Chemistry for any weather

Greenpeace tests outdoor clothes for perfluorinated toxins

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1. Summary

Greenpeace finds environmentally damaging toxins in outdoor clothing. Tests were conducted on 14 rain jackets and rain pants. Each sample contained perfluorinated compounds (PFC).

Images of pristine nature are often used for advertising outdoor clothing. But nature does not remain untouched by the chemicals in weather-resistant fabrics. All over the world, from secluded mountain lakes and Arctic polar ice to deep in the oceans, traces can be found of perfluorinated and polyfluorinated compounds (PFCs), pollutants with properties that are harmful to the environment and health.

Outdoor clothing is in close contact with a whole range of chemicals before it is used for hiking or skiing. Yarns, fabrics and even ready-made garments are treated with chemical substances to enhance functionality and make items easy to care for. Most brand name manufacturers use PFCs so that we stay dry in our outdoor wear, inside and outside. These man-made compounds of carbon and fluorine are so stable that they can hardly be removed from the environment, if at all.

For the consumer, it is not clear which chemicals have been used during the production of outdoor clothing and which harmful substances clothing may still contain. PFCs and other chemicals reach drinking water, food and ultimately human blood and breast milk from such various sources as manufacturing and household wastewater, dust, and the disposal of textiles. It is even possible to inhale them.

The Detox campaign works to improve the environmental balance of textile production

In the context of the international Detox campaign, Greenpeace is calling on textile manufacturers to replace hazardous production chemicals with harmless alternatives. Greenpeace is also calling on governments to regulate more chemicals that are hazardous. PFCs are among the groups of substances [1] on the Detox campaign's priority list. Some PFCs are known to be endocrine disruptors and are harmful to the reproductive system.

As early as 2011, Greenpeace proved that PFCs from the production of brand name textiles in China were discharged to rivers. [2] This study proves that residues of PFCs and other chemicals are in the outdoor wear made by well-known manufacturers.

Commissioned by Greenpeace, two independent laboratories tested weatherproof jackets and pants between June and September 2012. PFCs [3] were found in all 14 samples; among them was the well-known hazardous compound perfluorooctanoic acid (PFOA). In six samples, PFOA was found in significant concentrations. In addition, six samples had fluorotelomer alcohols (FTOHs) in high concentrations.

Hazardous chemicals must be removed from outdoor clothing production

The findings from this product investigation underline the urgent need to ban PFCs from outdoor wear production. PFC-free materials are already available today. The outdoor clothing industry must continue to develop safer alternatives and use them in processing their products.

The hazardous properties of well-researched PFCs such as PFOS and PFOA and insufficient data on other PFCs call for much more stringent regulation to protect health and the environment. Greenpeace supports the initiative of Germany's Federal Environment Agency to place PFOA on the Candidate List of Substances of Very High Concern (SVHC) so that they are subject to further restriction through REACH [4].

In view of the hazardous properties of C8 PFCs (PFOA and PFOS), and in view of research findings indicating that other PFCs (C6) might possess similar hazardous properties, it is not enough to regulate only single substances such as PFOA. Greenpeace demands that the entire group of PFCs is put under scrutiny for a possible regulative ban.

Correction

The current version of the Report "Chemistry for any weather" was updated in February 2013. According to the laboratories samples were switched during the analysis for perfluorinated chemicals. The concentrations of the Mammut jacket have to be corrected upwards: The PFOA concentration is now 4,7 µg/m² instead of 0,6 µg/m². The sum of perfluorinated carboxylic acids is now 46,8 µg/m² instead of 5,4 µg/m². The original version was published in October 2012.

1) See Section 7.1 in the Appendix.
2) http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/GP_2011_Dirty_Laundry_Brochure_D_02.pdf
3) PFCs are differentiated into perfluorinated and polyfluorinated compounds. The subgroup of perfluorinated compounds includes perfluorinated carboxylic acids (PFCAs) and perfluorocarbon sulfonic acids (PFSAs); the subgroup of polyfluorinated compounds includes fluorotelomer alcohols (FTOHs). Each of these subgroups includes a number of individual substances, so that, for example, perfluorooctanoic acid (PFOA) is a PFCA, and perfluorooctane sulfonate (PFOS) is a PFSA. The fluorotelomer alcohols include polyfluorinated substances such as 8:2 FTOH (to be exact: 1H,1H,2H,2H-perfluoro-1-decanol).
4) REACH (Registration, Evaluation, and Authorisation of CHemicals), the main general European Union chemicals regulation.

2

Sampling and methodology

2. Sampling and methodology

2.1 What was tested?

In the spring of 2012, Greenpeace purchased 13 items of outdoor clothing bearing well-known outdoor brand names. These included four jackets and one pair of pants for children, and eight jackets for women.[5)] Nine jackets were purchased in Germany, two in Switzerland, and two in Austria. The products were bought either in flagship or specialized stores, or ordered online. In addition to these purchased items, a rain jacket made especially for Greenpeace activists (manufactured by Zimtstern) was also tested. These jackets are not available for sale.

Two jackets, one from Zimtstern (made for Greenpeace) and one from Fjällräven, were labeled as PFC-free. According to the labels, eleven of the 14 products were made in China, and one each was made in Indonesia, Vietnam and Ukraine.

The products were either purchased in their original packaging or put into an uncontaminated plastic bag immediately after purchase. The samples were registered at Greenpeace and documented in photos. A sample of fabric measuring 20 x 20 cm was cut out of the back of each garment where there was no printing or labeling. Samples were individually wrapped tightly in aluminum foil and tested in two independent labs.

Table 1: The outdoor clothing items that were tested

Brand Name	Country of Production	Product Name or Description	Technology for Coating/Finish	Environmental Label or Claim	Store
Purchased in Germany					
Zimtstern / Greenpeace	China	Light rain jacket for women	Membrane: polyester (SympaTex), Dendrimer finish (Bionic finish ECO)	Bluesign	Own product
Jack Wolfskin	Indonesia	Cloud Stream Jacket (for children/boys)	Membrane: Texapore AIR, Outer shell: 100% polyamide		Globetrotter
Vaude	China	Kids Escape Jacket	Membrane: Ceplex advanced, 100% PU Outer shell: polyamide, PU-coating	GreenShape Bluesign	Vaude.de
Vaude	Vietnam	Escape Bike Jacket III (for women)	Membrane: Ceplex advanced, 100% PU Outer shell: polyamide, PU-coating		globetrotter.de
North Face	China	Sutherland Jacket (for women)	Membrane: PTFE(Gore-Tex), 100% 100% polyester laminated		globetrotter.de
Mountain Equipment	Ukraine	WMNS Firefox-Jacket	Membrane: PTFE(Gore-Tex)		Globetrotter
Marmot	China	Boy's Torrey Pant #64310	UPF / UV40: 96% Nylon, 4% Elastan		Globetrotter
Fjällräven	China	Eco-Trail Jacket Women (Trekking)	Membrane: Eco-Shell 100% recycled polyester	Fluorcarbon-free	Amazon.de Sportausstatter Meinunger
Patagonia	China	Piolet Jacket Lady Black (Modell 2012)	Membrane: PTFE(Gore-Tex) Outer shell: 100% nylon	Common Threats Initiative	Backpacking ForEver
Adidas	China	Terrex Feather Jacket (for women)	Membrane: PTFE(Gore-Tex), 100% polyamide		Adidas.de
Purchased in Austria					
Northland	China	Basic Child Rain Poncho	Membrane: 100% polyester		Northland store in in train station, Vienna
Seven Summits	China	Tamina Kinder-Regenjacke (child's rain jacket)	Membrane: Ice Tech 5000 MM 5000 MVP / polyamide		Intersport Eybl Megastore, Vienna
Purchased in Switzerlans					
Mammut	China	Fujiyama Jacket Women	Membrane: PTFE(Gore-Tex)		Mammut Store, Zurich
Kaikkialla	China	Annuka Jacket Womens XS	Membrane: Toray DermizaxEV		Transa, Zurich

5) Only women's jackets were purchased because they can be worn in small sizes by young teenagers.

2.2 How was testing done?

The samples were sent to two laboratories and tested for perfluorinated and polyfluorinated compounds and for other hazardous chemicals such as plasticizers (phthalates), surfactants (nonylphenol ethoxylates), organotin compounds, and carcinogenic amines that can be released from azo dyes.

The first lab tested for a comprehensive list of perfluorinated and polyfluorinated compounds, among them perfluorinated carboxylic acids such as PFOA and perfluorinated sulfonic acids such as PFOS. The list also included, among other compounds, fluorotelomer alcohols (FTOHs)[6]; FTOHs are the main starting product today in the synthesis of fluorinated polymers.[7] Polymers ensure the waterproofing and/or dirt-repellent properties of the PFC finish on outdoor textiles.[8] To the best of our knowledge, very few studies so far have tested for such a comprehensive list of PFCs in outdoor clothing.[9]

The Bremer Umweltinstitut [environmental institute] analyzed outdoor textiles for Greenpeace.

The testing covered the PFCs that could be extracted using solvents. The analysis of PFCAs extracted with methanol was done using high-performance liquid chromatography combined with tandem mass spectrometry (HPLC-MS/MS), and the FTOHs extracted with methyl tertiary butyl ether (MTBE) were analyzed using gas chromatography coupled with mass spectrometry (GC-MS).

The second lab tested the clothing for other toxins. The selection of substances for testing was determined by the nature of the fabrics. Among others, alkylphenol ethoxylates, plasticizers (phthalates), aromatic amines released from azo dyes, isocyanates, and organotin compounds were measured using GC-MS. Among the alkylphenol ethoxylates were nonylphenol ethoxylates (NPEs), which have been discussed extensively in earlier Greenpeace reports. [10] Some samples were tested for antimony.

A scanning electron microscope (SEM) was used in qualitative testing to detect the presence of fluorine. This testing indicates whether a membrane or fabric contains fluorine. Fluorine is not subject to official declaration. It is already a known fact that Gore-Tex and Teflon membranes contain fluorine in the form of polytetrafluoroethylene (PTFE). For other membranes, SEM analysis provides valuable information on the mode of production.

PFCs

Per- and Polyfluorinated chemicals (PFC)[11] are chemical compounds in which the hydrogen atoms on a carbon skeleton are replaced completely (perfluorinated) or partially (polyfluorinated) by fluorine atoms. PFCs do not occur in nature. They have been made for more than 50 years by fluorochemical manufacturers. The OECD (Organization for Economic Cooperation and Development) lists a total of 853 different fluorine compounds.

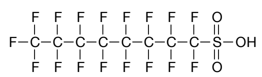
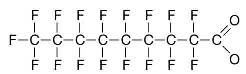
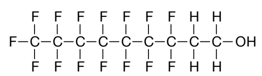
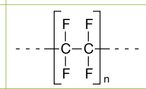
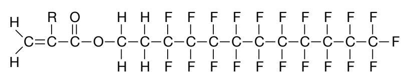
In the apparel industry, perfluorinated carboxylic acids (PFCAs) such as perfluorooctanoic acid (PFOA), for instance, and the fluorotelomer alcohols (FTOHs) play a role. Because the carbon-fluorine bond is the most stable in organic chemistry, PFCs are very persistent. Once they have been released to the environment, they barely degrade and remain there for long periods of time. It is therefore not surprising that these chemicals have been found around the globe. Scientists have found them in the snow of the Alps and the waters of the deep sea. Even the blood of Arctic polar bears and the dung of penguins on Tierra del Fuego are contaminated with PFCs.

PFCs accumulate mainly in blood. These chemicals enter the human body in food, air and drinking water. According to present knowledge, absorption through the skin is rather low. The fact is that PFCs are detectable in human blood around the world (Bonefeld-Jorgensen 2011), and have even been found in the blood of umbilical cords and newborns (Fromme 2010). This is particularly worrisome because PFCs circulate through the human body for a relatively long time. The retention time for perfluorooctanoic acid (PFOA) is more than three years on average. PFCs have been found in breast milk (Fromme 2010). Although concentrations are lower than in blood, they are nevertheless problematic because infants are still developing and therefore are particularly sensitive. A study carried out in Germany showed that infants actually had higher PFC contaminations than their mothers (Fromme 2010).

Animal testing has shown that some PFCs are harmful to reproduction. They can also promote the growth of tumors (UBA 2009). There is growing evidence that PFOA in particular does other harm, and it is suspected of being an endocrine disruptor. Recent epidemiological studies have suggested an association between PFOA exposure and adiposity (Thorhallur 2012), diminished fertility (Fei 2009), immune disorders (Grandjean 2012) and thyroid diseases (Melzer 2010). PFOA is currently not subject to legal regulation. Germany's Federal Environment Agency is working to put PFOA on the REACH Candidate List of Substances of Very High Concern (SVHC) (Vierke 2012).

PFCs end up in the environment either directly – during production – or indirectly when products containing PFCs are used and disposed of. The apparel industry uses PFCs in particular for coating and finishing outdoor garments or sporting goods (1) or for the production of breathable membranes (2).

