

Assessment of the differing environmental impacts between reusable and disposable diapers.

*Jelena Meseldzija, Danijela Poznanovic & Richard Frank,
Dufferin Research (November 2013)*

Introduction

In recent years there has been a growing awareness of the many environmental problems that exist such as global warming, ozone depletion, water and air pollution, excessive resource consumption and hazardous waste to name a few. These issues affect people, societies and ecosystems. Due to this growing awareness and its political importance, governments are trying to reduce this negative impact through various legislative measures. Similarly corporations are seeking to build a “greener” more sustainable image of the way they do business as more people seriously consider more eco-friendly’s ways of living and there is a greater support for more sustainable development. Finally there are the actions of the individual (who is a consumer) to consider.

The phrase “Think global, act local” (attributed to Scots town planner and social activist Patrick Geddes in 1915) is the best way that people as individuals can help to mitigate the problem. Since humans, in aggregate, are responsible for most of the environmental problems, yet we as individuals are directly responsible only for our own activities, it is important that each person takes responsibility for his or her actions and become aware that the individual (and their family unit) has a significant effect on the natural environment through choices he or she makes.

Let’s discuss one simple example that most people encounter in their lives when starting a family: diaper choice - disposable vs. reusable (cloth/fabric).

Many scientists, parents and environmentalists have tackled the cloth versus disposable diaper debate. A number of scientific studies have been undertaken (admittedly some are quite biased one way or the other based on the study sponsor), but biases notwithstanding, it is quite clear that both cloth and disposable diapers have environmental effects, such as the consumption of natural resources, energy usage, health issues, air and water pollution and waste disposal. The question is which one of them has the greater environmental cost. A life cycle analysis is the obvious way to discern the true and total environmental and economic cost of each method. However it is not a simple task since the number of variables to consider within the life cycle are numerous and not fully transparent. As well there is substantial variability at the consumer end based on their household practices (especially related to cloth diapers). But let’s examine what’s out there.

According to some studies disposable diapers are more harmful because they create enormous amounts of trash, while others think that maintaining cloth diapers requires lots

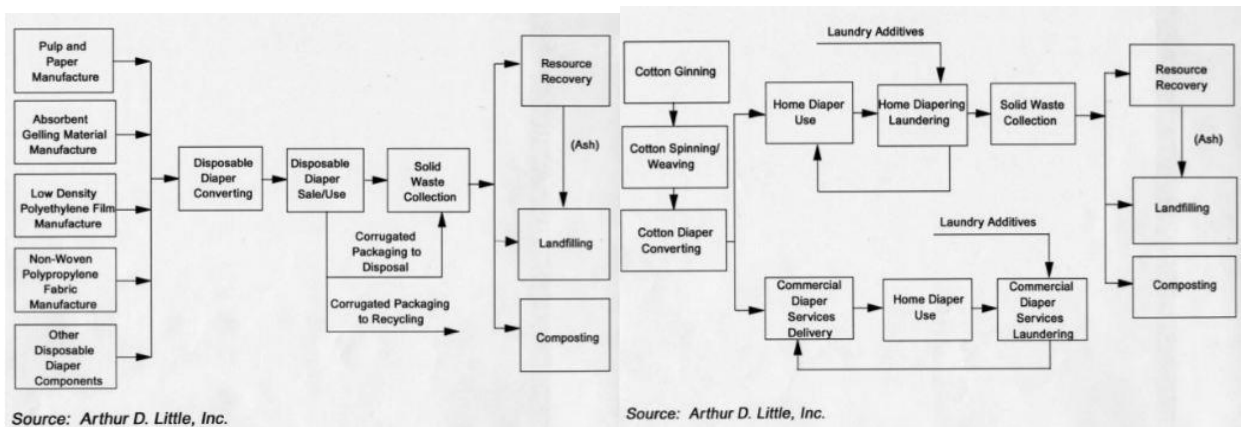
of energy and water and contribute significantly to air and water pollution at the consumer end of the cycle. In addition during an examination of the whole life cycle of both types of diapers the production process and initial resources used must be examined, which includes forests cut down, harmful chemicals released during the bleaching of paper, fuel costs during transportation to the warehouse, retail outlet, consumer's home and finally to the landfill or incinerator.

Since all this requires energy, chemicals, water, and equipment that affects the environment, the best way to compare these two types of diaper, is to have a look at the different key areas they affect: natural resources consumption, air and water pollution and waste disposal.

