics (flexibility and toughness). Plasticizers are organic substances.
- Stabilizers: prevent chemical degradation of plastics. By nature, stabilizers are antioxidants.
- Fillers: increase the tensile strength of plastics (Hardness and resistance to shock). Fillers are wood flour and glass wool.
- Reinforcing agents: increase plastics mechanical strength, e.g. glass fiber.
- Pigments: used to impart a particular color to the plastic.

The binder gives a plastic its main characteristics and usually its name. Thus, PVC is both the name of a binder and the name of a plastic into which it is made.

## 10. PLASTIC MATERIAL SAFETY DATA SHEET (MSDS)

- Hazardous materials are common in the plastics industry.
- MSDS are required to accompany any purchased hazardous industrial raw material.
- Plastics are defined as "potentially hazardous" because in the course of normal use, plastics may produce dusts, mists, gases, fumes, vapors, or smokes, which are dangerous.

## 11. REACTIVITY DATA

*11.1. Thermo-oxidative degradation can yield hazardous gases:*

– PVC: at 100°C releases HCl
– PMMA: at 100°C releases MMA
– POM: at 230°C releases formaldehyde
– Teflon (other fluoroplastics): at 250°C release HF
– PET: at 300°C releases acetaldehyde
– Nylons: at 300°C nylons release CO and ammonia
– Nylon 6: at 340°C releases e-caprolactam

*11.2. Thermal degradation of PVC*

PVC degradation is a serious problem. Can decompose catastrophically, if overheated in barrel. Remaining materials is tightly packed carbon. Fumes contain high concentrations of HCl.

*11.3. Thermal degradation of POM (poly actetal or polyoxymethylene)*

Thermally degrades ($>$ 230°C) and releases formaldehyde.

*11.4. Thermal degradation of Phenolics*

Major uses in adhesive applications (plywood and particleboard).

Can release small amounts of ammonia, formaldehyde, and phenol.

Phenol: TLV of 5 ppm, LD50 of 414 mg/kg, and LC50 of 821 ppm. Formaldehyde: ceiling of 0.3 ppm

*11.5. Thermal degradation of Nylon 6:*

Degrades into monomer_ e-caprolactam, and residual caprolactam.

Caprolactam vapor: TLV is 5 ppm, LD50 (rat) is 2.14 mg/kg. Molding operation release some caprolactam vapor, with more produced during purging and extrusions.

*11.6. Thermal degradation of PMMA (acrylic)_ Plexiglass. PMMA degrades into MMA (methyl methacrylate). TLV for MMA is 100 ppm (410 mg/m3)*

## 12. PHTHALATES AND HUMAN HEALTH

People are increasingly concerned about the safety of their food, water, consumer, and medical products. Groups such as Greenpeace and Health Care Without Harm have suggested that chemicals used to soften normally-rigid PVC plastics pose a threat to human health, and should be banned.

Greenpeace suggests that two such chemicals, called phthalates (pronounced thall-eights; DEHP), are suspect as human cancer-causing agents, could damage the liver and kidneys, might damage the development of reproductive organs, and might interfere with development by acting as a mimic of the sex hormone estrogen.

Some regulatory groups, e.g. the U.S. Consumer Product Safety Commission and the NIH Center for the Evaluation of Risks to Human Reproduction are also concerned about one phthalate, DEHP. Their concern stems from

the fact that maximally exposed humans can receive (for a short term) a dose close to that seen to cause adverse effects in animals (when administered over a lifetime).

DEHP, DINP (a second type of phthalate), and other phthalates have indeed been shown to cause various harms to experimental animals when administered at high doses. But the key determinant of human risk is the dose. For DEHP, a plasticizer used in manufacturing medical devices, the difference between human doses and harmful animal doses are generally large; foe example while a lifetime DEHP dose of 200 mg/kg b. wt /day can cause shortened lifespans or weight loss in rats, people at the high end of DEHP exposure get a short term dose that is 28 x less. On the other hand, while a lifetime DEHP dose of 50 mg/kg of b. wt /day can cause low level cancerous changes and liver enlargement in rats, people at the high end of DEHP exposure get a short term dose that is 7x less. A lifetime DEHP dose of 400 mg/kg/ day can cause liver tumors in rats, people at the high end of DEHP exposure get a short term dose that is 56 x less.

For DINP, a plasticizer used in manufacturing softened-vinyl toys or products for children, the situation is similar.