Examples of PFCs and their chemical structure

Group[12]	Example for a compound	Chemical Structure
Perfluorinated sulfonic acids	PFOS	
Perfluorinated carboxylic acids	PFOA	
Fluorotelomer alcohols	8:2 FTOH	
Fluorocarbon polymers	Polytetrafluoroethylene (PTFE) (Breathable membranes such as Gore-Tex)	
Fluorinated polymers	Perfluoroalkyl monomer (Waterproofing and dirt-repellent treatment of textiles)	

1. Coatings and finishes

Fluorotelomer alcohols (FTOHs) are processed on a large scale into fluorinated polymers which are used to make textiles waterproof, dirt-repellent or grease-resistant. Many impregnating fabric care products also contain fluorinated polymers. Finished products such as outdoor jackets or impregnating sprays can contain residues of FTOH. Annual FTOH production is estimated at 11,000 to 14,000 tons around the world. Since fluorotelomer alcohols are volatile compounds, they are thought to play an important role in global spreading. Air currents can transport them even to remote areas (Weinberg 2011), and they can be inhaled and retained in the body. These substances are problematic because they can be converted into perfluorinated carboxylic acids (such as PFOA) in the environment and in organisms. There are indications that during this conversion process, intermediate products form in the body that can actually be much more harmful than the end product of perfluorinated carboxylic acid (Rand und Mabury 2012). Even the production of FTOHs is itself a problem because PFOA can form as an impurity.

2. Membranes

Compounds containing fluorine are also used to produce outdoor membranes (Gore-Tex, Teflon). Many of these membranes are made of polytetrafluoroethylene (PTFE), for which PFOA is used as a process additive during manufacturing. This can be found again as an impurity in the finished product. Some manufacturers have therefore already switched to using other fluorine-containing additives. But these are also persistent and therefore not environmentally compatible.

6) X:Y-FTOH: Telomers are derived from alcohols (-OH). Figure X stands for the number of fluorinated carbon atoms, figure Y for the number of non-fluorinated carbon atoms. Because some carbons atoms in telomers are never fluorinated, these are called polyfluorinated and not perfluorinated. FTOHs are more volatile than ionic perfluorinated carboxylic acids (PFCAs).
7) Walters A, Santillo D.: Uses of Perfluorinated Substances, Greenpeace Research Laboratories Technical Note 06/2006 (http://www.greenpeace.to/greenpeace/wp-content/uploads/2011/05/uses-of-perfluorinated-chemicals.pdf) and Walters A, Santillo D, Johnston P: An Overview of Textiles Processing and Related Environmental Concerns (http://www.greenpeace.org/seasia/th/Global/seasia/report/2008/5/textile-processing.pdf)
8) Fluorotelomer alcohols are usually not taken into account in other investigations testing for hazardous residues in textiles. This is a serious deficit because these very volatile compounds are often the main contaminant in textiles. Moreover, within the body and in the atmosphere they degrade into PFOAs and other carboxylates.
9) Friends of the Earth Norway (2006): Fluorinated pollutants in all-weather clothing: http://www.snf.se/pdf/rap-hmv-allvadersklader-eng.pdf
Berger U, Herzke D (2006). Per- and polyfluorinated alkyl substances (PFAS) extracted from textile samples. Poster presentation
10) http://www.greenpeace.org/international/en/publications/reports/Dirty-Laundry-2/
11) References for text see Section 7.2 in the Appendix.

12) http://www.umweltdaten.de/publikationen/fpdf-l/3818.pdf

2

In the production and processing of textiles containing PFCs, chemicals are released into wastewater. Even private households can be a source (UBA 2009) when, for example, coated textiles are washed. How much PFC is released during washing has not been investigated. Most PFCs do not degrade in sewage treatment plants. Some of these chemicals are collected in sewage sludge. The rest reaches rivers and lakes in "clean" sewage water (UBA 2009) and disperses through waterways all around the globe. Due to its high nutrient content, sewage sludge is often used as agricultural fertilizer. In this way, PFCs leach into the soil and into groundwater, or accumulate in plants which are processed into food. A few years ago, the use of PFC-contaminated sewage sludge around the town of Arnsberg (in western Germany's Hochsauerland district) meant that drinking water had become highly contaminated. Tests in Arnsberg revealed that people who had consumed contaminated drinking water had concentrations of up to eight times more PFOA in their blood than those who had not been exposed (UBA 2009).

Scientists have found PFCs in fish, meat, milk products and plants, including in grains grown on contaminated soils. PFCs are in dust and indoor air. In fact, the indoor air of houses, apartments and offices is 30 to 570 times more contaminated than outdoor air (UBA 2009). Air measurements taken inside two outdoor equipment stores in Germany showed particularly high concentrations of FTOHs (Langer 2010). Scientists suspect that PFCs evaporating from products such as impregnated clothing are the source of this contamination. Testing for PFCs in rainwear from Norway and Sweden also found residues of FTOHs and perfluorinated carboxylic acids (PFCAs) (Berger 2006).

It is not clear what happens to an outdoor jacket when it is no longer worn and ends up in the rubbish. Occasional air measurements at waste dumps have shown increased PFC contamination in these locations (Weinberg 2010). However, there are no data on the chemical behavior of materials containing PFCs when they are incinerated as waste. If combustion is incomplete, it is conceivable that dioxin-like substances form. Here there is an urgent need for research.

Since the public debate on PFOA (eight carbon atoms) is ongoing, the industry has also recently begun to use short-chain PFCs (with four to six carbon atoms). In 2006, eight major fluorochemical manufacturers pledged to reduce their PFOA emissions and residues in products by 95 percent by 2010. Samples taken in the environment since then show an increasing contamination with short-chain PFCs in water (Möller 2010) and air (Weinberg 2011). These short-chain alternatives have also been found in Antarctica (Llorca 2012), in snow (Cai 2012), in drinking water (Dauchy 2012) and in rainwater (Eschauzier 2010).

The accumulation potential of these substances in the body is lower than for PFOA. A study carried out in Sweden shows however that the contamination of blood with these substances has increased significantly in the Swedish population in recent years (Berger 2012, presentation). Samples of breast milk from China and Sweden were also contaminated (Jensen 2008). Short-chain PFCs are as persistent as PFOA. It is also worrisome that short-chain PFCs can reach groundwater more easily because they bond less well to particles. Compared to PFOA, short-chain PFCs have been poorly investigated, a situation which must be addressed urgently due to the increasing use and pervasiveness of these compounds. Germany's Federal Environment Agency does not rate these chemicals as environmentally-friendly alternatives due to their high stability and potential to contaminate drinking water (UBA 2009).

3

3. Results for perfluorinated and polyfluorinated compounds (PFCs)

All 14 samples of outdoor clothing contained extractable PFCs. This was regardless of whether the label indicated that the product was made with a fluorine membrane such as Gore-Tex or Teflon, or finished with a coating containing fluorine compounds.

Even the items of clothing for which production intentionally abstained from using fluorochemicals, such as the jackets from Fjällräven and Zimtstern, contained a small amount of fluorine chemicals (see Table 3 in the Appendix). [13] The sources of these low concentrations are unclear. PFCs are persistent and – as a consequence of their industrial use – they are so widespread that it may be a real challenge to engage in clean production in which chemicals and/or production facilities are not contaminated by PFCs. [14]

- Significant levels of PFOA (> 1 µg/m^2) [15] were found in six of 14 samples, in the jackets made by Mammut, Jack Wolfskin, The North Face, Patagonia and Kaikkialla, and the child's pants from Marmot (see Figure 1).

- The lowest concentrations of PFOA were found in jackets made by Mountain Equipment, Vaude Women and Zimtstern (manufactured for Greenpeace). In six of 14 samples, concentrations of PFOA were above the detection level but below 0.3 µg/m^2. Samples were from the brands just named as well as from Adidas, Fjällräven and Seven Summits.

- The highest sums of all perfluorinated carboxylic acids (PFCAs) were found in jackets made by Mammut (46 µg/m^2), Kaikkialla (11 µg/m^2) and Patagonia (8.5 µg/m^2), and in the child's pants from Marmot (6.3 µg/m^2). Sums were lowest in the samples from Mountain Equipment, Seven Summits and Zimtstern (Greenpeace).

- Fluorotelomer alcohols were found in eight of 14 samples. Where FTOHs were found, their concentrations were significantly higher than concentrations of perfluorinated carboxylic acids. The highest FTOH concentrations (> 400 µg/m^2) were in the jackets made by Mammut and Vaude Kids. Likewise, high FTOH concentrations (> 100 µg/m^2) were found in the samples from Kaikkialla and Patagonia (see Figure 2).

- Perfluorooctane sulfonate (PFOS) was not detected in any sample. The 2008 ban on this substance is apparently effective.

The findings of the PFC study are described below according to the class of substance. The test results are listed in detail in Tables 1 to 4 of the Appendix.

13) The Greenpeace jacket from Zimtstern, made with SympaTex and finished with BIONIC-FINISH ECO had the lowest residues of PFOA in the test series. That PFCs were detected at all may have various reasons (see section 3.1).
14) Greenpeace is taking on this challenge and will work together with manufacturers to investigate sources of contamination and produce jackets for its activists that are free of fluorocarbon compounds. (Kindly note that these jackets are not for sale.) Contamination must cease.
15) Significant concentration: the EU permissible limit for perfluorooctane sulfonate (PFOS) of 1µg/m^2 (micrograms of PFOS per square meter of fabric) is used as the comparison value. PFOA's hazardous properties are similar to those of PFOS – it is harmful to fertility (toxic to reproduction) and is suspected of being an endocrine (hormonal) disruptor.

3

3.1 Perfluorinated carboxylic acids (PFCAs) with perfluorooctanoic acid (PFOA)

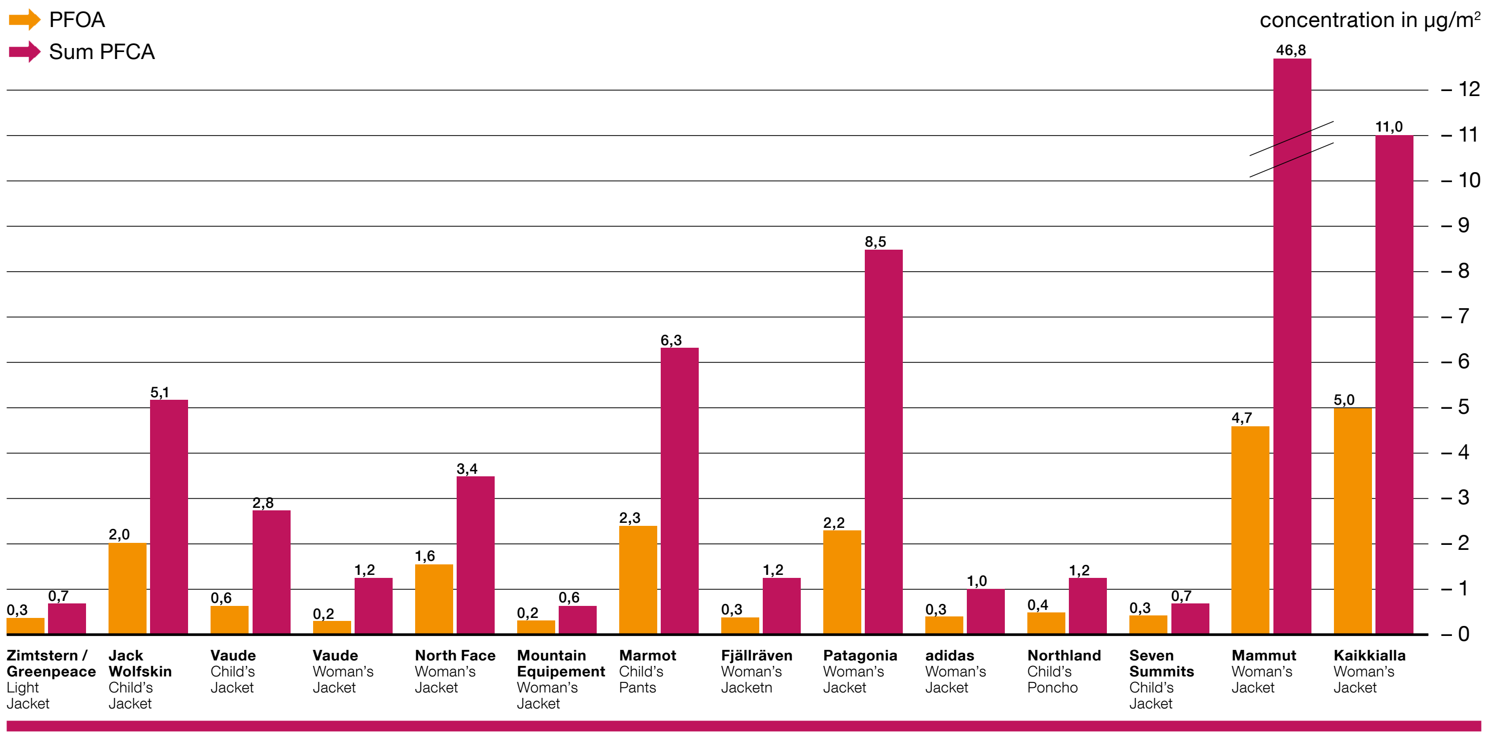
Among the PFCs found in every sample was perfluorooctanoic acid (PFOA), a substance with hazardous properties. Since there are no regulations for PFOA, the EU limit value for perfluorooctane sulfonate (PFOS) of 1 μg/m² (micrograms of PFOS per square meter of fabric) was used as the comparison value. PFOA's hazardous properties are similar to those of PFOS – it is harmful for fertility (toxic to reproduction) and is suspected of being an endocrine (hormonal) disruptor.

PFOA concentration of 1 μg/m² was exceeded in six samples: the Mammut Fujiyama Jacket Women, the Jack Wolfskin child's jacket, the North Face woman's jacket, the Marmot child's pants, the Patagonia woman's jacket and the Kaikkialla woman's jacket (see Figure 1).