A caution to the reader: We will where possible state the context, especially when numbers are quoted as they vary from country to country and most studies are done at the national level. When viewing these numbers consider that there are currently between 193 (UN members) and 245 "countries" in the world (depending on your definition of country and the political agreement that supports that. As well be aware that the disposal diaper culture is more of a "western" developed nation issue than a developing nation or from many "eastern" cultures. For example the use of disposable diapers is historically foreign to the Chinese culture and economy. Therefore global numbers are hard to extrapolate.

Let us begin by looking at the parts and then we can try and figure the whole.

The life cycle of disposable (left) vs. cloth reusable diapers (right)



The plastic in 1 disposable diaper



Is created by 1 cup (236 ml) of crude oil



Infographic © Kirya Consumer Products LLP

Resource consumption

Production and use of both cloth and disposable diapers implies the consumption of various renewal and non-renewable resources, production processes, water and energy usage, but even a quick review reveals there is

difference in the impact they create on the environment.

a) Non-Renewable Resource Consumption

During the last several decades, disposable diapers have become a widely accepted alternative to cloth reusable diapers. It is a huge industry. It has been estimated that 95% of parents in Canada buy only disposable diapers. In order to satisfy these needs, it is necessary to produce approximately 1.5 billion of diapers.¹ This requires a lot of natural resources and energy. It has been estimated that “over 300 pounds of wood, 50 pounds of petroleum and 20 pounds of chlorine are used to produce disposable diapers for one baby each year”.²

Oil is used as a raw material for the polyethylene, which provides waterproof outer layer of disposal diaper. To make the plastic for only one disposable diaper, it takes 1 cup of crude oil, approximately 236 ml.³

Assuming that one child will use at least 6,500 diapers in a lifetime, this means that it takes about 1,625 quarts of oil to diaper one baby for 30 months - not including the oil involved in the diapers manufacture and delivery. It has been stated that it takes more oil to keep one baby dry for two and a half years than it does to lubricate all the cars an individual will ever own in a lifetime.⁴

On examination of the interior of the diaper, the inner layer is made mostly from paper and sodium polyacrylate. The 70 percent of the diaper that is made of paper comes from trees (some undoubtedly these days is recycled paper but we found no clear numbers for this). Tree production (plantations growth for harvesting) requires some plant nutrients, pesticide, mechanical energy, water, and other inputs and it may tend to reduce plant species diversity.⁵

It takes 200-400 kg of fluff pulp to keep one baby in disposables for one year. It is estimated that this requires one billion trees per year (globally) and approximately 4.5 for each baby who uses them.⁶ Although wood and wood products such as paper, can be

¹<http://recycling.about.com/od/Paper/a/Knowaste-Targets-Absorbent-Hygiene-Product-Recycling.htm>

²<http://www.realdiaperassociation.org/diaperfacts.php>

³<http://www.ocdiaperservice.com/Environment.html>

⁴<http://www.smallfootprintfamily.com/dangers-of-disposable-diapers>

⁵<http://www.extension.umn.edu/distribution/housingandclothing/dk5911.html>

⁶<http://www.sagediaper.com/blog/2009/12/top-ten-environmental-reasons-for-choosing-cloth-diapers/>

considered as a renewable resource, we need to remember that our forests are complex, fragile ecosystems and are being deleted faster than they are being replanted.

The situation is different when it comes to cloth diapers. They are made of natural, renewable resources, such as cotton. For two years of diapering, less than 10 kg of cotton is used. Bamboo is also being used in cloth diapers recently due to its sustainability and absorbency. It is a good, green option since the bamboo plant is rapidly growing and regenerates itself quickly. Hemp is also becoming a very popular material to use in cloth diapers as it is a sustainable, environmentally friendly fabric.

Although cloth diapers manufacturing and cleaning process consume fossil fuels as well, most studies conclude that they require less non-renewable resources, so choosing cloth, instead of disposable diapers represents a significant way to reduce oil and tree consumption.

b) Water and energy consumption

The most frequently quoted area in which disposable diapers are stated to have a lesser negative impact on the environment than reusable ones is in the area of water and energy usage. Several studies claim that the growing of cotton and washing required for reusable diapers consume more water than the manufacturing process required for producing disposable diapers. However this is disputed in many studies such as the one by The Land Bank Consultancy for the Women's Environmental Network, production of disposable diapers includes 230% more water and 350% more energy than the manufacturing, using and washing of cloth diapers. One can conclude when examining both sides of the argument that on a per diaper basis, disposables use less energy and water to manufacture than cloth diapers but the scale of production is vastly different, so it is a rather spurious claim.