The final content of phthalate in the finished plastic product varies depending on the product, but ranges from 10 to 60% of the product mass on a weight basis.

## 13. HOW ARE HUMANS EXPOSED TO VINYL PLASTICIZERS?

Humans can be exposed to vinyl plasticizers through ingestion, inhalation, direct injection, or by skin contact. But exposure is only a small part of the story: absorption rates vary dramatically among the different exposure pathways and among different animal species as well. In addition, the ingested, inhaled, injected, or absorbed chemical can undergo different types of chemical modification along the path of entry or travel through the body, changing the potential effect it has on the various tissues and organs of the body.

Exposures to phthalates, as with most other chemicals, is expressed as a ratio of the exposure to the b. wt. of the exposed organism. Exposures to phthalates range from mgs to μgs. Body weights for exposed humans range from about 11 kg to well over 100 kg for an adult.

## 14. METABOLIC PROCESSING

Different animals breakdown different chemicals differently. In the case of phthalates, while it is clear that the metabolic pathway in rats and mice requires more steps than in primates or humans, it is unclear exactly how that alters the exposure of possibly sensitive tissues to DEHP, or the main breakdown product, mono (2-ethylhexyl) phthalate, or MEHP. It is also unknown whether DEHP is the chemical uniquely responsible for causing the negative symptoms seen in animal studies, or whether a breakdown product, such as MEHP, is responsible. This could be important since in primates and humans, for example, MEHP is formed at much lower levels within the digestive system than is the case in rats and mice. It also relates back to the pathway of exposure, in that humans receiving an exposure to phthalates through, say, a feeding tube would subject the DEHP to different metabolic processing than they would to DEHP injected during, say, a dialysis procedure.

## 15. DIFFERENT CANCER–CAUSATION MECHANISMS

One physiological process that scientists monitor to gauge the cancer-causing potential of a chemical is called “peroxisome proliferation.” In peroxisome proliferation studies, scientists look for evidence that peroxisomes have developed at

abnormally high levels in liver cells or other suspected sites of cancer formation. But the peroxisome proliferation ability of different chemicals differs among different animal species, and it is uncertain whether peroxisome proliferation is truly an indicator of cancer-causing potential. The Syrian hamster, for example, is four times less likely to display peroxisome proliferation when given the same dose of a known peroxisome proliferator as a rat or mouse. Dogs and rhesus monkeys are even less likely to experience peroxisome proliferation when given chemicals known to cause peroxisome proliferation in rats and mice. Huber, *et al*. point out that: "The greater sensitivity of the rat to peroxisome proliferators such as DEHP suggests that human risk calculations based exclusively on rat data and dose might lead to an overestimation of the actual threat." Most recently, the UN Internat-ional Agency for Research on Cancer changed the classification of DEHP from a "possible" human carcinogen to "Cannot be classified as to its carcinogenicity in humans."

## 16. PLASTIC POISONS AND POLLUTES

Plastic is made from oil and coal, materials that are both unsustainable and non-renewable. Mining, transport, energy production and petrochemical processes all damage the environment. In this way, plastic production contributes to problems such as oil spills, toxic emissions, and global warming through the release of greenhouse gases (GHG). If you decide to burn plastic to try to get rid of it, there are also problems. Dioxins and furans are two highly toxic chemicals created unintentionally during plastic incin-eration. Open burning of plastics is a common practice in Africa. Most of the African countries do not have proper incinerators. Moreover, plastic bags in the villages and town is used to ignite the charcoal for cooking. Therefore, most of the inhabitants and their neighbors are forced to inhale the smoke and the highly damaging vapors.

## 17. CLOGGED BY PLASTIC BAGS, AFRICA BEGINS BANNING THEM

*17.1. Lagos, Nigeria; and Nairobi, Kenya:* Once a month, John Ebiwari drags an iron rake through the open sewer that runs in front of his house in Nigeria's sprawling commercial capital of Lagos and scoops out the discarded plastic bags that block the flow of bubbling black filth. On the last Saturday of each month Lagos police officers armed with big sticks make sure residents fulfill their legal duty and clean up their neighborhoods for 'Sanitation Day.' But, in a move more drastic than seen in most Western countries, several African nations are tackling the scourge by banning or restricting use of plastic bags.