In six of 14 samples, the PFOA concentration was above the detection level but below 0.3 μg/m². The lowest concentrations of PFOA were measured in the jackets made by Mountain Equipment, Vaude Women, Zimtstern (manufactured for Greenpeace), Adidas, Fjällräven and Seven Summits. It remains unclear where the contamination came from. It may be that factories producing textiles containing fluorine compounds are not able to manufacture fabrics that are completely free of PFCs. This would necessitate textiles being manufactured in plants that completely exclude using perfluorinated chemicals. But it is also conceivable that contamination occurs in transit, during storage or in the store. Even the process of sampling and testing can lead to contamination.

Greenpeace believes that even minor contamination during production should cease. To reach this objective, outdoor clothing producers and their material suppliers, but also the chemicals industry, must work together and strictly control which substances are used in production. Greenpeace will work together with the manufacturers of its activists' jackets (not for sale) to investigate sources of PFC contamination and take corrective action.

Figure 1: Concentrations of perfluorinated carboxylic acids (PFCAs) in 14 samples of outdoor clothing



3.2 Fluorotelomer alcohols (FTOHs)

FTOHs were found in eight of the 14 samples. The highest concentration of fluorotelomer alcohols was found in the jacket from Mammut (464 μg/m²). The child's jacket made by Vaude also had a high concentration of FTOHs at 419 μg/m² (see Figure 2).

Test results showed that some manufacturers are already using C6 telomer alcohols, which were dominant in the jackets from Adidas und Fjällräven. The item from Adidas contained 99 μg/m² of 6:2 FTOH. Although the Fjällräven jacket was explicitly labeled as PFC-free, it contained 52 μg/m² of this substance.

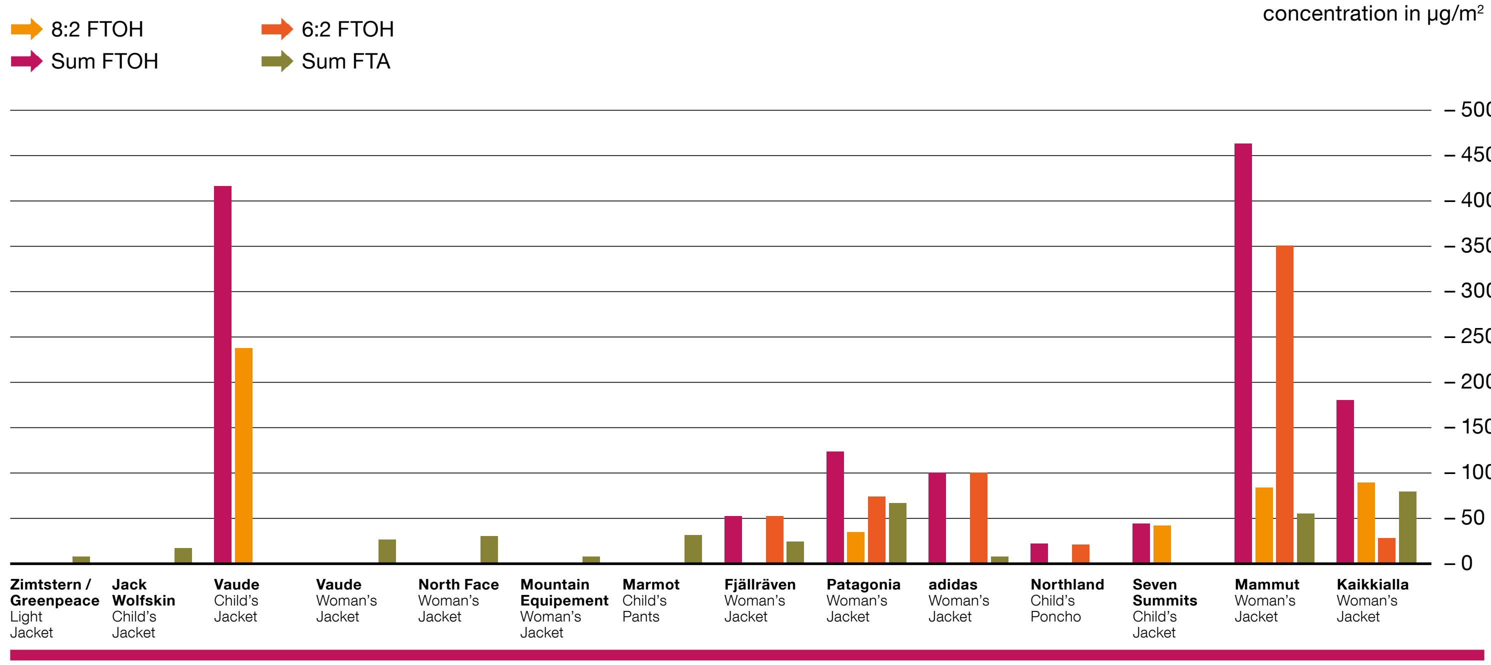
C6 telomer alcohols were also found in the Northland child's poncho purchased in Austria (17.6 μg/m² of 6:2 FTOH) and in the two jackets purchased in Switzerland, with the Kaikkialla article containing 27.0 μg/m² of 6:2 FTOH, and the Mammut item containing (considerably higher) 352 μg/m² of 6:2 FTOH. Long-chain C10 telomers were used in the products from Vaude, Patagonia, Mammut and Kaikkialla.

Next to the fluorotelomer alcohols, fluorotelomer acrylates (FTAs), also known as polyfluorinated acrylates, were also detected in some samples. These acrylates are intermediates in the production of fluorinated polymers. Like the C8 telomers, they can be converted into PFOA through oxidation. Significant C8 FTA concentrations were found in the items from Vaude, The North Face, Marmot and Patagonia, as well as in the Mammut and Kaikkialla items purchased in Switzerland. Lower concentrations of C8 FTA were found in the Jack Wolfskin, Mountain Equipment and Adidas items, and the lowest concentration of C8-FTA was found in the Greenpeace (Zimtstern) jacket.

Fluorotelomer alcohols, when used for waterproof and dirt-repellent finishes, are supposed to ensure that fewer PFC intermediates such as PFOS are formed. They are divided into long-chain and short-chain compounds. Basically, the longer their chains, the more these toxic substances can accumulate in an organism. The compound 8:2 FTOH must be evaluated critically because it is converted into PFOA through oxidation in the atmosphere and in the body. Some manufacturers therefore want to switch from C8 to short-chain substances such as 6:2 FTOH. But C6 and C4 PFCs, used as alternatives, are also persistent and found in the environment and in humans around the world. They can also oxidize into their respective carboxylic acids, which are potentially hazardous to health.

So far, no regulation or value limits have been established for fluorotelomer alcohols.

Figure 2: Concentrations of fluorotelomer alcohols (FTOHs) in 14 samples of outdoor clothing



3

3.3 Perfluorinated sulfonate (PFOS)

No perfluorooctane sulfonate (PFOS) was found in the investigation. PFOS is rated as a PBT substance (Persistent, Bioaccumulative, Toxic). The use and marketing of PFOS has been banned in the EU since 2008, with a few exceptions. Evidently the ban on PFOS has been effective.

PFOS has been covered by the Stockholm Convention since 2009. A permissible limit was set for PFOS of 1 ffig/m2 (one microgram of PFOS per 1 square meter of fabric) for textiles and coatings. This value also applies to imported products such as textiles.

4

Results for other toxins

4. Results for other toxins

All samples of outdoor clothing were tested for alkylphenol ethoxylates, which are used as tensides or surfactants in wet processes in textile production. All samples were also tested for the phthalate group of substances which are used as plasticizers.

Depending on the nature of the textiles in question, some samples were additionally screened for other toxins. Testing was done for aromatic compounds released from azo dyes, organotin compounds and antimony. The specialist laboratory itself selected which products to test for these harmful substances.

Other chemicals used in textile production, itemized on Greenpeace's Detox List,[16] were not investigated if there was no immediate suspicion of their presence.

The findings of the test series and the methodology applied are explained in detail in Tables 5 and 6 of the Appendix. Here is an overview of the most important results.

Table 2: Results for other harmful substances

Brand Name	Country of Production	Product Name or Description	Nonylphenol Ethoxylate[17]	Phthalate (Sum)[18]	Organotins	Antimony	Isocyanates
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Purchased in gekauft							
Zimtstern / Greenpeace	China	Light rain jacket for women		15		3	
Jack Wolfskin	Indonesia	Cloud Stream Jacket (for children/boys)		9			
Vaude	China	Kids Escape Jacket	13	3		30	23 (TDI[22])
Vaude	Vietnam	Escape Bike Jacket III (for women)		10	13 (MOT[19]) 4,8 (DOT[20])	10	16
North Face	China	Sutherland Jacket (for women)		5		40	
Mountain Equipment	Ukraine	WMNS Firefox-Jacket		11			
Marmot	China	Boy's Torrey Pant #64310		5			
Fjällräven	China	Eco-Trail Jacket Women (Trekking)	19 (NP; 8)	16		120	
Patagonia	China	Piolet Jacket Lady Black (Modell 2012)		4		35	
Adidas	China	Terrex Feather Jacket (for women)	20 (NP; 8)	16*			
Purchased in Austria							
Northland	China	Basic Child Rain Poncho		5700		10	
Seven Summits	China	Tamina Kinder-Regenjacke (child's rain jacket)	320	270			
Purchased in Switzerland							
Mammut	China	Fujiyama Jacket Women		88*		1	
Kaikkialla	China	Annuka Jacket Womens XS	9	22*	2,3/0,55/5,8/5,6/0,18[21]	2	

16) See Section 7.1 in the Appendix.
17) The detection limit for nonylphenol ethoxylate (NPE) was 5 mg/kg in the method used; for nonylphenol (NP) it was 3 mg/kg.
18) In the samples marked with an asterisk*, testing was done on the fabric's plastisol print.
19) Monooctyltin
20) Dioctyltin
21) Monobutytin MBT, Monooctyltin MOT, Dibutyltin DBT, Dioctyltin DOT, Tetraethyltin TeEtT
22) Toluylene diisocyanate

4

4.1 Alkylphenol ethoxylates

Nonylphenol ethoxylates (NPEs) were found in five of the 14 samples. NPEs belong to the substance group of alkylphenol ethoxylates, are very harmful to the environment and should not be detectable because they degrade to nonylphenol (NP). NP is persistent, bioaccumulative and toxic, and can disrupt the endocrine (hormonal) systems of animals and humans.

The highest concentration of NPEs was found in the Seven Summits child's rain jacket purchased in Austria. This sample contained 320 mg/kg of NPE. Other significant concentrations were found in the jackets from Vaude (NPE 13 mg/kg), Fjällräven (NPE 19 mg/kg, plus NP 8 mg/kg) and Adidas (NPE 20 mg/kg). The Kaikkialla jacket purchased in Switzerland contained an NPE concentration of 9 mg/kg.[23]

Lower levels of NPEs do not necessarily indicate that NPEs were used in lower amounts during manufacturing. Greenpeace reported in 2012 that NPE residues can be washed out in just a few washes.

All of these items were manufactured in China. In 2011, Greenpeace proved that nonylphenol from the textile industry constitutes a serious problem of water pollution in China.[24] NPEs are used in the dyeing process. Their effect is similar to that of estrogen and they can disrupt the development of reproductive organs in fish and other aquatic animals. Since January 2005, textiles containing more than 0.1 percent of NPs or NPEs are not marketable.

25) GOTS: Global Organic Textile Standard: http://tilth.org/files/certification/GOTSStandard.pdf

4.2 Phthalate plasticizers

Plasticizers in the phthalate group of substances were detected in every sample. The highest concentration, 5,700 mg/kg, was in the Northland child's rain poncho. The di-2-ethylhexyl phthalate (DEHP) found is considered to be particularly harmful.

In comparison, the currently valid EU guideline for toys or objects that children can put into their mouths prescribes a permissible limit of 1,000 mg/kg (equivalent to 0.1 percent by mass). Because the product tested is a rain poncho for children, the concentration found is unacceptable. Northland is an Austrian outdoor brand with high market shares, especially in China and South America.

The Seven Summits child's jacket purchased in Austria also contained significant concentrations of phthalates (270 mg/kg, dominated by 260 ppm of DiNP). In comparison, the sum of phthalates in textiles manufactured in compliance with the GOTS standard[25] is not allowed to be more than 100mg/kg.

In the other twelve samples, phthalate concentrations were lower than 100mg/kg, and in six samples they were below 10mg/kg.

These concentrations indicate that phthalates were probably not used intentionally as plasticizers, but are contaminants.[26]

Phthalates are used as plasticizers, for instance to soften the rigid plastic PVC. In the textile industry they are used for artificial leather, rubber and for printing (plastisol or dyes). Phthalates can severely disrupt the endocrine system and lead to infertility and adiposity. According to the EU chemicals regulation REACH (Registration, Evaluation, and Authorisation of CHemicals), some compounds in this group will be banned from 2015.

23) The non-detection of NPEs does not rule out NPEs being used in the production of a garment, as the finished clothing may have undergone thorough washing prior to retailing. This may have washed out all residues of NPEs from the fabric prior to sale. Such washing would only have further contributed to inputs of NPEs/NP into the environment during the manufacturing stage.
24) http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/Dirty_LaundryHung_Out_to_Dry_WEB_FINAL2.pdf und http://www.greenpeace.de/fileadmin/gpd/user_upload/themen/chemie/20110826_FS_Nonylphenol_FINAL2.pdf
25) GOTS: Global Organic Textile Standard: http://tilth.org/files/certification/GOTSStandard.pdf
26) Either phthalates were used elsewhere in the production facilities or contamination was a result of samples being in contact with other items that contained phthalates.