When you dig into the data, we can see that even though cotton is a very water hungry crop often growing in areas with water shortages (and is a heavier user of pesticides) cloth diapers represent a small fraction of the total cotton market, and therefore a smaller percentage of water is needed for its cultivation (when examined from the point of view of life cycle of the product).

Everyone more or less agrees that laundering cycle for reusable diapers consists of washing and drying the diaper and treatment of the water involved, requires a lot of water and energy.⁷According to National Geographic's Human Footprint documentary, it takes 22,455 gallons of water to launder all of the cloth diapers one human will need in a lifetime.⁸However, advancing technology in washing machines and dryers and laundry services has helped tremendously to keep the energy and water usage to a minimum.

⁷ Lehrburger C., Mullen J., Jones C.V., "Diapers: Environmental impacts and lifecycle analysis", The National Association of Diaper Services, 1991.

⁸<http://thenewmamiaries.blogspot.com/2012/11/cloth-diapers-versus-disposable-diapers.html>

As well the use of a diaper laundry service uses over 2.5 times less net water per diaper change and only about half the energy compared to home laundered reusable diapers. They have lower resources and environmental impacts than home laundering due to economics of scale and use of more efficient machinery that requires less water and energy.⁹ However, there is much more variability in the impact at the household level (which makes all such studies at best estimates). Users of home-laundered cloth diapers can easily reduce environmental impact up to 38 % through their laundering choices. Appliance energy rating, washing temperature, number of diapers laundered the type of washer and cleaners used, and how it is dried all have a significant impact on the numbers.¹⁰

It has been estimated that:

*laundering diapers from birth to toilet-training in a high efficiency front - loading washer will use approximately ten thousand gallons of water. To put that number into perspective, over the same time period, a faucet dripping once per second would waste almost six thousand gallons of water and the average toilet flushing five times a day would use over twenty thousand gallons. Watering the average lawn uses twenty thousand gallons each year. So the extra water usage at home could easily be alleviated by fixing that drippy tap, taking shorter showers or planting more water-efficient landscaping (all good water conservation practices at any rate).*¹¹

On the other hand, it takes massive amounts of water to process wood pulp into paper for throwaways, according to the Cotton Diaper Coalition.¹²

*From the standpoint of total water requirements (gross water use); disposable diapers use 37 % more water than home laundered or diapers service laundered reusable. When in-plant water recycling is taken into account (net water use), cloth diapers laundered by a diaper service use approximately 40% less water than single-use diapers when fecal disposal to the toilet is included*¹³

However no one knows how many people actually do this even though it is “required” by law since landfilling of human waste is illegal in most industrialized countries.

The situation is similar when it comes to energy use. On a per-diaper-change basis, manufacturing of disposable diapers requires nearly 6 times the amount of energy used in manufacturing reusable diapers. Even when laundering is taken into account (the majority of energy use in washing comes from heating the water) along with manufacturing, energy consumption for the weighted average of home and commercially laundered reusable diapers is approximately 80% that of single-use diapers.¹⁴

⁹ Lehrburger C., Mullen J., Jones C.V., “Diapers: Environmental impacts and lifecycle analysis”, The National Association of Diaper Services, 1991.

¹⁰ <http://www.cbc.ca/news/diaper-debate-cloth-makes-a-comeback-1.746176>

¹¹ http://www.naturallifemagazine.com/0910/which_are_greener_cloth_or_single-use_diapers.htm

¹² <http://www.ocdiaperservice.com/Environment.html>

¹³ Lehrburger C., Mullen J., Jones C.V., “Diapers: Environmental impacts and lifecycle analysis”, The National Association of Diaper Services, 1991.

¹⁴ Lehrburger C., Mullen J., Jones C.V., “Diapers: Environmental impacts and lifecycle analysis”, The National Association of Diaper Services, 1991.

Therefore, after examining a large number of articles and studies, and trying to balance both sides of the argument, and digging into the data, we can conclude that cloth diapers use less renewable and non-renewable resources at all levels of production and use than do disposables. But what is the situation with regard to the pollution issue?