The UN estimates that only 10% of rubbish in Africa makes it to dumps, with the rest left to rot in communities or burned in acrid bonfires. As Africans increasingly live in cities, waste management has become a real development problem. Rwanda, Tanzania, and Uganda have passed laws banning or restricting the use of the ordinary plastic grocery bag. By the end of the year, Kenya is expected to follow suit. More than 48 million plastic bags are produced in Kenya each year. "We need to ban these flimsy plastic bags, which we only use once and dispose of, because all of them make their way into the environment," says environmentalist Joseph Gondi of Kenya's prominent Green Belt Movement. "You may collect them and say you are taking them to the dump site, but we do not have well managed landfill sites here in Kenya." The bags are more than a nuisance. Blocked sewers help spread disease. Farmers complain that precious livestock are choking to death on plastic bags, ruining their livelihoods, while rubbish-strewn streets and countryside are counter-productive for Kenya's tourism-based economy. The government has already passed legislation that

will usher in a 120% tax on plastic carrier bags and packaging, and a ban on plastic bags $< 30\ \mu$ thick. On the outskirts of the city center, most of Nairobi's 3 million residents live in slums. "Plastic bags are a big problem, one of our worst in life today," says Khamasi Josephat Bandi who lives and works for a small charity in Nairobi's Kibera slum. He supports the proposed ban, and deep among the tin shacks, where pit latrines empty into a broad sewage channel, it's easy to see why. The channel, which before it became clogged with rubbish was regularly flushed clean by rain, is a stomach churning mass of feces and plastic bags. When the rains come, standing water is a breeding ground for malarial mosquitoes. "Plastic bags only recently came to Kenya," says Gondi. "Only 15 years ago, women shopped with baskets, and I remember buying fish and sweet potatoes wrapped in banana leaves, not a flimsy plastic bag." January 2008, the country applied a thickness rule to pl. bags.

In Nigeria, where plastic bags are legal, women prepare and sell food that customers take away in plastic bags so thin many items have to be double wrapped. The only affordable clean drinking water comes in plastic sachets, too. Deola Asabia says there is little hope of a ban on plastic bags in Nigeria until the population has access to clean drinking water. "The government realizes that they can't get rid of plastic bags," says Mr. Asabia. With sponsorship from a local bank and cooperation with the Lagos State Waste Management Authority, they're making sure that Sanitation Day is as widely adhered to as possible.

*17.2. Botswana*

When people started voicing their concern at the widespread use and disposal of plastic bags, a NGO in Botswana, decided to do something about it. Following a workshop (government authorities, stakeholders) met to discuss possible solutions to the "Plastics Menace", the Plastics Petition Campaign was launched, which requested that the government take action on the following points:

- Shops should only stock plastic bags thicker than 60μ.
- Shoppers should pay for the stronger bags, so that they would be more likely to re-use them than throw them away.
- Manufacturers should make sure that plastic bags are made of materials that can be recycled more easily.
- Manufacturers, distributors, and retailers should apply environmental policies for the management and disposal of plastic bags.
- The use of recycled paper bags and cloth bags should be promoted.

The Parliament and the President of Botswana turned it into a policy proposal for consideration by the Ministry of the Environment, Wildlife and Tourism.

*17.3. Namibia*

The beaches are beautiful, but a walk along the shoreline and a quick beach cleanup showed that like coastal areas all over the world, Namibia has a problem with plastic trash accumulating on its otherwise relatively pristine beaches. The majority of the plastic trash was left by beachgoers rather than washed up by actions of the gyre. Trash building up on beaches is one of the most direct pathways to marine plastic pollution, and every time the tide comes in, the actions of the Atlantic Ocean bring much of what is on the beach out to sea. With one of the lowest population densities in Africa, the majority of Namibians live in dire poverty on $>$ \$2 a day. It's estimated that one in five of Namibians are infected with HIV, and AIDS as the leading cause of death in the country. The country has a looming energy crisis and unemployment rates at unacceptably high levels. With negligible funds for coastal protection, trash will continue to accumulate until something drastic changes. Many of the packaging that ends up here is produced nationally in Africa, but remnants of imported products hailing from as far away as the US and Argentina. The effects of our

throwaway culture has reaches far beyond our backyard.

*17.4. Congo*

The Republic of Congo has banned the production, import, sale and use of plastic bags in a move to fight environmental pollution. The government adopted a decree prohibits the use of plastic bags to pack food, groceries, water and other beverages. "For some years now, particularly in urban areas, Congo has witnessed major environmental pollution caused by discarded plastic bags which block drainage systems, causing floods and landslides,". Congo, like many developing nations, lacks adequate waste management and recycling facilities. The widely used non-biodegradable plastic bags are strewn about, causing harm to the environment.