4.3 Azo dyes

Testing was also done for carcinogenic aromatic amines that can be released from azo dyes. They were not detected in any of the samples tested, which were from the products made by Vaude, The North Face, Adidas, Seven Summits, Mammut and Kaikkialla. Some azo dyes used in the textile industry can cause cancer when they release cancerogenic amines.

4.4 Organotin compounds

The use of organotin compounds is already heavily restricted due to the toxicity of these chemicals. The GOTS standard allows no more than 0.05 mg/kg of tributyltin (TBT), and the OEKO-TEX standard for textiles sets a limit of 0.5 mg/kg for TBT and 1.0 mg/kg for dioctyltin (DOT). The samples from Vaude, Mammut and Kaikkialla were tested. Both standards' limits were significantly exceeded in the Vaude jacket for women; the value for DOT was 4.8 kg/mg and for monooctyltin (MOT) 13 mg/kg. The Kaikkialla jacket contained 5.6 mg/kg of DOT, 18 mg/kg of tetraethyltin (TeET), 2.3 mg/kg of monobutyltin (MBT), 0.55 mg/kg of MOT, and 5.8 mg/kg of dibutyltin (DBT).

Organic tin compounds are used as biocides and anti-fungal agents. They have an antibacterial effect on socks, shoes and sportswear and are supposed to prevent odors. They are also used in PU as an accelerator. If tributyltin (TBT) is released into the environment, it can accumulate in the body where it disrupts the immune system and diminishes fertility.

4.5 Antimony

Antimony is used in the production of polyester; its toxicity is often compared to that of arsenic. Antimony should not be in children's clothing. Because antimony is used to manufacture polyester, all jackets with a polyester membrane were tested. These were from Vaude, The North Face, Fjällräven, Northland, Patagonia, Mammut and Kaikkialla.

The highest concentration was found in the Fjällräven jacket (120 mg/kg). The North Face jacket contained 40 mg/kg, and the jacket from Patagonia contained 35 mg/kg of antimony. Much lower concentrations were detected in the jackets from Northland (10 mg/kg), Mammut (1 mg/kg), Kaikkialla (2 mg/kg) and Zimtstern (manufactured for Greenpeace, 3 mg/kg).

4.6 Isocyanates

Isocyanates are used in polyurethane (PU) production. They can trigger allergies and cause severe irritation to the respiratory tract; they can also damage the lungs and cause asthma. Some of them are suspected of being carcinogenic; one such compound is toluene diisocyanate.

Polyurethane thermal insulation and PU membranes come into question as sources of isocyanates. The membranes of both Vaude jackets were made either of PU or of polyester laminated with PU, and isocyanates were detected in both. The Kids Escape Jacket contained 23 mg/kg of toluene diisocyanate, and the Escape Bike Jacket for women contained 16 mg/kg of this substance. Testing was done in a VOC screening process.

Illustration 1: Soxhlet solvent extraction
Illustration 2: Textile sample in a separating funnel (GC-MS)
Illustration 3: Analysis in the gas chromatograph
Illustration 4: Inserting samples into the scanning electron microscope (SEM)
Illustration 5: Analysis of clothing samples in the SEM
Illustration 6: Analysis of polyester membrane at a magnification of 70

4

The outdoor industry – still not trailblazers in protecting the environment

The outdoor industry stands for cutting loose and being close to nature. This positive image has brought strong double-digit growth in recent years to the suppliers of weather clothing. The European market in 2010 was worth about 4.5 billion euros. Germany, with a turnover of 1.02 billion euros, is the leader in Europe, followed by Great Britain, Ireland and France.

Jackets and pants are the most popular items (50 percent), followed by shoes (25 percent), and backpacks (6 percent). Consumers often pay several hundred euros for an extra warm deluxe anorak and – unlike in the fast fashion industry – do not haggle over every cent. Profits of the VF Corporation, to which the world's largest outdoor wear supplier The North Face belongs as a brand, rose between 2007 and 2011 from 24 to 36 million dollars.

Brands like The North Face, Patagonia, Vaude or Jack Wolfskin have long since become household names, not only for mountain climbers and hikers. The industry has gone from being a specialist supplier to a producer of trendy everyday clothes. Every city's downtown area boasts brand name stores. Jack Wolfskin (from Idstein in Germany) alone has 200 of its own stores between the North Sea and the Alps, and in China it sells its products in more than 300 stores.

Advertising uses pictures of daring skiers plunging through deep snow and fearless climbers scaling dizzying heights – although most customers are not exceptional athletes but city dwellers looking to stay warm and dry during a bike ride or a walk in the rain. Nevertheless, the industry has started a veritable arms race so that outdoor clothing can withstand ever more extreme weather conditions – and this has been accompanied by a steady increase in chemical pollution, especially from controversial PFCs.

The latest novelties can be admired at the OutDoor show in Friedrichshafen, where in July 2012 more than 900 businesses and manufacturers exhibited their products. But the hazards of the substances used for production are kept secret from nature-conscious clientele. Instead, the talk is about natural fibers made of corn, coconut, hemp and merino wool. The industry has made real progress in environmental protection elsewhere, but here it has been criminally careless, neglecting to replace the problematic chemical compounds used in membranes, coatings and finishings. Greenpeace's Detox campaign is now stirring this up.

China

China is Germany's largest import trade partner for textiles. Some 30 percent of total annual imports of textiles and apparel come from the People's Republic. Textile production steps for 95 percent of the textiles available on the German market are partially or wholly outsourced abroad. This makes it particularly difficult to control the use of substances that are harmful to the environment and health.

5

Alternatives to fluorocarbon coatings and finishes

5. Alternatives to fluorocarbon coatings and finishes

Fluorine-free technologies are becoming increasingly available on the market. An investigative research project at the Berlin University of Applied Sciences (HTW) attested to the performance of these alternatives to fluorine products. [27)]

Fabrics for apparel with wind and weather protection are generally impregnated on the outside and have a membrane on the inside. Alternatives to fluorine membranes based on PTFE (such as Gore-Tex®) are membranes made from polyester (such as SympaTex®) or polyurethane (PU). Alternatives to fluorocarbon finishes and coatings are waxes, paraffins (such as ecorepel®), polyurethane (such as Purtex®), dendrimers (such as BIONIC-FINISH®ECO) and silicones.

Three fluorine-free coatings and finishes and one fluorine-free membrane were tested in the laboratory to compare their performance to that of conventional fluorocarbon products. Testing investigated properties such as oil repellency, water repellency, waterproofing, resistance to abrasion, windproofing, and breathability.

Whether an item of clothing is waterproof and can withstand even a strong downpour is not governed by the outer coating or finish. Waterproofing, windproofing, air permeability and breathability depend chiefly on the membrane on the inside of the jacket. Here lab testing showed that the fluorine-free SympaTex membrane could withstand high water pressure and its performance was in fact as good, if not better, than that of Gore-Tex. Over and above that, fluorine-free membranes are very breathable and allow perspiration to evaporate to the outside. Testing also showed another advantage – the alternatives' windproofing qualities were as good as those of conventional membranes containing fluorine compounds.

The additional coating or finishing of an article's outside surface is there to repel water, dirt and oily substances. Testing showed that fluorine-free alternatives were just as waterproof and that water beaded off these materials just as well. Only the PU finish demonstrated less of the water-beading effect, but the wearer remained dry. The protective finishing of fluorine-free alternatives can be reactivated by refreshing it with PFC-free agents. For the longevity of outdoor clothing, it is important that the coating is resistant to abrasion. The BIONIC-FINISH ECO made by the Rudolf company shows particularly high abrasion resistance, even after 10,000 abrasion cycles. In fact, it performs better than conventional finishes containing fluorine compounds.

Regarding oil repellency, however, the products containing controversial PFCs are superior to fluorine-free alternatives. There is still no replacement product with oil-repelling qualities. Here research is needed. But experience has shown that effective products are ready for the market and available as soon as outdoor clothing manufacturers specify a deadline by which time they want to completely stop using hazardous chemicals.

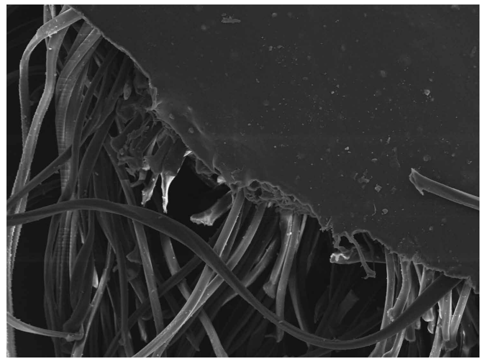
For the consumer, oil repellency is generally not a relevant criterion – the decisive factor is optimal water repellency. Functional clothing is supposed to keep the wearer dry, inside and outside. The research study explains that good workmanship on jackets and pants is also essential for the wearer's comfort. Good quality means that zippers are covered and seams are glued so that water and air cannot penetrate through.

Marijke Schöttmer's research findings provided evidence that the outdoor clothing industry can go without using PFC and nevertheless manufacture items that meet most customers' demands for functionality. Before being used, alternatives need to be checked for hazardousness to health and environment.

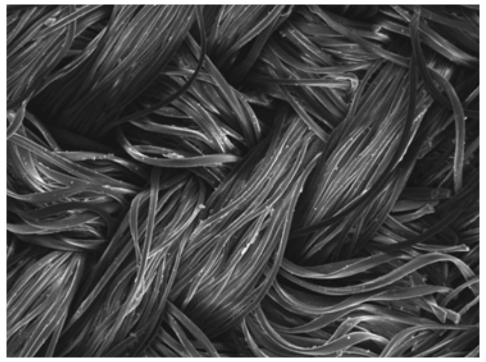
27) Marijke Schöttmer, master's thesis: Investigation of Alternatives to Fluorocarbon Finishes for Textiles. Berlin University of Applied Sciences, 2012.

5

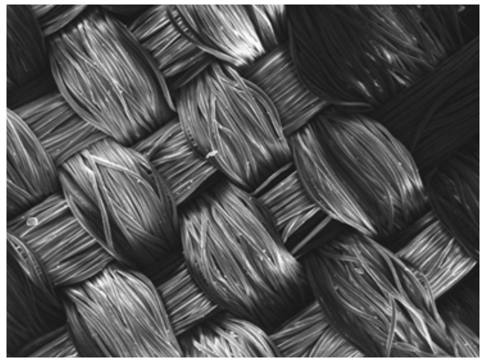
Figure 3: Fluorine-free alternatives under the electron microscope



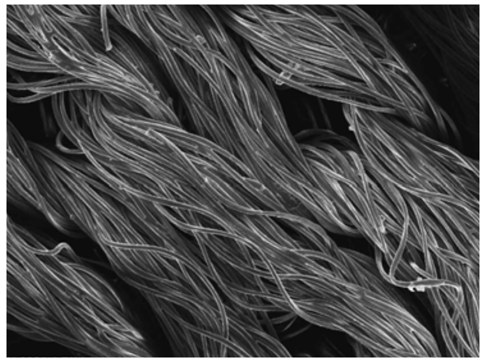
Sample 1:
SympaTex®: membrane at a magnification of 220
Illustration 1 – membrane



Sample 1:
SympaTex® finish at a magnification of 130
Illustration 2 – fabric with finish



Sample 2:
Schoeller Ecorepel® at a magnification of 130
Illustration 1 – fabric with finish



Sample 4:
Freudenberg at a magnification of 130
Illustration 1 – fabric with finish

Tips for consumers

Necessity or desire?
For which purpose do you need outdoor clothing? For an expedition to the Arctic or for an autumn walk? For normal rainy or slushy weather your jacket does not need to withstand a 50,000 mm water column. Selective buying helps outdoor clothing manufacturers phase out their high-performance rat race that calls for using ever more chemicals.

Beware of textile labels.
Certifications and textile labels indicate that materials are free of hazardous substances, which is not always true. In spite of known risks to health and the environment, products coated with fluorine compounds can still be awarded the OEKO-TEX Standard 100 or the bluesign standard that is popular with outdoor clothing manufacturers. There is an urgent need to raise these standards.

Buy secondhand items.
In thrift shops, at flea markets and on the Internet, there are masses of clothing that others no longer wear. This is where you can sometimes find items that become long-time favorites.

Buy classic pieces.
Select items of clothing that are not outdated after one season. Clothing worn for a long time is truly ecological.

Buy green.
If you do need new functional clothing, select items that are largely free of PFCs. There are outdoor brands that use only fluorine-free membranes. There is very little difference in price.

Buy quality.
Check the workmanship of the article. It's better to leave it on the rack if it doesn't pass inspection for quality work on zippers and seams.

Do laundry in an environmentally-friendly way.
A large share of the environmental life cycle assessment of clothing is attributed to laundering. Make sure your washer is filled to capacity. Most electricity is used to heat water. Use low temperatures – in fact, washing normally soiled clothes at 30 degrees centigrade will get them clean.

Empty out your closet.
Are there clothes in your closet that you never wear? Get rid of them! Give them to friends, donate them to charities, sell them, auction them off, or throw a clothing-swap party.

Return outdoor articles to the store.
Some manufacturers such as Patagonia take back worn-out clothes and shoes in their stores.