Water and air pollution

Life cycles for both disposable and reusable diapers create waterborne and airborne wastes. These wastes arise not just from the manufacturing process for the diapers themselves, but also from the manufacturing process for things like soap (used in washing reusable diapers), the energy production process for running things like clothes dryers, and the transportation channel for shipping diapers from manufacturers to distributors (and ultimately consumers) and from landfills where most of diapers are disposed (less so in Western Europe where much is incinerated, but this is the exception, landfilling is still the norm globally).

a) Waste water

During the process of getting the raw materials - cotton, pulp, plastics and the production of diapers, waste waters are produced. Many believe that growing of cotton, which requires use of pesticides and herbicides, and laundering cloth diapers, contributes to water and environmental pollution, but, according to the report of the Environment Canada, effluents from the disposable diaper manufacturing process (plastic, pulp and bleached paper) are more damaging to the environment.¹⁵

Cotton is a very fertilizer and herbicide intensive crop. It is responsible for 10% of pesticide used and 25% of herbicide used worldwide.¹⁶

Some concern has been raised that the use of pesticides in cotton growing would increase with a shift towards cotton diapers. However, even if all disposable diapers were replaced with 100% cotton diapers, the impact on the cotton industry would be minimal as cotton diapers requires less than 10 kg of cotton per baby.¹⁷

Another concern, when it comes to cloth diapers and water pollution is related with their maintaining, because detergents that are used pollute water.¹⁸ Some studies have come to conclusion that waste waters created by laundering reusable diapers are similar to other domestic waste waters and that contains little or no hazardous constituents, but can contain high level of nitrogen and phosphorous.¹⁹ Even if these studies are not true, there is

¹⁵<http://www.cbc.ca/news/diaper-debate-cloth-makes-a-comeback-1.746176>

¹⁶<http://www.thegreenmama.com/analyzing-environmental-life-cycle-costs-diapers>

¹⁷<http://borntolove.com/yourchoi.html>

¹⁸<http://life.familyeducation.com/diapers/baby/50452.html>

¹⁹ Lehrburger C., Mullen J., Jones C.V., "Diapers: Environmental impacts and lifecycle analysis", The National Association of Diaper Services, 1991.

possibility to use biodegradable detergents and environmentally friendly laundry products that can reduce this negative impact on the environment.

Waste water created in cloth diaper manufacturing contains high amounts of suspended solids but relatively low COD²⁰. On the other hand, plastics, pulp and paper waste waters are lower volume, but contain high COD and numerous potentially toxic organic and inorganic residues.²¹

They contain priority pollutants and compounds which are considered hazardous, including dioxins, furans and chlorophenols, solvents, sludge and additional heavy metals. Release of effluents from these industries has resulted with significant environmental degradation.²²

Waste water from growing cotton and manufacturing cloth is relatively high volume and low impact compared to waste water generated from single-use diaper components and product manufacturing.²³ Products that are gentle to the environment can be used for the cloth diaper washing, while dangerous chemicals that appear in production of disposable diapers are inevitable.²⁴

b) Air pollution and global warming

During the processes of production, use, distribution and disposal of diapers, harmful substances are released into the air and it is argued that they contribute to greenhouse gas production, global warming and air pollution. Cloth and disposables have similar global warming impact, though for different reasons. The manufacturing of disposable diapers has a larger carbon footprint, but the electricity used to wash reusable diapers cancels out most of the difference.²⁵

According to a report commissioned by the Environment Agency, cloth diapers are responsible for 560 kg of greenhouse gas over the baby's first two and a half years of life, whereas a disposable diaper is responsible for 630 kg, which is equal to an average car driven 1800 miles.²⁶

Some studies claimed that cloth diapers have a **greater global warming impact** than disposables, due to washing and sterilization.²⁷ Trying to find out whether this statement is

²⁰ COD - Chemical Oxygen Demand – standard method for indirect measurement of the amount of pollution

²¹ Lehrburger C., Mullen J., Jones C.V., "Diapers: Environmental impacts and lifecycle analysis", The National Association of Diaper Services, 1991.

²² Lehrburger C., Mullen J., Jones C.V., "Diapers: Environmental impacts and lifecycle analysis", The National Association of Diaper Services, 1991.

²³ Lehrburger C., Mullen J., Jones C.V., "Diapers: Environmental impacts and lifecycle analysis", The National Association of Diaper Services, 1991.