*17.5. Other Countries;*

Rwanda has led Africa's fight against plastic bags, banning them five years ago. Other countries have also moved to either ban or limit their usage. Eritrea in 2005, banned plastic bags outright. Ethiopia in 2008, government passed a new law (Proclamation 513) that bans the manufacture and import of plastic bags $< 0.33$ mm in thickness. Ghana, proposed a thickness rule on plastic bags. The outcome is not known at this time. July 2004, the government created a Recycling Taskforce to hire waste collectors to collect and deliver plastic bags to warehouses for recycling. Plastic producers required to help fund the project. A terrible impact on tourism; give foreign tourists the impression that Ghana is a filthy country. Lesotho proposed thickness rule on plastic bags; the outcome is not known at this time. Rwanda (2005): government banned plastic bags outright. Somaliland; banned plastic bags completely as of March 2005. South Africa (20030; applied a thickness rule to plastic bags. Tanzania (2006); banned plastic bags. Uganda (June 20070; imposed a thickness rule on platic bags. Sudan, Gadarif and gezira states prevent the use of plastioc bages $> 10$ yr ago. The outcome is not encouraging despite the tough measures taken agaist sellers and users.

## 18. PLASTIC WASTE AND LIVESTOCK

Plastic bags littering the countryside are also a danger to livestock. Grazing cattle, sheep and goates eat them and die when the bag becomes entangled in their stomachs. Farmers, especially those who farm near towns, often report this problem (Dreyer *et al*, 1999, and Rasmussen, 1999). One can emphasize that death from swallowing plastic bags and robes exceeds that resulting from diseases and other causes in most African countries, especially the Sudan, Chad, Erirea, Ethiopia, the Central Republic of Africa, Burkina Faso and others.

## 19. WHAT CAN WE DO?

It makes sense for "everyone" to reduce their use of plastic bags. The more people who bring their own re-useable non-plastic bag to the shops, the less plastic bags are needed. If one already has plastic bags, one could re-use them several times himself. Thick plastic bags are easier to re-use, and they are also easier and more profitable to recycle. Below are some examples for actions taken in some African countries.

## 20. WAYS TO REDUCE EXPOSURE TO PLASTIC TOXINS

- Avoid disposable plastic packages and opt for storage containers like glass that can be reused.
- Buy food in glass or paper containers or transfer to these containers shortly after purchase.
- Don't microwave or heat food in plastic containers.
- Avoid storing fatty foods, such as meat, oil,

and cheese, in plastic containers or plastic wrap and don't buy fatty foods in plastic, if at all possible.
- Avoid storing acidic foods in plastic like tomatoes or citrus as those tend to draw out the plastic poisons much like fats.
- Avoid storing liquids and water in plastic as those are great transp-orters and will help the plastic leach into the liquid.
- Don't drink the water, if it tastes like plastic; plastic is sure to have leached into the drink if it does.
- Don't drink from the outdoor hose; the plastic is not food grade or safe and the harm is compounded since the hose is heated causing these chemicals to easily enter into the water that flows from the hose.
- Instead of relying upon the establishment for their containers, bring your own glass bowls to salad bars or bring your own paper cups to yogurt shops. Ask that they use your container instead of the plastic one offered for environmental and health reasons and educate others at the same time.
- Instead of plastic forks, sporks, spoons and knives, use the real thing. Use stainless steel or wooden utensils over plastic especially when cooking or heating food as well as when eating heated foods. Offer these to guests and children and even opt for the real thing in lunch boxes. Choose plastic made of corn that is compostable or opt for recycled paper products.
- Use wood instead of plastic cutting boards. Use separate boards for uncooked poultry, vegetables, uncooked meats, fruit, and cooked meats.
- Remember that the plastic wrap used in the supermarket will leach into the foods wrapped in them. Try to get foods wrapped in paper instead or if not available and they use plastic, slice off a thin layer where the food came into contact with the plastic as soon as you get home and store in a safer container.
- Buy containers in glass or paper whenever possible. Read the bottom and refuse to buy anything packaged in the worst plastics: 3, 6, and 7.