Become active.
Check with your favorite brand or ask at your favorite store whether they implement ecological and socially responsible policies and find out how they manage their chemicals. Let salespeople know that you like the clothing but that you want to see improvements in production.

Join campaigns.
Tell your family, friends, and colleagues about these problems in the textile industry. To sensitize this issue, Greenpeace is putting pressure on the textile industry – for a toxin-free future.

6

6. Conclusions and recommendations

The outdoor clothing industry presents a very flattering image of itself and expresses commitment to environmental protection in numerous publications and promotional activities. However, the Greenpeace investigation described here points out a mismatch between assertion and action. The industry is still far from reducing its use of hazardous chemicals to zero and thereby ending its pollution of waters and drinking water. Water is a scarce and threatened resource in many regions of the world.

Since 2011, Greenpeace activists have been working around the world in the Detox campaign for the production of textiles free from harmful substances. By testing samples of wastewater and textiles, Greenpeace has revealed that the textile industry releases chemical compounds that are harmful to the environment and health. Eleven groups of substances are named which must be phased out of textile production due to their hazardous properties. Among these groups are the perfluorinated chemical compounds (PFCs). Some PFCs are known to be endocrine (hormone system) disruptors and harmful to the reproductive system.

This study identified per- and polyfluorinated chemicals in outdoor articles manufactured for major brands and drew conclusions about environmental risks and the safety of consumers. Although some outdoor clothing manufacturers have switched to using short-chain alternatives in their production, Greenpeace's test series has shown that the use of C8 fluorotelomer alcohols is still common practice. Textiles are free of PFOS, but still contain PFOA as an impurity or degraded product.

Our investigation also tested for other substances hazardous to health such as plasticizers and alkylphenol ethoxylates. Our findings emphasize the urgent need to ban dangerous chemicals from outdoor clothing production.

Outdoor clothing brands make the consumers of their products unwitting assistants in releasing perfluorinated compounds to the environment. Even if the amount of PFC is low in single items of clothing tested, the total amount released from the massive volume of clothing sold today can be substantial. Greenpeace is working on instituting a register of hazardous substance emissions in China. Only in this way can local residents find out which chemicals have contaminated the wastewater from "their" textile factory.

Next to this analytical investigation of hazardous substances, Greenpeace also helped to see through a research project on "Alternatives to Fluorocarbon Finishes for Textiles" carried out at the Berlin University of Applied Sciences in 2012. In this context, fluorine-free alternative fabrics were physically tested for their capabilities and chemically tested for hazardous substances. The project proved that fluorine-free materials are already on the market that largely meet expectations for outdoor clothing and that can be used in their production.

What must happen next

The outdoor clothing industry is called on to ban hazardous substances such as PFCs from its production processes and immediately switch to safe functional alternatives wherever possible. The industry must immediately take steps to further develop safer alternatives and use them in production. Greenpeace calls on all manufacturers of outdoor clothing to immediately address this issue and begin phasing out the entire group of PFC compounds from production.

The key elements for a toxin-free future are:

▸ The phaseout of PFC chemistry and authentic commitment to this endeavor.
All dangerous chemicals must be banned from manufacturing processes and their products. The findings from this product investigation underline the urgent need to ban PFCs from outdoor wear production. PFC-free materials are already available today. The outdoor clothing industry must continue to develop safer alternatives and use them in processing their products.[28]

▸ Precaution.
The hazardous properties of well-researched PFCs such as PFOS and PFOA and insufficient data on other PFCs call for much more stringent regulation to protect health and the environment. In view of the hazardous properties of C8 PFCs (PFOA and PFOS) and in view of research findings indicating that other PFCs (C6) possess similar hazardous properties, it is not enough to regulate only single substances such as PFOA. The entire group of PFCs has to be under scrutiny for a possible regulative ban.

It's time to act. Now.
www.greenpeace.de/detox

28) http://www.ipe.org.cn/En/pollution/

7

Appendix

Key steps to Detox our clothes

To effectively stop the pollution of our waters with hazardous chemicals, brands should:

- credibly commit to phasing out the use of all toxic chemicals in their global supply chains and in all products by 1 January 2020.

Credible commitment means that three fundamental principles are unambiguously adopted – precaution [29], comprehensive and complete elimination (including zero discharges) [30], and the right to know [31].

- walk the talk by committing to rapid and full public disclosure of the use and release of toxic chemicals in and from suppliers' facilities. This information must be precise and comprehensive, and it must be updated at regular and relevant intervals (at least once a year), especially with regard to local/national inhabitants. Credible public information platforms [32]) should be used for this purpose. Clear and ambitious deadlines must be set for the elimination of priority substances such as APEs, and a new sectoral blacklist of hazardous chemicals to be eliminated must be drawn up which is based on and takes into account the intrinsic properties already identified in other hazardous chemicals.

The need for government action

Governments need to do their share as well and adopt political commitment to the **zero discharge** of all hazardous chemicals within one generation, based on the **precautionary principle** and including a **preventative approach** by avoiding the production and use, and therefore, exposure to hazardous chemicals.

This commitment must be matched with an implementation plan containing intermediate short-term targets, a dynamic list of priority hazardous substances requiring immediate action based on the **substitution principle**, and a publicly available register of data on discharge emissions and losses of hazardous substances, such as a Pollutant Release and Transfer Register (PRTR).

Governments must adopt comprehensive chemicals management policies and regulations in order to:

- level the playing field and make leading brands' actions a reality throughout the entire sector and beyond, as many of the hazardous chemicals used in textiles are also in use in other sectors;
- give industry a clear direction by showing that hazardous chemicals have no place in a sustainable society, which will in turn drive innovation towards safer alternatives; and
- prevent ongoing releases into the environment that may require future clean-up and have serious impact on the environment and on people's health and livelihoods, especially in the Global South.

29) This means "caution practiced in the context of uncertainty." An action (such as the use of a chemical substance and/or process) should not be taken if the consequences are uncertain and potentially dangerous.
30) "Zero" means zero use of all hazardous substances, via all pathways of release (i.e., discharges, emissions and losses), in global supply chains and in all products. “Elimination” means “not detectable,” to the limits of current technology, and where only naturally occurring (where relevant) background levels are acceptable.
31) All local communities sharing their water systems with the production of apparel/footwear and/or the products produced, all workers within this global supplier chain, and all customers have the right to know, on an ongoing basis, precisely which substances are being released from precisely which facilities during production and from the products themselves.
32) For example, IPE in China; see http://www.ipe.org.cn/en/pollution/

7. Appendix

Results for perfluorinated and polyfluorinated compounds

Table 1: PFCs (perfluorinated compounds) in outdoor clothing purchased in Germany

Material	Country of Production	PFOA	PFCA (Sum)	PFS (Sum)	FTA (Sum)	8:2 FTOH	FTOH (Sum)
		µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²
Greenpeace in Germany, jacket	China	0,27	0,70	n.d.	1,4	n.d.	n.d.
Jack Wolfskin, child's jacket	Indonesia	2,01	5,11	n.d.	10,1	n.d.	n.d.
Vaude, child's outdoor jacket	China	0,58	2,78	n.d.	n.d.	230	418,5
Vaude, woman's jacket	Vietnam	0,24	1,21	n.d.	19,5	n.d.	n.d.
The North Face, woman's jacket	China	1,58	3,37	n.d.	23,8	n.d.	n.d.
Mountain Equipment, woman's jacket	Ukraine	0,20	0,58	n.d.	6,1	n.d.	n.d.
Marmot, boys rain pants	China	2,31	6,29	n.d.	25,6	n.d.	n.d.
Fjällräven, woman's jacket	China	0,29	1,17	n.d.	20,8	n.d.	52,0
Patagonia, outdoor-jacket	China	2,16	8,48	n.d.	65,0	30	123,0
Adidas, outdoor-jacket	China	0,29	1,04	n.d.	5,6	n.d.	99,0

Table 2: PFCs (perfluorinated compounds) in outdoor clothing purchased in Austria (AT) and Switzerland (CH)

Material	Country of Production	PFOA	PFCA (Sum)	PFS (Sum)	FTA (Sum)	8:2 FTOH	FTOH (Sum)
		µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²
Northland, child's poncho	China	0,45	1,20	n.d.	n.d.	n.d.	17,6
Seven Summits, child's jacket	China	0,30	0,66	n.d.	n.d.	40,6	40,6
Mammut, woman's jacket	China	4,69	46,34	0,46	57,2	78,1	464,2
Kaikkialla, woman's jacket	China	4,98	10,96	n.d.	78,3	87,8	175,5

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Table 3: PFC concentrations of PFCAs (perfluorinated carboxylic acids) and PFSAs (perfluorinated sulfonic acids) in outdoor clothing

		Zimtstern / Greenpeace activist's jacket Polyester SympaTex, Bionic-Finish Eco	Jack Wolfskin child's jacket Texapore Air, 100% polyamide	Vaude child's jacket Ceplex ad, 100% PU, polyamide + PU coating	Vaude woman's jacket Ceplex ad, 100% PU, polyamide + PU coating	North Face woman's Jacket PTFE- (GoreTex) polyester laminate	Mountain Equipment woman's Jacket GoreTex, outer shell: 100% polyamide	Marmot child's pants 96% nylon, 4% elastane	Fjällräven woman's Jacket Eco-Shell, PFC-free, 100% rec. polyester	Patagonia woman's Jacket GoreTex, outer shell: 100% nylon	adidas woman's Jacket GoreTex, Pro Shell, 100% polyamide	North-land child's poncho 100% polyester	Seven Summits child's Jacket Ice Tech 5000 100% polyamide	Mammut Fujiyama woman's Jacket PTFE (Gore Tex)	Kaikkialla woman's Jacket Membrane: Toray Dermizax EV
	conc.	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²
Perfluorobutane sulfonate	PFBS	<0,064	<0,090	<0,201	<0,096	<0,077	<0,148	<1,207	<0,178	<0,145	<0,208	<0,115	<0,168	<0,244	<0,170
Perfluorohexane sulfonate	PFHxS	<0,064	<0,090	<0,201	<0,096	<0,077	<0,148	<1,207	<0,178	<0,145	<0,208	<0,115	<0,168	<0,244	<0,170
Perfluoroheptane sulfonate	PFHp	<0,064	<0,090	<0,201	<0,096	<0,077	<0,148	<1,207	<0,178	<0,145	<0,208	<0,115	<0,168	<0,244	<0,170
Perfluorooctane sulfonate	PFOS	<0,042	<0,060	<0,134	<0,064	<0,051	<0,098	<0,804	<0,118	<0,096	<0,138	<0,077	<0,112	<0,163	<0,112
Perfluorodecane sulfonate	PFDS	<0,064	<0,090	<0,201	<0,096	<0,077	<0,148	<1,207	<0,178	<0,145	<0,208	<0,115	<0,168	<0,244	<0,170
Perfluorooctane sulfonate	PFOSA	<0,042	<0,060	<0,134	<0,064	<0,051	<0,098	<0,804	<0,118	<0,096	<0,138	<0,077	<0,112	<0,163	<0,112
P1H,1H,2H,2H Perfluorooctane sulfonate	H4PFOS; 6:2 FTS	<0,064	<0,090	<0,268	<0,096	<0,077	<0,198	<1,609	<0,237	<0,194	<0,277	<0,153	<0,224	0,5	<0,170
Perfluorobutane carboxylate	PFBA	0,273	0,218	0,909	0,200	0,312	0,373	2,261	0,581	0,891	0,543	0,280	0,363	1,0	0,559
Perfluoropentane carboxylate	PFPA	<0,042	0,177	0,366	<0,064	<0,051	<0,098	<0,804	<0,118	0,554	<0,138	<0,077	<0,112	2,3	0,173
Perfluorohexane carboxylate	PFHxA	0,084	0,470	0,359	<0,064	0,644	<0,098	<0,804	0,295	3,211	0,204	<0,077	<0,112	26,9	1,485
Perfluoroheptane carboxylate	PFHpA	0,077	0,244	0,232	<0,064	0,092	<0,098	0,842	<0,118	0,644	<0,138	<0,077	<0,112	7,3	0,475
Perfluorooctane carboxylate	PFOA	0,266	2,014	0,576	0,242	1,575	0,202	2,312	0,294	2,157	0,293	0,446	0,296	4,7	4,982
Perfluorononane carboxylate	PFNA	<0,042	0,255	<0,134	<0,064	0,111	<0,098	<0,804	<0,118	0,098	<0,138	0,094	<0,112	1,2	0,446
Perfluorodecane carboxylate	PFDA	<0,042	1,015	0,197	0,082	0,433	<0,098	0,877	<0,118	0,667	<0,138	0,200	<0,112	1,9	1,958
Perfluoroundecane carboxylate	PFUnA	<0,042	0,081	0,142	<0,064	<0,051	<0,098	<0,804	<0,118	0,103	<0,138	0,083	<0,112	0,4	0,238
Perfluorododecane carboxylate	PFDoA	<0,042	0,462	<0,134	<0,064	0,066	<0,098	<0,804	<0,118	0,155	<0,138	0,097	<0,112	0,5	0,647
Perfluorotridecane carboxylate	PFTrA	<0,042	<0,060	<0,134	<0,064	<0,051	<0,098	<0,804	<0,118	<0,096	<0,138	<0,077	<0,112	0,2	<0,112
Perfluorotetradecane carboxylate	PFTeA	<0,042	<0,060	<0,134	<0,064	<0,051	<0,098	<0,804	<0,118	<0,096	<0,138	<0,077	<0,112	<0,163	<0,112

Concentrations are given in micrograms of PFC per square meter of fabric (µg/m²)
Method of testing for PFCAs and PFSAs: extraction with methanol in a Soxhlet extractor, separation, identification and quantification with an internal standard using HPLC-MS/MS (high-performance liquid chromatography combined with tandem triple-quadrupole mass spectrometry).