²⁴ <http://www.thenaturalbabyco.com/diaper-experts/disposable-vs-cloth-diapers/>

²⁵ http://alumni.stanford.edu/get/page/magazine/article/?article_id=56347

²⁶ [http://www.climatechangechallenge.org/News/Featured-](http://www.climatechangechallenge.org/News/Featured-Articles/Disposable_Nappies_(diapers)_No_Worse_for_the_Environment_Than_Cloth_Nappies.htm)

[Articles/Disposable Nappies \(diapers\) No Worse for the Environment Than Cloth Nappies.htm](http://www.climatechangechallenge.org/News/Featured-Articles/Disposable_Nappies_(diapers)_No_Worse_for_the_Environment_Than_Cloth_Nappies.htm)

²⁷ <http://news.medill.northwestern.edu/chicago/news.aspx?id=127835>

true, an updated lifecycle assessment study for disposable and reusable nappies (diapers) by the U.K. Environment Agency and Department for Environment, Food and Rural Affairs in 2008 concluded that this impact may vary and that reusable diapers can cause significantly less or more damage to the environment than disposable ones, depending mostly on how parents wash and dry them.

Washing them in full loads, line-drying them outdoors all the time and reusing them on a second child lowered the global warming impact by 40% from the baseline scenario, or some (440 pounds) 220 kg of carbon dioxide equivalents over the two-and-a-half years of usage, equal to driving a car approximately 620 miles (1000 kilometers).²⁸

However, most studies agree that the air pollution from the manufacture of disposables is far more noxious than the air pollution from production and use of cloth diapers, because it includes **dangerous chemicals**, such as sodium polyacrylate, chlorine, dioxin, TBT that are released into the environment.²⁹

Even though many cloth diapers are bleached in making and causes creation of chlorinated organic compounds, **chlorine** is greater environmental issue in the making of disposable diaper in part because there are much greater numbers of them made and in part because bleaching paper products release dioxin, furans and chlorine gas into the air.³⁰

Even though some diaper producers are trying to mitigate this impact by using unbleached wood pulp from sustainably managed forests and produce so called “eco-diapers”³¹, we should not forget that distribution and packaging of diapers can contribute to emissions and air pollution. After they were produced, diapers must be packaged and trucks have to deliver diapers to stores and there are a much more trucks delivering a lot more disposable diapers than there are delivering cloth diapers.³²

And another thing must be taken into account. Used diapers end up in landfills and during the decomposition of disposable diapers methane is released in the air. It is a greenhouse gas, that replaces oxygen and which, from billion diapers thrown away, significantly contributes to the global warming.³³ Even when they are burned, they contribute to air pollution.³⁴ Incineration emits dioxin and furans into the air and produce toxic air emissions and toxic ash.

²⁸ http://www.naturallifemagazine.com/0910/which_are_greener_cloth_or_single-use_diapers.htm

²⁹ <http://www.roda.hr/article/readlink/1745>

³⁰ <http://www.thegreenmama.com/analyzing-environmental-life-cycle-costs-diapers>

³¹ <http://www.thegreenmama.com/analyzing-environmental-life-cycle-costs-diapers>

http://www.dm.de/de_homepage/babylove/produkte/windeln/nature-oeko-windeln/172418/babylove-nature-oeko-windeln-mini-3-6-kg.html

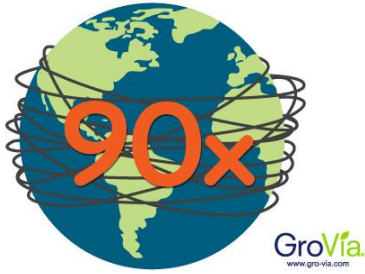
³² <http://thenewmamadiaries.blogspot.com/2012/11/cloth-diapers-versus-disposable-diapers.html>

³³ <http://www.extension.umn.edu/distribution/housingandclothing/dk5911.html>

<http://www.diapernet.org/whycloth.htm>

³⁴ <http://libaware.economads.com/ddiapermyth.php>

Solid waste and landfill



Did you know that in the US we throw away 20 billion disposable diapers every year? That's enough to circle the globe 90 times!

The most obvious environmental impact of disposable diapers lies in the fact that they are thrown away. Considering that the average baby goes through 5,000 diapers before being potty-trained, and that 95% of these diaper changes are disposable diapers, it is clear that they make up a huge part of the garbage we dump every day.

Numbers shows that one baby produce one ton of trash over one year when using disposable diapers and that in a house with a child in diapers, disposables make up 50% of household waste.³⁵They are the third largest individual constituent of municipal solid waste, just after newspapers and bottles, accounting for probably somewhere between 1.5% and 4% of the total. It is also a growing problem.