## References 1

Economic history of Africa – Wikipedia, the free encyclopedia
References
Goldsmith, Arthur A. "Foreign Aid and Statehood in Africa." The MIT Press 55.1 (2001): 123–48. JSTOR. Web. 25 Mar. 2012. "[1]"
Kayizzi-Mugerwa, Steve The African Economy: Policy, Institutions and the Future (Routledge, 1999, ISBN 0–415–18323–5)
Moshomba, Richard E. Africa in the Global Economy (Lynne Rienner, 2000, ISBN 1–55587–718–4)
OECD. African Economic Outlook 2006/2007 (OECD, 2007, ISBN 978–92–64–03313–9)

## References 2

Aguado, J. and Serrano, D. (1999). Feedstock Recycling of Plastic wastes. RSC Clean Technology Monographs. Royal Society of Chemistry, Cambridge.
Association of Plastics Manufacturers in Europe (APME) (2002–2003). Plastics in Europe-An analysis of plastics consumption and recovery in Europe.
Amankwah, A. (2005). Plastic Waste Wahala.
http:www.ghanaweb.com/public_agenda/arcticle (access on 08 June, 2006).
Baldisimo, J.M.(1985). Recycling Potential of Solid Wastes at source and disposal sites in Manila, The Philippines.
Beumer, P.F.M. *et al* (1991). Arbeidsomstandigheden in de chemische industrie: Overzicht van de voornaamste knelpunten wat betreft de blootstelling aan geluid, trillingen, gassen, dampen en stof. Directoraat-Generaal van de Arbeid Van het Ministerie Van Sociale Zaken en Werkgelegenheid, Den Haag.
CAPS (1992). Recycling Activities in Metro Manila. WAREN project WASTE CONSULTANTS, The Netherlands
Cointreau, S. *et al* (1984). Recycling from municipal refuse: A state-of-the-art review and annoted bibliography. Integrated Resource Recovery. Technical Paper Number 30 World Bank, Washington, DC.

Ehrig, R.J. (1992). Plastics Recycling: Products and Processes. Hanser Publishers, Munich.

Environment and Plastics Industry Council (EPIC). Plastic Recycling Overview. Summary Report by Environment and Plastics Industry Council (EPIC). – A Council of the Canadian Plastic Industry Association. Available in www. plastic.ca/epic.

EQI (1991). The recycling of solid waste in Cairo, Egypt. WAREN project, WASTE Consultants, The Netherlands.

Gaiker-IVL and KTH (2005). Technological Reference Paper on Recycling Plastics.

GNA (2005). AMA to temporarily ban use of plastics.

http://www.ghanaweb.com/ghanahomepage/ newsarchive/article (access on12 June, 2006)

Halbekath, J. (1989). The hazards of recycling plastics.

Horrocks, R. A. (1996). Recycling Textile and Plastic Waste. Woodhead publishing Limited, Cambridge, England.

IRIN (2006). Government declares recycling war on plastic waste

http://www.irinnews.org (access on 08 June, 2006)

IRIN (2004). Ghana: No to water in plastic bags.

http://www.scienceinafrica.co.za/ghanaplastic. htm (08 June, 2006)

Konings, P. (1989). Small-scale industrial reprocessing of plastics: A field-study in Istanbul, Turkey. Waste Consultants/Delft University of Technology, Netherlands.

Lardinois, I. and Klundert, A. (1995). Plastic Waste: Options for Small Scale Recovery. The Netherlands: Waste Consultants.

Mewis, J. (1983). Gevaarlijke stoffen. Monografieen leefmilienu. De Nederlandse boekhandel, Antwerp/Amsterdam.

Nagelhout, D. (1989). Information document waste plastics. Report number 738902005. RIVM, Bilthoren.

Scheirs, J. (1998). Polymer Recycling. Wiley, Chiches, UK.

Saechtling, H. (1987). International Plastics Handbook for the Technologist, Engineer and User, 2nd edition. Hanser Publishes, Munich.

Schouten, A.E. and Van der Vegt, A.K. (1991). Plastics, 9th edition. Delta Press BV, Amerongen.

Tall, S. (2002). Recycling of Mixed Plastic Waste—Is Separation Worthwhile? PhD Thesis, Department of Polymer Technology, Royal Institute of Technology, Stockholm-Sweden.

TNO (1993). Emissiefactoren Kunststof-en rubberverwerkende industrie. Publikatiereeks Emissieregistratie Nr.11. Ministry of Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, The Hague, Netherlands.

Vogler, J. (1984). Small-Scale Recycling of Plastics. Intermediate Technology Publications, UK.

Warmer Fact Sheet (1992). Plastic Recycling, number 32.

Yankson, P.W. and Gough, K.V. (1999). The environmental impact of rapid urbanization in the peri-urban area of Accra, Ghana.