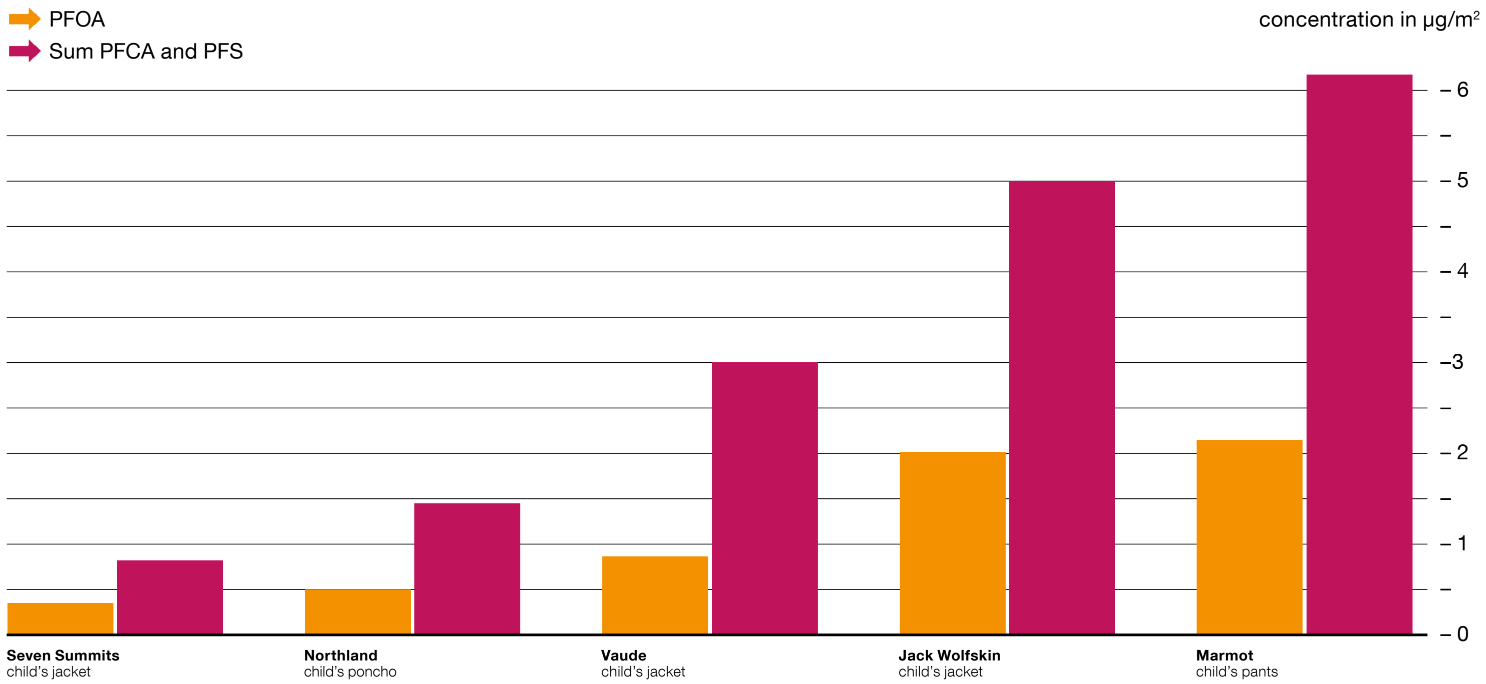
Table 4: PFC concentrations of PFCAs (perfluorinated carboxylic acids), PFSAs (perfluorinated sulfonic acids) and fluorotelomer alcohols (FTOHs) in outdoor clothing

		Zimtstern / Greenpeace activist's jacket Polyester SympaTex, Bionic-Finish Eco	Jack Wolfskin child's jacket Texapore Air, 100% polyamide	Vaude child's jacket Ceplex ad, 100% PU, polyamide + PU coating	Vaude woman's jacket Ceplex ad, 100% PU, polyamide + PU coating	North Face woman's jacket PTFE- (GoreTex) polyester laminate	Mountain Equipment woman's jacket GoreTex, outer shell: 100% polyamide	Marmot child's pants 96% nylon, 4% elastan	Fjällräven woman's Jacket Eco-Shell, PFC-free, 100% rec. polyester	Patagonia woman's jacket GoreTex, outer shell: 100% nylon	adidas woman's jacket GoreTex, Pro Shell, 100% polyamide	North-land shild's poncho 100% polyester	Seven Summits child's jacket Ice Tech 5000 100% polyamide	Mammut Fujiyama woman's jacket PTFE (Gore Tex)	Kaikkialla woman's jacket Membrane: Toray Dermizax EV
	conc.	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²	µg/m²
Perfluoro-3,7-dimethyloc-tane carboxylate	PF-3,7-DMOA	<0,085	<0,121	<0,268	<0,128	<0,103	<0,198	<1,609	<0,237	<0,194	<0,277	<0,153	<0,224	<0,326	<0,225
7H-Dodecanefluoroheptane carboxylate	HPFHpA	<0,064	<0,090	<0,268	<0,096	<0,077	<0,198	<1,609	<0,237	<0,194	<0,277	<0,153	<0,224	<0,326	<0,225
2H,2H-Perfluorodecane carboxylate	H2PFDA	<0,064	<0,090	<0,268	<0,096	<0,077	<0,198	<1,609	<0,237	<0,194	<0,277	<0,153	<0,224	<0,326	<0,225
2H,2H,3H,3H-Perfluor-oundecane carboxylate	H4PFUnA	<0,064	0,170	<0,268	0,684	0,138	<0,198	<1,609	<0,237	<0,194	<0,277	<0,153	<0,224	<0,326	<0,225
1H,1H,2H,2H-Perfluor-ooctylacrylat	6:2 FTA	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	20,80	<4	<5,4	<1,59	<5,6	<5,5	<4,05
1H,1H,2H,2H-Perfluor-odecylacrylat	8:2 FTA	1,36	10,13	<29,7	19,50	23,75	6,09	25,60	<6,5	35,00	5,58	<1,59	<5,6	39,6	58,1
1H,1H,2H,2H-Perfluor-ododecylacrylat	10:2 FTA	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	<6,5	30,00	<5,4	<1,59	<5,6	17,6	20,3
1H,1H,2H,2H-Perfluoro-1-hexanol	4:2 FTOH	<2,55	<5,06	<59,4	<7,8	<10,4	<7,35	<22,4	<14,3	<8	<9,9	<3,19	<11,9	<11	<6,75
1H,1H,2H,2H-Perfluoro-1-oktanol	6:2 FTOH	<6,8	<15,2	<179	<22,1	<30,4	<21	<65,6	52,00	72,00	99,00	17,60	<35	352	27,0
1H,1H,2H,2H-Perfluoro-1-decanol	8:2 FTOH	<6,8	<15,2	229,50	<22,1	<30,4	<21	<65,6	<42,9	30,00	<29,7	<8,79	40,60	78,1	87,8
1H,1H,2H,2H-Perfluoro-1-dodecanol	10:2 FTOH	<4,25	<10,1	189,00	<14,3	<20,9	<13,6	<44,8	<28,6	21,00	<19,8	<5,59	<23,8	34,1	60,8
2-(N-methylperfluoro-FASE 1-octanesulfonamido)-ethanol	MeFOSE	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	<6,5	<4	<5,4	<1,59	<5,6	<5,5	<4,05
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	EtFOSE	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	<6,5	<4	<5,4	<1,59	<5,6	<5,5	<4,05
N-methylperfluoro-1-octansulfonamide	MeFOSA	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	<6,5	<4	<5,4	<1,59	<5,6	<5,5	<4,05
N-ethylperfluoro-1-octanesulfonamide	EtFOSA	<0,85	<2,53	<29,7	<3,9	<4,75	<3,15	<11,2	<6,5	<4	<5,4	<1,59	<5,6	<5,5	<4,05

Concentrations are given in micrograms of PFC per square meter of material/fabric (µg/m²)
Method of testing for FTOHs: extraction with MTBE (methyl tertiary butyl ether) in an ultrasonic bath, separation, identification and quantification with an internal standard using GC-MS (gas chromatography coupled with mass spectrometry), verification using HPLC-MS/MS.

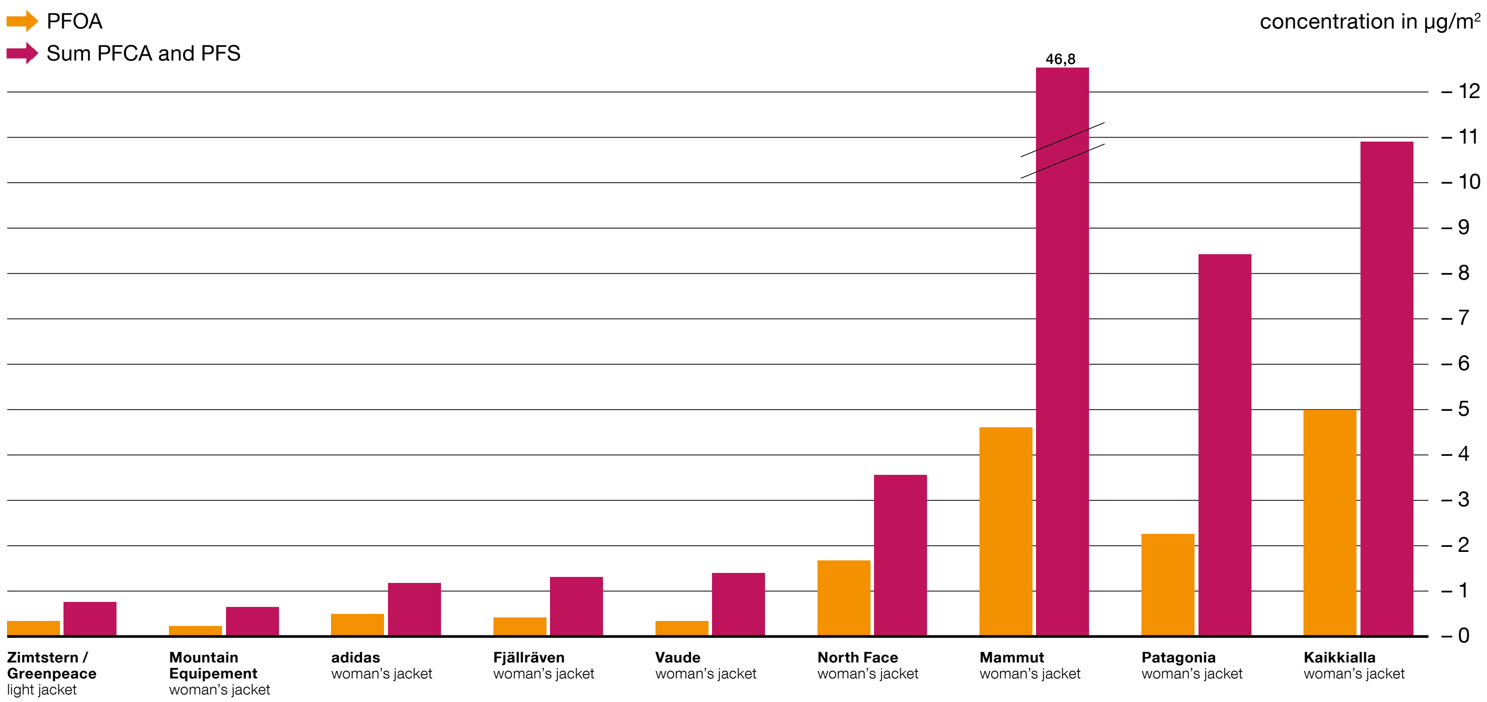
7

Children's clothing (sum PFCA in µg/m²)



Perfluorinated compounds in children's clothes

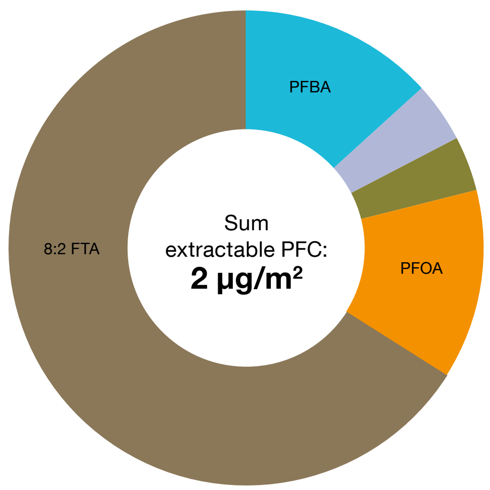
Woman's jacket (sum PFCA in µg/m²)