The amount of disposable diaper waste has been increasing over the years as recycling becomes more effective in other areas, disposable diapers will inevitably account for an increasing percentage as they have a negligible recycling rate.³⁶

After they end up at landfills, disposable diapers stay there for a long time. Because of the plastic and super-absorbance gel they contained, it takes hundreds of years for them to decompose when exposed to sunlight and air.

But, since diapers are dumped into landfills, covered and not exposed to sun or air at all, nobody knows how many hundreds, or even thousands of years they could be around. Without sun and air, even so-called "eco-friendly" diapers labeled biodegradable do not biodegrade in landfills, and cause just as much of a problem as regular diapers.³⁷

Another problem is that not only is the diaper product being thrown away, but untreated feces and urine as well. Waste from diaper should be cleaned and down the toilet. But, almost all parents put it away with diapers to the trash, even though it is illegal in most states and forbidden by World Health Organization. Those human feces can leach and cause contamination or spread communicable diseases when disposed of in the landfills.³⁸They can be a breeding ground for a wide variety of viruses, including hepatitis B and polio from vaccines given to newborns, states Environment Canada.

If we compare disposable diapers with cloth ones, the number of diapers and trash that end up in landfills is far smaller. In a cradle to grave study sponsored by the National Association of Diaper Services (U.S), it was found that disposable diapers produce seven times more solid waste when discarded and three times more solid waste during the

³⁵<http://www.greenspotdropoff.org/blog/uncategorized/cloth-diapers-vs-disposable-diapers/>

³⁶<http://www.nearta.com/Papers/DiaperEnvironment.pdf>

³⁷<http://www.smallfootprintfamily.com/dangers-of-disposable-diapers>

³⁸<http://www.thegreenmama.com/analyzing-environmental-life-cycle-costs-diapers>

manufacturing process, when compared modern cloth diapers. Cloth diapers create less than 13% of the solid waste generated by disposable diapers, most of which is sludge generated at waste water treatment facilities. Unlike disposable diapers, cloth diapers are used many times and incorporate both waste reduction and product reuse practices.

While most disposable diapers can decompose readily within five months, as they are just wood products and cotton, the absorbent gels and plastic components do not. They need at least 500 year to decompose.



The waste water treatment system, contrasted with the solid waste disposal system, is more appropriate for handling diaper waste, since it was specifically designed to handle all human sewage. It also appears to provide a more efficient, sanitary disposal pathway with greater opportunity for beneficial reuse of concentrated and processed sludge. If all diapers consumers relied on reusable diapers, the waste water load from diapers would be less than 0.5% of total municipal waste water, compared to 4% loading of the solid waste stream if all consumers relied on single-use diapers. From a relative resource impact perspective reusable diapers have a lower environmental impact than single-use disposables.³⁹

Greater reliance on cloth diapers represents the obvious way to reduce solid waste created by disposable diapers.

Conclusion

It appears that while both cloth and disposable diapers have an impact on our environment in the ways they are made, transported, disposed of and laundered, the damage from cloth diapers is smaller than that of disposable diapers.

Disposable diaper manufacture requires more natural resources, and arguably more water, and energy. During the production, toxic substances, like dioxin, chlorine, TBT, are released and this contributes to water and air pollution and global warming. Another concern when it comes to disposable diapers is their disposal. They make a huge part of household garbage and occupy a large percent of landfills. Because of plastic and super-absorbance gel

³⁹ Lehrburger C., Mullen J., Jones C.V., “Diapers: Environmental impacts and lifecycle analysis”, The National Association of Diaper Services, 1991.

they contained it takes hundreds of years for them to decompose (if ever). Staying there they can be a breeding ground for a wide variety of viruses, including hepatitis B and polio from vaccines given to newborns.

On the other hand, cotton diapers are made from mostly renewable resources, like cotton, bamboo or hemp. They also use lots of water and energy during production and maintaining and do create green gasses emission. But depending on how parent washes and dries them, much of this negative impact can be mitigated.

Even if they have the same impact on the environment as disposables, we must keep in mind the fact that during the approximately two and a half years, a period from baby born to being potty trained, one baby will need between 15 and 25 cloth diapers, while for the same period between 5000 and 7500 reusable diapers is going to be needed.

Even other issues must be considered when making decision about type of diaper you are going to use, like impact on health and economic aspect, certainly there are lots of environmental reasons to feel good about choosing cloth diapers.