Perfluorinated compounds in woman's jackets

Results: Perfluorinated and polyfluorinated compounds of separate brands

Greenpeace

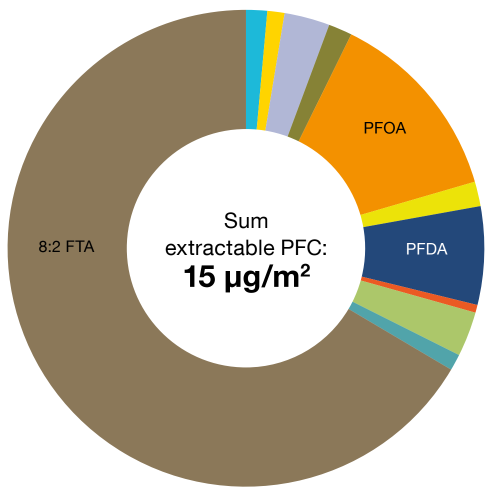


PFC concentration/amount	µg/m²	%
PFBA	0,3	13
PFHxA	0,1	4
PFHpA	0,1	4
PFOA	0,3	13
8:2 FTA	1,4	66

concentration in µg/m²
amount PFC in %

Zimtstern / Greenpeace | activist's jacket

Jack Wolfskin

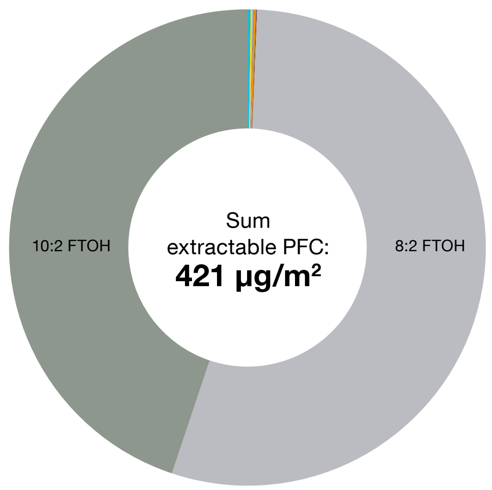


PFC concentration/amount	µg/m²	%
PFBA	0,2	1
PFPA	0,2	1
PFHxA	0,5	3
PFHpA	0,2	2
PFOA	2,0	13
PFNA	0,3	2
PFDA	1,0	7
PFUnA	0,1	1
PFDoA	0,5	3
H4PFUnA	0,2	1
8:2 FTA	10,1	66

concentration in µg/m²
amount PFC in %

Jack Wolfskin | child's jacket

Vaude

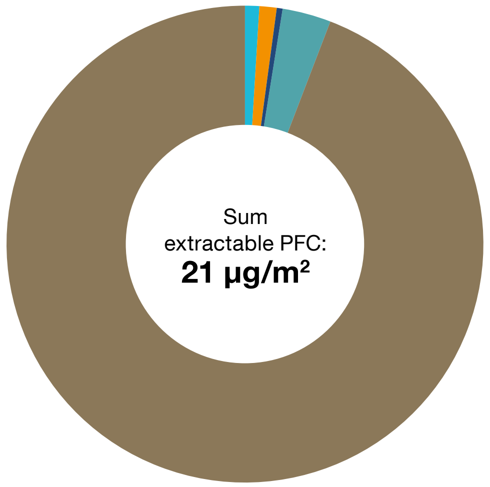


PFC concentration/amount	µg/m²	%
PFBA	0,9	0
PFPA	0,4	0
PFHxA	0,4	0
PFHpA	0,2	0
PFOA	0,6	0
PFDA	0,2	0
PFUnA	0,1	0
8:2 FTOH	229,5	54
10:2 FTOH	189,0	45

concentration in µg/m²
amount PFC in %

Vaude | child's Jacket

Vaude

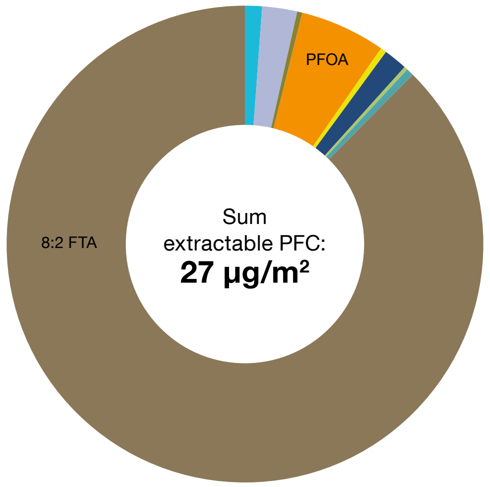


PFC concentration/amount	µg/m²	%
PFBA	0,2	1
PFOA	0,2	1
PFDA	0,1	0
H4PFUnA	0,7	3
8:2 FTA	19,5	94

concentration in µg/m²
amount PFC in %

Vaude | woman's jacket

North Face

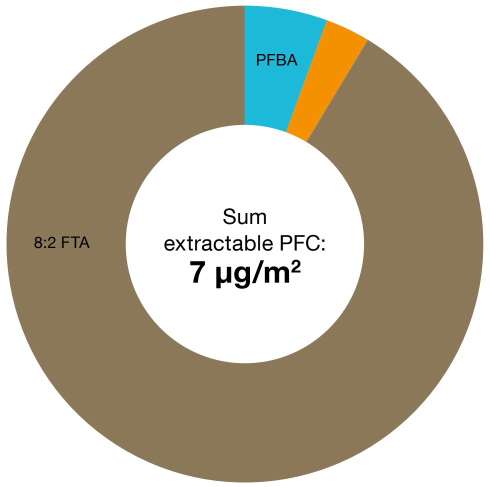


PFC concentration/amount	µg/m²	%
PFBA	0,3	1
PFHxA	0,6	2
PFHpA	0,1	0
PFOA	1,6	6
PFNA	0,1	0
PFDA	0,4	2
PFDoA	0,1	0
H4PFUnA	0,1	1
8:2 FTA	23,8	88

concentration in µg/m²
amount PFC in %

North Face | woman's jacket

Mountain Equipment

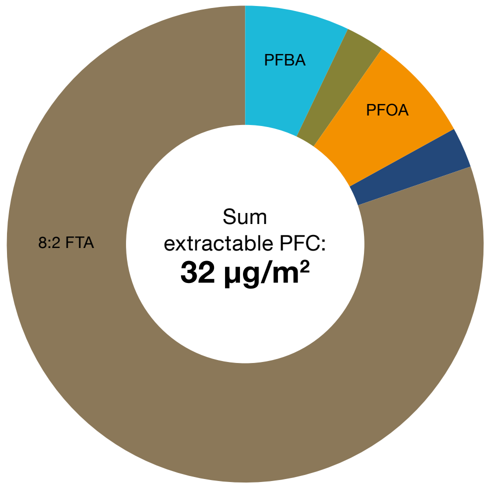


PFC concentration/amount	µg/m²	%
PFBA	0,4	6
PFOA	0,2	3
8:2 FTA	6,1	91

concentration in µg/m²
amount PFC in %

Mountain Equipment | woman's jacket

Marmot

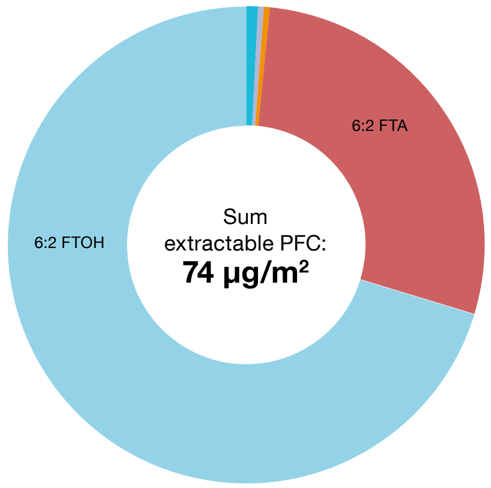


PFC concentration/amount	µg/m²	%
PFBA	2,3	7
PFHpA	0,8	3
PFOA	2,3	7
PFDA	0,9	3
8:2 FTA	25,6	80

concentration in µg/m²
amount PFC in %

Marmot | child's pants

Fjällräven

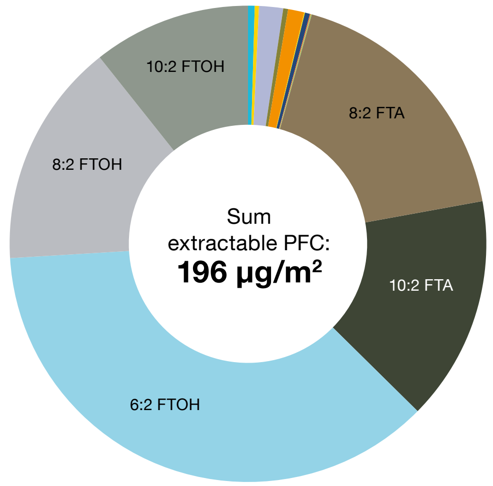


PFC concentration/amount	µg/m²	%
PFBA	0,6	1
PFHxA	0,3	0
PFOA	0,3	0
6:2 FTA	20,8	28
6:2 FTOH	52,0	70

concentration in µg/m²
amount PFC in %

Fjällräven | woman's jacket

Patagonia



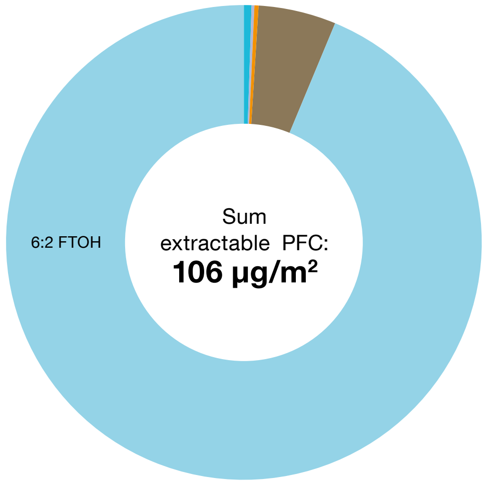
PFC concentration/amount	µg/m²	%
PFBA	0,9	0
PFPA	0,6	0
PFHxA	3,2	2
PFHpA	0,6	0
PFOA	2,2	1
PFNA	0,1	0
PFDA	0,7	0
PFUnA	0,1	0
PFDoA	0,2	0
8:2 FTA	35,0	18
10:2 FTA	30,0	15
6:2 FTOH	72,0	37
8:2 FTOH	30,0	15
10:2 FTOH	21,0	11

concentration in µg/m²
amount PFC in %

Patagonia | woman's jacket

7

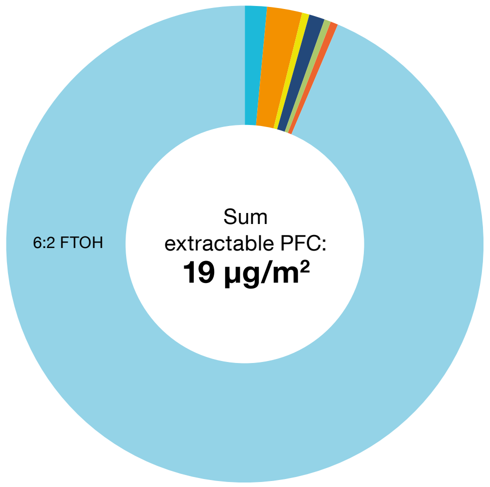
Adidas



PFC concentration/amount	μg/m²	%
PFBA	0,5	1
PFHxA	0,2	0
PFOA	0,3	0
8:2 FTA	5,6	5
6:2 FTOH	99,0	94

concentration in μg/m²
amount PFC in %

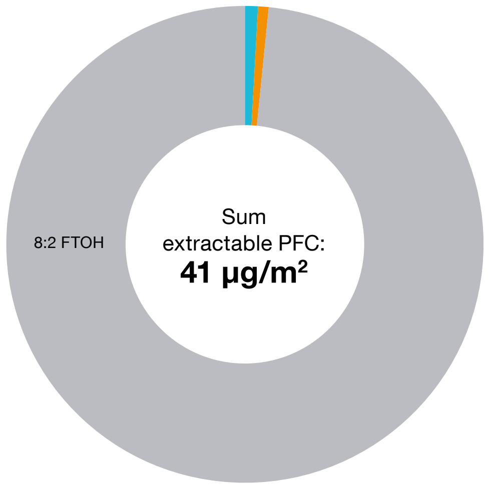
Northland



PFC concentration/amount	μg/m²	%
PFBA	0,3	1
PFOA	0,4	2
PFNA	0,1	0
PFDA	0,2	1
PFUnA	0,1	0
PFDoA	0,1	1
6:2 FTOH	17,6	94

concentration in μg/m²
amount PFC in %

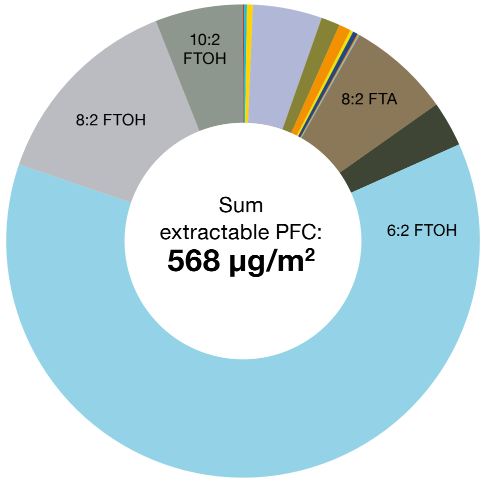
Seven Summits



PFC concentration/amount	μg/m²	%
PFBA	0,4	1
PFOA	0,3	1
8:2 FTOH	40,6	98

concentration in μg/m²
amount PFC in %

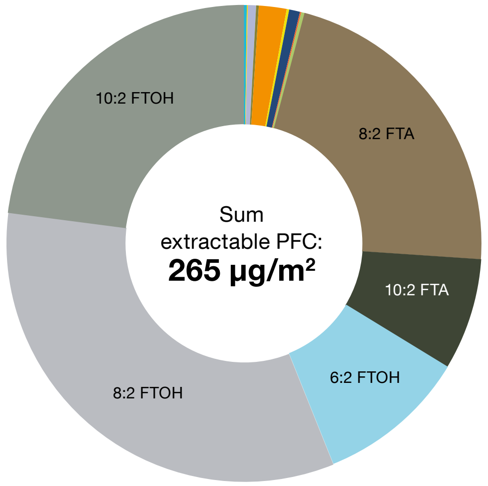
Mammut Fujiyama



PFC concentration/amount	μg/m²	%
PFBA	1,0	0
PFPA	2,3	0
PFHxA	26,9	5
PFHpA	7,3	1
PFOA	4,7	1
PFNA	1,2	0
PFDA	1,9	0
PFUnA	0,4	0
PFDoA	0,5	0
PFTrA	0,2	0
8:2 FTA	39,6	7
10:2 FTA	17,6	3
6:2 FTOH	352,0	62
8:2 FTOH	78,1	14
10:2 FTOH	34,1	6
H4PFOS	0,5	0

concentration in μg/m²
amount PFC in %

Kaikkialla



PFC concentration/amount	μg/m²	%
PFBA	0,6	0
PFPA	0,2	0
PFHxA	1,5	1
PFHpA	0,5	0
PFOA	5,0	2
PFNA	0,4	0
PFDA	2,0	1
PFUnA	0,2	0
PFDoA	0,6	0
8:2 FTA	58,1	22
10:2 FTA	20,3	8
6:2 FTOH	27,0	10
8:2 FTOH	87,8	33
10:2 FTOH	60,8	23

concentration in μg/m²
amount PFC in %

adidas | woman's jacket

Northland | child's poncho

Seven Summits | woman's jacket

Mammut Fujiyama | woman's jacket

Kaikkialla | woman's jacket

Table 5: Concentrations of phthalates, alkylphenols and alkylphenol ethoxylates in outdoor clothing

		Zimtstern / Greenpeace activist's jacket Polyester SympaTex, Bionic-Finish Eco	Jack Wolfskin Boys Jacket Texapore Air, 100% polyamide	Vaude child's jackej Ceplex ad, 100% PU, polyamide + PU coating	Vaude women's jacket Ceplex ad, 100% PU, polyamide + PU coating	North Face women's jacket PTFE- (GoreTex) polyester laminate	Mountain Equipment women's jacket GoreTex, outer shell: 100% polyamide	Marmot child's pants 96% nylon, 4% elastan	Fjällräven women's jacket Eco Shell, PFC-free, 100% rec. polyester	Patagonia women's jacket GoreTex, outer shell: 100% nylon	adidas women's jacket GoreTex, Pro Shell, 100% polyamide	North-land child's poncho 100% polyester	Seven Summits child's jacket Ice Tech 5000 100% polyamide	Mammut Fujiyama women's jacket PTFE (Gore Tex)	Kaikkialla women's jacket Membrane: Toray Dermizax EV
	conc.	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Phthalate															
Butyl benzyl phthalate	BBP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Diisobutyl phthalate	DiBP	8	3	3	3	4	3	1	4	2	7	4	4	2	3
Dibutyl phthalate	DBP	<1	1	<1	2	1	4	1	2	1	2	2	<1	1	2
Di-(2-ethylhexyl)-phthalate	DEHP	7	5	<1	5	<1	4	3	10	1	7	5700	6	85	17
Di-(2-ethylhexyl)-iso-phthalate	DEHIP	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Diiso-decyl phthalate	DiDP	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Diiso-nonyl phthalate	DiNP	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	260	<15	<15
Di-n-octyl phthalate	DnOP	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bis-(2-methoxyethyl) phthalate	DMEP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Di-n-nonyl phthalate	DnNP	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Di-n-decyl phthalate	DnDP	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Diethyl phthalate	DEP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Dimethyl phthalate	DMP	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sum of phthalates		15*	9	3	10	5	11	5	16	4	16*	5706	270	88*	22*
Alkylphenols and Alkylphenol ethoxylate															
Nonylphenol	NP	<3	<3	<3	<3	<3	<3	<3	8	<3	8	<3	<3	<3	<3
Octylphenol	OP	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Nonylphenol ethoxylate	NPE	<5	<5	13	<5	<5	<5	<5	19	<5	20	<5	320	<5	9
Octylphenol ethoxylate	OPE	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Concentrations are given in milligrams of toxin per kilogram of fabric (mg/kg = ppm).
Values <x: concentrations are below the detection limit of xmg/kg.
In the samples marked with an asterisk*, testing for phthalates was done on the fabric's plastisol printing.
Method of testing for phthalates:
extraction using toluene in an ultrasonic bath, separation, identification and quantification using GC-MS and/or GC-ECD.
Method of testing for nonylphenols and octylphenols: extraction with acetonitrile in an ultrasonic bath, quantitative determination with GC-MS.
Method of testing for nonylphenol ethoxylates and octylphenol ethoxylates: extraction using acetonitrile in an ultrasonic bath, cleavage into alkylphenols with aluminum triiodide, determination with GC-MS, quantification based on Ethylan 77 and triton X 100 after cleavage.

GC: gas chromatography; MS: mass spectrometry; ECD: electron capture detector

Table 6: Compilation of the results of further testing of outdoor clothing for organotin compounds, antimony, aromatic amines, and volatile organic compounds (VOC)

		Zimtstern / Greenpeace activist's jacket Polyester SympaTex, Bionic-Finish Eco	Jack Wolfskin child's jacket Texapore Air, 100% Polyamid	Vaude child's jacket Ceplex ad, 100% PU, polyamide + PU coating	Vaude women's jacket Ceplex ad, 100% PU, polyamide + PU coating	North Face women's jacket PTFE- (GoreTex) polyester laminate	Mountain Equipment women's jacket GoreTex, outer shell: 100% polyamide	Marmot child's pants 96% nylon, 4% elastan	Fjällräven women's jacket Eco Shell, PFC-free, 100% Rec.PES	Patagonia women's jacket GoreTex, outer shell: 100% nylon	adidas women's jacket GoreTex, Pro Shell, 100% polyamide	North-land child's poncho 100% polyester	Seven Summits child's jacket Ice Tech 5000 100% polyamide	Mammut Fujiyama women's jacket PTFE (Gore Tex)	Kaikkialla women's jacket Membrane: Toray Dermizax EV
	conc.	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Organotin compounds															
Monobutyltin	MBT			<0,025	<0,025									<0,025	2,3
Monooctyltin	MOT			<0,025	13									<0,025	0,55
Dibutyltin	DBT			<0,025	<0,025									<0,025	5,8
Diphenyltin	DPhT			<0,025	<0,025									<0,025	<0,025
Dioctyltin	DOT			<0,025	4,8									<0,025	5,6
Tetrabutyltin	TeBT			<0,025	<0,025									<0,025	<0,025
Tetraethyltin	TeEtT			<0,025	<0,025									<0,025	0,18
Tributyltin	TBT			<0,025	<0,025									<0,025	<0,025
Tricyclohexyltin	TcyT			<0,025	<0,025									<0,025	<0,025
Triphenyltin	TPhT			<0,025	<0,025									<0,025	<0,025
<0,025Tripropyltin	TPT			<0,025	<0,025									<0,025	<0,025
Trioctyltin	TOT			<0,025	<0,025									<0,025	<0,025
Antimony	Sb	3		30	10	40			120	35		10		1	2
Aromatic amines					n.n	n.n.					n.n.		n.n.	n.n.	n.n.
VOC				Isocyanate	Isocyanate										
Fluorine / SEM	F	n.n.	detectable	n.n.	n.n.	detectable	detectable	detectable	detectable	detectable	n.n.	n.n.	n.n.	detectable	detectable

Concentrations are given in milligrams of toxin per kilogram of fabric (mg/kg = ppm).
Testing for the substance named was carried out only if its presence was suspected due to the nature of the fabric.
Method of testing for organotin compounds, on the basis of DIN EN ISO 17353 / DIN 38407-13:
extraction with ethanol/dimethyl carbonate in an ultrasonic bath, derivatization with tetraethylborate, identification and quantification with capillary gas chromatography using GC-MS.
Method of testing materials for volatile organic compounds (VOC): extraction with methanol in an ultrasonic bath, quantitative determination using GC-MS.
Method of testing textiles for aromatic amines – synthetic fibers: on the basis of LFGB § 64, 82.02-4, identical to DIN EN 14362-2 LFGB § 64, 82.02-9 for p-aminoazobenzene.
Method of testing textiles for antimony: microwave digestion, quantitative determination according to § DIN EN ISO 17294-2 using ICP-MS.

7

7.1 Glossar

Hazardous substances in the textile industry – 11 groups of chemicals

These eleven groups of chemicals are used extensively in the textile industry. Once released, many of them accumulate in the environment – in rivers, the oceans, in the soil and in plants. These substances are transported to a certain extent around the world and contaminate ecosystems far from where they were initially introduced to the environment. They are defined as persistent. Some substances are bioaccumulative, meaning they can accumulate in the blood, organs and tissues of living organisms and damage health.

▸ Alkylphenols:
The alkylphenols include nonylphenol and octylphenol. They are released from their ethoxylates. In this way, nonylphenols (NPs) are a product of nonylphenol ethoxylates (NPEs). NPEs are frequently used in the textile industry to wash materials during the dyeing process. The NPs generated in wastewater from NPEs behave similarly to estrogen and can disrupt the development of the reproductive organs of fish and other aquatic animals. The sale of products containing more than 0.1 percent of nonylphenols or nonylphenol ethoxylates has been severely restricted in the European Union since 2005.

▸ Phthalates:
Phthalates are used as plasticizers, for instance to soften the rigid plastic PVC. In the textile industry they are used for artificial leather, rubber and in dyes. Specifically, di-2-ethylhexyl phthalate (DEHP) and dibutyl phthalate (DBP) are considered hazardous because they inhibit the development of reproductive organs in mammals. Since 2005, four phthalates (DBP, BBP, DEHP and DIBP) have been on the REACH Candidate List of Substances of Very High Concern for Authorisation. [REACH (Registration, Evaluation, and Authorisation of CHemicals) is the main general European Union chemicals regulation]. This means they are subject to severe restriction criteria.

▸ Brominated and chlorinated flame retardants:
Many brominated flame retardants (BFRs) accumulate in the environment and can now be found everywhere. These chemicals are used for fire control, in textiles too. Specifically, polybrominated diphenyl ethers (PBDEs) are considered "particularly hazardous" according to EU water legislation. They are hormonally active and can damage the growth and development of reproductive organs. Their use in the European Union is subject to tight restrictions in order to protect surface waters.

▸ Azo dyes:
Azo dyes are widely used in the textile industry. Some azo dyes release aromatic amines, of which some such as 3.3'-dimethoxybenzidine (also known as o-dianisidine dihydrochloride), can cause skin cancer. According to EU regulations, 22 azo dyes may no longer be used for textiles worn directly on the skin. A similar regulation exists in China.

▸ Organotin compounds:
Organic tin compounds are used as biocides and anti-fungal agents in many products. They have an antibacterial effect on socks, shoes and sportswear and are supposed to prevent odors. If tributyltin (TBT) is released into the environment, it can accumulate in the bodies of humans and animals and disrupt the immune system and reduce fertility.

▸ Perfluorinated compounds (PFCs):
PFCs are used to make textiles and leather products water-repellent and dirt-repellent. They are persistent and some PFCs accumulate in human tissue and blood. They can damage the liver and disrupt the body's endocrine (hormonal) system. Perfluorooctane sulfonate (PFOS) is restricted around the world by the Stockholm Convention and is on the Candidate List of Substances of Very High Concern for Authorisation (SVHC). It is banned in Europe for certain applications. Germany's Federal Environment Agency has proposed putting perfluorooctanoic acid (PFOA) on the SVHC list as well.

▸ Chlorobenzenes:
Chlorobenzenes are used as biocides and solvents in textile production. Some of them damage the liver, the thyroid and the central nervous system. Hexachlorobenzene (HCB) is persistent and hormonally active. Like the polychlorinated biphenyls (PCBs), their use is severely restricted by the Stockholm Convention.

▸ Chlorinated solvents:
Chlorinated solvents such as trichloroethylene (TCE) are used to remove chemical residues from textiles and to clean them. TCE is damaging to the ozone layer. Moreover, it can damage the central nervous system, the liver and kidneys in humans and animals. Since 2008, TCE has been allowed only limited use in the EU.

▸ Chlorophenols:
Chlorophenols are used as biocides in the textile industry. Pentachlorophenol (PCP) in particular is highly toxic to aquatic organisms and can damage human organs and the central nervous system. The production and use of PCP has been banned in the European Union since 1991.

▸ Short-chain chlorinated paraffins (SCCPs):
Short-chain chlorinated paraffins are used in the textile industry as flame retardants and to finish textiles and leather. They are considered toxic to aquatic organisms and accumulate in living organisms. Their use has been restricted in the EU since 2004.

▸ Heavy metals:
Heavy metals like cadmium, lead and copper are in dyes and pigments. They can accumulate in the body and damage organs as well as the central nervous system. Chromium is used for tanning leather. As chromium VI, it is a potent environmental toxin even at low concentrations. Chromium VI, mercury and cadmium can cause cancer. The use of these heavy metals in the EU is subject to strict conditions.

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➡ No money from industry and state

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